Appendix A

Anacostia River Reports and Documents

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Charting a Course Toward Restoration:

A Toxic Chemical Management Strategy for the Anacostia River

Notice

This document was prepared by member organizations of the Anacostia Watershed Toxics Alliance (AWTA) and Anacostia Watershed Restoration Commission (AWRC). Publication does not signify that the contents of this report necessarily represents the complete official position of all of the AWTA and AWRC organizations. Any mention of trade names does not constitute endorsement or recommendation.

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Acknowledgments

The burden of addressing problems within the Anacostia River has generally been the responsibility of the three affected jurisdictions within the Anacostia Watershed - Prince George County, Montgomery County, and the District of Columbia – which have implemented a number of actions to correct environmental problems. After reviewing several years' worth of environmental data, however, it is clear that contaminated river sediments still pose an unacceptable risk to the public and the delicate ecosystem of the river. It is also quite clear that there is no quick fix and that, because this large watershed spans several jurisdictions, no single entity has either the ability or the resources to make the river swimmable and fishable alone. Concerned stakeholders have joined together in groups such as the Anacostia Watershed Toxics Alliance (AWTA), the Anacostia Watershed Society (AWS), and the Anacostia Watershed Restoration Committee (AWRC) to pool knowledge, expertise, and resources to address the problems afflicting this beautiful river. Because of this common goal, this document, which outlines a holistic, overall approach for dealing with river toxics, with an emphasis on contaminated sediment, is jointly issued by AWTA and AWRC.

The Anacostia Watershed Toxics Alliance (AWTA) was formed in 1999 as a voluntary public-private partnership to address the toxic chemical problems in the river. The mission of the Alliance is stated as follows: "To work together in good faith as partners to evaluate the presence, sources and impacts of toxic contaminants in the Anacostia River with all stakeholders, both public and private, and other interested parties and to evaluate and take actions to enhance the restoration of the Anacostia watershed to its beneficial use to the community and ecosystem as a whole." Three primary objectives have been adopted by AWTA to carry out this mission:

- Identify and quantitatively assess risks to human health and the environment from toxic contaminants in the Anacostia River;
- Reduce risks from toxic contaminants to levels that are safe for humans and aquatic life; and
- Build effective partnerships among AWTA members, encourage public input, and promote effective restoration of the Anacostia watershed.

The Alliance represents over 25 different groups, agencies, and institutions, in addition to four (4) Divisions at EPA: Superfund, Water, ESD, and Chesapeake Bay Program. Members include the Maryland Department of the Environment, District of Columbia Department of Health, Anacostia Waterfront Initiative (AWI), Montgomery County (MD), Prince George's County (MD), U.S. Navy, Naval Research Lab, Army Corps of Engineers, U.S. Air Force, National Oceanographic and Atmospheric Administration, U. S. Fish and Wildlife Services, National Park Service, U.S. Geological Survey, General Services Administration, Agency for Toxics Substances and Disease Registry, Washington Counsel of Governments, Interstate Commission of the Potomac River Basin, Academy of Natural Sciences, District of Columbia University, Washington Gas and Light, Potomac Electric Power Company, and community representatives.

Recently, members of the Remediation Technologies Development Forum (RTDF) have begun to collaborate with AWTA as well.

AWRC was created by the Anacostia Watershed Restoration Strategy Agreement, which was signed in 1984 by the State of Maryland Department of the Environment and the District of Columbia Department of Health (MWCOG 1986), and was expanded to form the Anacostia Watershed Restoration Committee in 1987, including Prince George Department of Environmental Resources and Montgomery County Department of Environmental Protection, as well as the US Army Corps of Engineers, the U.S. Environmental Protection Agency, and the National Park Service, the Interstate Commission on the Potomac River Basin (ICPRB), and the MWCOG (administrator of the agreement) (ICPRB, 1994 and 1996). Five years later, as the centerpiece of the 1991 renewal of the Anacostia Watershed Restoration Agreement, the four jurisdictions adopted a Six-Point Action Plan. The Six-Point Action Plan identified the following six fundamental restoration goals (ICPRB 1994):

- Reduction of pollution loads
- Restoration of ecological integrity
- Improvement of fish passage
- Increase in wetland acreage
- Expansion of forest coverage
- Increase in public and private participation and stewardship

In 1999, the signatories of the *Six-Point Action Plan* reaffirmed their commitment to restore the Anacostia watershed by pursuing the Anacostia Watershed restoration goals and interim Targets for the period 1999-2000. In doing so they also agreed to adopt, through a public participation process, a suite of 50 specific, long-term restoration indicators and targets, and pledged to continue a basin-wide strategy to equitably achieve the six fundamental goals and associated targets by 2010. This latest agreement was adopted by the four Anacostia signatories (state of Maryland, District of Columbia, and Montgomery and Prince George's counties) at a highly publicized signing event on December 3, 2001.

Since 1987, actions taken by the AWRC and AWTA, affiliated organizations, environmental and business groups, and individual citizens have resulted in substantial restoration progress. To date, these groups have identified over 700 storm water retrofit, wetland creation, stream restoration, riparian restoration, combined sewer overflow abatement, trash and toxics reduction, and other restoration-related projects designed to correct environmental problems and enhance overall ecosystem quality. Of these projects, approximately one-third have either been completed or are in progress. Over the last fifteen years, roughly $35 million has been spent on restoration project implementation, with close to $30 million additional spent on land acquisition, planning, monitoring, engineering, design, and maintenance.

The Anacostia Watershed Toxics Alliance and the Anacostia Watershed Restoration Committee wish to acknowledge the following contributors to this document, without whose participation this effort would not have been possible:

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U.S. Fish and Wildlife Service
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EXECUTIVE SUMMARY

- **BACKGROUND**

The Anacostia River is a freshwater tidal system draining an urban watershed that encompasses 456 km^2 in Maryland and the District of Columbia. The Anacostia River watershed has become increasingly degraded from decades of industrial and urban activities. Substantial destruction of tidal fringe wetlands and marshes has resulted in the loss of the watershed's filtering capacity. These losses have resulted in the river acting as a sink for contaminants. Ongoing contamination from many sources continues to degrade the system. Elevated concentrations of polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), lead and other trace elements, and pesticides are present in river sediments, posing a risk to humans and aquatic organisms. Even though there are currently fish advisories on the river for PCBs and pesticides, the river is still used for subsistence fishing by the local community. As a result, the Anacostia River has been designated one of three highest priority Regions of Concern within the Chesapeake Bay Region by the EPA Chesapeake Bay Program (1999).

The District of Columbia, Office of Planning has identified the potential of developing over 30,000 new residential housing units along the Anacostia waterfront over the coming 25 years. This urban revitalization opportunity will produce immeasurable local economic benefits for the communities along the shores of the Anacostia River, many of which are the poorest in the City and in the Region. Preliminary estimates identify a potential range of between $75 to $225 million dollars of new annual tax revenue for the District, resulting from the redevelopment of currently underutilized waterfront lands. Many of these sites, such as the Southeast Federal Center, Buzzard Point, Poplar Point and the Southwest Waterfront will be made much more attractive and desirable, after the environmental problems are eliminated.

Stakeholders in the river include federal, state, local governments, as well as non-governmental organizations. These stakeholders have been working to clean up sites and reducing the flow of contaminants to the river. They have repaired over 6.5 miles of leaking storm sewers, constructed 4 (four) sand filters that reduce trash and contaminant flow to the river, restored several miles of stream channels, built protective covers over 30 acres of former disposal sites to reduce contaminate migration, and removed over 7,000 gallons of coal tar, 20,000 gallons of petroleum, and 25 pounds of mercury. In addition, AWTA members have cleaned up over 27,000 tons of contaminated soil and 1 (one) million gallons of surface water and groundwater. In spite of these important advances, serious problems still exist and must be corrected.

- **VISION FOR THE RIVER**

The vision for the Anacostia River watershed is to restore this highly diverse and economically valuable natural resource to the community by making it fishable and swimmable by 2011, if funding for proposed actions is available.

- **PARTNERSHIP AND GOALS**

The Anacostia watershed spans three main jurisdictions: Prince George and Montgomery Counties in Maryland and the District of Columbia. In order to effectively address the complex environmental issues in the watershed, a phased, holistic approach has been adopted. To facilitate this innovative approach and assure successful management of this natural resource, concerned stakeholders have joined together to pool knowledge, expertise, and resources, and to work together to address the many environmental problems. These groups include the Anacostia Watershed Toxics Alliance (AWTA), Anacostia Watershed Restoration Committee (AWRC), and the Anacostia Watershed Society (AWS). This document addresses three primary objectives adopted by these groups to restore the watershed to beneficial use:

- Identify toxic contaminant sources and quantitatively assess risks to human health and the environment from toxic contaminants in the Anacostia River.
- Reduce risks from toxic contaminants to levels that are safe for humans and aquatic life, and
- Build effective partnerships among all stakeholders, encourage public input, and promote effective restoration of the Anacostia watershed.

- **CONCEPTUAL SITE MODEL**

Central to the restoration of the Anacostia is gaining an understanding of how contaminants enter, flow through, and ultimately how organisms and their predators (human and otherwise) are exposed. A Conceptual Site Model (CSM) is a basic description of how contaminants behave in a system. It provides an essential framework for determining source control requirements and addressing unacceptable risks.

Key requirements of a CSM are knowledge of contaminant sources, behavior, migration, and fate; hydrodynamics and transport factors; degradation rates; contaminant sinks; and mechanisms of exposure and uptake by ecological and human receptors. The CSM is also an important tool in helping to identify additional data needs in order to implement an effective cleanup. In addition to the semi-quantitative CSM, a quantitative mathematical model (Tidal Anacostia Model-Water Analysis Simulation Program "TAM-WASP") has been developed for the D.C. Department of Health and is being calibrated and refined to provide predictive capability. This model will allow for the evaluation of various source identification requirements and remedial options.

The current conceptual site model is based on numerous field investigations by many different groups. These studies focused on the biological, chemical, and physical characterization within the watershed. While some data gaps still exist, the CSM presented in this document presents our current understanding of the watershed's dynamics. The conceptual model is dynamic, subject to refinement as additional data is obtained. Hot spot locations in this document are presented

for geographical representation and are not meant to imply the specific sources of contaminants. Additional locations may be identified in the future.

The Anacostia River has undergone many changes in response to industrial and agricultural activities and growing population pressures. Much of the physical change in the Anacostia is the result of soils eroding along the shoreline and from upland areas of the watershed. Development in the form of clearing and tilling have greatly accelerated the rate that water and sediment are carried to the river. However, extensive navigational dredging along the lower part of the river during this same period relocated a considerable volume of contaminated sediments from the channel to many sections of the shoreline. Much of the current pollution entering the river is not from direct "dumping" into the river, but stem from widespread low level urban and industrial pollution throughout the watershed. Non-point-source pollution represents a challenge to the way our urban areas are planned and designed. The manner in which rainwater drains from our urban neighborhoods, as well as our transportation infrastructure, must be rethought so as not to place an undue burden on the watershed's capacity to absorb toxic loadings. Municipal regulations such as zoning, building codes and civil engineering standards must all be reviewed and reconsidered with regard to runoff issues.

Contaminants bond with sediments and move together through the sewers and small creeks to the river. The contaminated sediments of the watershed eventually end up in the river, which serves as a collection area or sink for all of the urban and industrial activities that are occurring throughout the watershed.

The primary sources of toxicity in the river appear to be from chemicals widespread in the environment. Polynuclear aromatic hydrocarbons or PAHs are mainly produced by the incomplete combustion of fossil fuels such as petroleum and coal, and are present in most common petroleum products, such as oils, greases, asphalt, roofing tar, and creosote. Poor management of these materials, common in modern society, and concentrated in an urban environment, leads to the continual loading of contaminants into the river. Polychlorinated biphenyls (PCBs) were in widespread use for a variety of purposes in the watershed, such as insulating oils in electrical transmission equipment and hydraulic fluids. Even inks used in early carbonless papers contained PCBs. Although the manufacture and commercial distribution of PCBs were banned in 1976, they have yet to be completely eliminated in the Anacostia watershed.

Historically, military, industrial, and urban pollution probably began to negatively affect the river near the turn of the 20th century, perhaps reaching a peak during WWII. The historical use of PCBs by the Washington Navy Yard (now split into the Washington Navy Yard and the Southeast Federal Center) was investigated in the 1990s. PCBs were found in onsite soils and in the storm sewers that drained the property. A considerable portion of the entire storm sewer system, that is the storm water lines on the eastern portion of the former facility, was recently rehabilitated. In the system on the western portion (currently the Southeast Federal Center) of the old installation, sediments have been removed from the sewer but the line has not been rehabilitated. In addition, PCBs were used and stored at an electric power company sited along

the river. The company has not been able to test all of the transformers in its power distribution area to determine if they contain PCB concentrations exceeding regulatory criteria. Data from the National Park Service, dated February 2002, shows evidence of new PCB sources entering the river from Kenilwoth Landfill.

The District has reported that coal gasification plants are known to have existed on several sites in the lower portion of the watershed. At the Washington Gas facility, free phase coal tar has been identified as a potential source of PAH's to the river. Recovery operations are currently in progress.

For some pollutants, loadings to the river may have begun tapering off with the environmental awareness and regulation of the 1970s and 1980s. However, environmental investigations are still in progress at almost all of the contaminated sites, and the contaminant loadings from these areas are largely yet to be determined. In addition, the ground water pathway to the river and its potential to contaminate the sediments is still poorly understood at most sites. As contaminated sediments from the watershed settled on the river bottom, the legacies of contamination were left behind. This is the result of sediment mixing caused by storm and dredging events; the continued deposition of contaminated sediments into the channel; and possible contamination of clean sediments by upwelling contaminated ground water. Although sediment contamination may be many feet deep, fish and other wildlife live in and are exposed to only the top few centimeters of sediments. Currently the top few inches of sediments in the Anacostia are contaminated. The few creatures that can survive there are unhealthy and may be impacting other fish that eat them. It is likely that the invertebrates that live in these sediments serve as a pathway for the transport of contaminants from sediments into fish and their predators. This is the result of sediment mixing caused by storm and dredging events; the continued deposition of contaminated sediments into the channel; and most likely the contamination of clean sediments by upwelling contaminated ground water. Moving up the food chain, this in turn poses unacceptable risks to the people who consume these fish.

In general, concerted attempts are being made to investigate, remediate and prevent contaminant loadings from the largest, most easily identified military/industrial facilities as well as from smaller operations. Further, state and local governments continue to implement controls and enforcement actions designed to prevent contaminant discharges from potential sources of urban pollution such as active and abandoned business sites, private properties, streets, parking lots and highways. However, due to budgetary constraints, all of these potential sources and others including the dumping of trash in public areas and discharges from antiquated combined sewer systems (CSOs), which currently is serving approximately one-third of the District of Columbia, continues to pose threats to human health and the environment. The CSOs are outdated systems that permit urban runoff pollution and raw sewage to bypass treatment plants during modest rain events. Averaging about 82 releases per year, the discharge volume equates to approximately 2.142 billion gallons of contaminated waste-water entering the river annually through overflows in the combined sewer system. Storm waters that bypass treatment facilities carry pollutants washed from bathrooms, streets, lawns and parking lots directly to the river. Natural, filtering wetlands and forested riparian buffer zones, which once lined the river and it's tributaries, have

been largely eliminated and replaced with efficient storm drain systems, so that urban pollution often flows unimpeded from the watershed to the river. While the AWRC and its affiliates have, since 1987, made great strides in reducing uncontrolled stormwater runoff and stream channel erosion conditions in the watershed, the uppermost layers of riverbed sediment remain contaminated. During large storm events there also is likely resuspension and mixing of these riverbed sediments. While the physical appearance of the river has generally improved, the bottom sediments have not recovered and will not until point and non-point source pollution is fully addressed.

Understanding human and ecological exposure pathways is an important component of any CSM. Ultimately, exposure routes to, and uptake by biota (including humans), is of principal concern. Bioaccumulation through the food web is a significant exposure route for many organic contaminants of concern for the Anacostia. The screening level risk assessment indicated that the primary pathway for human exposure is from ingestion of contaminated fish, although other pathways are present such as the ingestion of river-water during recreational use. The primary ecological receptors at risk within the river are bottom-dwelling organisms (benthic) and fish. Benthic organisms are exposed from direct contact with sediment and water or ingestion of particulates. Fish may be exposed to contaminants from direct contact with sediment and water plus from bioaccumulation through the food chain.

Since the late 1980's, there has been a fish consumption advisory in effect for the Anacostia for PCBs and pesticides. Liver tumors, most likely from exposure to PAHs, are also very common in bottom-dwelling fish, running as high as 56% in some samples. This is evidence that elevated levels of toxics are present in the river environment and are entering the food chain.

• GENERAL STRATEGY AND PHASED APPROACH FOR MANAGEMENT

Watershed restoration must not be thought of as restoring to historic conditions. It must thought of as a reintroduction of watershed "riparian systems". In many instances this will translate into the reconstruction of urban infrastructure and the construction of new parks and open space areas to form new "green" infrastructures. It could reach a condition where it is still mostly filled with the muds of the past centuries, but where the uppermost layers, where animal and plant life dwell and obtain food, are clean and healthy.

Millions of gallons a year of fresh water enter the watershed and river through rainfall. The new sediments flushing into the river each year, if no longer contaminated on their journey, could lead to the river's eventual recovery. However, to achieve the goals of restoration in a timely fashion, active remedial actions will be required to manage the contaminants flowing into the river. The general strategy for watershed management is:

- Identify for elimination major contaminant sources that are impairing the watershed.
- Identify applicable, relevant and appropriate regulations.

- With the aid of analytical data, the TAM-WASP computer model and the CSM, prioritize sources in terms of significance of contribution to impairment.
- Identify and evaluate alternative strategies to address contaminant sources or pathways and conduct an alternatives analysis for the most effective strategy that minimizes net risk. Ensure that selected alternatives are consistent with overall strategy for the watershed management plan, both spatially and temporally.
- Develop a schedule and sequence of phased actions based on the alternatives analysis, which build on and expand the stormwater retrofitting, stream restortation, wetland creation and riparian reforestation activities of the AWRC and it's affiliates.
- Work with appropriate parties and stakeholders to manage upgrade actions.
- Monitor response of the watershed to each phase of action; refine the conceptual site model, and revise the next phased action as appropriate.

In 1998, EPA issued the Contaminant Sediment Management Strategy to promote the use of consistent sediment assessment practices, consistent consideration of risks, consistent risk management. The management strategy encouraged the use of resources for implementing regulatory requirements, as well as for research and technology development with respect to contaminated sediment. In 2002, EPA issued eleven management principles for contaminated sediment management. The approach outlined in this document is consistent with current guidance and the approaches being developed by regulatory and stakeholder groups focusing on contaminated sediment issues.

- **ESTIMATED COSTS TO IMPLEMENT THE REMEDIATION MANAGEMENT STRATEGY**

Total projected costs to monitor and restore the Anacostia River to its beneficial use are approximately $212 Million. This amount includes, in part, remediation of hot spots, addressing contaminated outfalls and tributaries discharging into the river, monitor tributaries to identify sources of contaminants entering the Anacostia, conducting investigations to identify ongoing releases, enhanced trash removal operations, construction of storm water management practices and stream restoration projects to reduce contaminant and sediment loadings to the river, develop new watershed education and outreach programs designed to reduce pollutant loadings at or near their source, and continue to monitor both the river and the watershed to determine the effectiveness of the remediation efforts. It does not include the cost of major sewer upgrades in the three jurisdictions. This phased approach, with watershed-wide upgrades to reduce loadings, followed by careful monitoring of the river's responses to these improvements, should save money by significantly reducing the number and magnitude of cleanup actions required to render the river as a safe and useful community asset.

A summary of currently planned phased activities is given below. Monitoring activities will be tailored to specific objectives and may include chemical, physical or biological monitoring for indicator parameters.

- Conduct Human Health and Ecological Risk Assessment -2003
- Characterize contaminants and monitor storm flow of Combined Sewer Overflows (CSO) -2003
- Continued implementation of LID activities -2003-2008
- Monitor groundwater contaminant plume contribution to the river environment -2003-2004
- Conduct feasibility studies of Sediment remediation alternatives -2003-2007
- Implement Capping Pilot Demonstration and monitor for effectiveness -2003-2007
- Prioritize watershed remedial activities -2004 and on
- Implement pilot for CSO loading control (Engineered Treatment Wetlands) and monitor -2004-2005
- Implement feasibility studies of tributary sources and monitor -2005-2007
- Monitor environmental quality response to corrective measures, refine CSM and refine remedial strategies -2005-2010
- Construct Engineered Treatment Wetlands and monitor -2005 -2006
- Implement sediment remedial strategies and monitor -2005-2010
- Evaluate actions and discontinue monitoring if goals have been achieved or trends indicate success

These efforts are consistent with goals developed by AWTA and AWRC for the restoration of the Anacostia watershed, and are one of several key initiatives being planned that would collectively lead to the cleanup of the river and its restoration as an asset and source of pride to the community.

1 Introduction

1.1 OVERVIEW

This document presents a toxic chemical management strategy for the Anacostia River. It is based upon the 3-phased approach of the Anacostia Watershed Toxics Alliance (AWTA) and their synergy with the broader goals of the Anacostia Watershed Restoration Committee (AWRC). The document presents a holistic approach and projected costs for managing the toxic condition of the river. The approach provides for control of on-going sources of toxics as well as remediation for past releases. The goal is to restore the Anacostia River to a condition where it supports designated human uses and provides for ecological integrity.

Over the centuries, the Anacostia has undergone many changes due to the presence of man in its watershed. Some of these changes are irreversible physical alterations, while others are reversible impacts. These combined changes result in the depressed, degraded biological conditions observed in the river today. The river can never be returned to a condition or state close to what it would be today without man's influence. But it can and must be made safe and healthy again. With commitment, the Anacostia can once again be restored to functioning ecosystem and contribute to the economic viability and the quality of life in the surrounding communities. Improvements have been made to the Anacostia River and efforts are continuing.

The Anacostia River has been designated one of three high priority Regions Of Concern within the Chesapeake Bay Region by the Chesapeake Bay Program, partly due to the extent of sediment contamination. The District of Columbia, in consultation with the Agency for Toxic Substances and Disease Registry (ATSDR), declared several fish consumption health advisories in the 1990s with restrictions on bottom-feeding species and game fish. Also a fish consumption ban for pregnant women and children has been issued. Liver tumor prevalence in bottom-dwelling brown bullheads is as high as has been reported in contaminated areas of the Great Lakes. These lesions appear to result from exposure to carcinogens in the sediments. The strongest evidence for a specific class of chemicals has causative agents exists for PAHs. These examples illustrate the magnitude of the issues facing the river.

The ongoing discharge of pollutants to the river needs to be characterized and managed. There are several approaches recommended for reducing discharges to the river. Some are for point sources, while others are for non-point sources. Some are interim measures, while others are long-term. Some are aimed at intercepting what continues to be transported to the river just prior to discharge, while others are aimed at controlling migration throughout the watershed. Plans already exist to greatly modify the overflowing combined sewer systems to provide sufficient

volume to capture, store, and treat the water from major rainstorms prior to entering the river. Large facilities that are pollutant sources must be willing to reduce their contaminant loads below regulatory standards to meet risk based standards consistent with watershed restoration goals. Contaminants and trash need to be removed from streets and parking lots before they are washed into the river. Storm waters from our streets and parking lots need to be diverted through filtering beds or basins and wetland treatment facilities, to remove oil, grease, and other urban pollutants before entering the river. The local population must take greater responsibility through careful handling of hazardous substances and recycling.

Costs associated with the remediation of contaminated sediments of the Anacostia River are expected to be beyond the means of any single group or organization. Nor can any one remedy accomplish the process of restoring the Anacostia River. It will take a combination of efforts, directed at many different sources, to affect the river's recovery, with remediation of contaminated sediment as just one of the critical elements in this process. For this reason, all available avenues will be pursued in order to secure resources necessary to implement a permanent sediment restoration strategy for the Anacostia River. The remedial actions proposed in this strategy are not final: detailed analysis of remedial alternatives will be conducted as part of planning for each action. Appropriate actions will then be chosen based upon a number of factors, including protectiveness, effectiveness, cost, and public acceptance.

The Anacostia **can** recover, not to its original condition before human intervention, but to a new, healthy condition. It could reach a condition where it is still filled with the muds of the past centuries, but where the uppermost layers once again provide clean, healthy habitat for animal and plant life. Achieving this healthy condition will take years of hard work and significant resources.

A monitoring program, timed in phases, will be designed taking into account the planned improvements and recovery processes. Signs of ultimate recovery will be tracked, but early and intermediate indicators of progress will also be measured and recorded. The monitoring program for river toxics is designed to capitalize on other existing and planned monitoring programs intended for related but different purposes.

Measurable indicators of river recovery fall into different categories, in terms of the speed at which meaningful changes can be measured. The fastest will be the physical improvements, constructed facilities, and upgrades in the watershed, such as CSO upgrades, construction of filtering wetlands, and elimination of other point discharges and active hot spots. These improvements can be directly observed. Direct assessment of their efficacy can and should be observed as part of their construction and installation process as well. As improvements are made to these systems, the benefit to overall water quality should be verifiable by direct sampling.

The second-fastest-responding indicators should be direct water quality samplings of major sources, such as dissolved and particulate inputs from certain tributaries and point discharges to the river, such as storm sewer outfalls. Observation of improvements in water quality within the

main branch and major tributaries may lag however, as the level of control throughout the watershed increases. Some biological observations can serve as indicators of very rapid response to general water quality improvements as well.

The slowest indicators may be the river sediments themselves and biological receptors. These indicators include:

- The appearance of a clean layer of solids on top of the sediment column,
- The re-colonization and diversity of the community of creatures that dwell in sediments,
- The contamination levels in their tissues, and
- The health, contaminant tissue residues, and exposure indicators of fish and wildlife receptors.

These represent indicators that will respond directly to improvements. However, these parameters will respond on varying time-scales.

Reports on the progress and success of the toxics management effort will be issues on a periodic basis. In addition, refinements on the understanding of dynamic processes in the river (i.e. the conceptual model) and the remediation strategy will be made as additional information becomes available.

1.2 BACKGROUND INFORMATION

The Anacostia River (Figure 1) is a tributary of the Potomac River, which in turn flows into the Chesapeake Bay. The Anacostia River begins at the confluence of the Northwest and Northeast branches at Bladensburg, Maryland and runs less than nine miles to its confluence with the Potomac River in Washington DC. The river is completely freshwater, but tidally influenced throughout its entire run. The river's watershed drains a predominately urban area that encompasses 456 km^2 in Maryland and the District of Columbia.

Decades of industrial and urban activities throughout the watershed have increasingly degraded the river and caused the substantial loss of tidal fringe wetlands and marshes. Today, only about five percent of the original tidal wetlands remain in the Anacostia. Because of these impacts, the river can no longer filter substances and is a sink for contaminants. Development has greatly stressed the river's ecosystem and elevated the levels of hazardous substances present, negatively affecting the delicate balance of life in and around the river. Elevated concentrations of hazardous substances, including polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), lead and other trace elements, and pesticides are all present in sediment throughout the river, posing a risk to aquatic organisms and to humans. Bioaccumulation of

PCBs in fish tissues means that people may be at risk if they eat fish from the Anacostia River. With the increased bioavailability of contaminants in the river's food chains, habitats of species critical to the survival of the Anacostia River's ecosystem are in jeopardy.

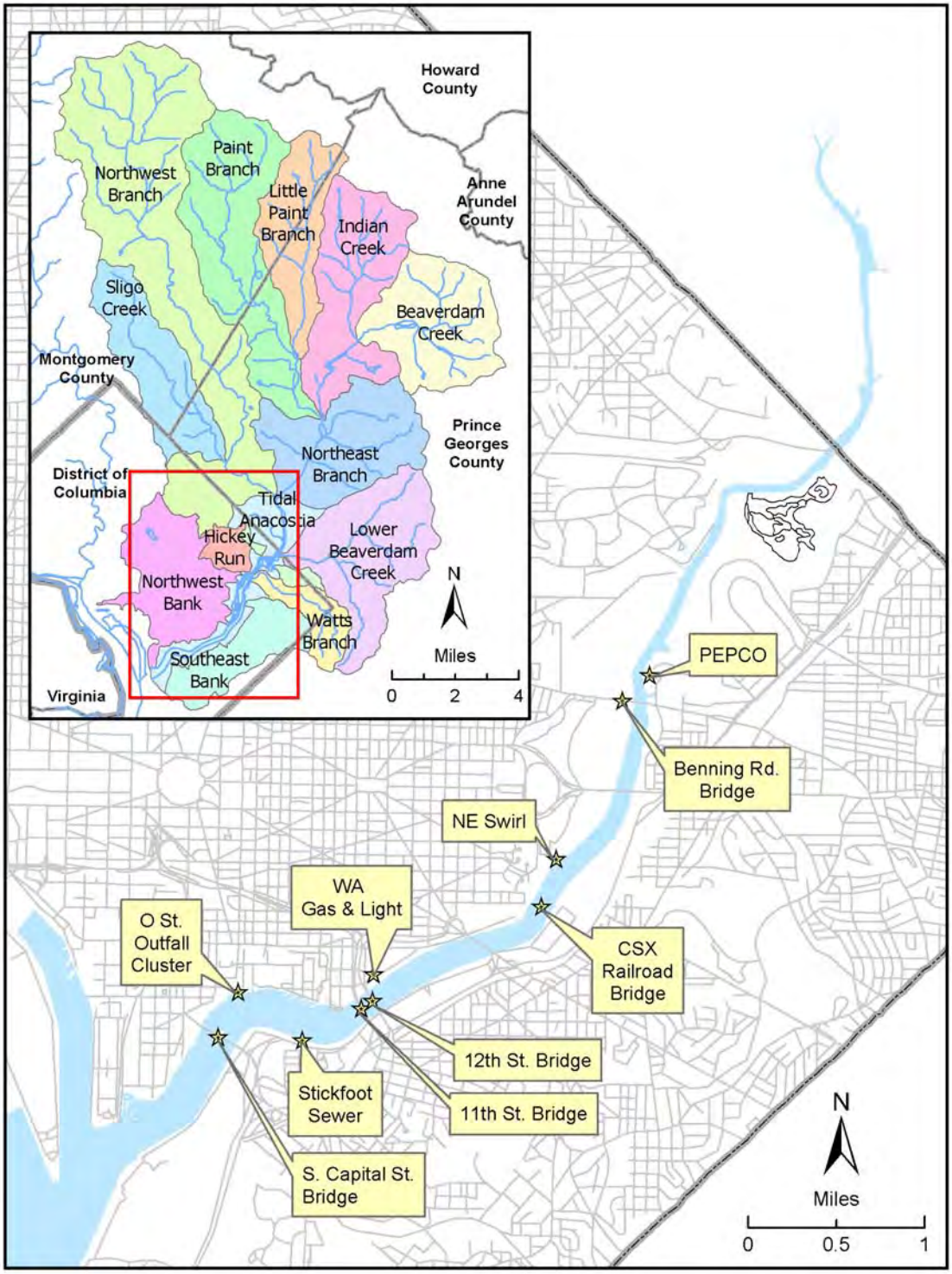

Figure 1: Anacostia River watershed showing subwatershed divisions and major tributaries.

Most of the physical change in the Anacostia involves the relocation of soils and sediments. Wetlands were intentionally filled with sediment dredged from the river channel. Even portions of the entire river course were relocated from their historical locations. After the arrival of humans, forest clearing, tilling, and development have greatly accelerated the rate at which sediment and water moved into the river. These material changes can be slowed by enlightened development and responsible land-use practices, but the river can never be put back, physically, the way it was or might have been. However, we *can* restore the biological integrity of the river in its current form.

Although chemical "pollution" makes up only one factor of the total changes in the Anacostia River, this factor makes much of the river harmful to fish and other wildlife. We must eliminate the pollution that causes toxicity so that we can restore the biological integrity of the river and make it swimmable and fishable again. While much of the historical pollution in the river was from direct "dumping" of solid and liquid wastes before most of the current environmental regulation were in place, the current problem is a result of pollution of water some distance from the river, which then flows to the river. Unseen, but no less significant, is the migration of potentially contaminated groundwater to the surface water body. The polluted water and solids flow to the river mainly through tributary streams and sewers. The pollution process is not limited to just along the river, but has occurred throughout the entire watershed. In this regard, the River serves as a gathering point or sink for what occurs throughout the watershed.

Pollution generally began in earnest at the turn of the past century, perhaps reaching a peak during and after the WWII era. Some pollution likely began tapering off with the environmental enlightenment and regulation in the 70s and 80s. As layer after layer of sediments settled on the river bottom, bands of contamination were left behind. One advantage is that although sediment contamination is many feet deep, fish and other wildlife live in and are exposed to only the top few inches of sediments. So, only a small fraction of the total pollutants are causing the current harm. But since the top few inches of sediments in the Anacostia are presently contaminated, the creatures that can survive serve as a pathway for exposure to fish and other predators. Even if all ongoing sources of pollution are eliminated, the repository of contamination present in the sediments of the river could serve as a secondary source of pollutants that needs to be addressed.

Although some pollution may have tapered off, more widespread urban pollution has not. Smaller active and abandoned business sites, private properties, streets, and highways continue to release pollutants. Development has expanded beyond the capacity for aging, "combined" sewer systems, allowing some urban pollution and sewage to bypass treatment plants during even modest rain events. Storm waters carry pollutants washed from streets and parking lots directly to the river. Natural, filtering wetlands and buffer zones, which once lined the river, have been eliminated, so urban pollution flows unimpeded from the watershed to the river. The result is that the newest, uppermost layers of sediments are hardly better than those laid down 30 or 40 years ago. While the physical appearance of the river may have improved, the bottom sediments have not recovered and will not until these present, on-going sources are curtailed.

The main causes of toxicity in the river are chemicals widespread in the environment. Polynuclear aromatic hydrocarbons or PAHs are present in most common petroleum products, such as oils and greases, and as by-products from combustion. Poor management of these materials, so common in modern society and so concentrated in an urban environment, leads to ongoing pollution of the river. PCBs were in widespread use for a variety of purposes in the watershed, such as insulating oils in electrical transmission equipment and hydraulic fluids. Even the inks used in early carbonless papers contained PCBs. PCBs are highly persistent once in the environment, and they have yet to be completely eliminated in the Anacostia watershed.

There is an advisory in effect against eating fish from the Anacostia due to their concentrations of PCBs and pesticides. Tumors are also very common in bottom-dwelling fish. This situation is unacceptable, and it is evident that elevated levels of toxics are present in the river environment and are moving to the fish.

1.3 Management Philosophy

To be able to effectively assess and manage contaminated sediments requires an understanding of both the Anacostia watershed and the river's dynamics. This includes an understanding of the hundreds of point and nonpoint sources; distributions of contaminants; fate and transport properties, including sediment transport and depositional patterns; and human and ecological resource use. This is an extensive effort, which is outside the requirements and fiscal resources of any single party

Several groups, including members of AWRC and AWTA, are working hard to restore the river. In order to accomplish this task, many parties are evaluating various aspects of the problems affecting the river (e.g., total maximum daily loadings, combined sewer overflow releases, and trash removal) and developing restoration plans, including Brownfields redevelopment. While some other rivers are being addressed nationally under Superfund, the work being done here is unique and well beyond normal operating procedures as defined in CERCLA and the NCP. The hazardous contaminants of the Anacostia watershed are being investigated, not by Superfund or potentially responsible parties, but by public and private volunteer stakeholders who are cooperatively performing this work without the issuance of any Administrative or Consent Order.

Voluntary pooling of resources to address an entire watershed's severe toxic contamination problems had not been done before. This effort is truly remarkable because of the lack of existing policy or guidance; the collective partnering approach that AWRC and AWTA took to jointly issue this document; the voluntary sharing of resources by stakeholders; and the innovative investigative methods employed by AWTA to fill in the data gaps. The participating volunteer member organizations comprise federal regulatory and resource agencies, state and local environmental agencies, industry, academia, and the public.

By pooling available fiscal and technical resources, AWRC and AWTA have successfully developed a watershed-based approach. The approach outlined in this document is consistent

with current guidance, such as EPA's 1998 Contaminant Sediment Management Strategy, and approaches developed by regulatory and non-regulatory groups focusing on contaminated sediment issues. This strategy was developed to complement and supplement existing efforts. It was also developed to work with, utilize, and assist existing regulatory programs and authorities. Finally, it has adopted the goal of returning the river to a swimmable and fishable condition.

1.4 1987-2001 Anacostia Watershed Restoration Activities and Progress

Before the 1987 Anacostia Watershed Restoration Agreement was signed, much of the regional environmental concern and focus was on the larger, ailing Potomac River. However, in the years since, local, state, regional, and Federal government agencies, as well as environmental organizations, businesses, and dedicated citizens have made a increasingly concerted and focused effort to protect and restore the Anacostia watershed.

Over the past 15 years, actions taken by the AWRC, AWTA, their affiliated organizations, environmental and business groups, and numerous individual citizens have resulted in substantial restoration progress. To date, members of AWRC and AWTA plus others have identified opportunities for over 700 storm water retrofit, wetland creation, stream restoration, riparian restoration, combined sewer overflow (CSO) abatement, trash and toxics reduction, and other restoration-related projects designed to correct environmental problems and enhance overall ecosystem quality. Of these projects, approximately one-third have either been completed or are in progress. Since 1987, roughly $35 million has been spent on restoration project implementation, with approximately $30 million additional spent on land acquisition, planning, monitoring, engineering, design, and maintenance. Further, $65 million has been spent on engineering controls designed to reduce the impacts of CSOs on the tidal river and of leaking, aging sewer lines on the tributary streams.

In just the last few years, members of AWTA, such as Washington Navy Yard, National Park Service, Washington Gas Light, and the General Services Administration, have been effectively cleaning up their sites, thereby reducing the flow of contaminants to the river. They have repaired over 6.5 miles of leaking storm sewers, constructed four sand filters to reduce trash and contaminant flow to the river, built protective covers over 30 acres to reduce contaminate migration, and removed over 7,000 gallons of coal tar, 20,000 gallons of petroleum, and 25 pounds of mercury. In addition, members have also abated over 27,000 tons of contaminated soil and 1 million gallons of surface and groundwater.

There are three special appropriations from Congress signaling the beginning of cleanup of the river's sediment under AWTA's Phase III plan (A discussion of the 3 Phased Approach is included in the following section). The Anacostia Park East legislation will increase the number of wetland acres present in the watershed by about 20%. This action will provide some filtration and degradation of contaminated particulates, but will also further help to preserve important food chains and habitats critical to the Anacostia River's ecosystem.

The second appropriation initiates a Phase III LID effort. This action will demonstrate the effectiveness of LID to detain and cleanse a storm's first flush. Based upon studies from other watersheds, detaining the first flush of rain - about an inch or less- can significantly reduce the toxics loading to the river.

The third appropriation is funding a sediment reactive-capping project being developed by EPA's Hazardous Substance Research Center (HSRC). The use of reactive caps over contaminated sediment in the Anacostia is intended to reduce contaminant levels and retard migration while final remedial actions are being implemented.

1.5 AWTA 3-Phased Approach

Although numerous chemical investigations had been conducted in the river over the years, they had not been collected or analyzed in a coordinated manner sufficient for a detailed evaluation of risk, nor for evaluating remediation. AWTA was formed in 1999, to some degree, in response to this situation. During its first year, AWTA drafted its three-phase approach, and completed the Phase I activity.

The Phase I assessment involved collecting, organizing, and summarizing all relevant existing data on the Anacostia River that could be used for characterizing contamination, developing a preliminary watershed conceptual model, and assessing potential risk to humans and ecological receptors (SRC and NOAA 2000).

Screening for human health risk was conducted using conservative assumptions, which would eliminate contaminants that do not pose risk under worst-case scenarios. This conservative approach compared maximum concentrations in sediment, surface water, and fish tissue to risk-based benchmarks. Results identified 39 contaminants of potential concern (COPCs) in fish tissue. The primary chemical classes identified in fish tissue were dioxins and furans, pesticides, PCBs, and trace elements, including arsenic, cadmium, lead, and mercury. COPCs in sediment were arsenic, PCBs, and four PAH compounds. Arsenic, PCBs, and heptachlor, DDE, and DDT were identified as COPCs in surface water. Because of data limitations, significant information gaps, such as fishing and recreational use throughout the river, were noted.

A screening of potential risk to ecological receptors was also conducted using highly conservative assumptions that tend to eliminate contaminants that do not pose risk even under even worst-case scenarios. Risk for aquatic organisms and wildlife, grouped into categories called ecological receptors, were estimated for aquatic birds, aquatic mammals, fish, and benthic invertebrates. The benthic, or bottom-dwelling, invertebrates are considered key elements of the food chain necessary for supporting other organisms. Results indicate that sediment levels of chromium, lead, mercury, nickel, zinc, PAHs, PCBs, and several pesticides are sufficiently elevated in certain locations to be toxic to benthic invertebrates, and that sediment PAH concentrations are high enough to pose a risk to fish. Also, concentrations of PCBs in fish tissue may be high enough to impair reproductive success. Using very conservative approaches, the risk posed to aquatic birds or mammals does not appear to be significant. Given the large

uncertainty associated with these conservative estimates, firm conclusions regarding the actual risk posed were not possible.

By the end of its first year and based upon results from Phase I, AWTA had identified the major gaps in information that would be required to formulate management decisions and initiated Phase II by drafting a scope of work to conduct field studies to fill these critical information needs. Some of these included:

- Spatial and temporal profiles of chemical concentrations in the sediment and water column;
- Data on chemical inputs from major point and nonpoint sources to support quantitative models of loadings to the river;
- Greater understanding of hydrodynamics and sediment transport to model spatial contaminant concentration profiles and identify high impact areas; and
- A finer-scale spatial characterization of ecological exposure and effects.

During its second year, AWTA secured funding for Phase II and implemented many of the studies that were necessary to develop management plans. Table 1 lists Phase II field investigations that have been completed or are underway.

Table 1: Field investigations and status of Phase II Studies.

Conceptual Model Component	Type of Data Proposed or Collected	Investigator	Status
Contaminant Inputs			
Ground water[a]	Groundwater discharge rates and PAH concentrations in pore water at six locations	SPAWAR	Report submitted
Storm water effluent[a]	Storm drain sampling of contaminants during base flow and storm water events	MWCOG	Will begin 2002
Modeled inputs	Mass balance model to estimate sediment and metal loads to the tidal river	ICPRB	Preliminary results available
Fate and Transport			
Hydrodynamics[a]	Bathymetry, tidal mixing, current velocities, circulation, flushing time	SPAWAR	Report submitted
	Contaminant transport, mixing, and dispersion	Limno-Tech	Report submitted
Sediment trend analysis	Grain size analysis to determine areas of erosion, stability, and deposition	GeoSea Consulting, Inc.	Report submitted
Modeled fate and transport	Mass balance model of hydrodynamics, sediment, and metals transport in the tidal river	ICPRB	Preliminary results available
Nature and Extent of Contamination			
Sediment	Field screening for contaminants	SPAWAR	Report submitted
	Definitive sampling for contaminants	ANS	Report submitted

Surface water	Field screening for contaminants	SPAWAR	Report submitted
	Definitive sampling for contaminants	ANS Velinsky	Partial data submission
Ecological Risk Exposure Pathways and Effects			
Benthic community exposure and effects	Benthic community analyses and bioassays	USFWS, UDC	Report submitted
Fish exposure and effects	Tumor prevalence in brown bullheads	USFWS	Report submitted
	Early life stage water toxicity tests	USFWS	Report submitted
	In situ bioaccumulation measurements	USFWS	Report submitted

[a] Data from these investigations will be incorporated into the mass balance modeling.

With work on Phase II nearly complete, key information gaps have been filled. Several major advancements in understanding were realized:

- River bathymetry was updated and existing river morphology was corrected. Some significant differences in river volume were noted over previous calculations.
- The first river-wide investigation of sediment transport and dynamics was conducted. Analysis from over 600 samples confirmed general downstream transport of sediment with settling in the lower river, but also indicated the small scale variations in dynamics, the influx of sediment from multiple sources, and the extent of influx of sediment from the Potomac River.
- The most comprehensive characterization of sediment contamination was conducted through two separate surveys, encompassing the entire river, with over 100 samples each.
- The first synoptic, river-wide survey of general water quality was conducted.

Results from these studies and the information gained are being used to refine the Conceptual Site Model (CSM), presented as an appendix to this document, and as a basis for the Management Strategy which begins AWTA's Phase III efforts.

Under Phase III, the AWTA/AWRC partnership will continue to develop and implement an overall remediation strategy that deals with the watershed as a whole, using a mix of short- and long-term actions as appropriate to achieve mutual restoration goals by 2011. AWTA will coordinate with the appropriate regulatory agencies to assist with incorporating point and nonpoint source assessments and source control into their programs. It will be the financial responsibility of each generator to address specific regulatory requirements. As these efforts proceed, they will:

- Identify, where practicable, current and historical sources;
- Comply with the CERCLA process, consistent with the 11 principles of EPA's Contaminated Sediment Management philosophy, when preparing for and implementing any cleanup action;
- Prepare decision documents outlining remedies necessary to address unacceptable risk situations;
- Solicit peer and public input into the process;

- Coordinate with appropriate authorities of findings for matters not Superfund-related; and,
- Identify resource requirements and develop a strategy to acquire funding and take appropriate actions to remediate negative impacts to sediment in the Anacostia Watershed.

2 Summary of the Conceptual Site Model

A conceptual site model (CSM) is a basic description of how contaminants enter a system, how they are transported around the system, and how the routes of exposure to organisms and humans occur. As such, it provides an essential framework for assessing risks from contaminants, determining unacceptable risks and the factors associated with such risks, developing remedial strategies, and determining source control requirements. Appendix A describes the current CSM for the Anacostia in detail. The conceptual model is dynamic, subject to refinement as additional data is obtained. Hot spot locations in this document are presented for geographical representation and are not meant to imply the specific sources of contaminants. Additional locations may be identified in the future. A highlight of major elements from the CSM is presented here.

Because of the complex interplay between the biological and physicochemical compartments of an ecosystem, CSM models that attempt to address every nuance and answer every scientific question can become quite complex. However, a CSM can rely on reasonable assumptions to arrive at more simplified view that is still an adequate tool for meeting objectives. More generalized results tend to be associated with broader uncertainties however. A CSM can also help identify key information gaps. When quantitative components of CSM's are developed and calibrated [such as the Tidal Anacostia Model (TAM)/Water quality Analysis Simulation Program (WASP)], they can also provide predictive capability that allows evaluation of various remedial options. The AWTA Phase I report introduced various CSM components for the Anacostia River, which helped guide the identification data gaps for Phase II. This report refines the CSM using available data from Phase II and other sources. A conceptual site model should be dynamic and incorporate new information as it becomes available. Much of the data collected under Phase II are in preliminary phases of analysis and have not yet been fully incorporated into a detailed model.

The major dynamic processes that affect contaminant fate in an urban river such as the Anacostia are illustrated in Figure 2. The primary routes for contaminants to enter any reach of the river are through surface water inputs (dissolved and/or suspended particulate form), groundwater, or sediment transport into that reach from another portion of the river. There are two main types of surface water inputs: either movement within the river from adjacent reaches (up- or downstream in the case of the Anacostia) or direct inputs to that reach from outside sources, such as tributaries, outfalls, wastewater treatment plants, permitted discharge facilities, other non-permitted sources.

Once within the river, contaminants are transported in surface water according to tidal movement, river flow and circulation, and dispersion. Because the primary contaminants of concern within the Anacostia are hydrophobic, sediment dynamics are a key element to understanding contaminant distribution. Important sediment fate and transport processes are bed load transport or deposition, sediment burial, and resuspension into the water column.

These are the major physical process that determine contaminant distribution. A CSM must also address the biological elements that determine the levels of pollutants to which animals and humans are exposed. It is just as critical to know the major routes of pollutant uptake into biota and the general structure of food webs. This knowledge helps us to identify the ecological components that may be at greatest risk from exposure to contaminants.

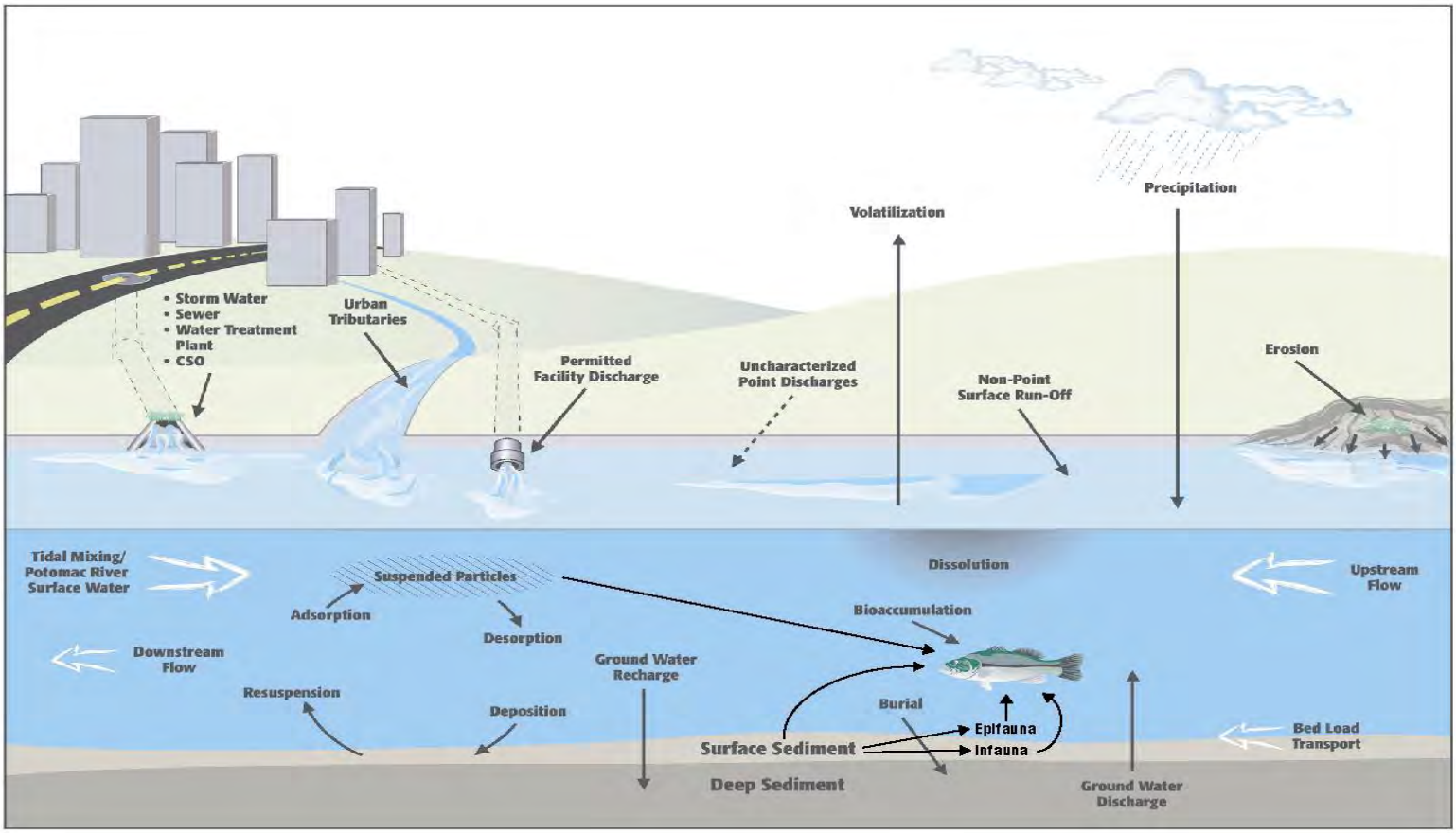

Figure 2: Schematic representation of the conceptual site model for the Anacostia River showing potential routes for contaminant mobility and fate.

The Anacostia River is generally shallow: less than a meter to two meters deep from Bladensburg to about the 12th Street Bridge, and three to six meters deep from the 12th Street Bridge to the river mouth. Water flow in the river, particularly during base flow conditions, is dominated by tides. Water levels change as a standing tidal wave, meaning that water levels rise and fall nearly simultaneously throughout the entire river. Current velocities are determined by changes in the river's cross-section and the tidal prism volume toward the head of the river, and are primarily directed along the axis of the channel and are relatively homogeneous throughout the water column. Maximum current velocities (30 cm/s) are relatively low and occur in the vicinity of the Railroad Bridge; velocities elsewhere are much lower. The water column is generally well-mixed, with little horizontal or vertical variation, although some vertical stratification in the lower river may occur after a storm event. The flushing time of the river is estimated to be between 23-28 days. A previous estimate of a 35-day flushing time (Scatena, 1986) was considered inaccurate because of an outdated river volume estimate.

The NE/NW (Northeast/Northwest) Branches account for about 60 to 70 percent of the river flow. Non-gauged flows include storm water sheet flow, CSOs, and/or groundwater. Water is entering into the groundwater system in the lower Anacostia tidal watershed through natural recharge in grassy, wooded, or otherwise unpaved areas, as well as through leaky infrastructure such as water and sewer lines. Therefore, it is either accumulating somewhere (change in storage), or it is discharging somewhere. This discharge will be to one of the two large bodies of water in the area (the Anacostia or Potomac Rivers), to local production wells (relatively less likely), to dewatering wells (possible), or to far away areas that draw on the regional groundwater system that outcrops or subcrops in the study area. Although some groundwater may be drawn out of the system by wells, much of the groundwater in areas close to the Anacostia River will eventually discharge to the river or tributaries.

With this in mind, the main information that needs to be determined is "How much groundwater is flowing into the Anacostia, how fast is it flowing, is it contaminated, and if it is, does contamination from groundwater represent a large or a small threat to the river?" The answer to these questions is unclear at this time. Several localized groundwater studies have been done, and a model to determine the shallow groundwater flux to the tidal Anacostia River was done for DC DOH (Logan 1999). The TAM/WASP model described in this document also includes an estimate of groundwater flux. There are uncertainties in both models. In addition, there are locations in the tidal watershed where groundwater contamination is suspected of having an impact on the overall contaminant load of the Anacostia River due to the proximity of potential contaminant sources or to the presence of contaminant "hot spots" within the river channel. Assuming that there are at least localized areas with contaminated groundwater, it is important to determine how prevalent the contaminated areas are, and if they will have an effect (local or regional) on the river.

Analyses from water samples at the NE/NW Branches confirm downstream migration and discharge into the river of both aqueous and particulate contaminants. Other tributaries, such as Hickey Run, Pope Branch, Fort Dupont Creek, Stickfoot Creek, etc., are also known to contribute contaminants to the Anacostia, however data for the

loadings are currently not available. (This is a significant data gap which is being addressed by AWTA.) There are no combined sewers discharging into the NW or NE Branches. However, there are approximately 30 storm sewers and 17 combined sewers discharging directly into the Anacostia River (MWCOG 1997). A model constructed by the DC Water and Sewer Authority (WASA) predicted that over 93 percent of the CSO flow volume was contributed by the two CSO systems at Main and O Street and at Northeast Boundary. Although more than half of the Northeast Boundary total flow goes through a swirl concentrator, but that facility is not currently at full treatment efficiency due to disrepair. Observations of concentrations of many trace metals increasing after storm events, with the most substantial increases occurring after rainfall greater than 0.6 inches over a 24-hr period, reinforce the impact of stormwater on the chemical water quality of the Anacostia.

Deployment of clams and semi-permeable membrane devices (SPMDs) in the NE and NW Branches, and at seven other locations in the Anacostia verify that there is both an aqueous and particulate contaminant load of PCBs, PAHs, and pesticides that is bioavailable. Limited toxicity tests for survival and growth in larval fish also confirm that toxic conditions can exist . One high flow test showed diminished survival at two locations (Bladensburg and Kenilworth Marsh) compared to survival at the control and two remaining locations (CSX Railroad Bridge and James Creek). Growth was also lowest at the Bladensburg and Kenilworth Marsh locations.

Over the last two hundred and fifty years, a great deal of sediments have washed into the Anacostia River. A very detailed account of the history of the town of Bladensburg based on a book by George D. Denny, Jr. states that when the town was founded in 1742 it was "a thriving port with a depth of 40 feet of water in the river … By 1800, the shipping lane to and from the port of Bladensburg had begun to fill with silt, making passage by large ships impossible. The problem worsened over the next few decades, such that Bladensburg as a port became a thing of the past." The huge volume of sediments that began to fill in the river also posed major problems for shipping downstream. According to historical records from the U.S. Army Corps of Engineers, for many years Congress was petitioned for funds for navigational dredging to provide ships safe access to the Washington Navy Yard. The deposition, contamination and relocation of these contaminated sediments by the placement of dredge spoils along the shoreline have largely contributed to the toxic sediment problems in the river today

As noted earlier, the primary contaminants of concern within the Anacostia are hydrophobic, therefore sediment dynamics are a key element to understanding contaminant distribution in the river. Sediments in the river channel are moved by baseflow, storm events, and tides. The following discussion pertains to general sediment transport trends. Sediments in the Anacostia vary from gravelly sand in the upstream portions of the river, to mainly mud in the lower reaches. The NW and NE Branches appear to be predominant sediment sources, though there are secondary sources which have localized effects. As the two major tributaries meet, coarser material settles out and is deposited in an accretion zone in the vicinity of Bladensburg Marina. The current here is unable to transport coarser sediments, so only the fines are transported downstream. Downstream from here, coarser sediments are found only locally where smaller streams and outfalls enter.

From Bladensburg to the Railway Lift Bridge, sediments, particularly the fines, move through the system much like a conveyer belt. The higher flow velocities and shallower depths in this region appear to cause resuspension of sediment, as reflected in high Total Suspended Solids (TSS) in surface water. Between the Railway Lift Bridge and the 12th Street Bridge, the "conveyer-belt" transport zone merges with a deposition zone, which then becomes a zone of Total Deposition below the 12th Street Bridge. This is also an area where the river widens and the depth increases, allowing the currents to slow and sediment fines to settle.

The lower reaches of the river are completely depositional. About 1.5 km upstream from the mouth of the river, a downstream depositional transport regime is met by an upstream transport regime at the deepest point in the river. The sediments moving upstream are most likely driven by tidal currents and include particulates from the Potomac River.

TSS concentrations varies with tide height. A decrease in TSS concentrations at high tide, slack water suggests that some of the material may be depositing out at these low flow conditions. Preliminary calibration of the updated TAM/WASP model for sediment transport indicates that 90 percent of sediment stays within the tidal Anacostia, and that the current rate of sediment deposition is 1.4 cm/year.

The sedimentary record of contamination, as a temporal integrator of inputs, can help to identify, and prioritize, apparent loading sources to the river. Concentrations of contaminants in sediment can also be used to derive estimates of the potential for adverse biological conditions.

Based on a comparison to Threshold Effects Level (TEL) and Probable Effects Level (PEL) sediment quality guidelines, the Phase I screening-level ecological risk assessment indicated that risk may be posed to benthic invertebrates from exposure to metals, PAHs, PCBs, and several pesticides in sediment. Elevated concentrations of PAHs in sediment may pose a threat to bottom-feeding fish based on comparison to a sediment quality threshold of 2 mg/kg. The screening level Ecological Risk Assessment (ERA) found that PCBs, pesticides, and lead were present in fish tissue at concentrations that may adversely affect fish. Also, risk to birds and mammals were estimated to not be at lower risk.

Recent chemical analyses results from the extensive Phase II surveys (almost 250 samples) of sediment samples confirm that contamination of the river is widespread, but that areas of relatively greater contamination of the river represent a small portion of the river (about 5%) and are primarily oriented to depositional areas of the lower half of the river (below Kingman Lake), plus some additional, isolated locales of the river where sediment is being deposited. The results of are consistent with what has been observed previously in more limited studies and with the results of screening risk assessments, and also confirm that the primary contaminants of concern (CoCs) are two classes of chemicals- PCBs and PAHs. Metals are of lesser concern.

Consistent with predictions based upon sediment chemistry, the benthic community of the Anacostia is essentially depauparate with low diversity, low abundance, and

dominance by pollution tolerant worms. Note that in some areas of the river, anoxic (low to non-oxygenated) conditions may be responsible for some of these findings. Only a limited number of sediment samples have been subjected to laboratory testing for toxicity, however, chronic impacts to growth of invertebrates in samples from the station in the vicinity of the O Street/Southeast Federal Center (SEFC)/Washington Navy Yard (WNY) area have been observed. Re-testing of sediment from this area suggest that toxicity is due primarily to organic contaminants. These observations are consistent with predictions based on the sediment trend analysis: contaminants are more likely to be observed in the lower portions of the river where sediments are fine-grained. It is also expected that contamination from upstream and localized sources should be dispersed along the mobile transport path in the mid-reaches of the river and "hot spots" from localized sources would mainly be found in the depositional parts of the river.

A screening-level risk assessment indicated that eating contaminated fish is the primary pathway for human exposure, although other pathways may be present as identified in the Phase I report. See Appendix A for more detail. The primary ecological receptors at risk within the river are benthic organisms and fish. Benthic organisms may be exposed from direct contact with sediment and water or ingestion of particulates. This exposure may lead to lethal effects, reduce growth, and/or community level effects. Fish may be exposed from direct contact with sediment and water plus bioaccumulation of contaminants through the food chain. This exposure may lead to reduced reproductive capacity and/or tumors which may effect survival and growth. Risks also may exist to birds and mammals through aquatic food chain exposure. Very conservative assumptions were used in evaluations of risk to birds and mammals, thus there is considerable uncertainty as to whether they are actually at risk. A more detailed baseline risk assessment will be conducted in the future to obtain a better understanding of site specific exposure and effect relationships. Probabilistic methods may be used to characterize and manage for uncertainties in the assessment.

3 Comprehensive Toxics Load Reduction and Sediment Remediation Strategy

3.1 Strategy Overview

Restoration of the Anacostia, and a return to fishable and swimmable conditions, will take time. Although actions to deal with existing contaminated sediment in the river could begin at any time, there is a need to address the possibility of significant re-contamination before such actions are taken. This will require either controlling ongoing sources, or, intercepting releases before their discharge to the river. Achieving the sort of broad, sweeping control of ongoing sources of pollution will not be accomplished by a single action. Nor will it be accomplished quickly. To achieve the restoration of the Anacostia within the desired timeframe, multiple actions will need to be taken along two tracks:

The continuing input of contaminants into the river's headwaters, plus discharges within the river basin, will need to be diminished to a level at which significant exposures to aquatic life within the river will not occur and significant re-contamination of sediment will be prevented.	Existing sediment contamination within the river system, and ongoing point sources that contribute to sediment contamination, will need to be addressed by remedial actions to reduce on-going exposures to aquatic resources from contamination already present within the sediments

These objectives are interrelated, and the success of meeting the restoration objective is obviously dependent on controlling loadings to the river. And the goal of reducing loadings to the river will depend on a great number of actions dealing with a great number of contaminant sources, both point and nonpoint releases. ***Accordingly, source control will be best accomplished by applying a broad suite of techniques, such as stream bank stabilization and Low Impact Development, designed to reduce pollutant loadings, to eliminate transport routes of contaminants in the watershed, and to intercept contaminants before they are released to the river.***

Because of the breadth of actions that will be required, it is recognized that reductions in contaminant loadings throughout the watershed and to the Anacostia will require several years. Accordingly, some interim actions will be required so that actions within the river are not unduly delayed and phased remediation of contaminated sediments can proceed. In this manner, ongoing injury to aquatic resources and limitations on the use of the river can be curtailed long before complete source control can be implemented. This will be necessary to reach restoration goal by 2011. Also, general habitat restoration efforts throughout the Anacostia watershed would be accelerated and enhanced by improvements achieved with the river. The strategy presented here also contains proposals for longer-range, elements to address contaminant loadings well into the future.

The remediation strategy is dynamic, subject to refinement as additional data is obtained. Hot spot locations in this document are presented for geographical representation and are not meant to imply the specific sources of contaminants. Additional locations may be identified in the future. Known and possible new hot spots will require additional characterization and evaluation of remedial technologies before implementation.

Although there can be major engineering issues to address during implementation, conceptually, remediation of contaminated sediment is the more straightforward proposition of the two major objectives. It has a more manageable definition of the problems and scope, and is largely predicated upon engineering and economic constraints. Experience at many contaminated sediment sites across the country indicates that there is a relatively limited universe of remedial options to choose from. However, because of the wide variety of contaminant types and contaminant sources, reducing loadings within a sub-watershed can involve a broader suite of approaches than that for dealing with contaminated sediments. Each individual situation will require its own analysis and selection of remedial approaches tailored to the specific conditions presented. It is also anticipated that within a sub-watershed, no single approach will accomplish the objective, no matter how small the area. Therefore, this management strategy presents a large menu of choices for achieving loadings reductions under the many situations that may be presented within a sub-watershed.

3.2 Institutional Changes Needed to Accomplish Source Control

Some of the techniques proposed for reduction of toxic loadings within the watershed and for remediation of sediment in the Anacostia River are relatively new and innovative. Collectively, they represent alternative approaches for doing stormwater management and environmental restoration. Education and outreach efforts are building blocks for institutional change, and critical in helping to reshape public opinion and policies. Both of these need to be long-term efforts.

Often the current state of practices are entrenched in institutional systems and are better known by agencies and by the public through past and current outreach efforts There are often several barriers to achieving changes in existing practices and systems. There can be financial barriers, psychological ones, institutional policies, and regulatory requirements (or lack thereof), which can collectively hinder incorporating the changes and improvements necessary. Changes in personal, corporate, and governmental habits will be required. Also, because management of contaminants and stormwater is codified in regulatory statutes, improvements to these institutional policies will be required.

Institutional barriers to change are often the most difficult obstacles to overcome when attempting something new. Barriers such as cost or situation uniqueness are easier to address and overcome by employing price breaks, longer financing terms, and tailoring the design to fit the situation. But decision makers are often resistant to change because of the risks involved, should it fail on their watch. Few public works engineers or administrators want to be tied to something that is viewed as risky or untested. Changes in habits or institutional policies often take more time and require both successful pilot projects and an integrated effort by multiple parties to succeed.

Below is a bulleted summary of general actions and initiatives that could help achieve the necessary changes to accomplish reductions in contaminant releases and loadings to the river:

- Pilot project studies in representative catchments or riverbed areas.
- Technical and institutional workshops comprehensively covering these alternative techniques. This would most likely include focused workshops/seminars given to financial decisions makers, technical professionals/permit regulators, public works agencies, grass roots organizations, and the construction/developer industry.
- Research grants to academia so that they can experiment with new techniques (create test bed/pilot projects).
- Pilot project articles/videos, public tours and mailings, and demonstrations (target homeowner associations and the general public).
- Media press releases/peer reviewed professional journal article.
- Tradeshow/Conference/Internet presentations.
- Brown-bag luncheons to the consulting and engineering professions.
- Curriculum/coursework additions at the university level incorporating these innovative methods.

Nonstructured outreach programs are the most difficult to address and do not readily lend themselves to a bulleted listing. These should really be termed “less” structured. The concept basically involves the old expression to “think outside the box.” Nonstructured outreach programs are typically voluntary and non-regulatory. This is the area where public outreach and education can be improved in a less structured manner/program. Such voluntary things like the “adopt a highway/road” effort could incorporate steps to reduce loadings of toxics/sediment and improve stormwater management along with their primary task of removing litter from the roadways. Incentives and variances are also avenues that can promote institutional change in a less structured format.

3.2.1 Watershed Education, Outreach, and Pollution Prevention

The Anacostia River watershed includes a wide range of communities, all with different levels of knowledge and interest in issues pertaining to the river. However, many of its citizens are aware that significant threats to the river include raw sewage, contaminated sediments, and continued contamination of the Anacostia River through stormwater runoff. Citizens understand that this contamination affects the fish and other aquatic life that may ultimately become part of the human food chain. This general awareness needs to be heightened into a sense of stakeholder participation and refined to a sense of stewardship for the river. Success for restoring the river depends upon community (citizens, local businesses, municipalities, etc.) involvement and support.

This strategy proposes that grant money be provided to a coalition of AWTA/AWRC approved community representatives whose sole purpose will be to educate the broader watershed communities about the technical issues surrounding the impacts of contamination in the Anacostia River and to involve the community in formulating

solutions. A Technical Assistance Grant (TAG) will require the coalition to hire a technical expert who will describe the issue of contamination in terms easily understood by community representatives. The technical expert would communicate the extensive amount of research done by AWTA and will also use other sources to give the community a broad understanding of the issue and possible solutions.

As envisioned, the technical expert and at least one member of the community coalition would also attend AWTA and AWRC meetings and serve in an advisory role. These representatives would also be responsible for relaying information back to the broader community and raising community concerns to AWTA and AWRC.

Another pollution prevention consideration may include funding for an inventory and then, if warranted, an accelerated phase-out of PCB-containing equipment. This approach has been used in the Great Lakes and should be considered for the Anacostia. Additional efforts may involve small businesses, by providing free testing and/or reduced disposal costs for PCBs and other hazardous wastes.

3.2.2 Changes in building codes, zoning, and permitting processes

Many institutional changes can actually be hampered by the regulatory systems developed to protect the environment and ensure the safety of the general public. Even in today's electronic world, building codes, zoning, permitting, and maintenance requirements are difficult to revise and are not changed overnight. These potential barriers are often formidable impediments to achieving improvement and can be used by the reluctant to halt the possibility of implementing improvements. Traditional Best Management Practices (BMPs) are codified into existing regulations (state, county, and city level), often resulting in an additional resistance or disincentive to change. Actions to address these barriers require a concerted effort from multiple parties ("top-down" and "bottom-up" approaches).

It is recognized that pilot or demonstration projects, such as the LID pilot recommended below, can only accomplish a certain, limited reduction in storm water volume and contaminant loadings. The value of pilot projects is often more in the demonstration that such approaches do achieve the desired result than the magnitude of the the actual reductions. In order for broader application of these techniques, for faster incorporation of these approaches, and for greater reductions to be achieved, it is also recognized that institutional changes must be made that require use of such practices beyond what can be accomplished through government-sponsored pilot projects.

Despite the difficulties that may be encountered while updating the institutional controls that address storm water, making these changes is paramount to achieving source reduction in a reasonable time frame. Requiring certain obvious improvements as a condition for obtaining a permit, either for new construction or for appropriate remodels, is one necessary element to achieving timely, broad-scale storm water control. For instance, Prince George's County issued over 31,000 building permits for new construction and remodels in 2001. D.C. has also implemented changes in building codes and permitting processes. If all new construction and only a fraction of remodel permits

included requirements for stormwater management**,** a greater contribution would be made than that achieved through pilot demonstration projects. It is important to realize that the benefits that could be realized by reducing stormwater volume also carries tremendous benefits in reducing contaminant transport to the Anacostia as well.

Zoning regulations are an effective way to regulate building coverage on sites. These should be revised and refined to bring about appropriate pervious and impervious restrictions. Zoning in the District of Columbia can be revised to include sustainable design practices. These could be negotiated in the Planned Urban Development review process on large-scale redevelopment projects. New developments in urban areas such as big box retail centers and large-scale federal office buildings should all be constructed with state-of-the-art best practices such as green roofs and best practice parking lots.

This strategy recommends that grants be made available to the counties and DC at $125K each to assist with the review of their zoning, building codes, and permit processes for the integration of LID and other innovative approaches into these institutional programs. Grants would help adsorb the costs of not only changing the code, but also with the public participation process, training of staff in new approaches, educational outreach, and so on.

Actions could also include comparing and revising stormwater management, building codes, zoning, and permitting requirements for jurisdictions that have already implemented and are using the proposed source reduction techniques. Such a comparison can be used to gain knowledge from lessons learned by others, as well as reduce the effort needed to make these institutional changes.

When creating new codes, zoning, and permitting requirements, some flexibility should be incorporated to allow for the possibility of trying new and future innovations. In addition, using new source control/stormwater management techniques helps to expand the library of data available to the decision makers.

3.3 Source Identification Needs

3.3.1 Tributary and Outfall Sampling

As described in the CSM, flow from the Northeast and Northwest branches is known to carry a flux of contaminants to the Anacostia River. However, actual concentrations have only been measured at the U.S. Geological Survey gauging stations and only a few occasions in one study (Gruessner et al. 1997). In terms of understanding how to address the problem of chemical contamination in the river, an important data gap that needs to be addressed is the lack of storm water monitoring data for contaminants, necessary to quantify loads. Without an adequate characterization of loads to the river, managers will be unable to evaluate the efficacy of potential sediment remediation strategies, and will not be able to address contaminant source areas in a cost effective way. AWTA has begun to address this gap with the collection of monitoring data at six outfalls and/or tributaries during three storm events in the spring and summer, as part of Phase II investigations.

Besides the Northeast and Northwest branches, a number of tributaries to the Anacostia tidal basin drain sub-watersheds, which are primarily located within the bounds of the District of Columbia. These smaller river basin streams include ones such as Fort Chaplin, Fort Davis, Fort Dupont, Fort Stanton, Hickey Run, Nash Run, Popes Branch, Texas Avenue Tributary, and Watts Branch. In general, portions of each of these streams are open channels and other portions are enclosed (piped) channels, and stormwater runoff is conveyed to these streams primarily via the District's separate storm sewer system. Most of these tributaries are listed as "Impaired Water Bodies" (scheduled to be updated in October 2002), as indicated in Table 2. Toxic chemicals (metals and/or organics) are given as causes of impairment for all the streams listed, and as part of the District's TMDL program, TMDL allocations will be developed for these chemicals. The "potential impairment sources" for all of the streams in Table 2 is given as "nonpoint source pollution."

Table 2: Anacostia Tidal Basin streams on the District of Columbia's list of impaired water bodies.

Tributary	**Impairments**
Fort Chaplin Run	metals, pathogens
Fort Davis Tributary	metals, pathogens, BOD
Fort Dupont Creek	metals, pathogens
Fort Stanton Tributary	metals, pathogens, organics
Hickey Run	pathogens, oil and grease, organics
Lower Watts Branch	pathogens, organics, total suspended solids
Upper Watts Branch	pathogens, organics, total suspended solids
Nash Run	metals, pathogens, organics
Popes Branch (Hawes Run)	metals, pathogens, organics
Texas Avenue Tributary	metals, pathogens, organics

The DC Department of Health Water Quality Division is conducting Municipal Separate Storm Sewer System (MS4) monitoring at a number of locations as part of the requirements for the District's National Pollutant Discharge Elimination System (NPDES) permit. The DC Department of Health also conducts additional monitoring of District water bodies as part of its routine monitoring program. This monitoring program is primarily concerned with collecting data on nutrients, but samples are also analyzed for the metals listed in Table 3 (Clifford Jarmon, DC DOH, personal communication). However, as shown in the table, the detection limits employed produce censored data, relative to levels related to the protection of aquatic life, for several of the analytes.

Table 3: Metals data available (1995 and later) from DC DOH Routine Monitoring Program

Metal	Detection Limit[1] (µg/L)	Chronic Ambient Water Quality Criteria for the Protection of Aquatic Life
Arsenic	5	150
Cadmium	5	2.2 [3]
Chromium	10	11 [3]
Copper	25	9 [3]
Lead	5	2.5 [3]
Mercury[2]	0.2	0.77
Zinc	20	120 [3]
Selenium	5	5

[1] Detection limits may vary.
[2] Available for 1995 only.
[3] Hardness-dependent

Because of the high cost of doing laboratory analyses with appropriate aqueous detection limits for organic chemicals and for some metals, there is little useful information from the tidal basin streams to determine whether there are significant sources of these chemicals in the tidal basin sub-watersheds, or to determine the relative loads. There is a need for screening-level base-flow and storm-flow water quality monitoring of toxic constituents of concern, at sufficiently low detection limits to estimate loads in each of the tidal basin streams.

We propose a screening level water-quality monitoring program to estimate annual toxic chemical loads. Additional data should be collected for 6 baseflow (if appropriate) and for 12 storm events from ten additional outfalls (including CSOs) and tributaries, chosen with consideration of both sub-watershed size and likely presence of significant source areas. The estimated cost of this additional data collection effort is $625,000.

AWTA's sediment characterization of the river also provides evidence of other loads or inputs of contaminants to the Anacostia River from direct discharges within the river basin. What has been measured just before the branches discharge to the river and what is reflected within the river itself, is the cumulative flux from all the sub-watersheds of the Anacostia.

Local, state, and federal stakeholders have often had to make difficult decisions as to how and where to best employ limited monitoring resources. In order to efficiently increase efforts to control sources, more definitive identification of specific sources and sub-watersheds that contribute disproportionately to the total, overall flux to the river will be needed. Such refinement in source identification will allow for prioritizing of how limited resources should be applied. The following sections outline recommendations for enhanced source identification efforts in both the upper watershed and the river.

In addition to assisting with the identification of on-going sources, the measurements recommended, repeated over time, can form the basis for evaluating progress toward restoration of the river. Initial rounds of assessment will not only serve to help identify sources, but in some cases will form the initial baseline for future monitoring programs.

3.3.2 Recommended Watershed Survey of Bioaccumulative Contaminants

Persistant organic contaminants (PCBs and chlorinated pesticides) are major contaminants within the Anacostia and accumulate in fish tissues, resulting in fishing advisories. PAHs, which persist in invertebrates but not substantially in fish, are believed to be the primary contaminants responsible for the high prevalence of fish tumors in bottom-feeding brown bullheads. As previously stated, a broad-based, synoptic characterization of sub-watersheds, which are potential sources of persistent, bioaccumulative toxics (PBTs) is lacking. Existing field programs primarily deal with benthic and fish community measures and stream morphology as indicators of habitat conditions. Therefore, an assessment program geared to the detection of these compounds is recommended to ensure efficient, subsequent application of limited resources for source identification, control, and restoration.

The use of semi-permeable membrane devices (SPMDs) is one promising passive sampling approach to estimate the aqueous loading of non-polar and hydrophobic contaminants. SPMDs are permeable bags filled with sequestering oil that mimics the lipid membrane of organisms. As such, they estimate how much of these type of contaminants are bioavailable from the water column. As currently envisioned, passive sampling devices (semi-permeable membrane device or SPMDs) would be deployed at the mouth of 20 tributaries to the Anacostia which are representative of the major sub-watersheds which discharge to and form a substantial portion of the base flow of the Anacostia. Analysis of the SPMDs will provide indications of the average, temporally-integrated concentrations of aqueous PBTs flowing to the Anacostia.Concurrent deployment of *Corbicula* clams would complement the results from the SPMDs by reflecting the suspended particulate flux of PBTs at the same locations.

Results from this synoptic survey will provide indications as to which sub-watersheds contribute disproportionately to the combined, cumulative flux discharging to the head of the Anacostia. Additionally, congener specific analysis for PCBs may provide further qualitative information useful for the tracking and control of sources. Costs for this effort is estimated at $250K.

3.3.2.1 Groundwater

Groundwater in the lower Anacostia tidal watershed is not well characterized, and, as mentioned earlier in this document, is possibly a source of contaminants to the river. Because of the urban nature of the watershed and the long history of industrial and residential development in the area, it is likely that groundwater in the area is contaminated. However, little is known about the spatial distribution or types of non-point source contaminants in the groundwater, the characteristics of groundwater flow, or the volumetric flux of groundwater and associated contaminants to the river. Because of

the many modifications to the river system (including bulkheads, dredging, filling, engineered wetlands, storm drains, and leaky infrastructure), groundwater interactions with the river are expected to be complex. It is therefore important to use a wide variety of investigative tools to help characterize the groundwater flow system, the groundwater quality, and the groundwater / surface-water interactions.

From a risk-based perspective, groundwater in the tidal Anacostia basin will not have an effect on aquatic ecological receptors until it discharges to surface water. Therefore, the best risk-based approach for investigating groundwater in the tidal Anacostia basin is to investigate the areas that are most likely to have a measurable impact on the contaminant load in the river. This would include investigating groundwater at all of the currently known contaminant hotspots within the river, as well as any future hotspots that are discovered, and installing and sampling monitoring wells down gradient of land uses (such as landfills and areas of dredge spoils) near the river that are identified as potential contaminant sources. The approach works on the premise that a systematic investigation of groundwater at the spots that are most likely to impact the river can be used to assess whether further action will be required to protect the river ecosystem from contaminated groundwater discharge.

Several contaminant hotspots within the river channel already have been identified, and the possibility exists that more hotspots will be discovered during future investigations. The source of the contaminants in these hotspots should be investigated at each location. In some cases, groundwater inputs have been investigated using innovative techniques such as seepage collectors (Chadwick 2001), and some sites (such as the Washington Navy Yard) have been extensively investigated. Therefore, the groundwater investigation could include (1) a retrospective study of available groundwater information to determine data gaps; (2) a survey of historical land uses to determine likely sources of groundwater contamination; (3) the installation and sampling of monitoring wells in suspect areas; and, (4) the interpretation of the potential impact of groundwater contamination on the Anacostia River tidal ecosystem.

The first year of the study should consist of obtaining and interpreting existing groundwater information and surveying historical land uses, with the goal of formulating a sampling and analysis strategy for groundwater that will be implemented in the second and third year of the study. The final year will be used to synthesize the data into a final report and to begin implementing remedial efforts, if they are necessary. It is anticipated that the retrospective and historical land-use studies can be completed for about $250K. The level of effort that will be required for sampling and analysis is hard to quantify at this time, but a two-year effort of $600 - $700K might suffice. The final year's effort should be on the order of $200K, for a total over the life of the investigation of about $1.15 million.

This approach is consistent with investigations presented in other parts of this document, in that it seeks to identify the most important contaminant sources or discharge areas, it is risk based, and it will be implemented in areas identified in other parts of the overall

management plan. Knowledge of the groundwater component in areas slated for remediation will greatly enhance the likelihood for successful remedial activities.

3.3.3 Recommended Automated Monitoring Station Network

To address the major gaps in information on toxics and other pollutants throughout the upper watershed, a network of seven automated water quality stations is recommended. Their purpose is to provide both the stormflow and baseflow water quality data required (i.e., sediment, nutrients, toxics, organic and bacterial loads, etc) for the accurate estimation of annual pollutant loads to the river from the upper portion of the watershed. The network includes two high priority stations (i.e., existing lower Northeast and Northwest Branch USGS gauging station sites), the existing Lower Beaverdam Creek NPDES monitoring station, and four key Northeast and Northwest Branch tributary sites (i.e., Indian Creek, Paint Branch, upper Northwest Branch, and Sligo Creek). The two high priority station sites are recommended as permanent stations, to reflect the total flux to the river, whereas the other five sites are planned temporary sites (i.e., minimum two to three-year operation). Upon monitoring period completion, one or more of the temporary stations would be relocated to provide additional and more geographically-specific subwatershed water quality data. In this manner, both the total subwatershed toxics loading contribution and the relative contribution from various portions of that subwatershed may be better quantified. The anticipated monitoring data should prove invaluable for: 1) quantifying annual pollutant loads to the river at the head-of-tide, 2) determining relative subwatershed pollutant load contributions, 3) assisting local, regional, state, and federal resource management and restoration agencies in identifying subwatershed areas in greatest need of stormwater management water quality and/or quantity control, stream restoration, land use control, and/or follow up studies, and 4) the additional calibration and refinement of watershed water quality models. The estimated full implementation automated monitoring station network costs, including sampling for toxics, for the period of FY 2002-2009 are estimated at $3.4 million.

3.3.4 Biological Monitoring, Tracking, and Reporting Network

There are many elements constituting a comprehensive biological monitoring station network that are either already in place or expected to be within the next two to three years. Data are collected by each county, the state of Maryland and the District of Columbia, but with some difference, which makes interpretation difficult. As proposed by the AWRC's Anacostia Restoration Potential Workgroup (ARPW), it is recommended that the existing and planned programs become more integrated and form the basis of a comprehensive monitoring, tracking and reporting network for the entire watershed. Seventy-seven (77) stations are deemed necessary to comprise an adequate biological monitoring network.

Of the 77 recommended stations, 73 are tributary system-specific, with the remaining four comprised by representative tidal river sites. As currently proposed, monitoring frequency is as follows: 1) tidal river - annually, 2) major tributary mainstem - biennially, 3) high priority tributaries – annually, and 4) smaller tributaries - every three to five years. Tributary monitoring will employ current MBSS protocols and metrics. In addition, to the examination of fishes for the presence of deformities, erosions, lesions, and tumors (i.e., DELT's), brown bullhead's (and their barbels) have been selected as a key watershed-wide toxics sentinel species. Finally, limited water quality grab sampling and toxics screening (e.g., possible use of Microtox toxicity test) will be performed where warranted. The estimated full 2010 implementation biological monitoring station network costs are estimated to be on the order of $344,000 (Appendix 1, Table 1).

While much of the Anacostia has been developed for decades, both new and redevelopment projects are continuing to occur across the watershed. Systematically tracking these land use changes, as well as identifying the nature and extent of restoration projects and their potential applications within the watershed remains a formidable challenge. Detailed knowledge of the type and extent of impervious surfaces and associated storm drainage networks is essential. The estimated costs for tracking these preceding activities are estimated to be $200,000.

3.3.5 Monitoring the Recovery of the Anacostia River Toxic Condition

As previously noted, the physical, chemical and biological restoration and recovery of the Anacostia River will be dependent upon actions taken throughout the entire watershed. These actions will address not just the release and mobilization of toxic compounds, but stream habitat restoration, removal of fish blockages, and more. It is also the very nature of this diversified distributed approach that creates challenges for measuring success. Assessment of the progress toward reaching these goals will require a multi-tiered watershed perspective. And because the time to realize these cumulative gains is long, a multi-year assessment or monitoring program is dictated.

With the focus upon toxics, the assessment and monitoring elements recommended here will target the lower, tidally influenced river as the ultimate repository or sink of the majority of contaminants of primary concern within the watershed. This monitoring element will be complimentary and supplementary to what has been proposed for the broader objectives of the Anacostia Restoration Signatories approved Anacostia Watershed Restoration Indicators and Targets. (AWRC, 2001) This element is essentially comprised of periodic monitoring of

contaminant levels in sediment and fish tissue. As ultimate sinks for contaminants like PCBs and pesticides, sediment and fish tissue present the most efficient, clearest, and unequivocal evidence for overall success in reducing sources, contaminant loadings to the river, and biological contaminant exposure. The potential uses of such information, however, are not limited. They are multiple and include uses such as measuring progress toward lifting fish consumption advisories, verification of sediment remedial actions at reducing exposure levels, evaluation of recontamination, verification of source reductions, identification of new releases, and so on.

Assessment of the toxic condition of the Anacostia does have distinct nuances that are different from the detection of on-going releases of contaminants to the river. While source identification is recognized as a vital precursor for source control and may have some overlap in terms of methodology, the recommendations made here attempt to keep the intent clear between these complimentary, but different purposes. Monitoring efforts should explicitly be directed toward assessing the progress toward specific objectives. Monitoring should not be viewed as a research program nor an activity to fill gaps, but rather the regular and repeated application of standardized investigation approaches for the detection of changes in time and space.

To address the need for a comprehensive assessment and monitoring program, AWTA and the AWRC's Anacostia Restoration Potential Workgroup (ARPW) will work cooperatively to integrate strategies, as well as in collecting, analyzing, and distributing this and other restoration-related information to their respective memberships and the general public. It should be noted that because of the inherent time lag associated with the development, funding, and implementation of monitoring and data management system protocols, programs, and initiatives, some database gaps are expected to remain for several years.

As previously stated, among the many challenges facing the Anacostia restoration effort is also the creation and maintenance of a comprehensive watershed-wide database, which permits the systematic tracking of changing physical, chemical, and biological conditions in the watershed and the river. Distribution of this information to watershed resource managers, policy makers, and the general public in a timely and effective manner is required as well.

The fundamental monitoring approach outlined herein relies on the prominence of conditions within the lower river as the ultimate sink and thus a dominant indicator of overall conditions. Since an adaptive management strategies will require having more detailed information available should the desired progress toward restoration and recovery not be observed, the assessment and monitoring recommendation are integrated and complimentary with components directed toward establishing baseline information throughout the watershed.

3.3.5.1 Monitoring of River Toxics Sediment Recovery

Because the Anacostia is an effective sediment trap and since the primary contaminants of concern are hydrophobic compounds, the sedimentary record offers clear, simple evidence of trends at a regional to sub-regional scale. Measuring contaminants in sediment at regular intervals is an efficient, cost-effective approach for monitoring the river's overall toxics condition. With sufficiently broad but high-density coverage, assessment of the sediment record indicates not only general patterns in the river, but also provides indications about specific sources or discharge points where contaminants enter the river.

In 2000, AWTA sponsored two extensive surveys of sediment contamination throughout the entire river. These ground-breaking investigations established a thorough baseline against which progress can be compared, particularly the ANS survey with its network of sampling stations in every river reach. Repetition of this basic sediment investigation is recommended as the basis for a sediment-monitoring element.

Given the depositional rates and mixing depths observed, measurable changes in contaminant concentration levels in surficial sediments are not expected to occur within a short time frame. Therefore, a three-year cycle for sediment assessment is recommended. A three-year period will balance the need for multiple observations required to detect temporal trends with the rate of change that might be expected.

Since a good baseline of sediment contamination has been established, and indications from that survey are consistent with more limited, previous efforts, there is no demand for repeating a sediment survey *until* specific actions are taken that are expected to result in decreased exposure levels. Therefore, the actual start for the first round of sediment monitoring would be tied to some future date when significant advances are reached on source control, transport reduction of contaminants to the river, or remedial actions dealing with the secondary contamination currently present in the river.

The sediment monitoring effort will also continue to contribute to identification of point source discharges or loadings within the tidal portion of the river. This monitoring plan will distribute a number of fixed stations throughout all reaches of the river, plus a limited number of “floating” stations to be relocated from one event to another. This approach to source identification relies on the detection of anomalous, elevated levels of contaminants in the sediment adjacent to a point source discharge. The “floating” stations can be targeted near specific points suspected of being discharge sources.

3.3.5.2 Monitoring of Fish Tissue Concentrations

As detailed in the CSM, bottom fish species such as eels, brown bullhead, channel catfish and carp have considerable exposure to contaminants in sediments. This is reflected in tissue contamination with PCBs and pesticides to levels that require advisories restricting human consumption.. The tissue concentrations of PCBs and chlorinated pesticides in fish have been the basis for a fish consumption advisory for many years. Samples of fish analyzed for PCBs suggest that tissue residues are sufficiently elevated enough to adversely impact reproduction. Additionally, PCBs are being transferred to eggs, which may further reduce reproductive viability. Modeling of tissue PCB residues indicates that dietary sources are the significant uptake route for the levels being observed. These dietary concentrations in turn reflect either suspended particulates or sediment.

PAHs in sediments are the chemicals that appear to be most strongly linked to the high (50-68%) prevalence of liver tumors in brown bullheads. This species also has a high (13-23%) prevalence of skin tumors and altered (missing, shortened, or clubbed) barbels (23-56%). PAHs and other polycyclic aromatic compounds bind to DNA in the liver forming adducts. This alteration in the DNA is a likely early stage in the cancer process. The concentrations of these adducts were equally high in one year old and three year old bullheads from theAnacostia.

Because the health and condition of the fish community is such a key element of restoring the function and uses of the Anacostia, direct observation of improvements in this keystone compartment are recommended. Because of the differences in how the primary contaminants of PCBs/pesticides and PAHs are metabolized by fish, assessing the condition of the fish community can offer both a long-term and short-term measurement parameter for gauging success in reducing exposures.

Because of the way that PCBs are cycled through the ecosystem, they are persistent for long periods of time. Measuring tissue residues of PCBs (and chlorinated pesticides) would provide long-term, temporally integrative indications of success toward controlling these substances. The frequency of such measurements, however, needs to be weighed against the persistence of these compounds.

PAHs on the other hand are metabolized and biologically process much faster in fish. Therefore, the measurement options for PAHs offer both a short-term (within a couple of weeks) as well as longer-term indications of exposure and effects. For instance, observations from one-year-old brown bullheads shows that they can provide early warning signs of the tumors that will be more prevalent as adults.

An assessment and monitoring program for fish which emphasizes a focus on measurement parameters that can be directly related to contamination and which complements and supplements the programs already in place or planned is recommended. The scope and frequency of this program should be compatible with the other monitoring efforts envisioned, and appropriate for the primary contaminants of concern. The program being recommended is a combination of tissue residue analysis for chlorinated compounds, plus analysis of bile metabolites and DNA adducts to address PAHs. To provide direct observation of the impact of contamination on the fish, continued assessment of the incidence of skin and liver tumors, especially in one- and two-year old fish, is also recommended. Monitoring of brown bullheads should be performed on a three or four year cycle using age 3+ year fish. This frequency is similar to that of the sediment monitoring and that of other existing monitoring efforts. This also strikes a reasonable balance between the slow response expected for tissue residues and the quick response possible for the other measurement parameters. The data generated by this focused effort on toxics can be combined with results from other existing programs dealing with the fish community to provide a broad-brush assessment of the general health of the fish community.

3.4 Comprehensive Load Reduction Approach

Much of the pollution in the river is not from “dumping” directly into the river, but a result of pollution some distance from the river, which then flows to the river. The polluted water and solids flow to the river mainly through tributary streams and sewers. The pollution process is not limited to just along the river, but has occurred throughout the entire watershed. The river then serves as a gathering point or sink for what occurs throughout the entire watershed.

Because of the variety of sources throughout the entire watershed and the number of routes of transport to the river, reducing loadings will not be accomplished through a single sort of action. Rather, many different approaches, tailored to each situation, must be applied. The following sections describe a suite of techniques that would work to reduce contaminant loadings to the river.

3.4.1 Stormwater Management Retrofitting Overview

It is widely recognized that urban runoff normally contains a myriad of pollutants, all of which contribute to the degradation of stream quality. Stormwater retrofitting, which is the placement of a stormwater management practice into an existing developed area for the purpose of either improving water quality, protecting downstream channels, reducing flooding or meeting other watershed restoration needs, has been a centerpiece of the ongoing Anacostia restoration effort. Since 1987, approximately 6,000 acres (approximately 9.4 square miles) of previously uncontrolled, developed land in the Anacostia watershed has been brought under control through the stormwater retrofitting efforts of AWRC affiliates. The stormwater retrofitting strategy proposed for reducing toxic loadings to the Anacostia River and its tributaries incorporates the six following elements:

- the employment of a comprehensive suite of stormwater retrofitting techniques, with the principal objective of targeting older, uncontrolled areas within the watershed having characteristically high pollutant loadings;
- the building upon proven successes with both traditional and non-traditional stormwater management techniques, with the recognition that institutional changes will be needed to facilitate new and emerging technologies;
- recognition that reducing stream channel erosion levels and the associated transport of sediment-attached pollutants remains a major Anacostia restoration objective;
- adherence to an overall flexible and dynamic approach which views stormwater retrofitting as part art and part science, and which also acknowledges that new techniques will arise as the stormwater management field continues to evolve;
- acknowledgment that pollution prevention and education of the citizenry is an integral component for assuring overall long-term success; and
- the incorporation of a comprehensive monitoring strategy to quantify the performance of various selected stormwater management techniques.

The following sections describe a variety of techniques that may be mixed and merged to accomplish reductions in stormwater flux of contaminants.

3.4.2 Wet Ponds

Wet ponds are retention basins featuring a permanent pool of water throughout the year. They typically feature a large, four to six feet deep portion, as well as shallower areas located along the margins, which allow for the establishment of some emergent wetland vegetation. More recent designs feature aquatic benches or shelves for the creation of fringe marsh habitat, variable topography, extensive landscaping for improved wildlife habitat and aesthetics, as well as extended detention stormwater control. Wet ponds remove stormwater borne pollutants through a combination of gravitational settling, dilution, filtration and biological uptake and retention. They may be designed as either on-stream or off-stream facilities (Figure 5) and can be designed to provide both water quality and quantity control for a wide range of drainage areas and land uses, including high pollutant generating ones (a.k.a. stormwater hot spots).

In general, a minimum drainage area of 10-25 acres is recommended for wet ponds. Also, for highly developed/ultra urban areas their employment will generally be limited due to the unavailability of requisite space. They may, however, be employed in such areas provided that an acceptable downstream site exists. Because of their relatively large space consumption and a decreasing unavailability of publicly owned land, wet pond siting in the Anacostia watershed has grown more difficult overtime. It should also be noted that wet pond facilities control approximately 40 percent of the total 6,000 stormwater retrofitted acres in the Anacostia watershed.

3.4.3 Artificial Wetlands

Artificial wetlands are retention ponds typically incorporating large, shallow-depth water areas which are ideally suited for the establishment and growth of wetland plant species (Figure 6). These stormwater wetlands are designed to maximize pollutant removal through gravitational settling, dilution, filtration, and biological uptake and retention mechanisms. They may be located either on or off-stream and can be designed to provide both water quality and quantity control for a wide array of drainage area and land use conditions, including stormwater hotspots.

Figure 5: On-Stream Wet Pond and Off-Stream Wet Pond

In general, a minimum drainage area of 10-25 acres is recommended for artificial wetlands (Schueler, 1993; Galli, 1997). It should be noted that for highly developed/ultra urban areas the employment of artificial wetlands employment may be restricted by the general unavailability of requisite open space. However, they may be used in such areas provided that a suitable downstream site exists. Finally, small off-stream wetlands may be carefully sited within riparian corridors so as to intercept and treat uncontrolled runoff from small adjacent catchments. As best exemplified by Montgomery County's upper Sligo Creek restoration initiative, small artificial wetlands may be employed in forested stream corridors so as to provide both water quality and partial water quantity control with minimal tree removal.

3.4.4 Extended Detention Dry Ponds

Extended detention dry ponds are basins whose outlet control structure has been intentionally designed so as to slowly release (i.e., generally over a 12 to 24 hour period) stormwater runoff. Because of their relative inability to remove soluble pollutants, extended detention dry ponds are generally not viewed as being primary water quality BMP's. Nevertheless, they have well-documented ability to remove particulate pollutants, as well as reducing downstream channel erosion problems (Shueler, 1994). Consequently, they are well suited for incorporation into linked BMP systems (i.e., BMP's used in series, in a complementary manner). They may be located either on or off-stream and can be designed to provide runoff control for a broad range of drainage areas and land uses, including stormwater hotspots (Figure 3).

In general, a minimum drainage area of 10 acres is recommended for extended detention dry ponds. As with all "pond" systems, their use is typically restricted in highly developed/ultra urban areas by the general unavailability of suitable open space areas. They may, however, be employed in these areas provided that an adequate downstream location exists.

Figure 3. Extended Detention Dry Pond

3.4.5 Filtration Systems

Investigating and controlling individual releases and dealing with nonpoint sources will take a great deal of time and effort. A sequential approach to dealing with source control and restoration would delay return of river function and usability far into the future. Interception of pollutants before they are discharged to the river is a key element of a

load reduction strategy that will allow for restoration in a timely fashion. Filtration systems are one promising approach that can deal with the entire volume of runoff from subwatersheds and be tailored to filter or treat the specific contaminants of concern. These facilities may well become part of a longer-range solution. In fact, part of the District's plans to deal with stormwater include renovating deteriorated structures.

For the purposes of this document the term filtration systems includes, but is not limited to, the following stormwater management Best Management Practices (BMP's): sand filters (both surface and underground), bioretention, biofiltration swales, peat – sand filters, and new generation of filter media. All of these practices employ some type of filtering media designed to provide varying levels of water quality control. With the exception of biofiltration swales, which are characteristically very long linear systems, all of the preceding techniques are well suited for highly developed/ultra urban areas (Figure 4). The common use of these systems has generally been for the treatment of first flush runoff from smaller sites (i.e., drainage areas under five acres in size). However, sites as large and with complex pollutant mixes as BWI airport are now being addressed with such systems.

Figure 4. D.C. Underground Sand Filter Box and PG CO Bioretention System

Over the past few years, all three Anacostia jurisdictions have funded several new BMP filtration systems to treat runoff discharged through storm drain outfalls or streams. One large filtration project planned by the District of Columbia, is the installation of a peat-sand filter for treating stormwater runoff from an approximately 150 acre catchment draining the River Terrace community located on the Anacostia's east bank. The proposed facility also includes an artificial wetland for water polishing. Total costs for this planned project were estimated by the District at $900K. Another proposed facility is the installation of stormwater controls on the two outfalls that serve the RFK Stadium area. These two outfalls collect stormwater for the stadium parking areas and surrounding neighborhoods and then discharge to Kingman Lake . A combination oil/grit separator and a constructed wetland are proposed as end-of-the-pipe technologies to remove pollutants from the stormwater. Total project costs were estimated by the District at $1.2 million

3.4.6 Low Impact Urban Development Pilot Program

Low Impact Development (LID) is a new, cost-effective, alternative stormwater management technology that can be used to restore water quality of the streams in urban watersheds. LID combines the following six principles to protect and restore natural watershed features and improve water quality:

- Conserving existing natural and topographic features;
- Retrofitting that minimizes environmental impacts from cleared land and impervious surfaces;
- Maintaining or lengthening the pre-existing detention time of storms;
- Installing Integrated Management Practices (IMPs);
- Reducing contaminant migration and releases to surface waterways; and
- Providing education about simple to install pollution prevention measures.

LID applies small-scale, source control, Integrated Management Practices (IMPs) to each project site. LID retrofit techniques reduce runoff peak discharge, volume, and frequency, and improve the water quality of receiving streams. LID designs can easily be integrated to address critical watershed issues.

Figure 5. Retrofit of residential areas.

Figure 5 illustrates several examples of retrofitting residential areas using LID technologies. The LID unique micro-management source control concept is quite different from conventional, end-of-pipe treatment or conservation techniques. Bioretention, filtration, and other small-scale filtration and storage treatment facilities are

the most common LID techniques to improve pollutant removal efficiency. Similar concepts can be used to retrofit commercial and highway developments.

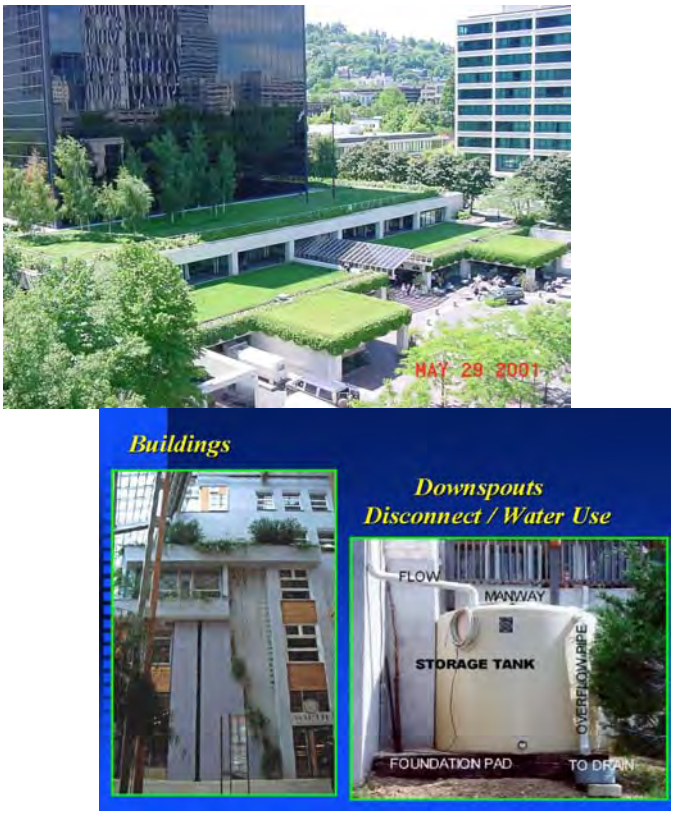

Figure 6. Retrofit of commercial developments.

Essentially, all aspects of the urban landscape can be designed to be multi-functional to treat urban runoff. Examples of practical and affordable LID projects include:

- Bioretention/rain gardens
- Strategic grading
- Amended soils
- Resource conservation
- Flatter wider swales
- Flatter slopes
- Tree/shrub depression/filtration
- Turf depression storage
- Landscape island storage/filtration
- Rooftop detention/retention
- Roof leader disconnection
- Parking lot/street storage/filtration
- Alternative surfaces and building materials
- Reduce impervious surface
- Surface roughness technology
- Rain barrels/cisterns/water use
- Catch basins/seepage pits
- Sidewalk storage
- Infiltration swales and trenches
- Tree box filters
- Trash collectors
- Maximize sheet flow
- Tree planting and landscaping
- reforestation

- Smaller culverts, pipes and inlets - Pollution prevention

Figure 7. Parking lot and court yard retrofits.

An Anacostia LID demonstration project is recommended to address runoff in all three Anacostia jurisdictions, from each of the following four (4) land use types: residential, commercial, industrial, and institutional areas. This proposed LID urban retrofit program will be modeled after programs and techniques pioneered through the Prince George County's Port Town Environmental Restoration Program. The demonstration project would encompass initial tasks, such as convening initial program meetings, all the way through construction, to monitoring effectiveness.

A total of fifteen (15) critical sub-watersheds will be selected within the three jurisdictions. On average, approximately 225 sites will be chosen for each watershed depending on watershed characteristics. Each LID site will control an average drainage area of approximately 1.0 acre. The total program cost is estimated to be $30,000,000. WASA has already targeted $2.8 million for LID development as part of their Long Term Control Plan to help control CSOs.

3.4.7 Street Sweeper Program

Despite the best efforts at minimizing the generation of pollutants, there will be some sources that escape control, particularly at the watershed scale. Deposition of soot, smoke particulates, exhaust, oil, fuels and so on within an urban landscape will undoubtedly continue. These types of sources – petroleum products and combustion by-products- are significant sources of PAHs, one of the major pollutants of the Anacostia. Collection of particulates from roadways, plus oil and grease, prior to their wash off is yet another approach to reducing contaminant loadings to the river.

While both conventional stormwater management techniques and LID are viewed as generally being effective at reducing the impacts of stormwater runoff on urban rivers and streams, new high-efficiency street sweepers, while not reducing runoff volumes, have been shown to yield significant and generally cost effective water quality benefits

by removing fine (i.e., ≤10 micron diameter) particles before they are mobilized and transported off-site by rainwater (EPA 1999).

There are several types of modern vacuum sweepers on the market today. Among the most efficient are regenerative-air sweepers, which dislodge and collect particles using a combined high velocity blower and vacuum system, and vacuum assisted dry sweepers. Independent studies of sweepers in Oregon and Washington have demonstrated that a 99.6 percent reduction in particulates over 10 microns is possible. Weekly sweepings yielded a 76 percent reduction in suspended solids reaching receiving waters (EPA 1999). Other evaluations of dry vacuum sweepers have shown 35 to 80 percent reductions in nonpoint source pollutants (Runoff Report, 1998). Recent estimates suggest that the new vacuum assisted dry sweeper might achieve a 50 to 88 percent overall reduction in the annual suspended solids loading for a residential street, depending on sweeping frequency (Bannerman, 1999).

Unlike surface and subsurface stormwater control solutions, which are often constrained by space limitations, implementation of street sweeping is limited primarily by the availability of funding. Implementation and long-term maintenance costs are highly variable, depending on curb mileage, whether sweepers are purchased or lease financed, and whether municipal staff or private contractors operate and maintain the machines. Equipment leasing can reduce program startup costs, while privatization of sweeping programs can eliminate the need for maintenance and can result in a significant reduction in sweeping costs per curb mile (NAPA 1995). Current sweeping costs range from approximately $10 to $70 per curb mile depending on frequency and program size (Table 4). Vacuum assisted sweepers typically last approximately eight years and range in cost from $80,000 to $250,000 each. Emerging sweeper technologies are expected to bring smaller, more maneuverable, and less costly sweepers to the market in the near future. The total estimated cost for implementing this alternative is $6.6 million dollars.

The effectiveness of street sweeping programs at removing both roadside trash and fine particles is heavily dependent upon sweeping frequency. Since optimal sweeping frequency is closely related to rainfall frequency and the rate of pollutant accumulation, it varies widely from city to city (see City of Alameda study). In many areas, weekly, year-round sweeping has been found to be both feasible and highly effective. It is also vital that sweepers have unimpeded access to curbs and gutters. This can be accomplished through the modification and strict enforcement of street parking regulations. Thus, it is important that sweeping schedules be widely and prominently posted through street signage and that the benefits of street sweeping be advertised.

In the Anacostia, street sweeping is currently performed with varying levels of frequency and success in portions of the District of Columbia, the City of Takoma Park, Silver Spring, and other Maryland municipalities. Perhaps the most effective is the Silver Spring Urban District’s public-private partnership sweeping program, which sweeps 26 curb miles three times a week using a regenerative-air sweeper. The District of Columbia also uses modern mechanical-vacuum sweepers on many of its streets, but has encountered significant maintenance problems and interference from parked cars. Furthermore, the program ceases operation on its regular routes each year between January and March.

While these local street sweeping programs continue to remove amounts of trash, debris, and sediment from local streets, each would benefit from additional funding for newer equipment, additional staff training, street signage, and enforcement of parking restrictions.

Table 4: Examples of Street Sweeping Programs

Location	Sweeper Type	Cost/Curb Mile	Frequency
Silver Spring, MD	Regenerative-Air	$14.79	3 times /week
Plymouth Township and Livonia, Michigan	Mechanical & Vacuum	$68.00 (average of two cities)	No data
Lakeland, FL	Vacuum Assisted	$33.38[1]	No data
Greeley, CO	Mechanical & Vacuum	$32.86	Arterial 18/yr Local 5/yr Parking 12/yr
Kansas City, MO	Mechanical & Vacuum (leased)	$28.62	Arterial 15/yr Residential 7/yr
Decatur, IL	Mechanical & Vacuum Assisted	$10.21	2 times /week
		$10.87	2 times /month

[1]Cost includes sweeper purchase, maintenance, salary (excluding benefits), and waste disposal

3.4.8 Water Quality Inlet Pilot Program

It is well known that stormwater runoff entering curbside and street inlets includes floatable, particulate (course and fine), and dissolved contaminants. Capture of these contaminants at their entry into the storm sewer system is another approach for reducing loadings to the river. Catchment basin inserts have been accepted as Best Management Practices (BMPs) for dealing with runoff in jurisdictions all across the country. This section focuses on the implementation of a demonstration project of catch basin retrofits and inserts (hence referred to as water quality inlet systems) that targets the improvement of water quality by reducing sediment and trash transport at the small watershed level.

Studies performed for New York City (Hydroqual 1995) revealed that generally less than ten percent (by weight) of the solids entering the storm sewer system is large enough to be retained by a 10-mesh screen. The passing debris is predominately dust, dirt, sand and small gravel. Since contaminants are more likely to adhere to smaller grain size particles, there is a limited emphasis on the prevention of trash entering the storm sewer system within this pilot program. However, areas that routinely require cleaning of trash would be candidates for screening of curb inlets to prevent trash entry.

Contamination in the storm runoff originates during rain events where impervious surfaces are washed free of the accumulated particulates and oil. Dissociation of the

chemicals in the storm water occurs rather quickly, generally reaching equilibrium within the water by the time storm water has reached a catch basin. Therefore, water quality inlet retrofits or inserts require proper design to address the site-specific ration of dissolved phase contamination to particulate contamination.

A review of technology and current practice will yield a good foundation on which to build a credible program to apply this evolving technology. Both the effectiveness and application of catch basin technology and an assessment of the local and standard practice within the industry will improve the program success. Data can then be extracted from these sources and placed within the context of existing information on the watershed.

In early designs, many storm drain inlets were limited in their ability to capture and retain small to medium-sized solids. The scouring affect caused by the hydraulic forces tended to continually mobilize any small grain particles and can even transport the larger settled particles during heavy rain events. Typically, routine maintenance involving removal of sediment is on a fairly limited schedule (once or twice a quarter) or on an as needed basis. While benefits to solids removal are evident during operation, failure to clean many inlets can render them ineffective for any beneficial effect. Various manufacturers have been working to address some of these issues with design changes to produce promising new water quality inlet systems and inserts. A partial listing of water quality inlet objectives and insert system solutions is provided as Table 5.

Table 5: Partial Listing of Water Quality Inlet and Insert Systems

Objectives	**Technology or Practice**
Reduce load of particles re-entrained	1) Vortex hood 2) Increased catch basin cleaning frequency 3) Appropriate design or filter material
Eliminate trash transport to next catch basin	Vortex hood
Reduce load of particles entering the catch basin	1) Increased frequency of street sweeping 2) Inlet strainers/filters
Reduce trash load entering catch basin	Curb screens
Reduce Oil an Grease loading	Sorbant filter media, sock, or cartridges
Odor reduction from sewer gas	1) Vortex hood 2) Appropriate design

The water quality inlet demonstration project recommended is a phased, public/private storm drain-based approach designed to maximize effectiveness and reduce cost. Implementing a water quality inlet demonstration project that targets one tributary of the Anacostia can verify design assumptions, improve the accuracy of cost design, installation, and operation costs.

Training and awareness and community involvement are also important aspects of the program. The objective is to raise interest and present opportunities to property owners to maximize participation. The possibility of granting storm water utility credits should also be explored as a means to increase participation. Training on operations and maintenance as well as procurement will be included.

The costs presented here are for budgetary use: assumptions and unit costs will be updated after the demonstration project is complete. The unit costs include assumptions based on site specific information obtained at the time of generation. Approximately $1.5 million would be required to implement the pilot water quality inlet demonstration project

Based on current information, one leading subwatershed candidate for this proposed water quality inlet system demonstration project is Hickey Run. This subwatershed is approximately 40 percent impervious and has a mix of land uses and storm drain inlet types. Extensive water quality data also exists in this tributary since it is also regulated under an NPDES permit. In older, highly developed areas lacking stormwater management controls, trash and particulate loading to the river can often be reduced through the installation of water quality and/or trash reduction devices at the point of entry into the storm drain system. In addition to the broader installation of water quality inlets to reduce floatable and sediment loading, devices that remove dissolved contaminants at certain inlets may also be required. The types of contamination typically present in the water column include suspended solid, total metal, oil and grease and other organic-based compounds. From these data, designs which can be implemented and is scaleable to encompass the full watershed can be performed.

3.4.9 Trash Management

Figure 8: Discarded Debris

It is estimated that over 20,000 tons of trash and debris enter the Anacostia River annually (PG DER, 1994). Of this amount, at least 165.5 tons of floatables (e.g., plastic bottles, styrofoam cups, plastic bags, aluminum cans, etc.) enter the river annually from the Maryland portion of the watershed (MWCOG, 2001). The 2001 Anacostia Watershed Society's annual trash collection event removed over 10 tons of trash from the river in just one day. WASA operates skimmer boats just for the removal of trash from the river. However, access throughout the river is an issue for these boats. Without question, floatable trash remains one of the watershed's most highly visible and aesthetic problems. Although trash is not generally thought of as presenting a significant threat from a toxic constituents perspective, trash and non-woody debris can have chemical and biological impacts on receiving waters including: interference with the establishment of aquatic plants; leaching of toxics from certain types of trash, such as used oil quart containers and filters, batteries; plus hazards to wildlife through ingestion of or entanglement in floating debris (Herson-Jones et al., 1994). Trash *does* impact overall efforts to restore the Anacostia

River. The occurrence of trash, especially floatables, degrades the perception the river's value of both residents and visitors and thus impacts the willingness to make changes necessary to restore the river.

Due to the long residence time for water in the river, the Anacostia is highly retentive of trash and other pollutants. Because of its tidal nature though, the Anacostia River presents some special challenges to trash control efforts. The fluctuations in flows and the daily, tidally-influenced movement of trash and other floating debris up and downriver generally make the installation of cross-river floating trash booms at many locations impractical. Another issue is the inaccessibility of existing mechanical trash collection technologies (i.e., deep-draft skimmer boats) to access emergent fringe wetland areas and shallow pocket embayments. The presence of the railroad crossing bridge downstream of New York Avenue further restricts access to otherwise accessible upstream trash accumulations by the DC-WASA trash skimmer boats. In addition to the large quantity of trash entering the river via its many tributaries and storm drain outfalls, 11 major Combined Sewer Overflow (CSO) outfalls flowing from the District of Columbia's CSO system (which dates from the 1880s) have proven to be significant conveyances of trash into the river.

Like many other issues facing the Anacostia, trash will not be dealt with by a single approach. Trash control will only likely be accomplished by a suite of techniques that range from reducing trash generation through community education, to interception before its discharge to the river, to enhanced recovery once in the river.

3.4.9.1 Trash Interception at Anacostia Floodway Levee Pumping Station Facilities

Prince George's County, in conjunction with the State of Maryland Department of the Environment, has recently installed two mechanically cleaned trash screens at the Colmar Manor Pumping Station Facility. The pumping stations are responsible for pumping stormwater flows from an approximately 1500-acre area along the urbanized-side of the levee to the riverside of the Levee. Stormwater runoff from the urbanized areas carries a significant load of floatable trash and debris. Prior to the installation of the mechanically cleaned trash screens, the stormwater runoff, with its floatable trash and debris, would be pumped directly to the Anacostia River. Since the completion of the Pilot Demonstration Project, the floatable trash and debris are now captured by the trash screens prior to the stormwater entering the pumping stations. Once the trash is captured, the trash is automatically removed by the mechanical trash screen cleaner and dumped into a trash dumpster. As a result, it is estimated that approximately 5-10 tons of trash will be prevented from entering the Anacostia River each year.

This demonstration project illustrates that trash catching and removal systems can be a viable tool to combat floatable debris in the river, and, that such approaches can be accomplished within very limited land. Based upon the success of this demonstration project, the County is currently seeking additional grant funding to pursue the installation of additional mechanically cleaned trash screens at its other pumping station facilities.

3.4.9.2 Pilot Trash Control Project At Selected Stormwater and CSO Outfalls

As already noted, storm drain systems, in general, represent major conveyors of floatable trash. While curbside screening and street sweeping may capture some trash, debris will still be swept off the streets and through street inlets and storm drain systems and ultimately transported to the receiving stream or river. Trash netting systems, designed to capture this floatable material, are generally placed either within the storm drain system or directly below its outfall. In the tidal Anacostia River, one floating net system was recently installed near the Sousa Bridge (CSO 018) by DC-WASA as a demonstration project. Results from the nine-month long evaluation period have been favorable and DC-WASA expects to install other similar trash reduction systems.

Prince George's County is about to enter into a Memorandum of Understanding with the State of Maryland's Department of the Environment to identify and install a pilot system to control floatable debris at selected stormwater outfalls in the Anacostia River. This trash reduction project calls for the following:

- Planning study to evaluate trash reduction options at storm drain outfalls and inlets.
- Identify selected trash reduction options to be implemented at specific outfall and/or inlet areas.
- Design selected trash reduction options at site–specific locations for installation.
- Advertise selected trash reduction options for construction and installation.
- Award contract for construction and installation of selected trash reduction options.
- Complete contract for construction and installation of selected trash reduction options.

Trash netting systems have also been modified to work for trash interception on streams. Three District of Columbia streams have been identified in this plan as potential locations suitable for the installation of trash nets. Pending final results of the current demonstration project, it is recommended that these devices be installed at Hickey Run, Watts Branch, and Lower Beaverdam Creek. Installation, maintenance, and evaluation costs for three systems would total approximately $750K.

3.4.9.3 Municipal Trash Management Program

Prince George's County also has a Municipal Trash Program to reduce the amount of trash entering storm drains in all municipalities in the County. The Program selects an intersection in one of the municipalities and retrofit several storm drain inlets with devices that will capture trash before it enters the storm drain system (Figure 9). In addition, street sweeping is implemented on a weekly basis. This program provides funding for storm drain retrofits in problem trash areas and to purchase or lease street sweepers.

Figure 9. Examples of Municipal Trash Management Devices and Removal Techniques

3.4.9.4 Anacostia Trash Steering Committee

Maryland Department of the Environment's (MDE) Anacostia Trash Steering Committee (MDE, 2001) has identified various options for tidal river trash removal, which include, but are not limited to, the establishment of a multi-jurisdictional trash removal program involving several lead agencies from the state, counties, and District. One option includes the expansion of mechanical skimmer boat operations above the CSX railroad bridge to serve Maryland/District of Columbia waters. This could be accomplished through the creation of a second skimmer boat program based at the Anacostia Waterfront Park at Bladensburg. The purchase of additional skimmer boats, including shallower-draft skimmer boats, should increase the effectiveness of such programs. Another option includes the expansion of annual volunteer river shoreline clean up efforts, with an increase in the number of boats provided by MDE, M-NCPPC, the District of Columbia, and others at such events. The development of new technologies and techniques for removing shoreline trash could also yield solutions to the problem of trash removal from otherwise inaccessible or hard to reach stretches of shoreline.

The Anacostia Trash Steering Committee has also suggested that the strategic placement of floating booms, netting systems, and other trash catching devices at strategic sites including tributaries such as Lower Beaverdam Creek, Watts Branch, Hickey Run, and key CSO outfalls, be evaluated and pursued.

The demands of the above mentioned programs and facilities would necessitate the employment of a full time trash removal/river maintenance staff supported by dedicated funding sources. Secondary benefits to having staff on the river full time would also accrue.

This Management Strategy acknowledges that trash is not a primary issue related to the toxic contamination of the river. Nor does it presume that these efforts will completely solve the trash issue. However, it cannot ignore the psychological impacts, physical impacts to wildlife, and chemical constituent aspects related to trash. Therefore, it is recommended that complementary efforts be taken to intercept and remove trash. In keeping with the Anacostia Trash Steering Committee's recommendation for additional trash interception devices at tributaries and outfalls, it is recommended that trash catching systems be installed at various strategic locations.

Because successful restoration of the Anacostia will require the involvement and long-term support of the public as stakeholders in the process, the public perception of the river is a key element. An educational campaign, such as the effort by the Anacostia River Business Coalition, should also be actively pursued.

3.4.10 Stream Stabilization and Buffer Wetland Restoration

Increases in stormwater runoff associated with watershed development have significantly contributed to stream erosion, habitat loss, and sedimentation damage in the Anacostia watershed. These impacts started with the clearing of land hundreds of years ago for timber and agricultural purposes and have continued as the nature of watershed development shifted to residential and commercial uses to accommodate population growth and regional economic development needs. In the recent past, the shift in watershed densities and increases in impervious areas to accommodate urban and suburban land uses was not accompanied by stormwater controls to mitigate the effects of increased peak runoff flows and reduced replenishment of groundwater to support stream base flows. The result was devastating in terms of stream channel erosion and the sediment damages to stream habitat able to support diverse biological life.

Figure 10: Examples of stream channel erosion and undercutting which require stabilization.

Figures 14 through 16 track the progression of stream impacts from a stable channel through the increasing impacts of channel widening and down-cutting as the stream attempts to readjust to accommodate the radical changes in hydrology that can accompany major watershed changes. It has been estimated that up to two-thirds of sediment loadings generated in developed urban and suburban areas are caused by accelerated channel erosion rather than from upland overland flow sources, as traditionally thought. Erosion may also be a significant source of nutrient loadings impacting waters.

Figure 11: Severe down-cutting of stream channel has exposed utility features.

Figure 12: Examples of severe undercutting of stream channels.

Montgomery County has an aggressive program to mitigate the effects of peak runoff and reduced groundwater infiltration on streams. Since 1927, a comprehensive park acquisition and subdivision review program has purchased or reserved, as conservation easements, protective stream buffer areas for most of the large and small Anacostia tributaries in Montgomery County. These buffer areas help filter pollutants in runoff and provide habitat cover for fish and wildlife. The County now also employs a diverse array of stormwater infiltration and detention controls, along with improved site planning, to help mitigate the impacts of impervious area increases that can so radically affect stream hydrology and degrade stream habitat. These controls capture and treat runoff to address both the peak flow quantity impacts on streams and reduce pollutant loadings contained

in the runoff. Increasingly effective efforts at construction site sediment control and stormwater runoff control have been in effect since the early 1970s to mitigate the stormwater impacts of new development.

Table 6: Montogmery County's Commitment to Regional Anacostia Restoration Efforts

Project Type	Completed or Under Construction	Underway or In Design
Storm water retrofit	1,917 acres in 11 projects	813 acres in 11 projects
Stream Restoration	5.4 miles in 6 projects	12.55 miles in 24 projects
Watershed study	Upper Paint Branch; NE Branch (37.5 sq. miles)	Lower Paint Branch (7.3 sq. miles)

Since 1990, Montgomery County's Department of Environmental Protection has also instituted proactive measures to address runoff impacts and degraded stream conditions generated in areas of the county that developed before runoff controls were required. This award-winning ***Countywide Stream Protection Strategy*** has received extensive local and national recognition for its progressive, comprehensive approach and emerging success. The above table (Table 6) quantifies the extent of Montgomery County's efforts to build storm water retrofit and stream restoration projects that stabilize stream channel erosion and restore stream habitat.

Thus far, recently completed watershed feasibility planning studies cover some 45 square miles of Montgomery County's Anacostia watershed drainage. These projects led to the identification of many opportunities for retrofitting stormwater controls and restoring degraded sections of Anacostia tributaries. The following photographs show examples of the Anacostia projects constructed thus far. Some of these projects have been carried out with cooperation and support from COG and the Maryland-National Capital Park and Planning Commission. Some have also been carried out in partnership with the U.S. Army Corps of Engineers. Many projects have also received cost-share grant assistance from the State of Maryland.

To date, the County Department of Environmental Protection (DEP) has built or has under design over 2,700 acres of stormwater retrofit controls (22 projects) and 18 miles of restored streams (30 stream restoration projects). Projects have been built or under design in Sligo Creek, Northwest Branch, Paint Branch, and the Little Paint Branch. Some of the restoration projects also included new wetlands at the end of storm drain outfalls to mitigate water quality impacts and recreate lost habitat for frogs and salamanders. DEP's work in the Sligo Creek watershed is the most extensive. Monitoring since 1989 indicates that the stream now is able to support eleven native fish species, where degraded habitat conditions in the past were only able to support two species. Benthic community diversity has also improved. In the upper Paint Branch, temperature reductions have been achieved in the Upper Gum springs tributary that seem to be extending the quality and range of the brown trout habitat.

Collectively, these projects are significantly improving habitat support for aquatic life. They are substantially reducing the extent of new sediment loads delivered from the artificially accelerated stream channel erosion that has been stimulated by uncontrolled or inadequately controlled stormwater runoff. The increased biological diversity that can be supported through restored stream habitat can also supplement upland stormwater controls to uptake nutrient loadings that would otherwise be delivered downstream to further stress conditions in the Anacostia mainstem. Other projects have also diverted storm flows or taken other measures to reduce stream temperature impacts associated with watershed development. These latter efforts have focused on protecting fragile headwater areas of the Upper Paint Branch where protection of the naturally propagating brown trout fishery is of primary concern.

there are many further opportunities to continue these types of enhancements. These projects not only enhance and restore habitat, but also substantially reduce pollutant flux primarily by trapping sediments. Two such projects are being proposed within Prince George's County. Streambank stabilization and wetland restoration is recommended for sites on Paint Branch and Cabin Branch Creek. These projects will reduce suspended sediment by approximately 75 per cent and trace metals by 40 percent from the drainage areas totaling approximately 3 square miles. The cost for these projects is estimated at $845,000. More projects may be developed in the future.

3.4.11 Stream Channel Stabilization and Riparian Buffer Restoration

Increases in stormwater runoff associated with watershed development have had a significant impact on stream erosion, habitat loss, and sedimentation damages in the Anacostia watershed. These impacts started with the clearing of land hundreds of years ago for timber and agricultural purposes and have continued as the nature of watershed development shifted to residential and commercial uses to accommodate population growth and regional economic development needs. In the recent past, the shift in watershed densities and increases in impervious areas to accommodate urban and suburban land uses was not accompanied by stormwater controls to mitigate the effects of increased peak runoff flows and reduced replenishment of groundwater to support stream base flows. The result was devastating in terms of stream channel erosion and the sediment damages it caused to stream habitat able to support diverse biological life.

The accompanying illustrations (Figures 24-26) track the progression of stream impacts from a stable channel through the increasing impacts of channel widening and down-cutting as the stream attempts to readjust to accommodate the radical changes in hydrology that can accompany major watershed changes. It has been estimated that up to two-third of sediment loadings generated in developed urban and suburban areas are caused by accelerated channel erosion rather than from upland overland flow sources, as traditionally thought. Erosion may also be a significant source of nutrient loadings impacting waters.

Urban streams are often buried in pipes and culverts or are otherwise covered to facilitate development or to channel stormwater. In recent years, restoring streams to their natural biological and physical functions is an issue that is becoming increasingly popular as the environmental, social, and even economic benefits of natural drainage patterns and stream channels are recognized.

Stream rehabilitation projects range from trash removal to daylighting. The term daylighting applies to projects that expose some or all of the flow of buried waterways. The daylighting process may be combined with re-naturalization projects such as recreating floodplains, establishing riparian vegetation, and creating ponds or wetlands. Although daylighting projects can be rather expensive and require extensive planning and community education, their potential benefits are manifold, ranging from improved water quality and stream channel capacity to restored habitats and beautified public spaces.

Daylighting can be a means of routing runoff from combined sewer systems, thereby reducing the incidences of combined sewer overflows, decreasing loads reaching wastewater treatment facilities, and lowering maintenance costs of stormwater infrastructures. The hydraulic performance of a restored stream and floodplain may be vastly improved over that of an enclosed waterway, and erosion and flooding may be reduced because runoff is slowed by channel sinuosity and roughness. The associated vegetation can improve water quality by slowing and infiltrating stormwater, trapping sediment, and filtering organic and inorganic pollutants. Moreover, restored aquatic, riparian, and wetland habitats provide valuable living space for fish and wildlife. A re-naturalized area may also become the focal point in a community park, contribute to urban greenways, create leisure activities such as fishing, and provide learning opportunities for local school children.

Since 1987, the AWRC and its affiliates have employed aggressive programs designed to mitigate the effects of peak runoff and reduced groundwater infiltration on Anacostia streams. Since 1927, the Maryland-National Capital Park and Planning Commission (M-NCPPC) has had a comprehensive park acquisition and subdivision review program and has acquired or reserved, as conservation easements, protective stream buffer areas for most of the large and small Anacostia tributaries in Montgomery and Prince George's Counties. These riparian forest buffer areas help filter pollutants in runoff and provide habitat cover for fish and wildlife. All three Anacostia jurisdictions now employ a diverse array of stormwater infiltration and detention controls along with improved site planning to help mitigate the impacts of impervious area increases that can so radically affect stream hydrology and degrade stream habitat. These controls are typically designed to

capture and treat runoff to address peak flow quantity impacts on streams and reduce pollutant loadings contained in the runoff. Increasingly effective efforts at construction site sediment control and stormwater runoff control have generally been in effect since the 1970s and 1980s to mitigate the stormwater impacts of new development.

An example of a comprehensive watershed-based approach is Montgomery County's Department of Environmental Protection's award-winning 1999 ***Countywide Stream Protection Strategy.*** This strategy has received extensive local and national recognition for its progressive and comprehensive approach toward addressing runoff impacts and degraded stream conditions. It is also being used as a successful model for restoration activities in of the Anacostia watershed.

The following section exemplifies Montgomery County's and the AWRC's efforts to build both stormwater retrofit and stream restoration projects in the Anacostia that improve water quality, stabilize stream channel erosion and restore stream habitat.

Thus far, recently completed watershed feasibility planning studies cover some 45 square miles of Montgomery County's Anacostia watershed drainage. These projects led to the identification of many opportunities for retrofitting stormwater controls and restoring degraded sections of Anacostia tributaries. Figures 27-29 show examples of the Anacostia projects constructed thus far. Some of these projects have been carried out with cooperation and support from COG and the Maryland-National Capital Park and Planning Commission and some in partnership with the U.S. Army Corps of Engineers. Many projects have also received cost-share grant assistance from Maryland.

To date, the County Department of Environmental Protection (DEP) has built or has under design over 2700 acres of stormwater retrofit controls (22 projects) and 18 miles of restored streams (30 stream restoration projects). Projects have been built or under design in Sligo Creek, Northwest Branch, Paint Branch and the Little Paint Branch. Some of the restoration projects also included the implementation of new wetlands at the end of storm drain outfalls to mitigate water quality impacts and recreate lost habitat for frogs and salamanders. DEP's work in the Sligo Creek watershed is currently the most extensive.

Sligo Creek monitoring, which has been underway since 1989, indicates that the stream now is able to support 14 native fish species, where degraded habitat conditions in the past were only able to support three species. Benthic community diversity has also improved. In the upper Paint Branch, temperature reductions have been achieved in the Upper Gum springs tributary through the employment of a parallel pipe storm drainage system. Initial monitoring results strongly suggest that this system seems to be extending the quality and range of the brown trout habitat.

Collectively, these projects are significantly improving habitat support for aquatic life and substantially reduce the extent of new sediment loads delivered from the artificially accelerated stream channel erosion that has been stimulated by uncontrolled or inadequately controlled stormwater runoff. The increased biological diversity that can be supported through restored stream and riparian habitats can also supplement upland stormwater controls to uptake nutrient and toxic loadings that would otherwise be

delivered downstream to further stress conditions in the Anacostia main stem. Other projects have also diverted storm flows or taken other measures to reduce stream temperature impacts associated with watershed development. These latter efforts have focused on protecting fragile headwater areas of the Upper Paint Branch where protection of the naturally propagating brown trout fishery is of primary concern.

Many further opportunities exist to continue these sorts of enhancements. These sort of projects not only serve to enhance and restore habitat, but also can achieve substantial reductions in pollutant flux primarily by trapping sediments.

As part of its ongoing stream restoration program, the Watershed Protection Division of DC DOH is in the process of evaluating several sub-sheds to determine the feasibility of creating new habitat in the tidally influenced portion of the Anacostia basin. Habitat creation possibilities under consideration include stream daylighting, wetlands creation, augmentation of the riparian buffer zone, and removal of blockages to fish passageways. So far, a preliminary survey of the Fort Chapin tributary has indicated that stream daylighting will probably not be feasible in this sub-shed. Surveys of the sub-sheds of three other Anacostia tributaries, the Watts Branch, Fort Dupont, and Pope Branch, are currently under way. Each of these tributaries alternates between an open channel and an enclosed (piped) channel along its course, and the potential for stream daylighting exists at a number of locations along each channel. The implementation phase of the habitat creation effort is likely to begin in late 2002, though the habitat creation techniques eventually chosen will depend on the outcome of the surveys and the associated cost/benefit analyses. Because stream daylighting and wetlands creation are in general extremely expensive undertakings in urban areas, the availability of funding will be an important factor in determining the extent to which these habitat restoration techniques will be utilized in the Anacostia basin.

The Stickfoot Sewer sub-shed is another area that is being considered for daylighting. The Stickfoot sewer drainage basin roughly extends from the St. Elizabeth Hospital to the Anacostia River and includes the Popular Point area. It has been envisioned by the DC Department of Health and NOAA that the culverted section of the Stickfoot Sewer in the Popular Point area be daylighted and combined with the creation of an intertidal wetland, with the ultimate goal of creating spawning and rearing habitat for anadromous fish. A funding source has been identified for this project. However, the ultimate use of the Poplar Point area and the fate of the Stickfoot sewer will not be decided until input from all interested stakeholders has been considered.

Because of the potential benefits of stream daylighting to urban water quality, we propose that funding be provided for stream daylighting in the Anacostia tidal sub-basin, including a comprehensive monitoring program to evaluate the impact on water quality. Eight tidal basin tributaries are listed on the District's 303(d) list of water bodies with water quality impairments due to toxic chemicals. Additionally, many storm sewer lines are known to convey flow along former small stream beds. We propose stream daylighting and associated monitoring in six small tributary or separate storm sewer sub-sheds in the Anacostia tidal sub-basin (in addition to the proposed daylighting of the Stickfoot sewer, for which District of Columbia Government funding is being made

available). Until sub-shed surveys are completed, it is not possible to do a detailed cost estimate for each project. However, assuming that approximately ¼ mile of buried channel is daylighted in each of three sub-sheds, and assuming that the average cost per linear foot is approximately $1000, the total estimated cost of the proposed daylighting is $4,000,000. In addition, the estimated cost of associated water quality monitoring, assuming that inflow and outflow are monitored for five base-flow and five storm events (with three samples per storm event) at each of three locations, and assuming a cost per sample of approximately $1200, is $97,000.

There are also other potential opportunities within the upper watershed of the Anacostia for stream daylighting with wetland creation as well. Therefore, it is recommended that approximately $100,000 be used for conducting a comprehensive stream daylighting evaluation for the Montgomery County, and Prince George's County portions of the watershed.

3.4.12 Tidal Wetland Restoration

Wetlands, and stream corridors, are the mix of land, plants, animals, and network of waterways, which perform a number of valuable ecologic functions, such as providing habitat for aquatic and terrestrial plants and animals. But these areas also provide important and economically valuable physical functions such as modulating stream and river flow, storing stormwater, removing harmful materials from the water, trapping particulates, groundwater recharge and so on.

Over 90% of tidal wetlands in the Anacostia have been lost: The Army Corps of Engineers estimates that, between Bladensburg and river's mouth, approximately 2,500 acres of tidal emergent wetlands have been destroyed, leaving less than 100 acres. Moreover, the restoration at Kenilworth Marsh constitutes about 32 of these remaining 100 acres.

To address this degradation and loss of valuable wetlands, the State of Maryland, the counties, and the District have signed various agreements committing each other to restoration goals. Several projects have been initiated to achieve these goals, and additional ones are planned. For instance, the District is working with the U.S. Army Corps of Engineers (US ACOE) and the National Park Service (NPS) to develop plans to restore 31 acres of wetlands in a fringe area downstream of New York Avenue where mudflats form along the bulkhead. The District also wants to explore allowing the continued deterioration of bulkheads, while allowing voluntary re-establishment of fringe emergent wetland plants. The District of Columbia proposed to fund this task for $300,000.

There are several other locations along the shoreline where mud flats have formed along the seawall in response to the sediment load from tributaries and the altered hydrodynamics of the river. With proper design of elevations, planting of wetland species, and possibly design of hydraulic control structures, many of these areas may be amenable to restoration of tidal wetlands. It is recommended that $500K be used to assess these areas and develop specific plans for wetland restoration projects as appropriate.

Factors that must be considered for any wetland restoration include ensuring a clean source of sediment that will not contribute to contamination; projects are suitable for their proposed sites and provide for adequate vegetation planting; wildlife habitat enhancement; long-term monitoring and contingency plans for maintenance; and, public participation in and education about wetland protection programs.

3.5 Sediment Remediation

3.5.1 Remediation Strategy Overview

Results from the preliminary risk screening, predictions based upon the Phase II comprehensive characterization of sediment contamination, observations from other Phase II work, the observations of other investigators working on the Anacostia, and the continued fish consumption advisory all indicate that there is unacceptable risk associated with the contamination of sediments within the Anacostia. To address these risks, the investigators developed proposals for potential sediment remedial actions. As its primary objectives, these actions would reduce risk to benthic organisms and fish from contaminants (primarily PAHs and PCBs) in sediment and to reduce risk to humans from contaminants in fish tissue.

The approach adopted incorporates all available information and integrates an understanding of the river system as developed through the updated Conceptual Site Model. It assumes the interception of significant loadings to the river as a prerequisite necessary to minimize the potential for recontamination, and also that ultimately the identification and control of point and nonpoint sources will be accomplished. Additionally, the requisite long-term monitoring needed to assess remedial and source control effectiveness as well as recovery has been included.

Natural attenuation of hot spot sediments by deposition of cleaner sediment on top of more contaminated sediment is not necessarily a stand-alone remedy. Natural recovery by deposition of clean solids is expected to occur for 90+% of the river sediments. However, this 10+ year recovery process will not abate unacceptable risks rapidly enough for certain hot spot areas of the river. Therefore these hot spot areas have been identified for potential active remediation in the shorter term. Once these hot spots have been actively addressed, they will continue to recover along with the remainder of the river as ongoing sources are controlled. Until source loadings are reduced, minor recontamination may occur in these remediated areas. At the very least, the surface sediment concentrations of hazardous substances will be consistent with the levels in the remainder of the river. Therefore, this management strategy focuses on active, integrated, remedial actions, such as capping, *in situ* treatment, dredging, and so on.

Given the economic, logistical, technological and ecological constraints involved with removal and either disposal or treatment technologies for sediment, there may be significant advantages to managing contaminants in place wherever possible. Treatment in place, capping, and capping with reactive barriers are all approaches that are considered for possible application. Any such technology being considered will undergo full pilot evaluation and feasibility study prior to its selection as a remedial action. The

investigators have chosen those technologies that have been applied elsewhere or appear most promising, and evaluated their appropriateness and scale of application simply for cost-estimating purposes at this time. The following section details a pilot-scale evaluation program to evaluate reactive barrier capping in the Anacostia that has been funded by Congress. This sort of evaluation is exemplary of the investigation and feasibility study that would be applied before selection of any approach.

3.5.2 Pilot Evaluation of Innovative Capping Approaches

Subaqueous capping involves placement of a covering or cap of clean isolating material over a deposit of contaminated sediment to physically and chemically isolate it from the aquatic environment. Innovative *active* capping techniques, offering both containment *and* treatment, however, have not been attempted on any significant scale but can be an effective, low-cost means of managing the sediments that endanger health. The goal of such a cap is to ensure that any contaminants that may migrate through a cap will be sorbed, chemically bound, or degraded before release into the overlying water, while working within the confines of navigational issues. The operation of such a cap is similar in function to reactive barrier technologies that have proven successful in managing migration of groundwater contaminants.

A pilot evaluation program has been funded to provide site-specific preliminary design information on the application of innovative technologies to the Anacostia River where historic industrial, municipal, and military activities have resulted in potentially hazardous levels of PAHs, PCBs, metals, and other contaminants. The project will also demonstrate, on a field scale, the ability to design and construct caps that will provide treatment of sediment contaminants while simultaneously providing containment. The project will advance the implementation and acceptance of these under-utilized technologies by validating their efficacy at a well-characterized field site.

The project approach is to place and monitor several different types of sediment caps in small pilot cells. These caps will include designs to actively control seepage of contaminants into the river through permeability control, physically or chemically bind chemical contaminants or encourage degradation of chemical contaminants. The objective is to demonstrate the ability to place these caps and evaluate/demonstrate their effectiveness in achieving their design goals of chemical containment and/or treatment. The project will be conducted in two phases, each composed of several tasks. The first phase is to conduct laboratory treatability tests to ensure feasibility and expected effectiveness of selected cap technologies in the Anacostia River. Also, the first phase will involve finer-scale characterization of candidate placement locations, design of the caps, and preparation for field mobilization. Phase Two will start with construction of the pilot caps, evaluation of placement effectiveness, and then proceed to evaluation of the cap effectiveness.

3.5.3 Preliminary Identification of Areas Potentially Requiring Active Remediation

This section presents a preliminary identification of areas of the river that are recommended for potential active remediation based on locations showing the greatest

risk to aquatic organisms due to elevated concentrations of PAHs and PCBs, and, on having river dynamics conducive to remedial actions. The selection of these areas draws upon factors that combine to define the area's suitability for potential active remedial strategies. A spatial evaluation of contaminant concentrations was performed using the GIS-based Anacostia Watershed Project. Figure 13 shows areas of elevated concentrations of PAHs and PCBs identified by current data. Further evaluation will be conducted to verify and characterize these locations. The sediment dynamics at these locations are also considered to determine what remedial actions might be appropriate and whether the site-specific sediment stability would lend itself to effective, long term remediation. For instance, areas where sediment dynamics of erosion or dynamic equilibrium were not considered amenable to standard remedial approaches. Placement of a standard cap in an erosional zone would not provide long-term protection. Due to the potential depth of contaminated sediments, dredging could involve removal of substantial volumes to reach acceptable concentrations. Alternatively, minimal dredge cuts, deep enough to be protective of benthic organisms, could be backfilled (capped) with clean material. Although this approach may be feasible in parts of the river, in an erosional zone this approach could not be expected to provide long-term protection because of potential erosion of the cap.

It should be emphasized that it is premature to make conclusions regarding the scope for any actual remedial actions before the risk assessments have been finalized, and before a more detailed evaluation of alternatives has been conducted. The investigators make their proposals based upon certain assumptions and the best available information to date, and do so to provide a basis for cost estimates.

The identification of areas contaminated to such a degree that they pose unacceptable risk was initially estimated by comparison of sediment chemistry to benchmarks for protection of ecological resources. For PCBs, the benchmarks applied were the freshwater Threshold Effect Levels and Probable Effect Levels (TELs/PELs; 34 and 277 ppb respectively) that are indicative of a low and high probability of risk to the benthic community, respectively. These values draw upon synoptic chemical analyses with observations not only from bioassays with several freshwater species, but also from observations of several benthic community metrics. Because of the broad basis for their derivation, these values are considered more robust than benchmarks derived from single measurement endpoints. For PCBs, guidelines for sediment have yet to be established for the protection of fish by bioaccumulation. Completion of the full risk assessment may indicate that lower sediment PCB concentration are required so that food web exposure routes to fish are reduced sufficiently such that tissue levels decrease below human health and ecological risk values. Values assessed by Doelling-Brown in her food web model were also evaluated geographically. She estimated bioaccumulation at the average PCB concentration of 286 pp and at half of that value.

For PAHs that are metabolized by higher-level organisms (fish for example), two benchmarks were used:

- A freshwater sediment TEL of 1.7 ppm, which is protective of the benthic community, and

- A sediment guideline of 2 ppm, which is a risk threshold for benthic fish.

These initial screenings indicate that PAHs in sediments exceed the benchmarks throughout the entire river. Also, PCBs throughout the entire river exceeded the TEL, suggesting the potential for toxicity. Because of the extent of the areas that exceeded benchmarks based upon toxicity, additional evaluations were conducted to help determine those areas potentially in need of active remediation. A preliminary spatial evaluation of contaminant data was conducted to identify those areas that indicated the greatest degree of contaminant enrichment.

This assessment, together with the sediment dynamics consideration, resulted in identifying six areas to target for consideration of active remediation (Figure 13).

- Area 1: near O Street/SEFC/WNY (PCBs, PAHs, and metals)
- Area 2: just upstream from CSX lift bridge (PCBs and PAHs)
- Area 3: between the 11th Street and CSX bridges (PAHs)
- Area 4: off Poplar Point (PAHs and some PCBs)
- Area 5: upstream from the PEPCO Benning Road facility (PCBs)
- Area 6: the area in between the "hot-spots" and within the depositional zone of the lower river extending roughly between the South Capitol and 12th Street Bridges.

Although it should be stressed that sediment contamination throughout the entire river exceeded toxicity benchmarks for both PAHs and PCBs, the influence of hot spots should not be overlooked. For instance, the distribution of PCBs as an example tends to reinforce the utility of dealing with "hot spots." Although the PCB average observed in discrete sediment samples is 0.286 ppm, only 13% of the river bottom is predicted to have values above this figure. And the area of the "hot spots" identified below is approximately only 5% of the river bottom. Preliminary evaluation of the data in the GIS-based Anacostia Watershed Project by NOAA (unpublished), reducing exposure levels within this 5% of the river would result in average sediment exposures across the entire river being cut nearly in half. Comparison of this value (0.286 ppm) to the median PCB concentration of suspended particulates of 0.171 ppm reported by Doelling-Brown (2001), or even the lower range measured in suspended sediment loads from the NE/NW Branches of 0.02 to 0.06 ppm would tend to infer that major recontamination issues are limited in scope to areas near localized sources.

3.5.4 Potential Remediation Approaches

The most common approaches for remediation of contaminated sediment typically applied at other contaminated sediment sites have been limited to:

- dredging to remove sediment (with several disposal variations);
- capping to isolate contaminants;
- natural attenuation with monitoring of natural recovery over time; or

- thin-layer amendment or augmentation with clean sediments to accelerate recovery, followed with monitoring.

The proposed approaches considered for the Anacostia River includes these standard approaches, but also leaves open the possibility of applying innovative methods for addressing contamination in place, some of which have only had limited testing on a full-scale basis.

AWTA has been coordinating with the Sediments Remediation Action Team, under the Remediation Technologies Development Forum (RTDF), and with others to identify appropriate innovative alternatives. These innovative in-situ methods can be more cost effective than standard techniques (dredging and disposal). Additionally, their use in the Anacostia River would provide opportunities for research and demonstration of promising new technologies and would eliminate the additional risks associated with re-mobilization of contaminated material.

An evaluation of the constraints and applicability of each of these emerging technologies identified was conducted. This was done partly to verify that they were amenable to the conditions and contaminants present, but also to form the basis of cost estimates should full feasibility studies support their application.

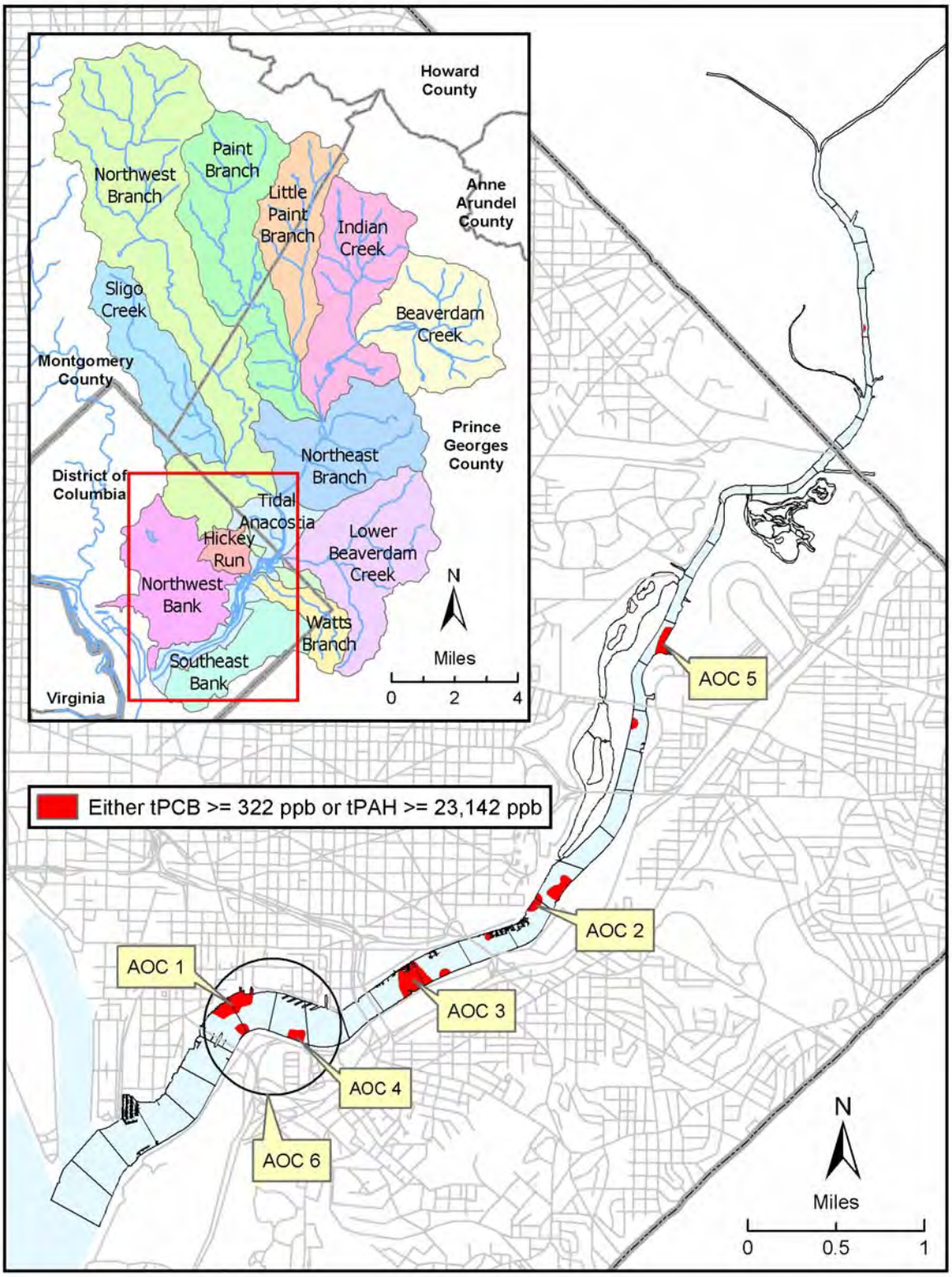

Figure 13 Areas identified for potential active remedial actions.

It must be stressed that this evaluation does not constitute presumptive remedies for these areas of concern. Full evaluation of each approach, which may entail pilot scale field trials, and alternatives would be conducted before any final approach is selected. Discussion of each Area and the proposed approach to be further evaluated follows.

3.5.4.1 Dredging

There are two areas that have been identified as potentially appropriate for dredging: Area 1 and Area 4. Area 1 is in the vicinity of O Street/SEFC/WNY, while Area 4 is off Poplar Point.

Area 1 covers about 15 acres near O Street/SEFC/WNY. A standard dredging will be considered to remove this hot spot of contamination. The degree of contamination, the range of contaminants observed (PCBs, PAHs, and metals), the temporal consistency of contamination at this locale, plus the prospects for source control are all factors for considering removal for this area.

Capping for isolation typically involves placement of a three foot cap. Addition of this depth of material may be problematic given the already shallow depths present in Area 1. Therefore, capping alone is not likely feasible. What is recommended is the removal of three feet of surficial material. Because this depth of removal is not expected to reach clean sediments, we propose that the dredge cuts be replaced or backfilled (capped essentially) with clean material. Since the depth of contaminated material at this location is unknown, this approach of removal and replacement is recommended as a more cost-effective alternative to complete removal by dredging down to baseline levels.

Costs for dredging only are estimated at \$15/ yd^3, based on recent dredging costs for the Kingman Lake wetland restoration project conducted in 2000. The Kingman Lake cost per cubic yard was based on mobilization/demobilization, new work/maintenance dredging, and water tube dike construction for movement of 186,000 yd^3 of material (O'Neill 2001, personal communication). This cost is comparable to a general estimate of \$15 to \$20/ yd^3 for removing and transporting contaminated sediments cited in a recent report summarizing contaminated sediment management and technology issues (Committee on Contaminated Marine Sediments 1997). These cost estimates encompass dredging and transport only; they do not include transport out of the area or disposal.

Within Area 1, the total volume of sediment, assuming a dredging depth of 3 feet, is approximately 73,000 yd^3, for a total dredging cost of \$1.5 million. Again, this figure does not include disposal costs. Because capping would involve acquiring clean material from outside the area and placing it, minimal costs for capping of the area of 73,000 yd^2 are expected to be approximately the same as for dredging, transporting and placement costs associated with Kingman Lake, or another \$1.5 million. If a no-cost source for clean fill could be found from outside the Anacostia (maintenance dredging along the Potomac, for instance), costs for capping would entail transporting (by barge most likely) and placement. Capping of an area this size is quite feasible. For instance, interim remedial actions at one Superfund site heavily contaminated with creosote involved a dispersal cap of 65 acres in water depths from 3 to 20 feet.

Disposal costs can be highly variable depending on site conditions and the degree of contamination. For cost estimating purposes, a figure of $300/yd^3 has been applied. This would result in total disposal costs of $21.9 million.

Area 4 lies in a depositional environment along the southern shoreline off Poplar Point and appears to stem from releases at the Stickfoot Sewer outfall. Planned restoration of Stickfoot Creek may address on-going contaminant flux from this apparent source. The area has elevated levels of primarily PAHs, but a smaller area of finer-grained material upstream from the outfall sandbar also contains PCBs. The surficial area covers 40,000 to 90,000 yd^2 of sediment, depending on definition of the "hot-spot."

Depth of contamination within this area is not well known. Additionally, the general Anacostia Waterfront Initiative effort has preliminary plans for renovation of the shoreline in this region that may entail construction of a boat ramp and other water-related facilities, and greater use of the waterfront. However, the area is currently quite shallow. To address risk concerns with this area as well as facilitate re-development, an aggressive combination of remedial approaches may be appropriate.

Dredging of three feet is identified as a potential remedial approach for the cost estimate for this area. Cost figures from Area 1 above are applied to the maximal coverage of this area at 90,000 yd^2. With combined estimates of $315 for dredging and disposal, total costs to dredge this area are estimated to be $28.4 million, although further characterization of the exact coverage of this area could reduce this figure.

Because sediments exposed after dredging may likely not be clean enough to pass risk screening, additional contingency measures are planned. This area may be appropriate for thin layer capping with innovative materials as an additional measure. The use of Aquablok™ is one such approach. AquaBlok is a patented, composite-aggregate technology resembling small stones and comprised of a dense aggregate core, clay or clay sized materials, and polymers. For typical product formulations, AquaBlok's clay component consists largely of bentonite clay. AquaBlok particles expand when hydrated, with the degree of expansion determined largely by the product formulation and salinity of the hydrating water. When a mass of discrete and relatively hard AquaBlok particles is hydrated, the mass transforms into a continuous and relatively soft body of material. Once developed, the hydrated AquaBlok material can act as an effective physical, hydraulic, and chemical environmental barrier. In addition to acting as an effective environmental barrier, AquaBlok can also provide adequate substrate for wetland vegetation as well as habitat for some macroinvertebrate organisms, particularly when additional organic materials (food) is provided as part of the product formulation. The AquaBlok technology can also act as a vector for delivery of wetland seeds as well as chemical reagents to facilitate in situ treatment of environmental contaminants.

There are several parameters that would influence how this technology might be applied for Area 4. The spatial coverage, depth of material, type of material, venting, proximity of railroad access, et cetera would affect overall costs. Applying some broad assumptions, costs for Area 4 have been estimated at $2 million.

3.5.4.2 Reactive Capping and/or in situ Treatment

There are three areas which may be amenable to innovative remedial approaches, either as reactive barrier caps or in situ treatment. Costs for various innovative techniques are often somewhat similar. Therefore, although specific ideas for each area have been explored in this strategy, the derived cost is considered generic enough for estimating purposes and allows for the flexibility to select an approach based on final feasibility studies for each area.

Area 3, located in a depositional environment in the vicinity of Washington Gas (WG) and Stewart Petroleum, contains elevated PAH concentrations in an area of approximately 44,400 yd^2. Measures to control offsite releases from the WG facility are being implemented. This area also stretches across the river to a large storm sewer outfall. The area is at the head of the depositional zone of the lower river. Sediment dynamics are a mix of total deposition and dynamic equilibrium.

An innovative technology called Limnofix may be considered on a preliminary basis for this area. Limnofix injects oxidants into the sediment to enhance bioremediation of PAHs. The Limnofix technology involves pumping calcium nitrate through an injection boom directly into the sediments (Senefelder 2001 personal communication). The Limnofix in situ treatment technology has been used in both pilot-scale and full-scale applications. Field demonstrations have been conducted at two Great Lakes areas of concern contaminated with PAHs - the Hamilton Harbor and St. Mary's River sites. A full-scale application has been conducted at a former manufactured gas plant site in Massachusetts with substantial reductions in PAH concentrations. Assuming a treatment depth of 1 meter, the total cost would be approximately $2.1 million with additional marginal costs for pilot scale testing.

Area 2, located just upstream from the CSX railroad lift bridge is an area with elevated concentrations of both PAHs and PCBs. This area is within a depositional sediment environment. The outfall from the NW Boundary swirl facility is one apparent source within this reach of the river and source control measures are being pursued for this facility (see Section 3.4.1).

Because contamination is a mix of organics, an innovative technology using electrochemistry might be considered for Area 2. The technology has been tested on a large scale in Europe, and has been field-tested in the United States. Further evaluation of this technology will be required. Area 2 would need to be adequately characterized to determine if this approach would apply to the sediment type at that location. The estimated volume of sediment to be treated at Area 2 is 15,000 yd^3.

Area 5 is the embayment in the vicinity of the northern, upstream boundary of the PEPCO Benning Road facility, where sediments contain PCBs. Sediments in the mainstream of the river at this location are in dynamic equilibrium, though the embayment of interest is more likely depositional.

One technology that may be amenable here is the *in situ* dechlorination of PCBs by the addition of reactive iron. Reports from bench-scale tests have demonstrated that colloidal

sized palladium/iron mixtures yielded extremely fast kinetics for dechlorination reactions, with slightly slower reactions with iron alone (Wang and Zhang 1997). Yak et al. (1999) demonstrated dechlorination of PCBs using zero-valent iron in subcritical water. Research efforts are currently underway to investigate the efficacy of this approach for in situ treatment of PCBs (Gardner personal communication).

Pending successful completion of further bench testing and a possible pilot scale test, this technique may be appropriate for treatment of PCBs within Area 5. This approach would have the benefit of not mobilizing PCBs from this area downstream. Bio AquaBlok capping may also be a viable alternative for this area. Due to uncertainties, firm cost estimates cannot be generated for remedial actions for this area as yet. Using costs for other approaches as a guideline, $1 million is estimated for potential implementation of this technique.

3.5.4.3 Area 6

Area 6 is defined as all the contaminated sediments within the lower river, roughly from the South Capital Street Bridge and the 12th Street Bridge not already encompassed by one of the other areas of concern. Sediments within this area appear to be contaminated by a mix of localized as well as upstream sources, but to a more moderate degree than those within the adjacent hot spots. Levels still are significant enough to pose unacceptable ecological risks when compared against benchmarks. These sediments are also all within a zone of depositional sediment dynamics which increases the likelihood that an active remedial action would have long-term stability. The total area from bridge to bridge, including “hot-spots” is about 100 acres.

As upstream source reduction and habitat restoration occurs, it is anticipated that there will be a reduction in suspended particulate loadings to the Anacostia. Therefore, sediment deposition rates within this region of the river, currently estimated to be on the order of 1½ cm per year (less than one inch per year), will be even lower. This reduced rate must be contrasted with the depth to which benthic organisms may burrow, disturb and mix sediment, referred to as the bioturbation depth, to evaluate whether natural burial processes would be sufficient within the desired timeframe to achieve restoration goals. Since bioturbation depths of healthy benthic communities typically extend from 10 to 20 cm, this deposition rate is not great enough to make natural attenuation of contaminated sediments within this area a viable alternative within the desired 2010 restoration time frame.

Since this area is depositional, accelerated burial of contaminated sediments may be a viable approach to achieve remedial goals within a reasonable time frame. Broadcast distribution of a thin layer of clean sediment over contaminated sediments is an approach that has been applied at other sediment sites around the country as an alternative to dredging and removal. Providing cleaner substrate also can accelerate recovery of benthic communities.

This approach to dealing with such an area assumes that a source of clean material of appropriate grain size would be available from dredging projects in the Potomac River

and could be barged to the Lower Anacostia for dispersal. Existing projects have shown that broadcast distribution can be easily and cheaply performed by simply washing sediments off barges with hydraulic force. This technique also results in a more uniform layer than other placement approaches.

This action would essentially be chosen as a final “polishing step,” subsequent to many other load reduction actions, should those actions and the remediation of the local hot spots not provide sufficient reductions in exposures to meet restoration goals. Because of the complex interaction of local sources and those throughout the entire watershed, it is not possible at this time to determine the likelihood of requiring such an action to meet the 2010 restoration goal. For estimating purposes, an amount of $5 million dollars has been budgeted for this action.

4 Total Costs for Toxics Reduction and Sediment Remediation

Category / Activity		Cost (% millions)
Non-point Source Reduction		
	Storm water retrofit	
	Retention/Detention facilities	32.0
	Low Impact Development (LID)	30.0
	Water Quality Inlets	1.5
	Filtration Devices	2.1
	Building Code/Institutional changes	0.4
	Sub-total	65.5
	Non-storm water Retrofit	
	Stream Restoration	22.0
	Tidal wetland Creation	7.2
	Street sweepr Programs	6.6
	Trash Reduction Systems	15.0
	Pollution Prevention/Watershed Outreach	10.0
	Sub-total	61.6
Poiont Source Reduction		
	End-of-pipe Controls	10.0
Tidal River Sediment Remediation		
	Anacostia Remediation Sites	65.0
Monitoring, Tracking, Reporting and Coordination		
	Automated Water Quality Monitoring Network	3.9
	Fish Tissue Sampling	0.6
	Bioaccumulative Flux	0.2
	SPMDs	0.2
	Groundwater Sampling	1.1
	Watershed tracking, reporting, coordination	5.0
	Sub-total	11.0
GRAND TOTAL		$212.6

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DRAFT
SITE CHARACTERIZATION REPORT
FOR
COMPARATIVE VALIDATION OF INNOVATIVE "ACTIVE CAPPING" TECHNOLOGIES
ANACOSTIA RIVER
WASHINGTON, DC

Purchase Order R137983

Prepared for the
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September 2003

EXECUTIVE SUMMARY

Horne Engineering Services Inc., (Horne Engineering), was contracted by the Hazardous Substance Research Center/South and Southwest (HSRC), Louisiana State University, to assist HSRC in conducting validation of "active capping" technologies in the Anacostia River, Washington, D.C. The objectives of the site characterization were to collect and analyze a broad range of physical, chemical and biological information; to establish an environmental baseline for the proposed capping areas; and to obtain sufficient sediment geotechnical data for cap placement and design. This report summarizes the site characterization investigation findings and results.

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LIST OF ACRONYMS

ADCP	Acoustic Doppler Current Profiler
ASTM	American Society for Testing and Materials
AVS/SEM	Acid Volatile Sulfide/Simultaneously Extracted Metals
AWTA	Anacostia Watershed Toxics Alliance
C	Celsius
CEC	Cation Exchange Capacity
CH	High Plasticity Silty Clay
CSO	Combined Sewer Outfall
DGPS	Differential Global Positioning System
DO	Dissolved Oxygen
DOH	Department of Health
DOT	Department of Transportation
dTPH	Diesel Total Petroleum Hydrocarbon
ECC	Earth Conservation Corps
ERL	Effects Range-Low
ERM	Effects Range-Medium
ERT	Earth Resource Technology
F	Fahrenheit
ft	Feet
FDA	Food and Drug Administration
GC/MS	Gas Chromatography/Mass Spectrophotometry
GIS	Geographic Information Systems
GPS	Global Positioning System
GSA	General Services Administration
HSRC	The Hazardous Substance Research Center/South and Southwest
Kg	Kilogram
Lb	Pounds
ICPRB	Interstate Commission on the Potomac River Basin
ID	Identification
LSU	Louisiana State University
MB	Method Blank
MS/MSD	Matrix spike/Matrix Spike Duplicate
Mg/kg	Milligram per kilogram
Mg/L	Milligram per Liter
ml	Milliliter
MDL	Method Detection Limit
MLLW	Mean Lower Low Water
NAD	North American Datum
NAVD	The North American Vertical Datum
NCR	Nonconformance Report
Ng/L	Nanograms per liter
NOAA	National Oceanic and Atmospheric Administration
NTu	Turbidity
OGM	Old Gas Manufacturing

OSI	Ocean Surveys, Inc.
PAHs	Polynuclear Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
POC	Point-of-Contact
PPE	Personnel Protection Equipment
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RL	Reporting Limit
RPD	Relative Percent Difference
SAV	Submerged Aquatic Vegetation
SCP	Site Characterization Plan
Sec	Second
SPI	Sediment Profile Imagery
SPAWAR	Navy Space and Warfare Systems Center
SRC	Syracuse Research Corporation
STL	Severn Trent Laboratories
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorus
tPAH	Total PAHs
tPCB	Total PCBs
TPH	Total Petroleum Hydrocarbon
TSS	Total Suspended Solids
µg/kg	Micrograms per kilogram
µmoles/g	Micromoles per gram
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USCS	Unified Soil Classification System
USDOA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOCs	Volatile Organic Compounds
WQC	Water Quality Certificate

1.0 PROJECT DESCRIPTION

Horne Engineering Services, Inc. (Horne Engineering) conducted the site characterization under the direction of the Hazardous Substance Research Center/South and Southwest (HSRC), Louisiana State University (LSU), and in accordance with the revised Site Characterization Plan (SCP) (Horne 2002). The SCP was reviewed, commented on, and approved by the members of the Anacostia Watershed Toxics Alliance (AWTA), including the United States Environmental Protection Agency (USEPA), the District of Columbia Department of Health (DOH), the National Park Service, and other government and private organizations.

1.1 Project Background

The HSRC is conducting comparative validation of innovative “active capping” technologies in the Anacostia River, Washington D.C. The goal of such a cap is to ensure that any contaminants that may migrate through the cap will be sorbed, chemically bound, or degraded before release into the overlying water. The project seeks to provide site-specific preliminary design information on the application of innovative technologies to the Anacostia River, where historic industrial, municipal, and military activities have resulted in potentially hazardous levels of polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), metals, and other contaminants. The project will also demonstrate, on a field scale, the ability to design and construct caps that will provide treatment of sediment contaminants while simultaneously providing containment. This project is an integral part of the efforts led by the AWTA to improve water quality and restore the river.

1.2 Project Purpose and Scope

The site characterization represented one component of the Anacostia River cap demonstration project. The purpose of the site characterization was the following:

- Establish the lateral and vertical variability of physical, chemical, and biological characteristics, including metal, PAHs, and PCBs, and benthic community assessment.
- Identify the current status of contamination
- Confirm appropriate areas for cap demonstration
- Determine the geotechnical characteristics of sediment to support cap design and construction
- Delineate the site geophysical conditions, including "chirp" sonar, side scan, sediment profiling imaging, bathymetric measures, and magnetometry survey
- Provide necessary baseline data for future evaluation of effectiveness of the capping placement and capping technologies.

1.3 Investigated Areas Description

Two investigation areas in the Anacostia River (Figure 1) were identified for characterization, based on previous site investigations and studies and known contamination summarized in the report tilted *Interpretive Summary of Existing Data Relevant to Potential Contaminants of Concern within the Anacostia River Watershed* by Syracuse Research Corporation (SRC) and the

Figure 1. Survey Area Location Map

National Oceanic and Atmospheric Administration (NOAA) (SRC and NOAA 2000). Both areas are adjacent to the Washington Navy Yard. Area 1 is just downstream from an old combined sewer outfall (CSO) site and in the area between the Earth Conservation Corps (ECC) pier and General Services Administration (GSA); Area 2 is near an old gas-manufacturing (OGM) site and a petroleum company site. The contaminants of concern are PCBs, PAHs, and metals near the CSO (SRC and NOAA 2000) and PAHs and metals at the OGM site (SRC and NOAA 2000). The areas selected for investigations are also identified for potential remedial actions in an AWTA report *Charting a Course Toward Restoration: A Toxic Chemical Management Strategy for the Anacostia River* (AWTA 2002).

1.4 Report Organization

This Site Characterization Report is organized in the following sections:

- Section 1 provides a brief project description
- Section 2 summarizes the Anacostia River background information including history, site selection, and existing contamination information
- Section 3 discusses the field investigations including utility clearance and permitting
- Section 4 discusses the geophysical investigations
- Section 5 discusses the sediment profile interface photography survey
- Section 6 discusses the sediment contamination characterization
- Section 7 discusses hydrodynamic data collection and the river flow current velocity survey
- Section 8 discusses the sediment geotechnical characterization
- Section 9 discusses the benthic community survey
- Section 10 provides references used in the preparation of this document.

2.0 BACKGROUND INFORMATION

2.1 The Anacostia River

The Anacostia River is a freshwater tidal system draining an urban watershed encompassing 176 square miles in Maryland and the District of Columbia (Figure 2). The Anacostia River watershed is a subwatershed within the Potomac River Drainage Basin, which in turn empties into the Chesapeake Bay.

The mean yearly discharge rate of the Anacostia River is 1,030 gallons/second (sec), and records dating from 1986 indicate a minimum discharge rate of 13 gallons/sec and a maximum of 237,760 gallons/sec. The high volume-to-influx ratio in the tidal Anacostia River results in a flow rate frequently described as "sluggish." Under normal conditions, river currents are driven by tidal fluctuations. Estimates of cumulative flushing times based solely on a tidal prism model (i.e., no river inflow), using updated river morphology, were calculated at 23 days (Katz et al. 2000). Because of the addition of river inflow, actual flushing times would be less.

2.2 Previous Investigations of the Anacostia River

Substantial deforestation and agricultural development, intense and continuous urbanization, industrial development, and significant loss of fringe wetlands and marshes have resulted in significant degradation of water quality in the Anacostia River. Elevated levels of hazardous substances, including PCBs, pesticides such as chlordane, lead and other heavy metals, and PAHs have been found in sediment throughout the 8.4-mile run of the Anacostia River (SRC and NOAA 2000, Velinsky and Ashley 2001). Hazardous substances such as PCBs have been found in fish at concentrations exceeding the Food and Drug Administration (FDA) Action Levels. The District of Columbia declared several fish consumption health advisories in the 1990s, with restrictions on consuming bottom-feeding species and game fish and a fish consumption ban for pregnant women and children.

In addition, the USEPA identified the Anacostia River as one of the most contaminated rivers in the Chesapeake Bay watershed; it is one of three Regions of Concern recognized by the USEPA's Chesapeake Bay Program as posing a significant risk to aquatic life from sediment contamination.

2.3 Regional Geology

The watershed is comprised of the Piedmont Plateau and the Coastal Plain provinces. The Piedmont's rolling hills are made of thin layers of sediment overlying metamorphic and crystalline rocks. The topography of the Coastal Plain gently grades from the fall line to the eastern shore and is made of a thickening wedge of fluvial and deltaic sediments to the east. The western limit of the province is commonly referred to as the Fall Line, which is located approximately 3 miles northwest of the site.

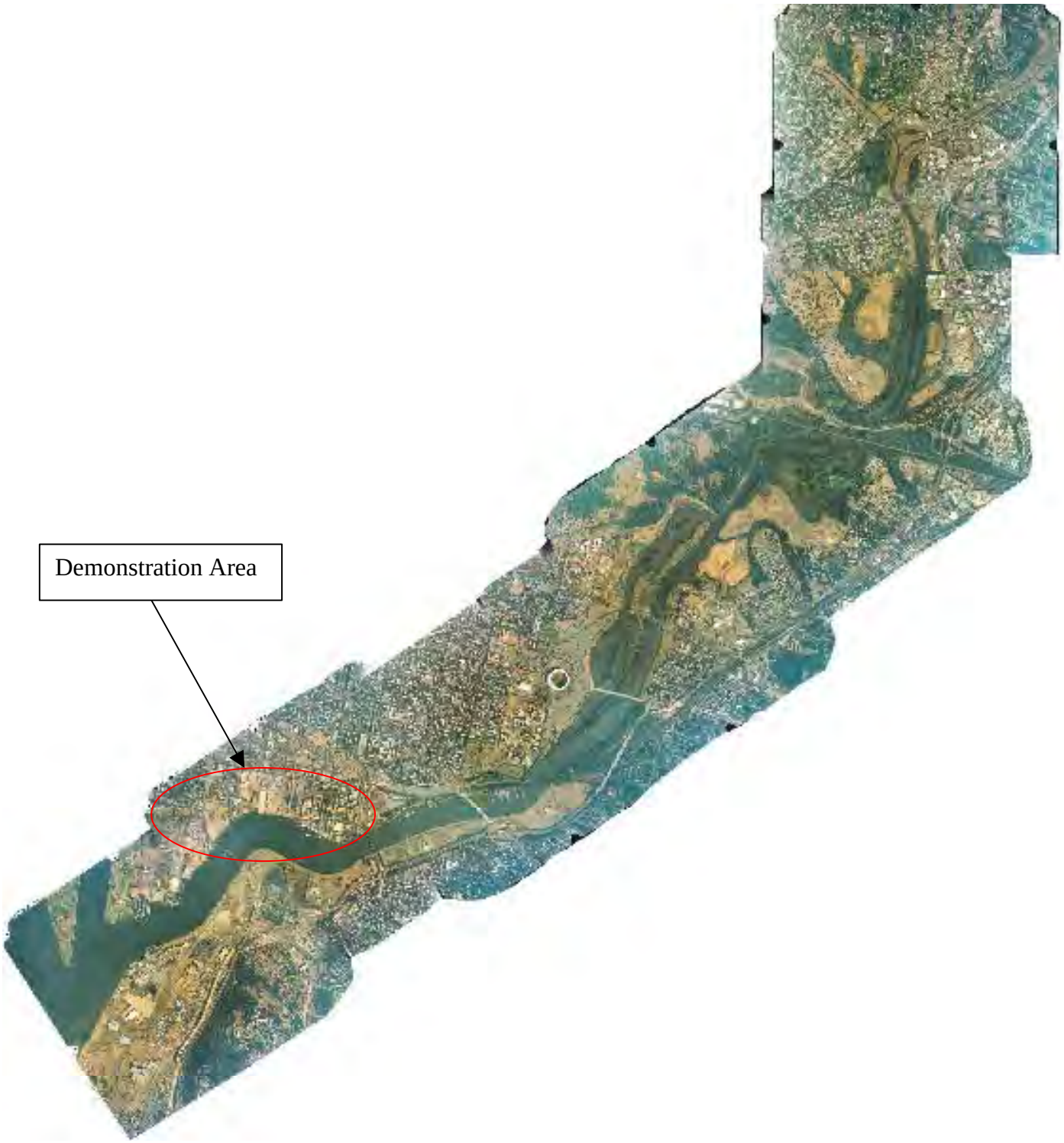

Figure 2. Anacostia River Map

(Sources: Anacostia Watershed Society Homepage)

2.4 Regional Climate

The region has a humid, continental climate marked by seasonal temperature changes. Annual precipitation is approximately 39 inches, with nearly uniform distribution throughout the year. The mean annual air temperature is about 57 degrees Fahrenheit (F) (USDOA 1976). In winter, the average temperature is 37 degrees F, and the average daily minimum is 29 degrees F (USDOA 1976). Ice formation in the Anacostia River during winter is unlikely.

2.5 Site Geology

The site geology information was derived from the test borings completed during the geotechnical investigation. The surficial sediment consisted of high-plasticity silty clay, which classifies as CH according to the Unified Soil Classification System (USCS). From the mud line and extending to at least 10 feet below that elevation, these soils were very soft, extremely weak, and highly compressible. Detailed site geology is discussed in Section 8.0.

3.0 FIELD INVESTIGATIONS

This section provides an overview of the field investigation methodologies. Mobilization for the site characterization commenced on 7 January 2003 and continued through 5 June 2003. A two-stage sampling approach was implemented to characterize the site. Stage 1field investigations included the following:

- Geophysical investigations with bathymetry measurement, side-scan sonar, "chirp" sonar, and magnetometry survey
- Sediment profile interface (SPI) photography survey
- Sediment characterization including sediment, sediment pore water, and water column contamination evaluation
- Current velocity measurement with the Acoustic Doppler Current Profiler (ADCP)
- Multicoring for sediment radionuclide characterization
- Geotechnical investigation

The Stage 1 field investigations were performed in phases, with information generated from each phase used to determine the best approach for conducting the next phase of data collection. The initial noninvasive geophysical work was used to confirm and refine the proposed sampling strategy and locations within the subject areas.

The Stage 2 field investigations included the following:

- Submerged aquatic vegetation (SAV)
- Benthic community survey

However, the originally proposed SAV sampling was determined unnecessary based on water conditions, sediment-profiling imaging review, and through consultation with the DOH. Therefore, the Stage 2 sampling included only the benthic community sampling collection and evaluation.

3.1 Utility Clearance

Prior to the field investigation activities, Miss Utility and owners of private utilities near the demonstration areas were contacted to ensure that the proposed sampling/boring locations would not impact any utilities near the shoreline or crossing the Anacostia River.

3.2 Permitting

A Section 10 permit under the River and Harbor Act was obtained from the United States Army Corps of Engineers (USACE) for the site characterization activities. The DOH issued a Water Quality Certificate (WQC) in accordance with Section 401 of the Clean Water Act and stipulated the specific conditions to be followed for the field activities. In addition, the State Historic Preservation Officer for the District of Columbia was contacted as required under the National Historic Preservation Act, Section 106.

4.0 GEOPHYSICAL INVESTIGATIONS

On 7 January 2003 through 9 January 2003, Horne Engineering and its subcontractors, (Earth Resource Technology (ERT) and Ocean Surveys, Inc. (OSI)), conducted geophysical/hydrographic surveys in the two demonstration areas shown in Figure 1. The objectives of the surveys were to determine the topography of the river bottom, to characterize the stratigraphy of the underlying sediments, to locate any metallic objects, and to detect any debris protruding out of the sediments. The surveys included a bathymetric survey, a side-scan sonar survey, a subbottom profiling survey, and a magnetic survey.

4.1 Materials and Methods

This section provides a brief discussion of geophysical surveys. A detailed discussion of field methodology and equipment is included in Appendix A.

Survey operations were conducted from the *R/V Willing*, a 26-foot enclosed-cabin survey vessel modified specifically for geophysical surveying. A Differential Satellite Global Positioning System (DGPS) receiver interfaced to a laptop computer was installed onboard to precisely navigate the vessel throughout the survey area. Differential satellite corrections were transmitted to the survey vessel via U.S. Coast Guard (USCG) DGPS radio beacon, providing accuracy to ± 3 feet throughout the survey area. Prior to conducting survey operations, the accuracy of the positioning system was verified by occupying a known horizontal point. This point, MW-3, was a *stilling well* located on the Navy Yard bulkhead at the edge of the Anacostia River and adjacent to the survey area. Also, prior to surveying, the Horne Engineering field team established a tide gauge and tide board at the Navy Yard bulkhead adjacent to MW-3. Tidal water level readings were recorded and used to correct the depth data to the North American Vertical Datum of 1988 (NAVD 88).

Bathymetric sounding, magnetometer, and subbottom profiling data were acquired simultaneously along 25 survey transects oriented parallel to the course of the river and evenly spaced at 20 foot intervals in both survey areas. Survey investigations were performed along a series of tracklines oriented parallel to the river shoreline in the demonstration areas. Survey transects were spaced at 20-foot intervals. Several survey transects oriented perpendicular to the primary survey transects were investigated, to provide quality control and to enhance the overall geophysical interpretation. In total, 32 transects were surveyed, equating to more than 28,000 feet of data acquisition. Additionally, side-scan sonar imagery was acquired along several longitudinal survey lines to provide approximately 100% coverage of the riverbed in both survey areas. Primary geophysical equipment installed on the vessel and employed to complete the investigation included the following:

- A Trimble DSM212 DGPS interfaced with a modified version of Coastal Oceanographic's HYPACK PC-based navigation and data logging software package
- An Innerspace Model 448 digital depth sounder
- A Marine Sonics side-scan sonar system

- A Geometrics Model G-881 cesium marine magnetometer

- An Edgetech Geostar full-spectrum "Chirp" subbottom profiler, equipped with a SB216-towed vehicle.

4.2 Data Analysis and Discussion

This section provides the overall summary discussion of the geophysical survey. Detailed data analysis and discussion are provided in Appendix A.

4.2.1 Bathymetric Data

Bathymetric data collected in the Anacostia River provided the framework to characterize and document the general river-bottom topography. The survey area for Area 1 is approximately 800 feet long and 375 feet wide with water depths ranging from approximately 5 feet to 20 feet below NAVD 88 or 3.6 feet to 18.6 feet below Mean Lower Low Water (MLLW). Figure 3 shows the conversion between NAVD88 and MLLW, with the benchmark located about 5,000 feet west of Area 1. Area 1 bathymetric data and the tracklines are depicted in Figure 4. The topography of the river bottom in the western half of the area slopes downward at less than a 4% grade from northwest to southeast throughout the area. The topography in the eastern half of the area shows that the riverbed is generally steep where a trough of deeper water approaches the shore, then displays a gentler slope from northwest to southeast further from shore.

The survey area for Area 2 is approximately 1,000 feet long and 200 feet wide, with water depths ranging from approximately 7 feet to 19 feet below NAVD 88 or 5.6 feet to 17.6 feet below MLLW. The topography of the river bottom in Area 2 is shown in Figure 5 and slopes from the northeastern and southwestern boundaries toward the approximate center of the area at slightly more than a 1% grade. The topography in the area shows that the riverbed is generally shallow near shore and then deepens toward the center of the area. In the very northern corner of the site adjacent to shore, the topography indicates a steeper slope near shore. This slope is interpolated due to limited vessel access caused by the presence of a barge in the survey area at the time of the survey.

4.2.2 Riverbed Characterization

Riverbed characterization was derived from the findings from side-scan sonar imagery, in conjunction with sounding data, subbottom profiler data, push probes, and field observations. Side-scan sonar mosaics of both areas, constructed from digital side-scan sonar imagery acquired in the river, present a view of the riverbed similar in appearance to a high-angle aerial photograph negative. The side-scan sonar mosaics for Area 1 and Area 2 are presented in Figure 6 and 7, respectively. Darkened areas on the image indicate features extending off the riverbed, while light areas are representative of shadows behind features or surface depressions. Figure 8 provides a representative section of side-scan sonar imagery that depicts the fine-grained sediments found throughout the majority of both areas.

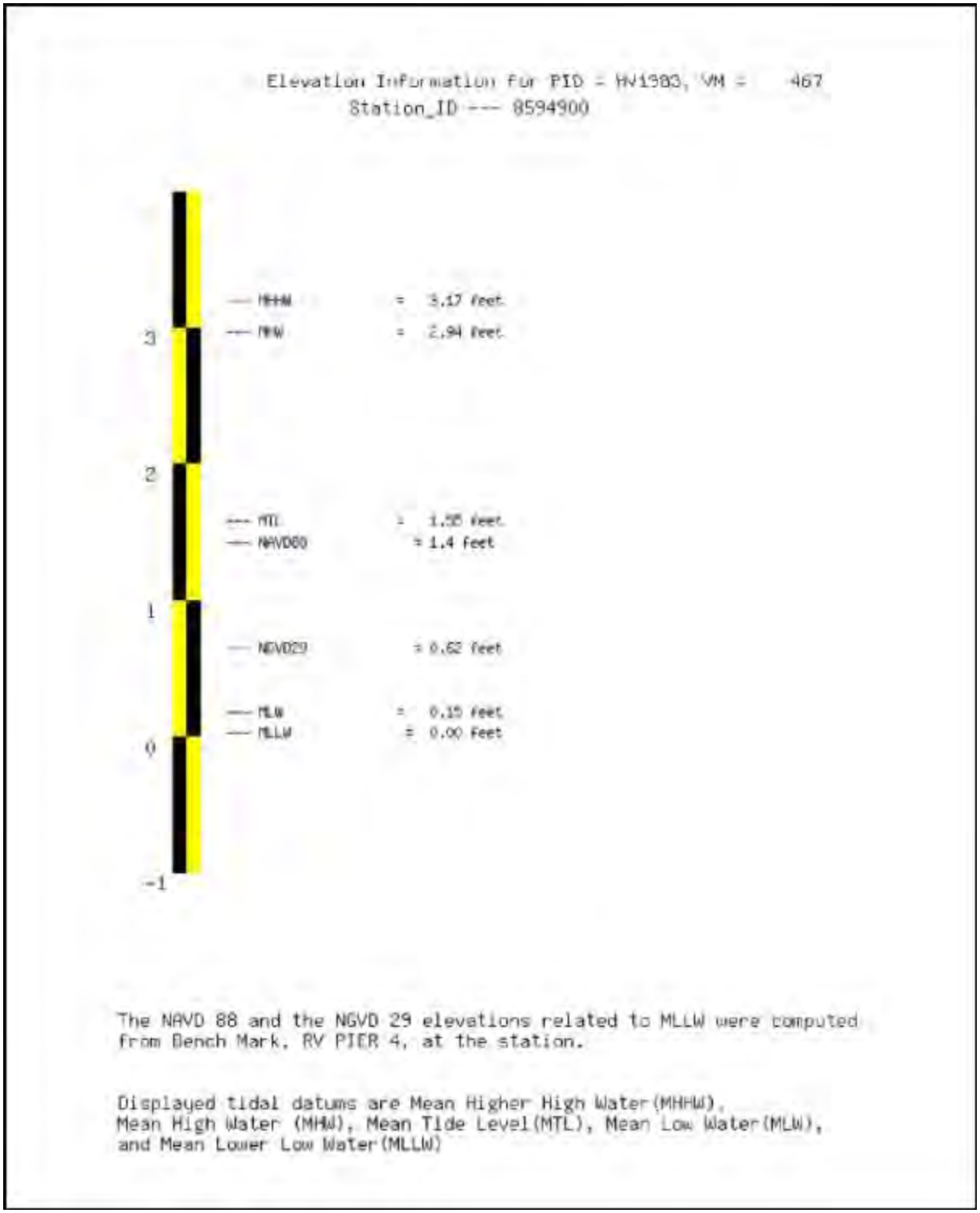

Figure 3. Conversion between NAVD88 and MLLW

(Source: http://www.ngs.noaa.gov/cgi-bin/ngs_opsd.prl)

Figure 4. Area 1 Bathymetric Data

Figure 5. Area 2 Bathymetric Data

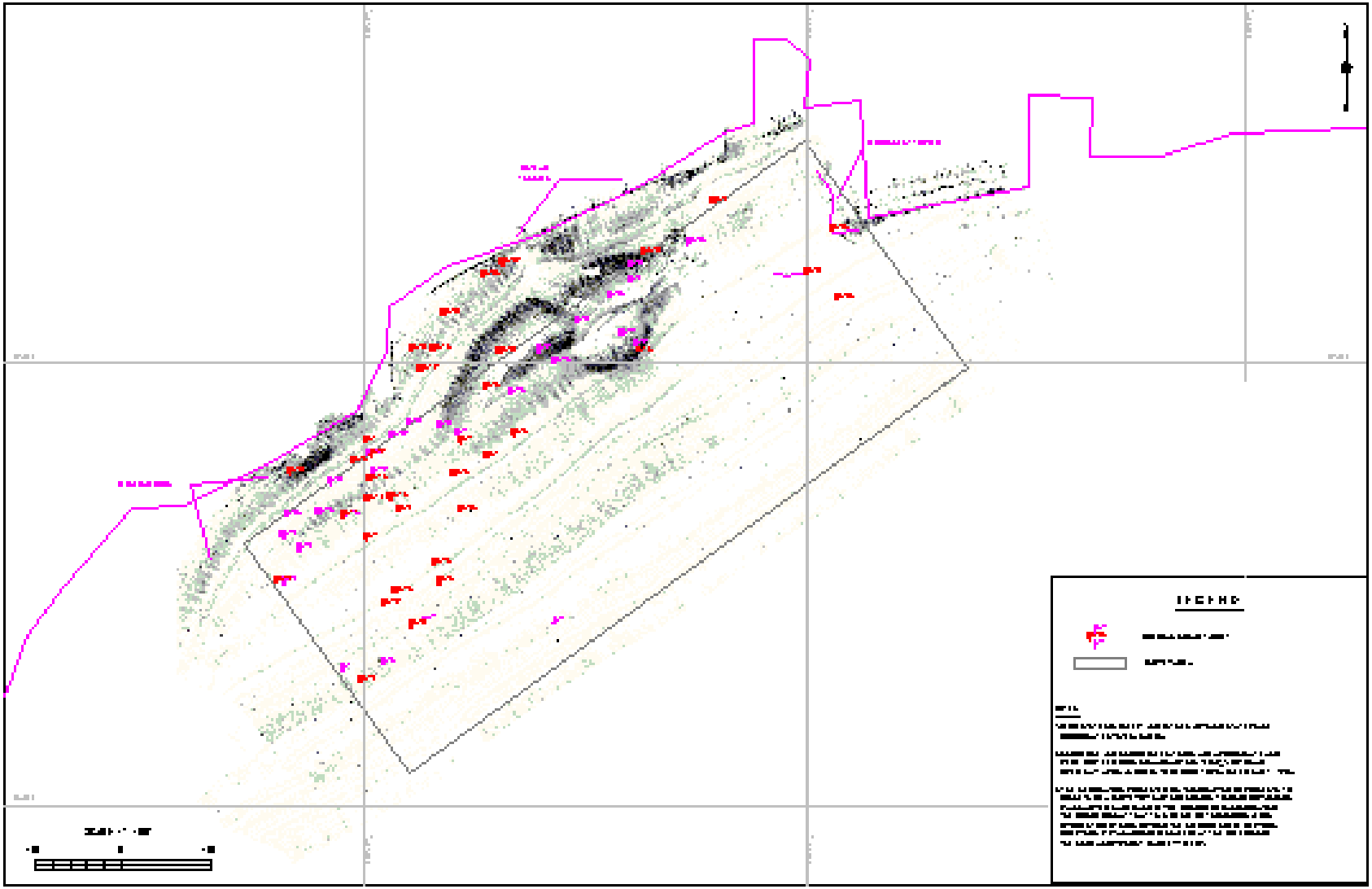

Figure 6. Area 1 Side-Scan Sonar Imagery

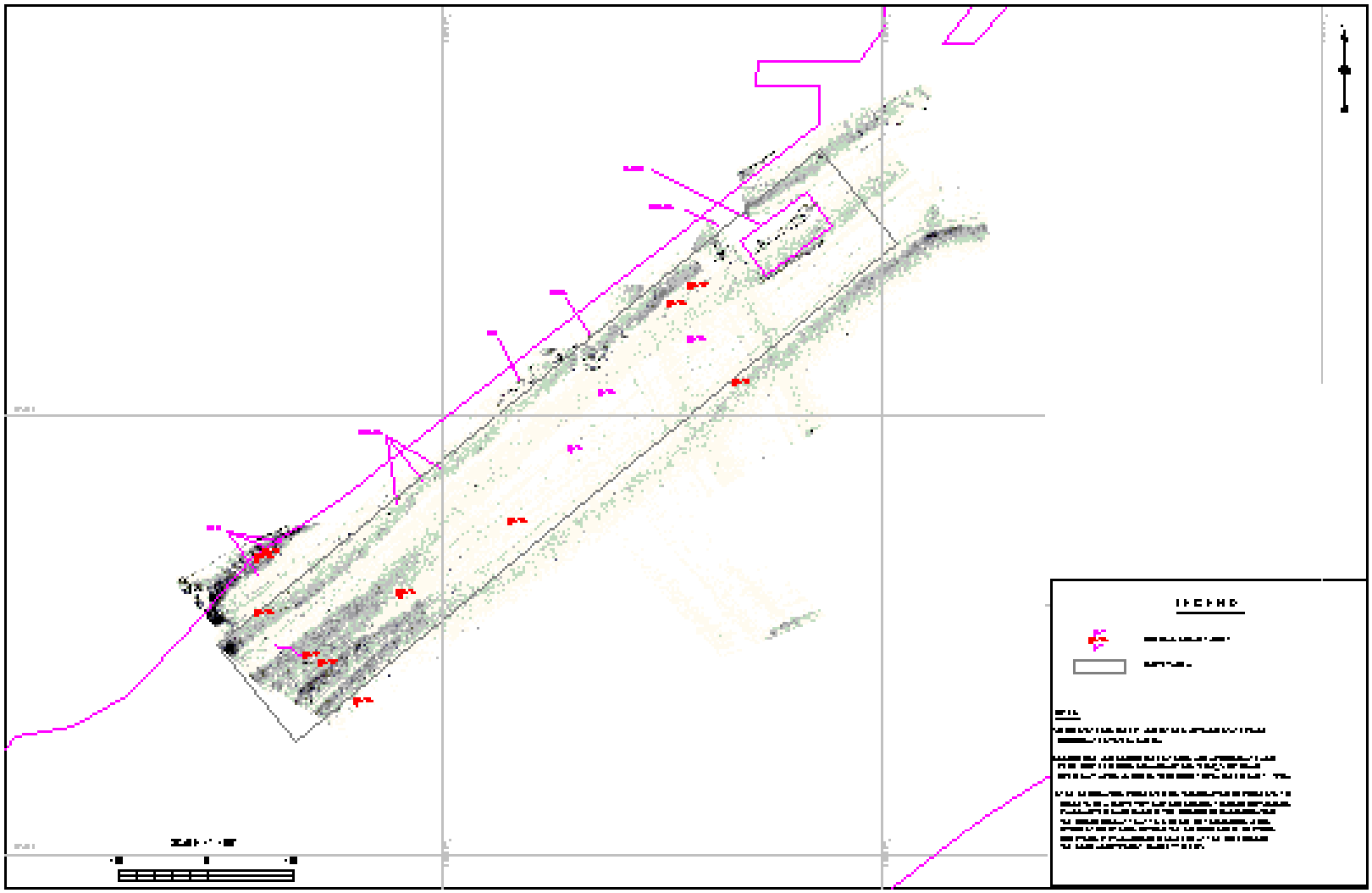

Figure 7. Area 2 Side-Scan Sonar Imagery

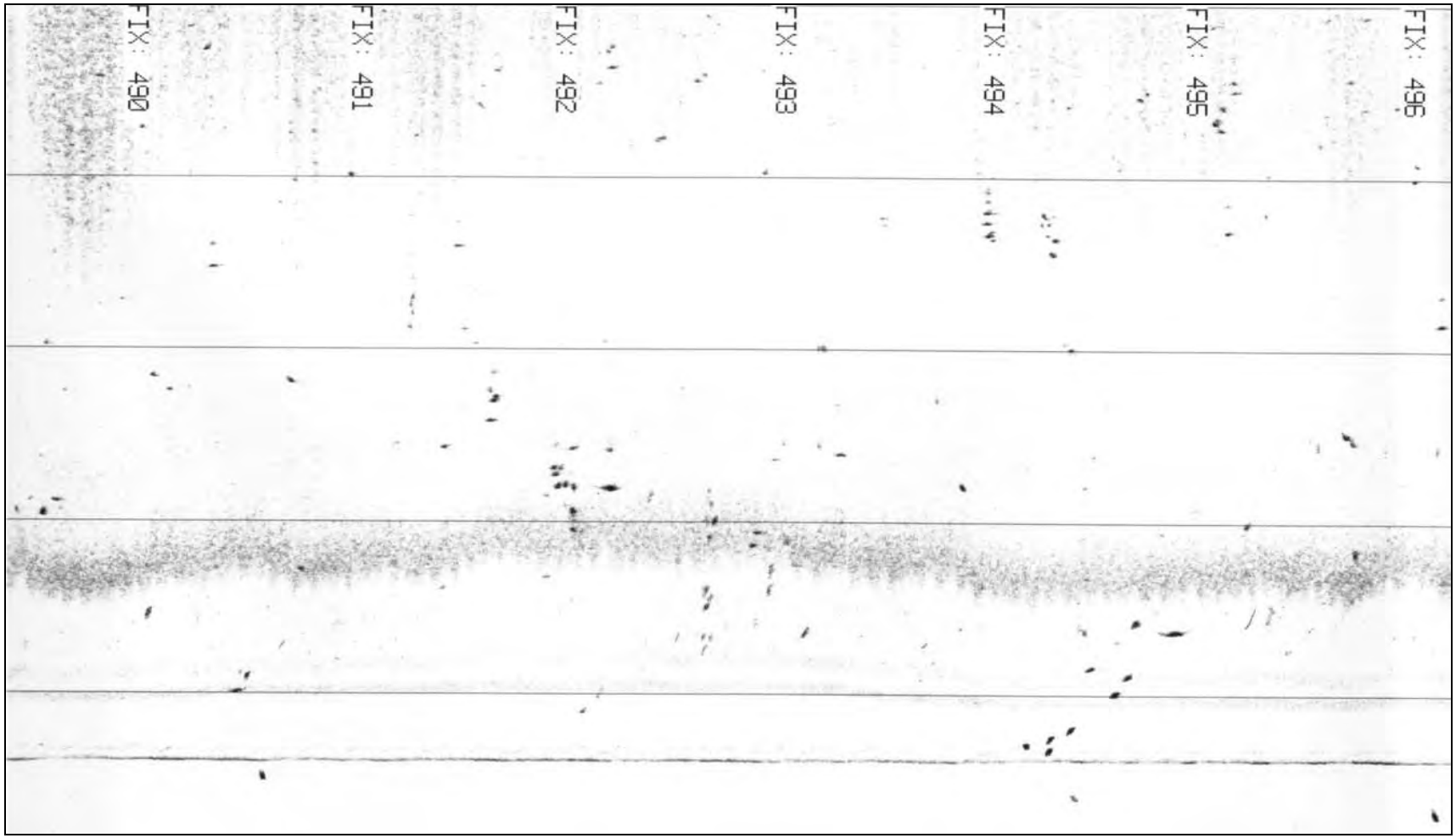

Figure 8. Reproduction of a Side-Scan Sonar Record Depicting the Acoustic Returns Typical of Fine-Grained Sediments

Fine-grained sediments ranging in size from clay to sand were identified on the riverbed and along most of the riverbank in both study areas. An area of slightly darker sonar returns was noted in Area 1 near the shore, adjacent to the outfall tunnels that make up part of the bulkhead. These returns appear dark because of the close proximity of the sides-can sonar fish to the steeper bottom slope in this area.

Subbottom penetration using the "Chirp" system was limited along all tracklines in the survey areas because of site conditions. The profiler system was only able to achieve penetration in approximately the upper 1 foot of riverbed sediments. Based on past experience, it is believed that the restriction in subbottom penetration may be attributable to the presence of gaseous-type sediments in the near subsurface. In the analysis of the sediment profile interface images (see Section 5), gas voids were noted in all of the images acquired in both survey areas. Gaseous-type sediments are defined as sediments that contain concentrations of gases generated as a by-product of the decomposition of organic matter (remnant of a paleo-estuarine environment) present in the sediment (Figure 9). The gases trapped in the sediment inhibit acoustic signal propagation (penetration) and reduce the ability of the subbottom profiler to resolve subsurface acoustic reflectors. The critical concentration of gases that inhibit acoustic penetration is variable and is related to many other factors such as sediment type, compaction, and the age of organics present in the sediment. The presence of organically derived gases in sediments is not an uncommon phenomenon and often characterizes sediments in upland rivers, bays, and estuaries. Figure 10 (a representative section of subbottom profile data acquired during this investigation) exemplifies the limited subbottom penetration that was typical within both survey areas and between the areas.

4.2.3 Obstruction Analysis

Numerous obstructions on the riverbed were detected in both survey areas. During side-scan sonar data analysis, several sonar targets were selected. The criteria for selecting sonar targets was primarily based on the relief, or height above the riverbed, a target displayed. Secondary criteria were based on the size of the target's length and width. Of the sonar targets identified within the survey areas and adjacent near shore areas, three targets in Area 1 and SS-62 in Area 2 had heights in excess of 3 feet. In addition, five of the sonar targets in Area 1 had corresponding magnetometer anomalies. Other magnetic anomalies detected on the riverbed were identified based on the magnitude and duration of their magnetic signature. Most of these targets displayed no corresponding sonar target, indicating these objects may be buried beneath the riverbed. The anomalies and magnetic intensity contours for each area are provided in Appendix A.

4.3 Summary

In summary, the acquired data sets and field observations indicate little variability in the surface and subsurface sediments, both horizontally and vertically. Push probes and sediment profile images (Section 5) show that throughout both areas the predominant sediment type ranged from aqueous silty clay to silty fine sand.

Several objects were noted on the surface of the riverbed in both survey areas. The largest objects in Area 1 and in Area 2 had measured heights above the riverbed in excess of 3 feet.

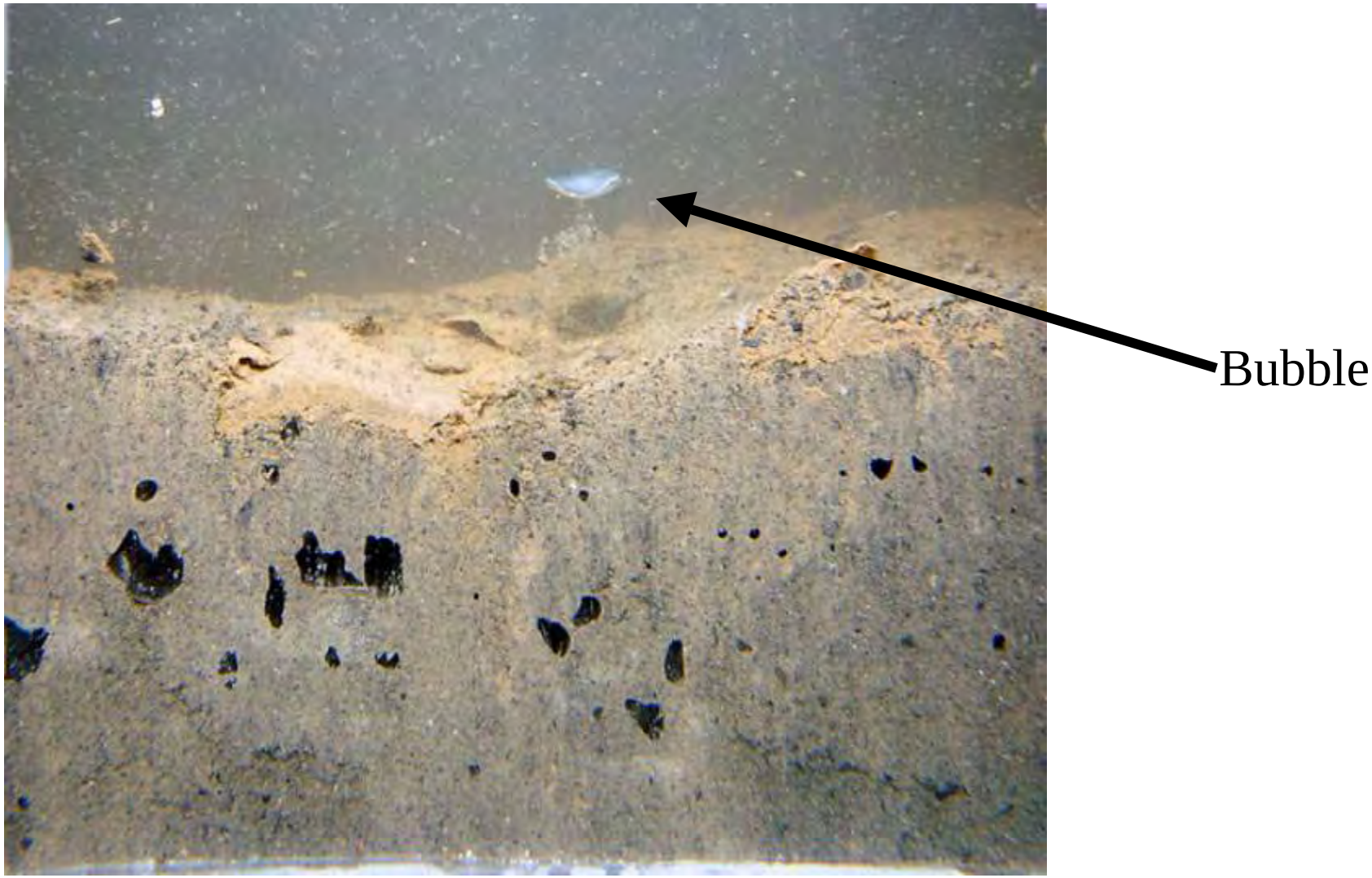

Figure 9. SPI Photo with Gas Bubble

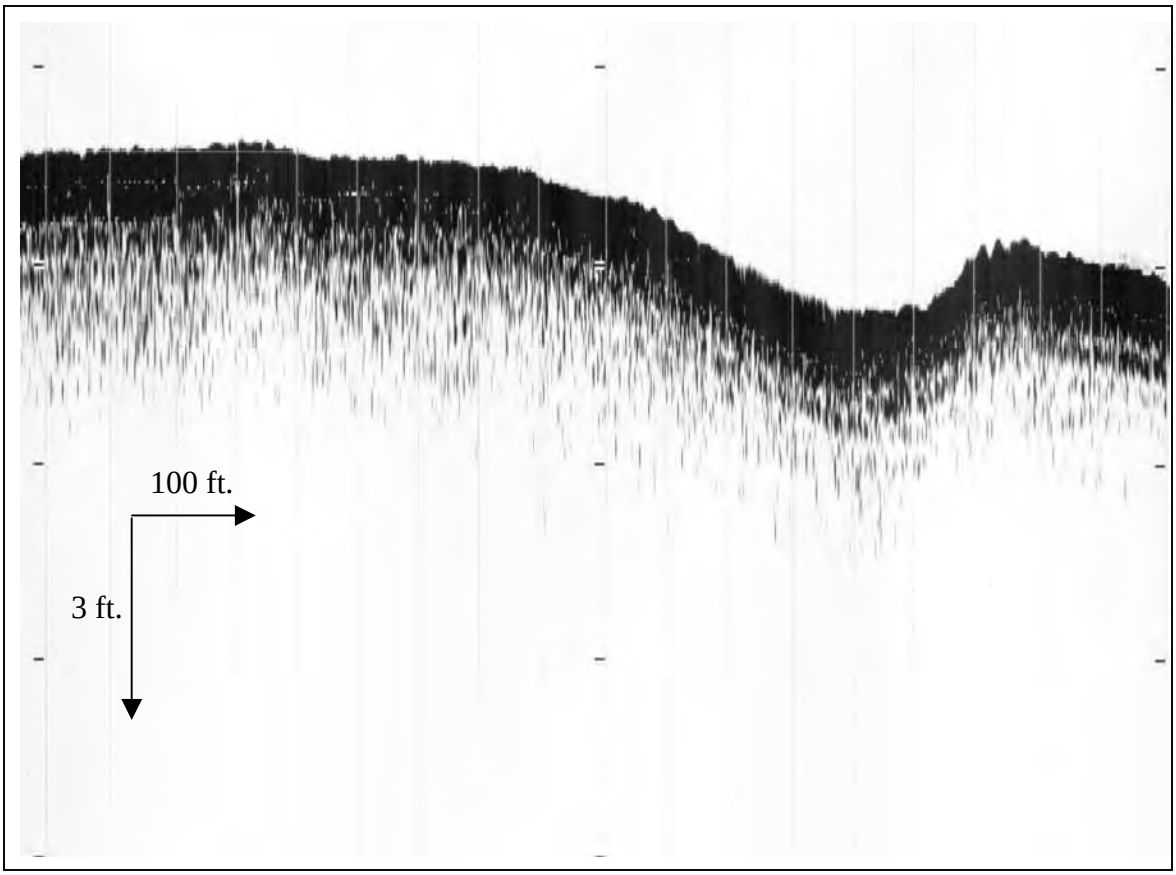

Figure 10. Reproduction of a Subbottom Profile Record Depicting the Limited Penetration of the Acoustic Signal

Numerous magnetic anomalies were identified within both survey areas. While many of these anomalies appear to represent objects buried beneath the surface of the riverbed, several also had corresponding side-scan sonar targets (Appendix A).

5.0 SEDIMENT PROFILE INTERFACE PHOTOGRAPHY SURVEY

On 10 January 2003, the Horne Engineering team conducted a SPI survey at the two designated areas in the Anacostia River. The objective of the survey was to determine near-surface sediment characteristics of the riverbed and to characterize the benthic habitats in the two areas prior to sampling for benthos and sediment chemistry.

A sediment profile camera was used to investigate processes and the structuring of the sediment-water interface, and to obtain in situ data on benthic habitat conditions. The SPI allowed for the development of a better understanding of the complexity of sediment dynamics, from both a biological and a physical sedimentation point of view.

5.1 Materials and Methods

Photography operations were conducted from the *R/V Willing*, a 26-foot enclosed-cabin survey vessel designed specifically for sediment profile camera operations. A digital Hulcher sediment profile camera was used to capture sediment images. The digital sediment image was deployed with a live video feed to the surface to monitor camera performance.

The digital profile camera captured a 5.2 megapixel image that produced a 14.1-megabyte RGB image. Images were stored on 1 gigabyte IBM microdrives. The camera was set to take a series of images on bottom contact at about a 1.5-sec interval (about 8 in the 12-sec period the camera was left on the bottom). Images were transferred from the microdrive to a computer and then to a CD-ROM for more permanent storage while still in the field. The weight of the camera frame was kept constant at 42 kilograms (kg) to allow direct comparison of sediment compaction between areas.

Sediment profile images were successfully collected at 50 stations in Area 1 and 31 in Area 2 (Figures 11 and 12, respectively). Stations were arranged in transects oriented perpendicular to the shoreline. For each area, a reference transect was extended from the area boundary across the river to the southern bank. Figures 13 and 14 are composite mosaics, with SPI images arranged spatially by station. The image from Station 17 in Area 1 was not included because it had no penetration.

5.2 Results and Discussion

This section provides the overall summary discussion of the SPI survey. Detailed data analysis and discussion are provided in Appendix A.

5.2.1 Physical Processes and Sediments

Physical processes appeared to dominate the two study areas, with the sediment surface at all stations being entirely physically dominated. None of the stations appeared to have sediment surfaces dominated by biological processes. The dominance of physical processes was most apparent in the distribution of sediment grain sizes and flocculent unconsolidated surface sediment layers. Flocculent layers occurred at 73% of the stations in Area 1 and 86% of stations in Area 2.

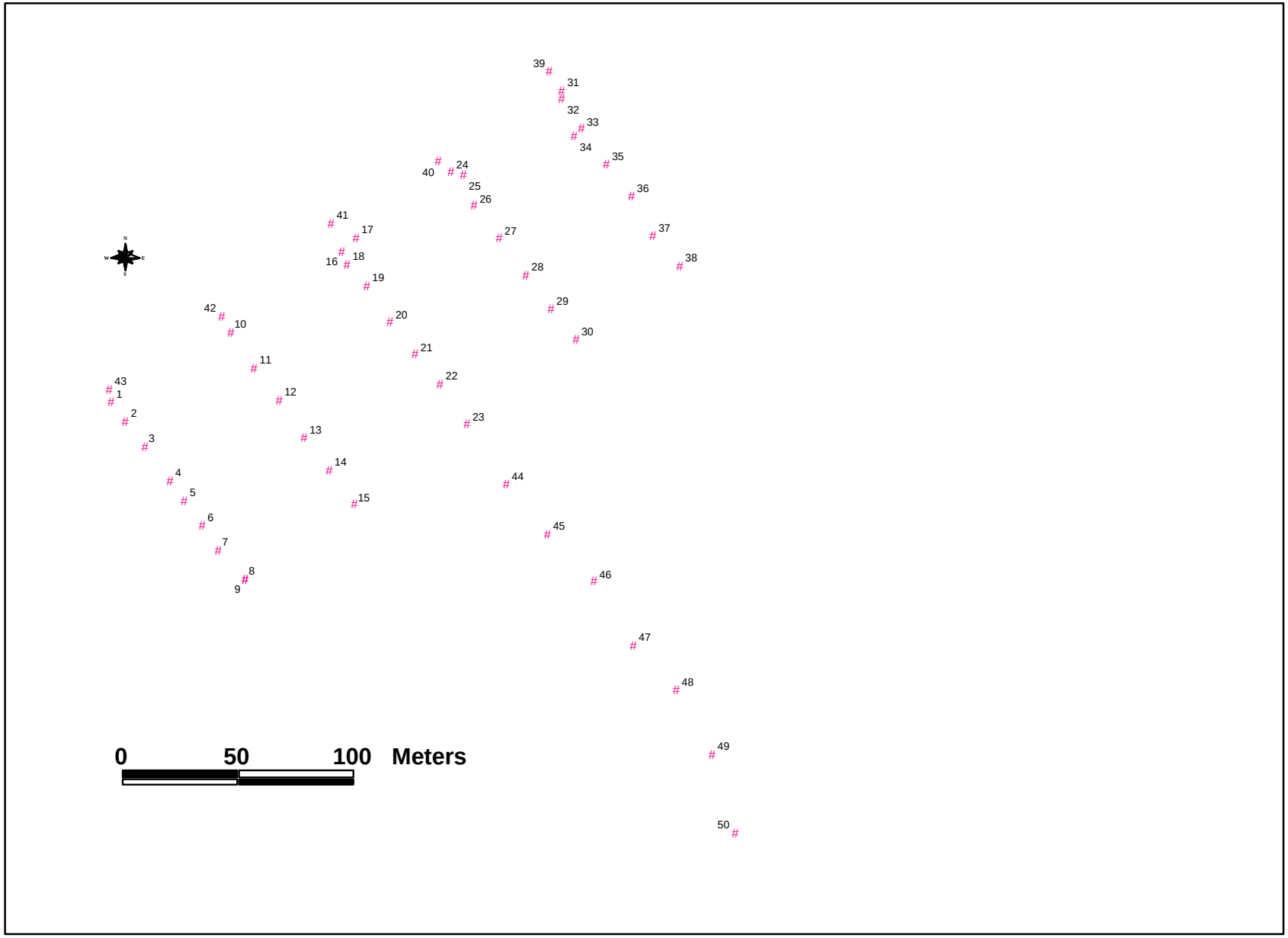

Figure 11. Locations of SPI Stations in Area 1

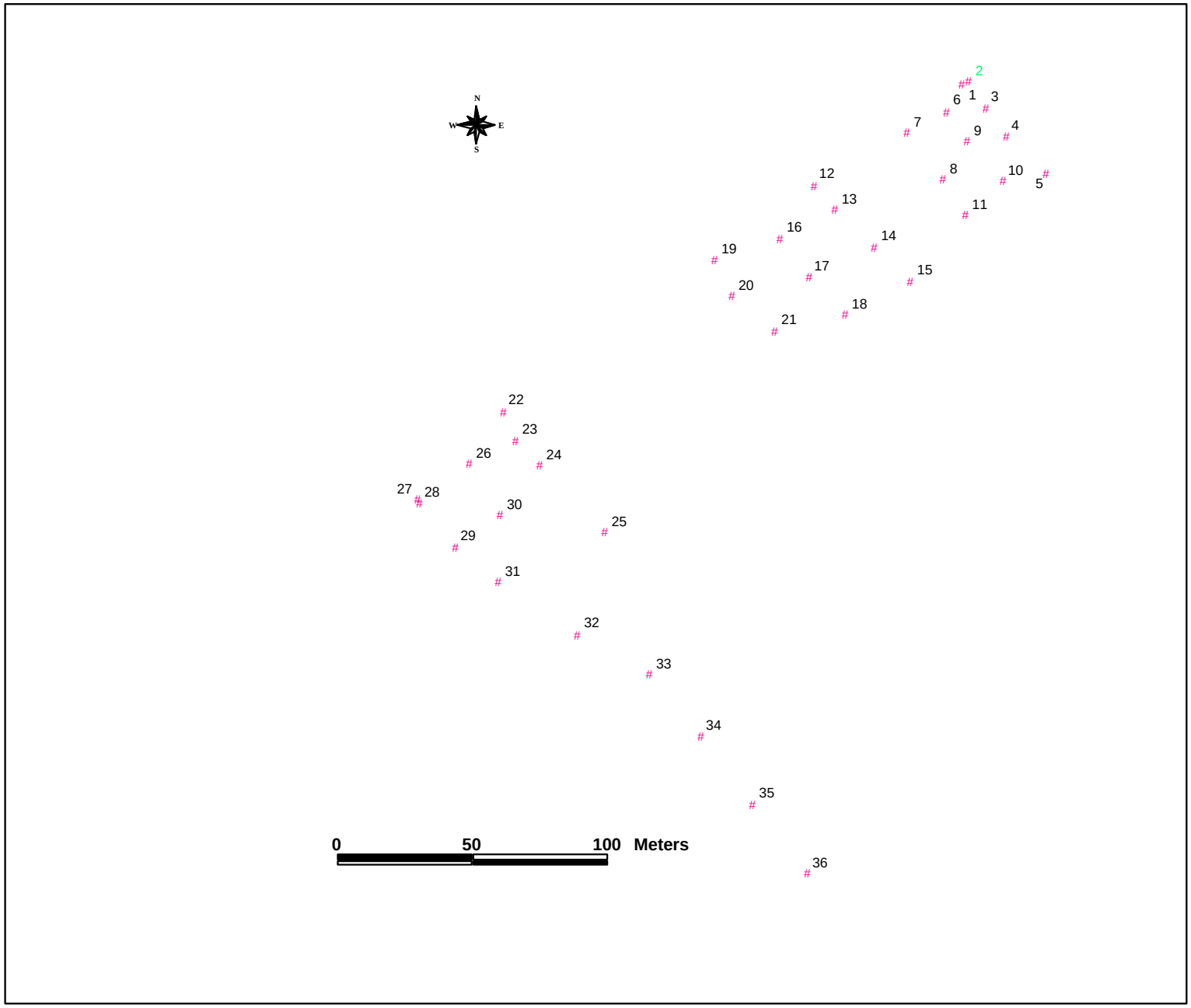

Figure 12. Locations of SPI Stations in Area 2

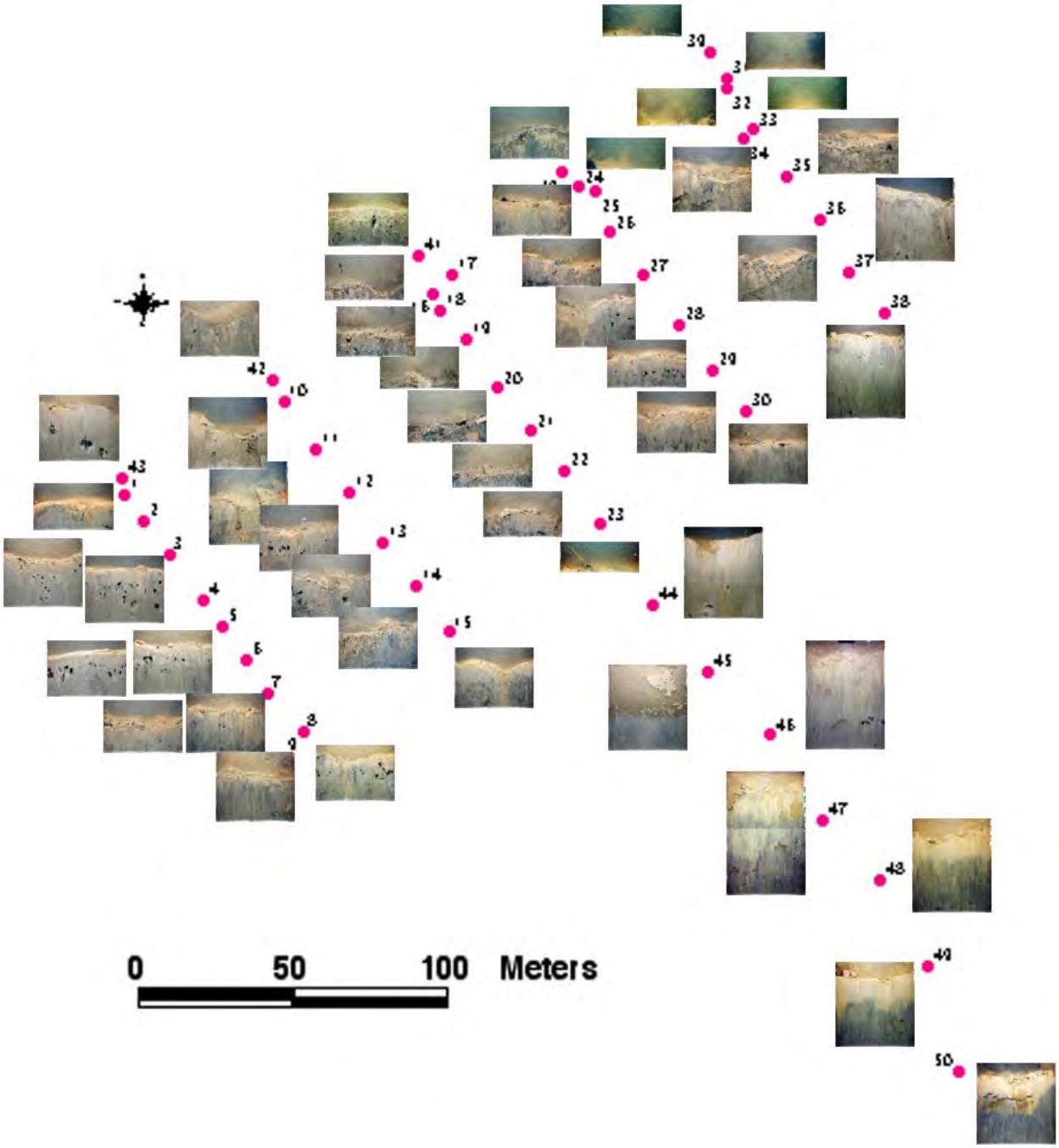

Figure 13. Mosaic of SPI Images in Area 1

(Image from Station 17 has no penetration. Images are all 15.5-cm wide)

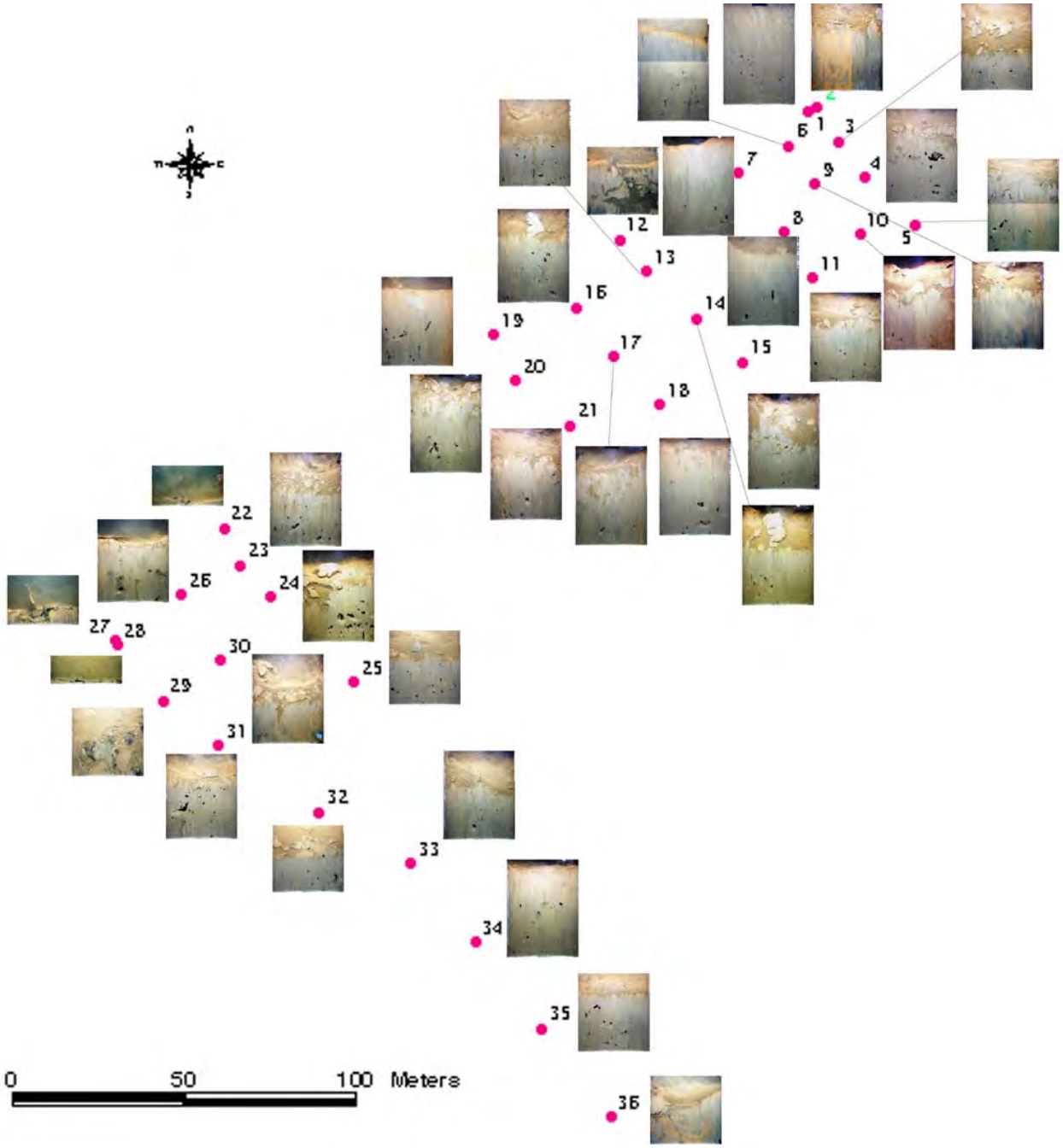

Figure 14. Mosaic of SPI Images in Area 2

(Images are all 15.5-cm wide)

Sediment grain size estimated from the SPI images compared favorably with samples collected from previous studies. The range of silt-clay for stations near Areas 1 and 2 was 44% to 99% and 86% to 98%, respectively. The side-scan survey conducted prior to SPI sampling indicated little variation in surface sediment texture within an area, the images also indicated that Area 1 was sandier than Area 2.

5.2.2 Biogenic Activity

It appeared that the dominance of physical processes at all of the stations has lead to unstable surface sediments that prevented the development of, or obscured, any surface biogenic structures, such as tubes or epifauna. Subsurface biogenic structures associated with infaunal burrowers, likely formed by larval chironomids, were seen at three stations (A1-6, A1-26, and A1-49). Oligochaetes, which are the numerically dominant fauna in the Anacostia River (McGee and Pinkney 2002) and other tidal freshwater systems (Diaz 1994), are free-burrowers that do not oxygenate their burrows (McCall and Fisher 1979).

5.3 Summary

The distribution of sediment types within both Areas 1 and 2 appeared to be dominated by physical processes, with unconsolidated flocculent sediment layer at the surface of most stations. Biogenic activity of epifauna and infauna was not a predominant factor in structuring surface sediment at any station. The presence of infaunal worms at many of the stations indicated that benthic habitats were not severely degraded. There was no evidence at either Areas 1 or 2 that submerged aquatic vegetation were present. All large pieces of detritus were of terrestrial origin.

There were no obvious gradients within either Area 1 or 2 relative to any of the SPI parameters, except for the northeast corner of Area 1 that had a series of stations with no penetration. It appeared that sediments at most of the stations had high concentrations of detritus mixed in, which supported a high rate of methanogenesis.

6.0 SEDIMENT CONTAMINATION CHARACTERIZATION

Due to budgetary constraints, studies in Area 1 were continued for contamination characterization. Area 2 characterization was on hold until funding becomes available.

The selection of Area 1 for characterization was based on previous site investigations and known elevated contamination summarized in the report *Interpretive Summary of Existing Data Relevant to Potential Contaminants of Concern within the Anacostia River Watershed* (SRC and NOAA 2000). The site is downstream of an active CSO site. The contaminants of concerns are PCBs, PAHs, and metals near and downstream of the CSO and are well documented (SRC and NOAA 2000). Area 1 is also identified for potential remedial actions in the AWTA report *Charting a Course Toward Restoration: A Toxic Chemical Management Strategy for the Anacostia River* (AWTA 2002).

Other considerations for Area 1 selection included the following:

- Area 1 is situated outside of the navigation channel. Therefore, encroachment into the navigational channel is unlikely.
- Area 1 is characterized as a relative slow-flow segment of the Anacostia River (Schultz, 2001). This was confirmed with the field measurements discussed in Section 7.0.
- The western half of Area 1 is characterized with a minimal slope (less than 4%).

Thus, an area in size of approximately 250 foot by 500 foot in the western half of Area 1 was selected for contamination characterization and comparative analysis.

6.1 Surficial Sediment Grid Determination

The sampling grid locations for surficial sediment were determined using a procedure described in *Statistical Methods for Environmental Pollution* (Gilbert 1987). This method describes a systematic sampling strategy to collect surficial sediment samples, with a proposed grid spacing 50 feet by 50 feet within the study area (Horne 2002). No refinement or adjustment was required to alter the surficial sediment sampling strategy, based on the findings from the geophysical surveys of relatively homogeneity across Area 1. A total of 60 surficial sediment samples were collected.

In addition, three additional surface sediment samples were collected near the CSO outfall at random locations for indicative analysis. The surficial sediment sampling locations are shown in Figure 15.

6.2 Gravity Coring Location Determination

The number of core samples required to characterize the site was determined using a method developed for sediment dredging activities (Keillor 1993). Based on this method, 8 random coring samples were required to cover the area of interest (Horne 2002). Eight coring locations were randomly selected within Area 1 to cover the range of possible variation within the

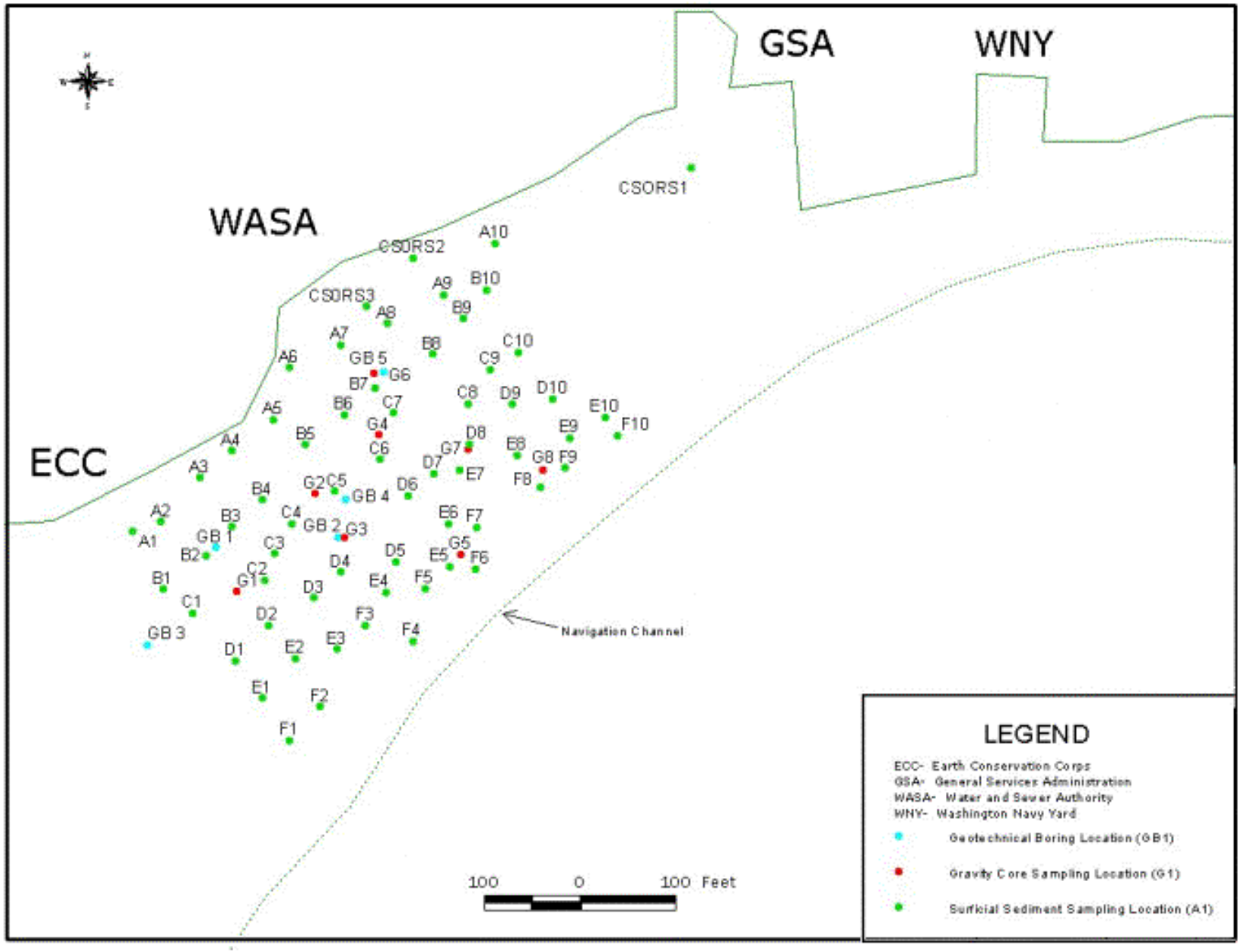

Figure 15. Sampling Locations for Surficial Sediment, Gravity Core, and Geotechnical Boring

sediment from near shore to near channel deposition. The gravity coring locations coordinates were averaged where three cores collected and plotted in Figure 15.

6.3 Surface Water and Pore Water Location Determination

Surface water samples and pore water samples locations were randomly selected across Area 1. Surface water samples were collected from middepth of the water column. The sediment-pore water samples were collected via the gravity corer. Both surface water and pore water sampling locations are presented in Figure 16.

6.4 Sample Location Identification

Sampling locations in the field were determined and recorded using a Trimble ProXRS DGPS. The ProXRS used the USCG Differential Beacon System to obtain the accuracy of sampling location. All sampling point nodes were located using DGPS coordinates with an accuracy of ± 3 feet. These locations were referenced to the Maryland State Plane Coordinate Systems North American Datum (NAD) 1983. The DGPS antenna was located directly above the lifting point where the sampling device (i.e., Ponar and gravity corer) was lowered into the water. Some sampling locations were adjusted in the field relative to grid locations, either because of the inability of the boat to hold a position as a result of high wind velocity or because of bottom conditions that resulted in low sediment volume recovery. The field notes are provided in Appendix B.

6.5 Sample Collection

6.5.1 Surficial Sediment Collection

Surficial sediment sampling was conducted from a 26-ft workboat equipped with a 12-inch-by-12 inch Ponar grab sampler, a gantry, and a hydraulic winch for sampling operations. The grab sampler weighs more than 30 lbs. The weight of the sampler is heavy enough to penetrate the bottom sediments to ensure that a sufficient quantity of sediment and the appropriate penetration depth (averaging 4 inches) was sampled. The sampling device actuates upon impact, using its weight from free fall to penetrate the sediment substrates. After the sampler was secured on deck, the sediment sample was inspected for the following acceptability criteria:

- The sampler was not overfilled
- The overlying water present was not excessively turbid, indicating minimal sample disturbance during collection
- The sediment surface was relatively flat, indicating minimal disturbance
- The desired penetration depth was achieved

If the sediment sample did not meet all the above criteria, it was rejected and the location re-sampled. The process was repeated until all surficial sediment samples were collected. The surficial sediment field notes are included in Appendix B.

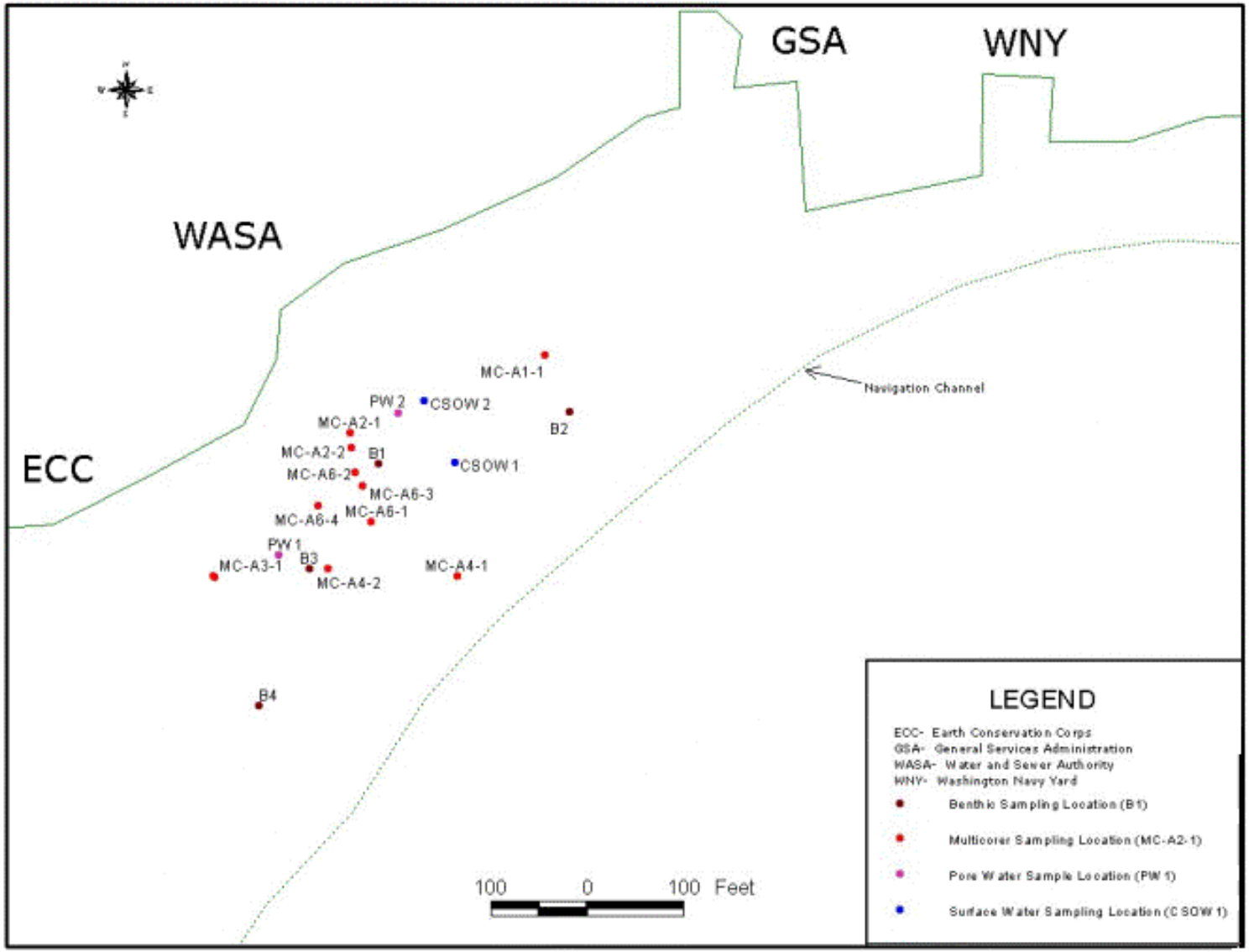

Figure 16. Sampling Locations for Surface Water, Pore Water, Benthos, and Multicore

6.5.2 Gravity Core Collection

Gravity coring was conducted from a 26-ft workboat equipped with a gantry and hydraulic winch for coring operations. The following procedures were used to collect sediment cores with a gravity corer:

- A precleaned, decontaminated 3-foot section of cellulose acetate butyrate plastic liner with a diameter of 4 inches was fitted with a clean stainless core catcher at the bottom and a pressure-relief valve at the top. The liner was placed inside the gravity corer.

- The boat was positioned and anchored near each sampling location. The corer was then lifted into position over the rear of the boat. The corer was lowered until the top of the corer was positioned just above the waterline and secured. The crew then released enough steel rope from the winch to allow freefall of the corer to penetrate the sediment below the mud line. The operator then released the corer. The winch operator woundin the winch wire until it was taut, and the rear of the boat was approximately over the core position on the bottom. The position of the corer was recorded, using the DGPS unit. After position was recorded, the gravity corer was bought up on deck and inspected for recovery.

- The core liner was removed from the corer, the core catcher was removed from the bottom of the core liner, a core cap was placed on the bottom of the core, and the cap was taped in place. The core was then moved into a vertical position. Excess liner above the sediment-water interface was cut off with a hacksaw and clean hacksaw blade. The top of the core was then capped and taped.

- The liner and both caps were labeled. Labeling included the following information:

    - Station location
    - Unique sample ID
    - Core number and total number of cores per station
    - Reference to top and bottom of core sample

- The process was repeated if additional sediment volume was required. An additional core was taken at the sampling location after the boat was repositioned approximately 1 to 10 ft off the original station.

- The boat was then relocated to the next station, and the process repeated.

The gravity coring field notes are included in Appendix B. Sample recovery for the gravity cores varied in length from 14 to 22 inches. Where refusal, no recovery or minimal recovery occurred, the sampling location was adjusted by offsetting the sampling location noted on Figure 15. Attempts were made at the beginning of the gravity core sampling to adjust the penetration and recovery by adding or subtracting weights to the gravity core. The maximum depth penetrated and recovered with and without additional weights was approximately 22 inches

below the mud line. Adding weights to the gravity core therefore was abandoned because of little or no improvement on the penetration and sediment recovery.

In only a few locations did refusal occur due to the presence of near shore cobbles and concrete near the former pier and near the centerline of the “mound” where again surface armoring had occurred with flat pebbles. In each case where there was little or no recovery, three additional attempts at that location were made.

6.5.3 Sediment Pore Water Sample Collection

Two sediment pore water (interstitial water) samples were obtained by extracting pore water from sediment cores collected using the gravity corer. In general, the same gravity core collection procedures described in the previous section were used for the sediment pore water collection. The only difference was that the overlying surface water was allowed to drain completely by cutting through the core liner with a hacksaw just above the sediment water interface after the sediment core was collected and sealed on board. This was done to avoid the exchange of surface water exchange with sediment interstitial water and to prevent any introduction of surface water into the uppermost sediments before sample processing.

In addition, to ensure that a sufficient quality of pore water was extracted from the sediment cores for contamination analysis, one sediment pore water sample comprised of 5 sediment cores, and the other included 6 sediment cores.

6.5.4 Surface Water Sample Collection

Surface water samples were collected from middepth (approximately 2 to 3 feet above the mudline) of the water column, using a Nissken water sampler. The sampler was triggered using a weighted "messenger" sent down a rope stricking a trigger release. This caused the plungers to seal the cylinder. The water column samples were collected on 10 March 2003. CSO-W1 was collected approximately 9 feet below the water surface. CSO-W2 was collected approximately 5 feet below the water surface (Figure 16).

6.5.5 Multicore Sediment Sample Collection

Multicore sediment samples were collected for a sediment depositional history characterization, using radionuclide-dating methodology. Sediment core samples were collected with a MC-400 Multicorer. The multicore sample locations are shown in Figure 16.

6.6 Sample Processing

Horne Engineering established a field staging/processing area on the waterfront, at the ECC Potomac and First Street office at which all sampling and processing activities were conducted. Upon sediment sample collection, the site geologist inspected the sediment, measured the sample recovery to determine if sufficient material was recovered for analysis, and described the lithology of the sample. This information was recorded on field data sheets, along with other observations (Appendix B).

6.6.1 Surficial Sediment Samples

After retrieving each sediment sample, it was given a unique sample identification described in Section 6.8.4. The sampling equipment (Ponar) was decontaminated prior to sampling and between each sampling location. Once the Ponar was on deck, the excess water brought up during sampling was siphoned off. The sediment was then homogenized inside the Ponar, using a laboratory-grade, precleaned, 6-ounce, single-use plastic scoop. The sample was then placed into appropriately labeled containers for analysis. Excess sediment from the Ponar was contained in a 55-gallon plastic drum for temporary storage, sampling and future disposal. Once the sampling was completed, the sampling scoop was placed in a plastic trash bag for disposal along with latex gloves that were changed for each sampling location. Containers and preservation requirements and minimum sampling volume requirements are discussed in the *Revised Draft Quality Assurance Project Plan* prepared by Horne Engineering (Horne 2003). Sample jars were wrapped with protective bubble wrap and placed into rigid sample coolers on ice until they were picked up by a courier for delivery to the Severn Trent Laboratories (STL) Pittsburgh laboratory for analysis. One duplicate sample was collected for every 10 samples.

Surficial sediment samples were analyzed for PCBs, PAHs, and metals (Table 1). In addition, 5 randomly selected surficial samples were analyzed for grain size distributions, and two (2) randomly selected surficial sediment samples were analyzed for specific gravity, density, cation exchange capacity (CEC), and acid volatile sulfide/simultaneously extracted metals (AVS/SEM).

Table 1. Surficial Sediment Samples Analytical Parameters

Analytical Parameters	**Surficial Sediment**				
	S	**SR**	**SRG**	**SRGC**	**RS**
PCBs (Aroclors)	√	√	√	√	√
PAHs	√	√	√	√	√
Pesticides					√
PPL list-13 metal & mercury	√	√	√	√	√
TOC		√	√	√	
TKN		√	√	√	
TP		√	√	√	
Grain size with hydrometer			√	√	
AVS/SEM			√	√	
Bulk density				√	
Specific gravity				√	
CEC				√	

Note:
S - Surface sample
SR - Random surface sample
SRG - Random surface sample for grain size
SRGC – Random surface sample for grain size, CEC and AVS/SEM
RS – Random surface sample collected in areas of interest for the DOH

6.6.2 Core Sediment Samples

After a core sample was retrieved, the core liner was capped with watertight plastic caps and sealed with tape, labeled with its unique sample identification and the core's orientation. Because of the instability of the sediment in the cores and the high pore water content, the cores were maintained in a vertical orientation during their transport to shore. The overlying water was then removed to just above the sample by cutting the core liner with a hacksaw. The remaining water was removed by siphoning before the sample was collected for analysis. If necessary, a second core sample was collected at each sample location to meet sample volume requirements. The core samples were collected and taken to the onshore processing area.

Once the sediment core was onshore the core was maintained in a vertically oriented position. The core was then cut through, just above the sediment water interface, using a hacksaw. The remaining water was siphoned off, and the sample was resealed. The sample was then marked into three sections: a 0-to-6 inch interval, a 6-to-12 inch interval, and an interval measuring from 12 inch to the maximum depth recovered. This information was logged and used as part of the sample identification for sediment. The core was then cut at the 6-inch interval mark. The sediment in the core was extruded from the 6-inch section of core. The remainder of the core was temporarily recapped while the first section was being described and processed. Once the sediment was described it was placed in a precleaned 2-gallon FDA food-grade zip-lock bag for homogenization. The material was then placed in the appropriate sample containers for shipment, using individually wrapped precleaned 6-oz. plastic scoops. This process was repeated for each subsequent sample interval. All core sediment samples were shipped to the STL laboratory for analysis. Excess sediment from core samples collected was temporarily contained in a 5-gallon bucket during the sampling process and then transferred to a 55-gallon DOT-approved container for subsequent sediment disposal.

Core sediment samples were analyzed for PCBs, PCBs congeners, PAHs, and metals (Table 2). In addition to these parameters the 0-to-6 inch interval was analyzed for TOC, TKN, TP, AVS/SEM, and pesticides. Grain size had been found to be homogeneous in the surficial sediments during the geophysical investigation phase. No additional analysis for grain size was performed on the core samples.

Two sediment core samples were selected for total petroleum hydrocarbon (TPH) and diesel total petroleum hydrocarbon (dTPH) analysis as a result of encountering strong petroleum odors during the core sediment sample processing. In addition, two other samples were selected and tested for petroleum identification.

6.6.3 Sediment Pore Water Samples

As described in the previous section, once the core sample was collected and capped on board, the overlying surface water was immediately allowed to drain completely through openings cut through the core liner with a hacksaw just above the sediment water interface. This was done to avoid the surface water mixing with the sediment and interstitial water and to prevent any introduction of surface water into the uppermost sediments.

Table 2. Gravity Core Samples Analytical Parameters

Analytical Parameters	Gravity Core Sediment Samples		
	0-6 inches	6-12 inches	12-36 inches
PCBs	√	√	√
PCBs Congeners	√		
PAHs	√	√	√
AVS/SEM	√		
Pesticides	√		
PPL list-13 Metal & Mercury	√	√	√
TOC	√		
TKN	√		
TP	√		
Diesel Range Organics	√		
Total Petroleum Hydrocarbons	√		

Once the pore water core samples were transported to shore for processing, the top section of core liner was then cut through just at the opening, which was at the sediment-water interface. Any residual water left on top of the sediment was removed by a sorbant (i.e., paper towel). The sample was then recapped, measured and marked at 12 inches below the sediment-water interface. The sample was cut, and the lower portion discarded. The sample remaining in the upper liner was placed in a 1-liter Teflon bottle. The process was repeated for the remaining gravity cores. The reason for selecting the12-inch interval was to have a consistent sediment core section for pore water extraction and this interval was the sediment depth selected as of interest of the project.

The sediment-pore water samples were shipped to the STL laboratory for pore water extraction using a cold-room centrifuge. The pore water volumes obtained from the CSOPORE1 and COREPOR2 were 900 milliliters (mls) and 1.5 mls, respectively. Samples were analyzed for PCBs, PCBs congeners, PAHs, and metals (Table 3). pH in the extracted pore water was measured. However, PCB congeners in COREPORE1 were not analyzed because of limited pore water volume recovered from the core samples. No duplicate sample was collected.

Table 3. Pore Water Samples Analytical Parameters

Parameter	Pore Water Samples
PCBs	√
PCBs Congeners	√
PAHs	√
PPL-List 13 Metal & Mercury	√
pH	√

6.6.4 Surface Water Samples

The surface water samples were collected on board. No further handling is required except for shipping. Samples were analyzed for PCBs, PAHs, metals ,pH, total suspended solids (TSS), total dissolved solids (TDS), TKN, TP, and TOC (Table 4). No duplicate sample was collected. In-situ surface water turbidity, salinity, dissolved oxygen (DO), and conducted were measured during the sampling events.

Table 4. Surface Water Samples Analytical Parameters

Parameter	Water Column Samples
PCBs	√
PCBs Congeners	√
PAHs	√
PPL list-13 Metal & Mercury	√
TOC	√
TKN	√
TP	√
pH	√
TSS	√
TDS	√
Turbidity	√ (Field Measurement in Anacostia at Sample Location)
Salinity	√ (Field Measurement in Anacostia at Sample Location)
DO	√ (Field Measurement in Anacostia at Sample Location)
Conductivity	√ (Field Measurement in Anacostia at Sample Location)

6.6.5 Multicore Core Samples

The multicore core samples were collected and processed by the LSU staff and shipped to the LSU laboratories for the radionuclide characterization.

6.6.6 Deep Sediment Samples

As part of contamination profiling at Area 1, limited sediment samples were collected for characterization at depth from 5 feet to 22 feet below the mudline during the geotechnical investigations. Two sediment samples were collected at approximately 5 to 7.5 feet below the mudline. One sediment sample was collected from each of the flowing intervals: 10.5 to 12.5 feet, 15.5 to 17.5 feet, and 20 to 22 feet. The sampling (boring) locations are shown in Figure 15. These samples were analyzed for PCBs, PAHs, and metals.

6.7 Field Measurement Procedures and Criteria

6.7.1 Background Samples

No background sediment samples were collected because the Anacostia River has been dredged in the past (SRC and NOAA 2000).

6.7.2 Field Duplicates

One field duplicate sample was collected for each 10 environmental samples in accordance with the SCP for surficial and core sediment samples. However, no duplicate samples were collected for the pore water, surface water, and deep sediment samples. Analytical results from the field duplicate samples were used to determine if there were any problems with the sample collection efforts.

Because of the collection techniques no rinsate samples were collected for analysis. Matrix spike/matrix spike duplicate (MS/MSD) samples serve as a check on the quality of the laboratory procedures and efficiency of the laboratory equipment. The results of these samples were interpreted in accordance with the STL's Quality Assurance/Quality Control (QA/QC) plan.

6.7.3 Trip and Temperature Blanks

No trip blanks were necessary because no volatile organic compounds (VOCs) were analyzed. Horne Engineering did include one temperature blank with each sample shipment. The laboratory checked the temperature of the sample upon receipt to ensure the samples were maintained at approximately 4 ^{0}C (± 2 ^{0}C)

6.7.4 Sample Containers and Preservation Techniques

All samples were stored on ice or with cold packs to maintain a temperature of approximately 4 ^{0}C (± 2 ^{0}C). The laboratory measured the temperature when the cooler arrived at the laboratory and entered the temperature reading on the laboratory receipt form. The laboratory was notified before sample shipment to ensure that personnel were available to accept samples upon arrival.

6.7.5 Decontamination Procedures

Equipment used to collect water and sediment samples was decontaminated between sampling to avoid cross-contamination. Once the sediment sample was labeled, the excess sediment was placed in the container. The decontamination procedure for the Ponar was as follows: some sediment or organic material adhering to the metal surfaces was removed by brush and these materials were placed in with the other drummed sediments; the sampler was then grossly decontaminated using river water.

All sampling was conducted in Modified Level D personnel protection equipment (PPE), using disposable PPE as necessary. Gloves were changed between each sample and sampling location. Gloves were discarded when torn or otherwise rendered unusable during sampling. These items were placed in plastic refuse bags for disposal and were stored away from the sampling activities.

Disposable PPE including Tyvek® suits or aprons were discarded each time the wearer left the sampling processing area, or when they become torn or otherwise rendered unusable during sampling. These items were placed in a plastic refuse bag, which were containerized and stored away from the sampling activities.

6.8 Sample Chain Of Custody/Documentation

6.8.1 Field Logbook

The sampling team leader maintained onsite a daily log of daily activities and events. When the project was completed, the logbooks were placed into the project files as part of the permanent record.

6.8.2 Photographs and Videos

Photographs and video clips were taken during the sampling events as needed. Photographs and video clips were provided to HSRC separately and are not included in this document.

6.8.3 Core Log

Lithologic logs of the sediment cores were prepared for each boring location; these included a brief description of sediment in the field log. The descriptions note any distinctive features of sediment such as color and texture. Field log notes are included in Appendix B.

6.8.4 Sample Numbering System

The sample numbering system was designed to prevent sample misidentification during the various sampling activities so data quality objectives could be controlled and documented.

Surficial Sediment Sample: Surficial sediment samples were identified by the location code, followed by a sequential grid point in which the sample was collected and a media/parameter code. CSO-A1S is an example of sediment sample ID format: CSO is the location code for Area 1, A1 is the grid code, and S is media/parameter code as sediment analyzed for metals, PCBs, and PAHs. Other media/parameter codes used are provided below:

- SR – metals, PCBs, PAHs, TOC, TKN, TP
- SRG - metals, PCBs, PAHs, TOC, TKN, TP, grain size with hydrometer
- SRGC - metals, PCBs, PAHs, TOC, TKN, TP, grain size with hydrometer, CEC, bulk density, and specific gravity
- RS - PCBs, PAHs, metals, and pesticide

Core Sediment Sample: Core sediment samples used the same sample numbering system as surficial sediment sample. The core samples collected at the different depths were identified by the core depths (for example, "-5" and "-10"), indicating from which depth the sample was taken. CSO-CORE1 0-6 is an example of core sediment sample identification format: CSO is the

location code, CORE1 is the coring number, and 0-6 indicates that the sample is collected at a depth of 6 inches from the sediment surface.

Field Duplicate Sample: Field duplicate samples were labeled in the same format as field samples, except that a "D" as added to the numbering system, indicating that the samples were field duplicates.

Water Column Sample: Water column samples were designated with CSO-W1, CSO-W2.

Pore Water Samples: Pore water samples collected were designed with CSOPORE1 and CSOPORE2.

Multicore Samples: No specific ID system was used, as the samples were processed by the LSU and shipped to LSU for further analysis.

6.8.5 Sample Documentation

The field team labeled each sample bottle with the following information:

- Project name: Anacostia CAP
- Sample ID number
- Date and time of collection
- Media
- Analysis required
- Sampler's initials
- Preservative

The sampling team used indelible ink in filling out the label and covered the label with waterproof tape after it had been placed on the bottle. After the label had been taped, the sampling technician placed custody tape over the top of the bottle.

6.8.6 Chain-of-Custody Records

After samplers labeled samples in the field, they brought labeled bottles to a processing area to prepare chains of custody. For each sample going into a single cooler, the chain of custody included the sample ID number, parameters to be analyzed, and any comments or notations to the laboratory. The sampling team leader checked each chain of custody to be sure it was correct. Any errors were corrected in accordance with Section 6.8.7.

After any necessary corrections were made, the team leader signed the document to indicate he or she had taken custody. A copy was retained for the project files; the remaining copy was placed in a sealed plastic bag that was taped to the inside lid of the cooler. All samples were taken by courier directly from the site to STL in Pittsburgh, Pennsylvania. The copies of Chain-of-Custody records are included in Appendix C.

When the laboratory received the samples, the sample manager responsible for sample receipt opened each cooler, removed the chain of custody, and signed it to indicate its receipt. The

sample manager measured the temperature when the cooler arrived at the laboratory and entered the temperature reading on the laboratory receipt form. The sample manager then remove the cooler's contents and checked to ensure the contents matched the chain-of-custody. The sample manager noted any discrepancies, as well as any broken bottles or other problems with the shipment. The laboratory's point of contact notified the sampling team leader immediately of discrepancies or problems.

6.8.7 Corrections to Documentation

Corrections to the documentation by the sampling team was made by marking a single line through the error. The errors remained visible. The person making the correction initialed beside the marked error.

6.9 Reporting and Data Quality Review

The analytical data was evaluated for precision, accuracy, and completeness to meet the data quality objectives. The data quality objective evaluation consisted of review of the laboratory internal QA/QC requirements, review of analytical method QA/QC requirements such as MS/MSD, review of blank contamination; and any available QA/QC requirements. No full data validation on the analytical data was performed.

Horne Engineering required STL to perform and document all sample preparation, analysis, and data verification activities in accordance with its approved quality assurance project plans, standard operating procedures, and certifications. The sediment and water samples were analyzed in accordance with the prescribed methods provided in the *Revised Draft Quality Assurance Project Plan* (Horne 2003). A brief discussion of each method is provided in Appendix D.

6.9.1 Precision

Precision data is generated by STL and is a quantitative measure of data quality that refers to the ability to generate reproducible data. Precision values represent both analytical precision and the homogeneity of the samples collected. Precision is expressed as a relative percent deviation (RPD) and is compared to the RPD provided in the analytical method or as calculated by the laboratory from statistical data. The exceedance information is provided in the STL nonconformance reports (NCR) submittals.

6.9.2 Accuracy

Accuracy is a quantitative measure of data quality, derived from the difference between measured values of a parameter and the true value of that parameter. Accuracy is calculated as percent recovery of known concentrations of analyte from quality control (QC) samples. The QC samples that result in accuracy information include standard reference materials and matrix spikes. The closer the measurement is to the known value, the more accurate the measurement. Cumulative data for accuracy using a specific matrix can be used to evaluate the bias that a matrix contributes to the accuracy of the reported data.

Analytical accuracy is dependent on the specific analyte, the method of analysis, and the sample matrix. The range of acceptable accuracy and precision is determined by the method or established through statistical procedures by the laboratory for each matrix. If accuracy and precision do not meet the guidelines, then the usability of the data need to be evaluated. Accuracy issues are provided in the STL NCR submittal.

6.9.3 Completeness

Completeness is a quantitative measure of data quality expressed as the percentage of valid or acceptable data obtained. The project achieved a completeness goal (at 100%). An adequate amount and type of data was collected for conclusions to be valid.

6.9.4 Detection Limits

There were two types of detection limits used in the reporting of the analytical result concentrations. These are method detection limits and reporting limits. The method detection limit (MDL), as defined by USEPA, is "the minimum concentration of a substance that can be determined with 99% confidence that the analyte concentration is greater than zero." In other words, without any reference to the accuracy of the data, it is the minimum value that can be distinguished from background noise. This MDL calculation procedure is outlined in 40 CFR part 136 Appendix B. The reporting limit (RL) is the lowest concentration that can be calculated from the calibration curve. Generally, values reported from within the calibration range of the instrument are considered to have a higher degree of confidence, when compared to data reported below the calibration range. The actual reported values for the RL and the MDL for a specific sample are provided on the data report. These sample-specific detection limit values reflect corrections made for sample dilution, sample weight (i.e., amount analyzed), and where appropriate adjustments are made for the percent moisture of the sample. The RL is always equal to or greater than the MDL.

In order to differentiate analytical results detected below the calibration curve from data calculated within calibration range, the laboratory qualifies analytes reported as an estimated valued ("J" qualified) if the calculated value is greater than the MDL and less than the RL.

6.9.5 Method Blank

The method blank (MB) is prepared from laboratory blank matrix and the same reagents and/or solvents being used to prepare the associated samples. The method blank confirms that the analytical instrument is "clean" and that the reagents/solvents are of acceptable quality. If MB data indicates the presence of any of the compounds associated with the sample, then the laboratory provides an explanation in the NCR and, the data is qualified with a "B" indicating blank contamination. Where the blank result is greater than the RL than the laboratory must implement a corrective action response, which may result in repreparation and reanalysis, depending on the effect that the blank result has on the associated data.

6.9.6 Matrix Effects

A matrix effect exists when the sample matrix possesses properties that affect the detection of analytes of concern. Matrix effects are common in sediment analyses for both metals and PAHs.

For example, STL has frequently reported matrix effects when measuring PAHs from the presence of a background of other petroleum products. It should be noted that matrix effects result in varying degrees of impact. Where the impact is low, the data usability may be unaffected. This requires a case-by-case evaluation.

6.9.7 Dilution Factors

Dilutions may be required because of high analyte concentrations and/or high background / matrix effects. As noted earlier, when a sample requires dilution prior to analysis, the dilution factor affects both the RL and the MDL. The more a sample is diluted, the higher the reporting limit and method detection limit. However, if a target compound has a very high concentration and it requires dilution in order to be within calibration range, the high MDL for that compound is not an issue, because it is present well above the detection limit. However, the method sensitivity for other compounds not detected in that sample are unavoidably raised.

6.9.8 Data Qualifiers

In addition to the NCR, STL flagged any data associated with low or high matrix-spike-recovery issues or other anomalies noted in analytical samples or results. Appendix E provides a list of data qualifier used for data flags and the effect on data quality

6.10 Sample Packaging and Shipping

After sample bottles had been properly labeled, the samplers wrapped each bottle in bubble pack and place the wrapped bottles in a cooler for shipment to the laboratory for analyses. The plastic bags prevent damage and potential cross contamination in the event that any bottle might break. Ice was placed in the coolers to maintain the samples at approximately 4 ^{0}C (± 2 ^{0}C).

Before sealing the cooler, the sampling team prepared a chain-of-custody, as described in section 6.8.6. One copy of the chain-of-custody was sealed in a plastic bag and taped inside the lid of the cooler. The outside of the cooler was sealed with tape. The field team member preparing the cooler for shipment sealed the cooler and signed his or her name in indelible ink across the seal where the lid and the cooler body meet.

At the end of each sampling day, the sampling team delivered the coolers to the laboratory transport for shipment. The sampling team leader coordinated with the laboratory's point of contact to ensure the laboratory executed the number and types of samples. The laboratory analyzed the samples within 30 days of receipt. The laboratory sent a hard copy of the results to Horne Engineering after the laboratory's internal QA/QC had been completed.

6.11 Investigation Derived Wastes

The sampling effort generated two types of waste: cuttings from sediment cores, from equipment decontamination, and disposable sampling equipment.

6.11.1 Excess Sediments

Excess sediments were containerized and characterized for disposal by EA Engineering.

6.11.2 Decontamination Water

No decontamination water was generated onsite.

6.11.3 Disposable Sampling Equipment

All PPE and disposable sampling scoops were disposed of as standard debris.

6.12 Corrective Actions

No problems occurred during the sampling program.

6.13 Analytical Methods

Table 5 lists the analytical methods used for the site characterization, including metals, TP, TKN, TOC, AVS/SEM, PAHs, PCBs (both aroclors and congeners), and pesticides. The parameters were analyzed in accordance with the QA/QC requirements specified in the *Revised Draft Quality Assurance Project Plan* (Horne 2003).

6.14 Sediment Characterization Results

Site sediment characterization included analysis of metals, TP, TKN, TOC, AVS/SEM, PAHs, PCBs (both aroclors and congeners), and pesticides. All analytical data are reported in dry weight units. Metals, TP, and TKN are reported in milligram per kilogram (mg/kg), 16 individual PAHs, PCBs and pesticides are reported in microgram per kilogram (µg/kg). AVS/SEM is reported in micromoles per gram (µmoles/g), and TOC in mg/kg (percent). The detailed analytical data are included in Appendix F. Summary discussions of each parameter are provided in the following sections.

6.14.1 Surficial Sediment Characterization Results

Polychlorinated biphenyls: Sediment samples were analyzed for aroclors. Figure 17 shows the surficial sediment total PCB (tPCB), comprised of aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260. The tPCB in the sediment ranged from 25 µg/kg to 2,400 µg/kg. The dominant aroclors in the sediment are aroclor 1248, 1254, and 1400. No aroclor 1016, 1221, or 1232 was detected.

Polynuclear Aromatic Hydrocarbon: Sediment PAH was characterized according to the USEPA regulated 16 PAH compounds expressed as “total PAH” (tPAH). The 16 regulated PAHs are acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)perylene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorine, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene. These 16 regulated PAH compounds comprise both low and high molecular weight compounds (Table

6). Those PAH with two or three rings are defined as LPAH, and those with four or more rings are defined as HPAH.

Table 5. Analytical Methods

Analytical Parameter	Aqueous Methodology	Solid Methodology
Total PCBs (PCB Aroclors)	SW-846 8082	SW-846 8082
STL Environmentally Significant PCB Congener List (55)	EPA 1668	SW-846 8082
ICP Metals (PPL List-13)	SW-846 6020	SW-846 6010
Mercury	SW-846 7471A	SW-846 7471A
PAHs (NOAA Status & Trends)	SW-846 5030B/8270C SIM	SW-846 8270C
Pesticides - TCL	SW-846 8081A	SW-846 8081A
AVS/SEM	Not Applicable	EPA SEM
Total Petroleum Hydrocarbons (TPH)	Not Applicable	SW846 8015B or SW846 9071A/ EPA 1664A
Cation Exchange Capacity	Not Applicable	SW846 9081
Grain Size w/ Hydrometer	Not Applicable	D422
Total Suspended Solids-(TSS)	EPA 160.2	Not Applicable
Total Dissolved Solids-(TDS)	EAP 160.1	Not Applicable
Total Kjeldahl Nitrogen (TKN)	EPA 351.3	EPA 351 modified
Phosphorus	EPA 365.2	EPA 365 modified
Total Organic Carbon	EPA 415.1	Lloyd Kahn
Biological		
Benthic Macroinvertebrate		EPA/600/4-90/030

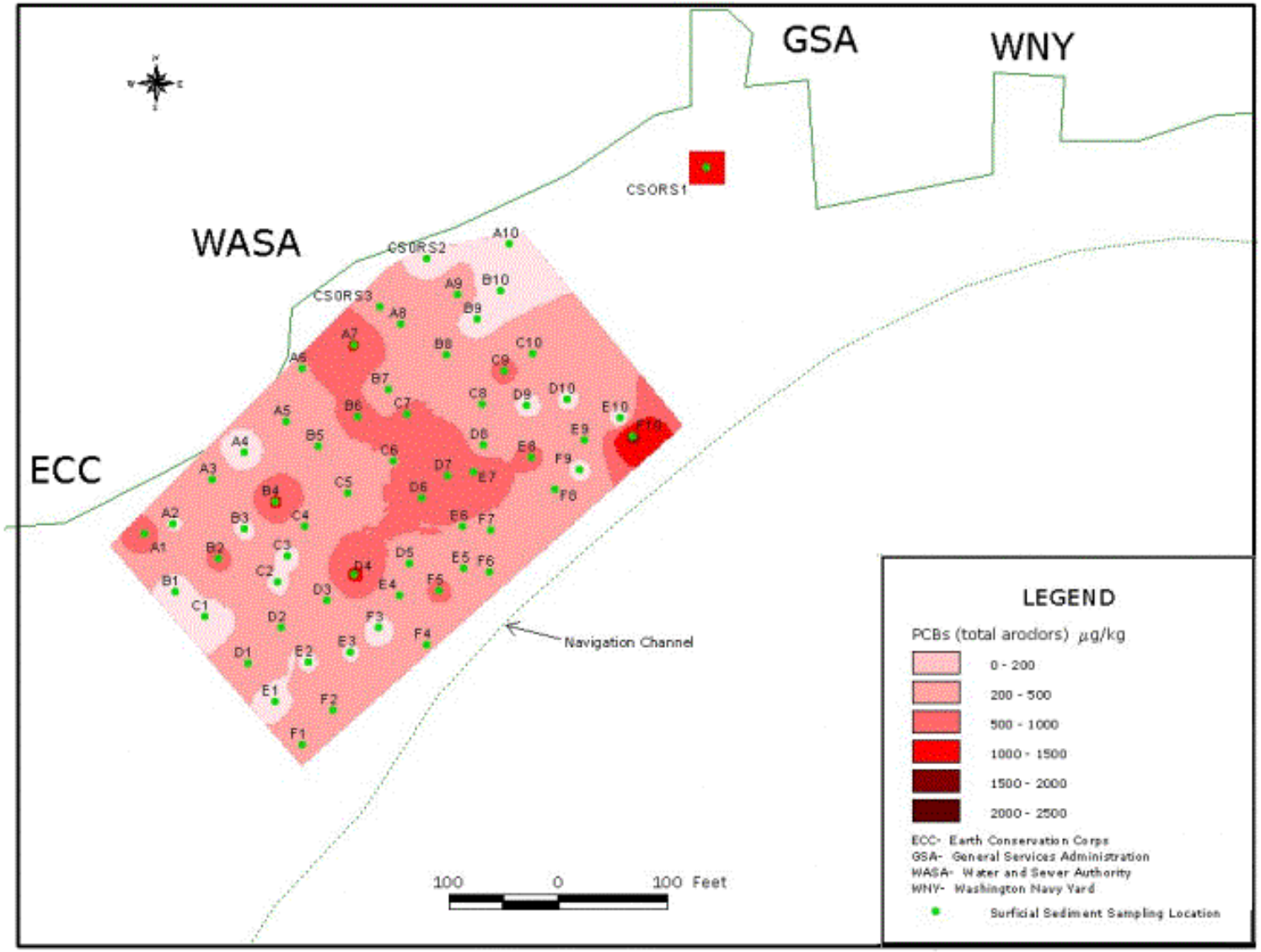

Figure 17. Total PCB (Aroclors) Concentration Distribution in the Surficial Sediment

The tPAH concentrations determined in the surficial sediment samples ranged from 470 µg/kg to 82,360 µg/kg dry weight, as shown in Figure 18. The highest tPAH concentration (82,360 µg/kg) was detected near the CSO. The PAH data were further evaluated for LPAH and HPAH. The average of LPAH/HPAH ratio in the sediment was calculated to be roughly 80%, which indicated that high-molecular-weight PAH are adsorbed to the silt-clay fraction and sedimented.

Metals: Sediment samples were analyzed and evaluated for the EPA 13 priority metals, including antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc. Figures 19 through 31 show the contamination distributions of the 13-targeted metals in the surficial sediment samples.

In summary, detected metal concentration ranges in the surficial sediment samples were as follows, in mg/kg dry weight: antimony 0.33 to 5.0; arsenic 1.6 to 10.8; beryllium 0.31 to1.5; cadmium 0.32 to 3.8; chromium 11.3 to 94.8; copper 18 to 437; lead 29.3 to 726; mercury 0.033 to 10.7; nickel 15.3 to 69.8; selenium nondetected to 1.9; silver 0.29 to 22.5; thallium nondetected to 2.0; and zinc 109 to 892.

Acid Volatile Sulfide/Simultaneously Extracted Metals: Two surficial sediment samples (CSO-C5-SGC and CSO-B2-SRGC0) were analyzed for AVS and SEM. The bioavailability of SEM (i.e., cadmium, chromium, lead, mercury, and nickel) was correlated to the AVS concentrations in sediments with a SEM/AVS ratio (Table 7). The SEM/AVS ratios were calculated to be less than one (1) at two sampling locations indicating that the metals cadmium, chromium, lead, mercury, and nickel are not available in bioavailable forms. It should be noted that the AVS/SEM ratio is not the only parameter to assess the metal toxicity. Other site conditions may need to be considered to assess the metal toxicity.

Table 6. Low and High Molecular Weight PAH Speciation

Low molecular weight PAH (LPAH)	High molecular weight PAH (HPAH)
Acenaphthene	Fluoranthene
Acenaphthylene	Benzo(a)anthracene
Anthracene	Benzo(b)fluoranthene
Fluorene	Benzo(k)fluoranthene
Naphthalene	Benzo(ghi)perylene
Phenanthrene	Benzo(a)pyrene
	Chrysene
	Dibenzo(a,h)anthracene
	Indeno(1,2,3-cd)pyrene
	Pyrene

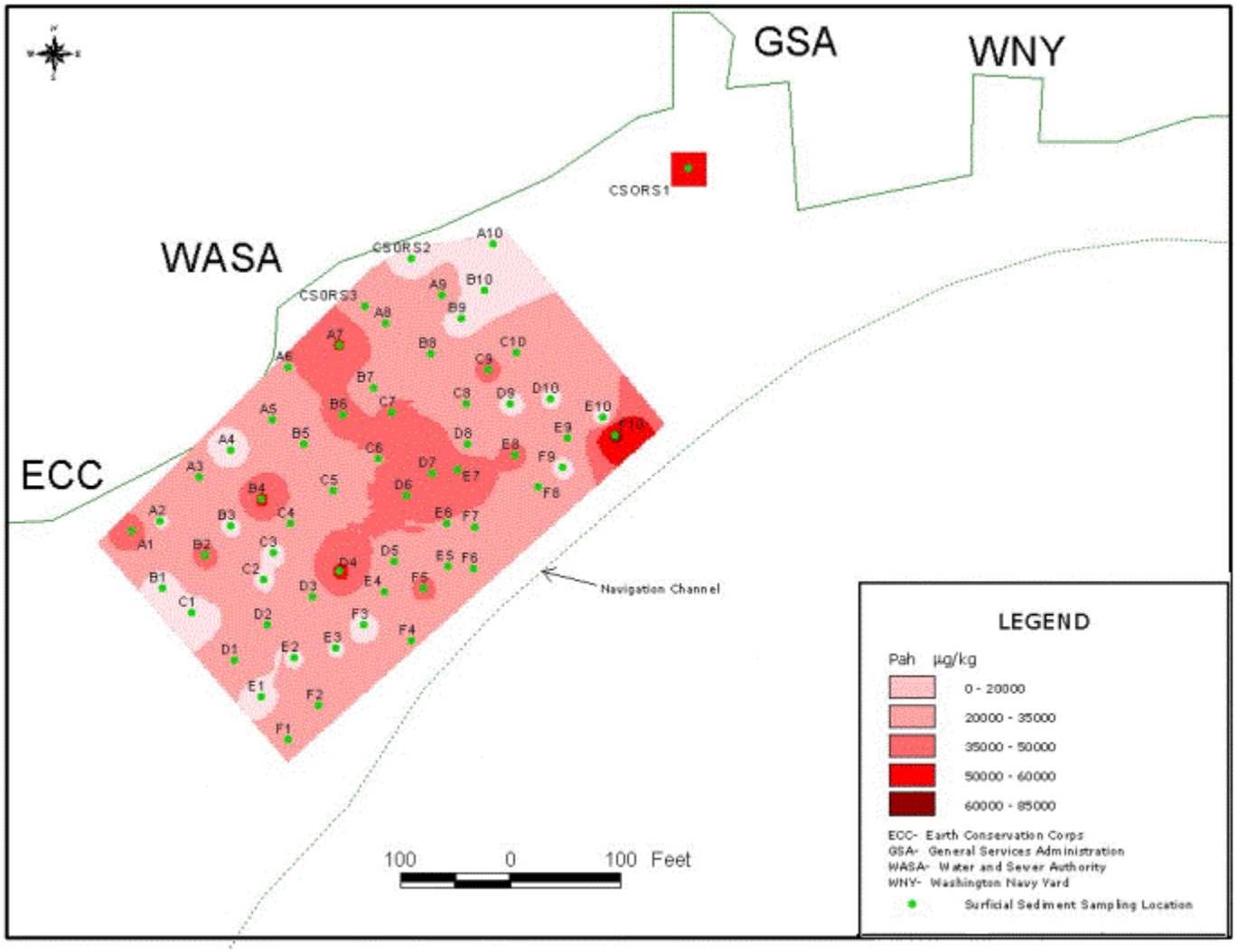

Figure 18. Total PAH Concentration Distribution in the Surficial Sediment

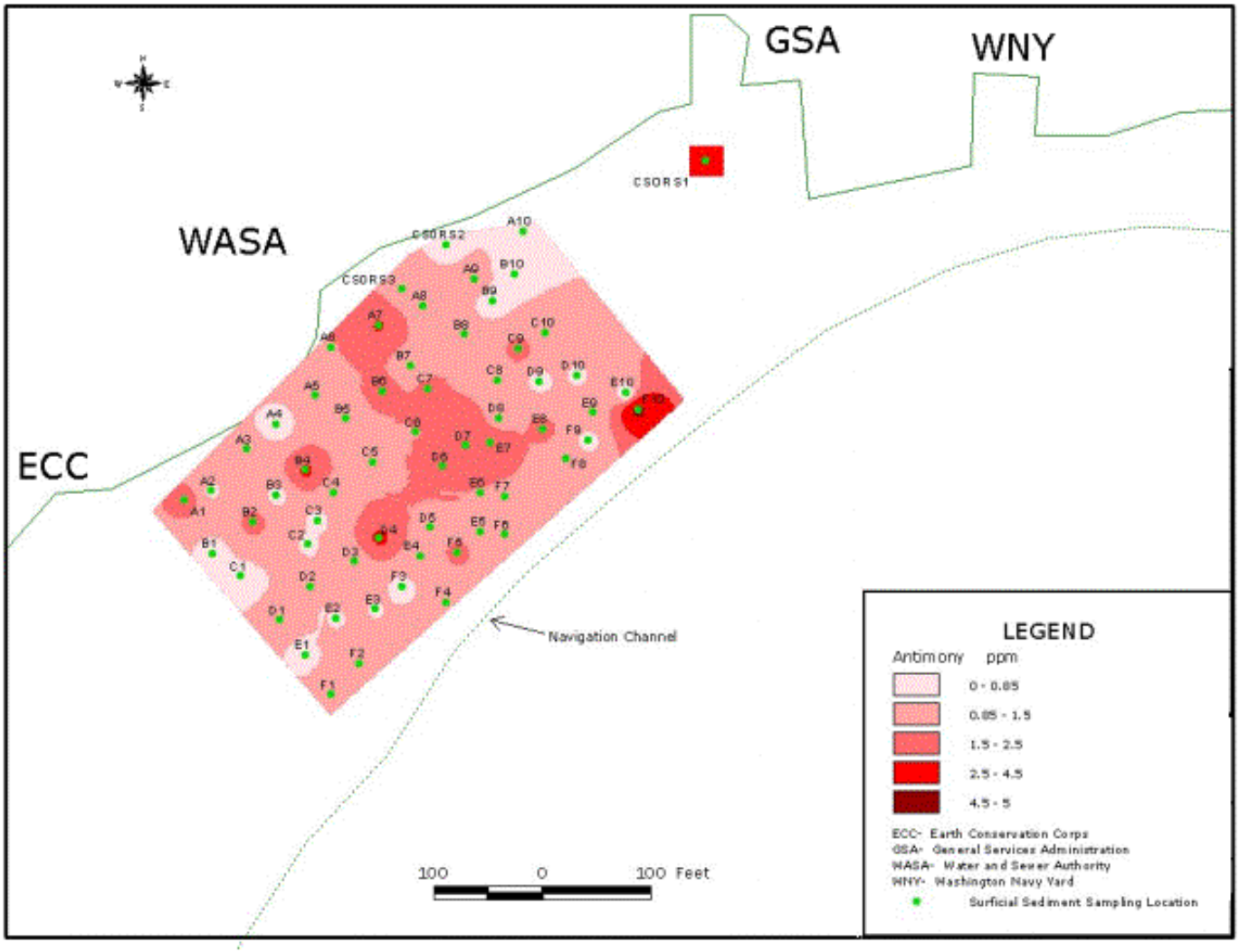

Figure 19. Antimony Concentration Distribution in the Surficial Sediment

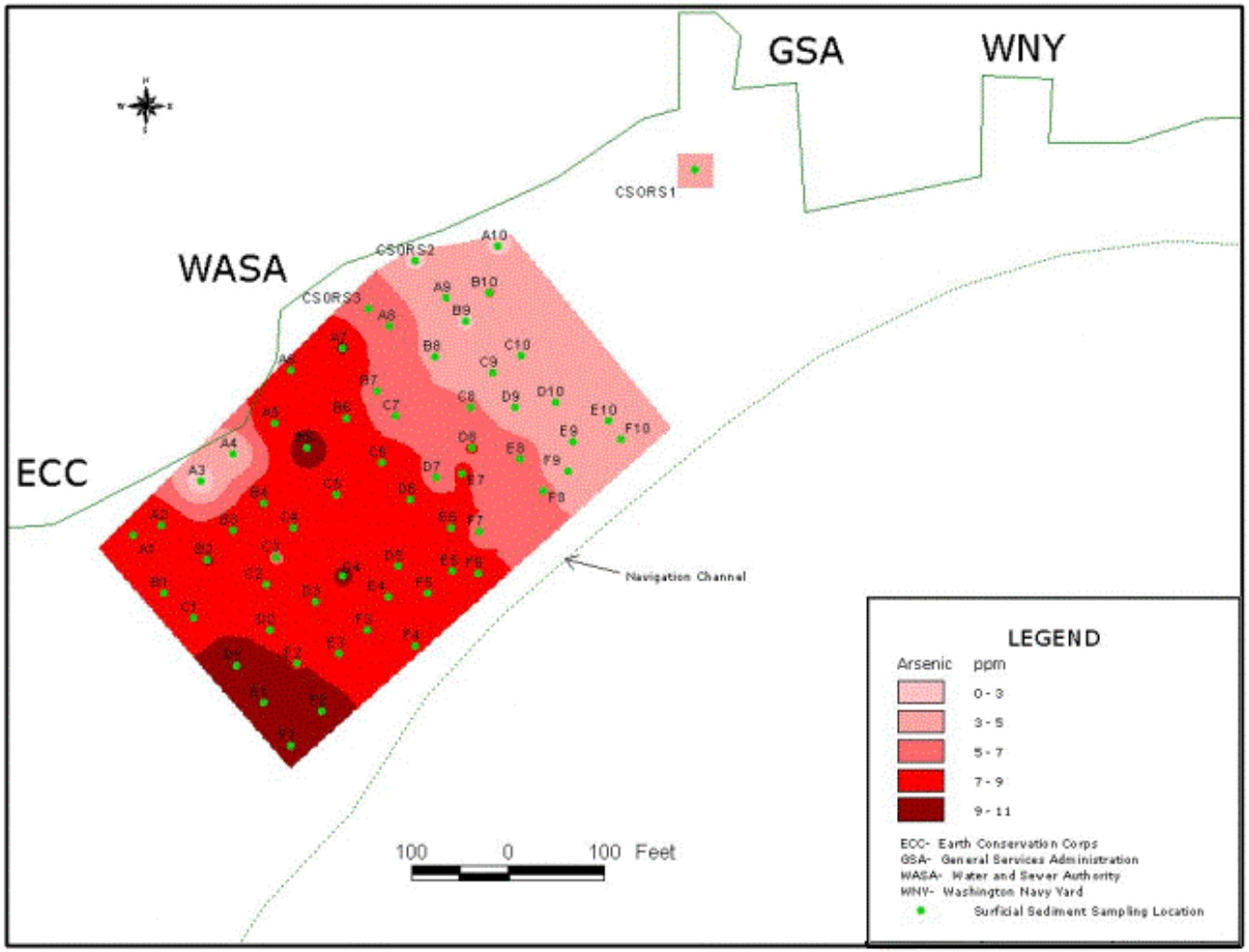

Figure 20. Arsenic Concentration Distribution in the Surficial Sediment

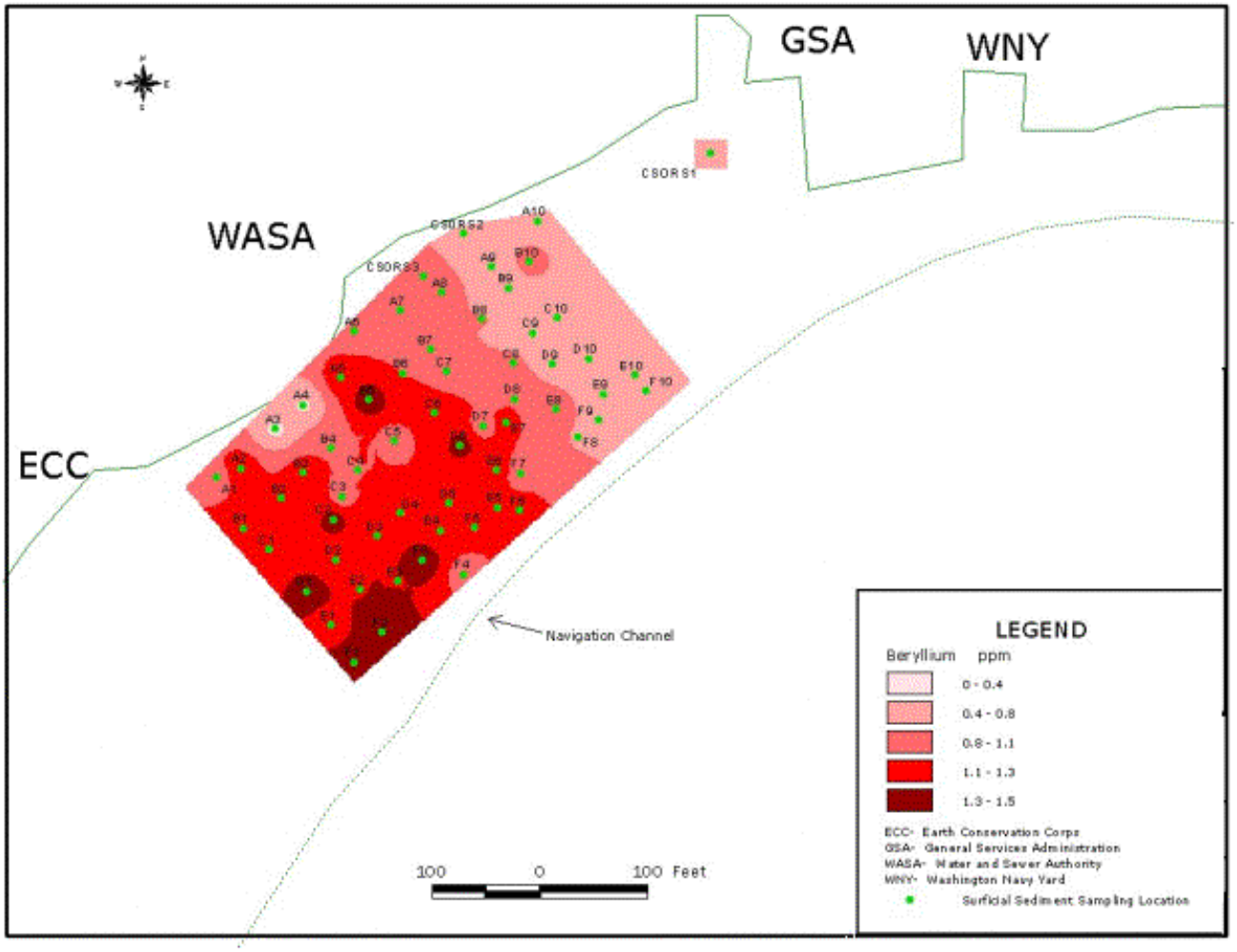

Figure 21. Beryllium Concentration Distribution in the Surficial Sediment

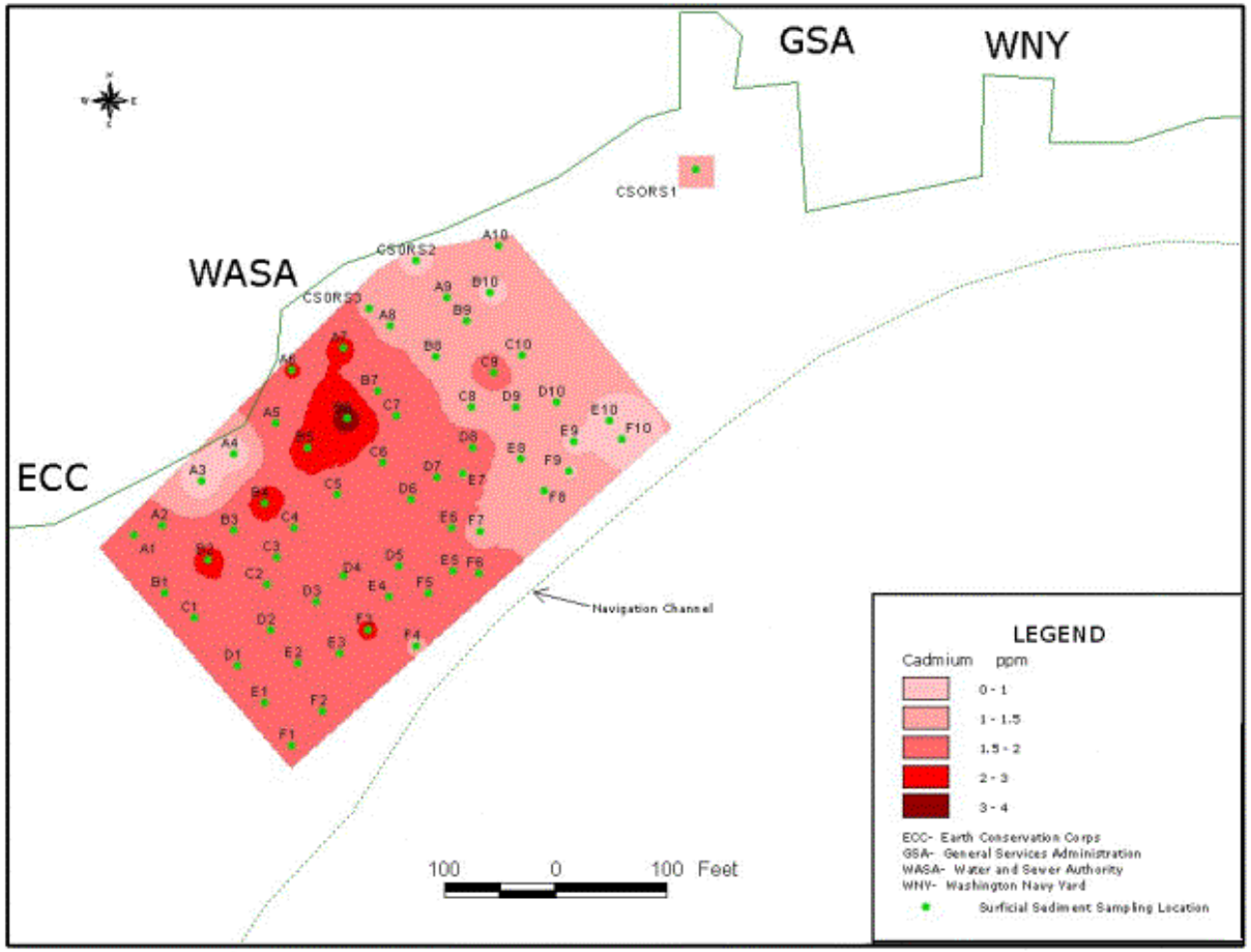

Figure 22. Cadmium Concentration Distribution in the Surficial Sediment

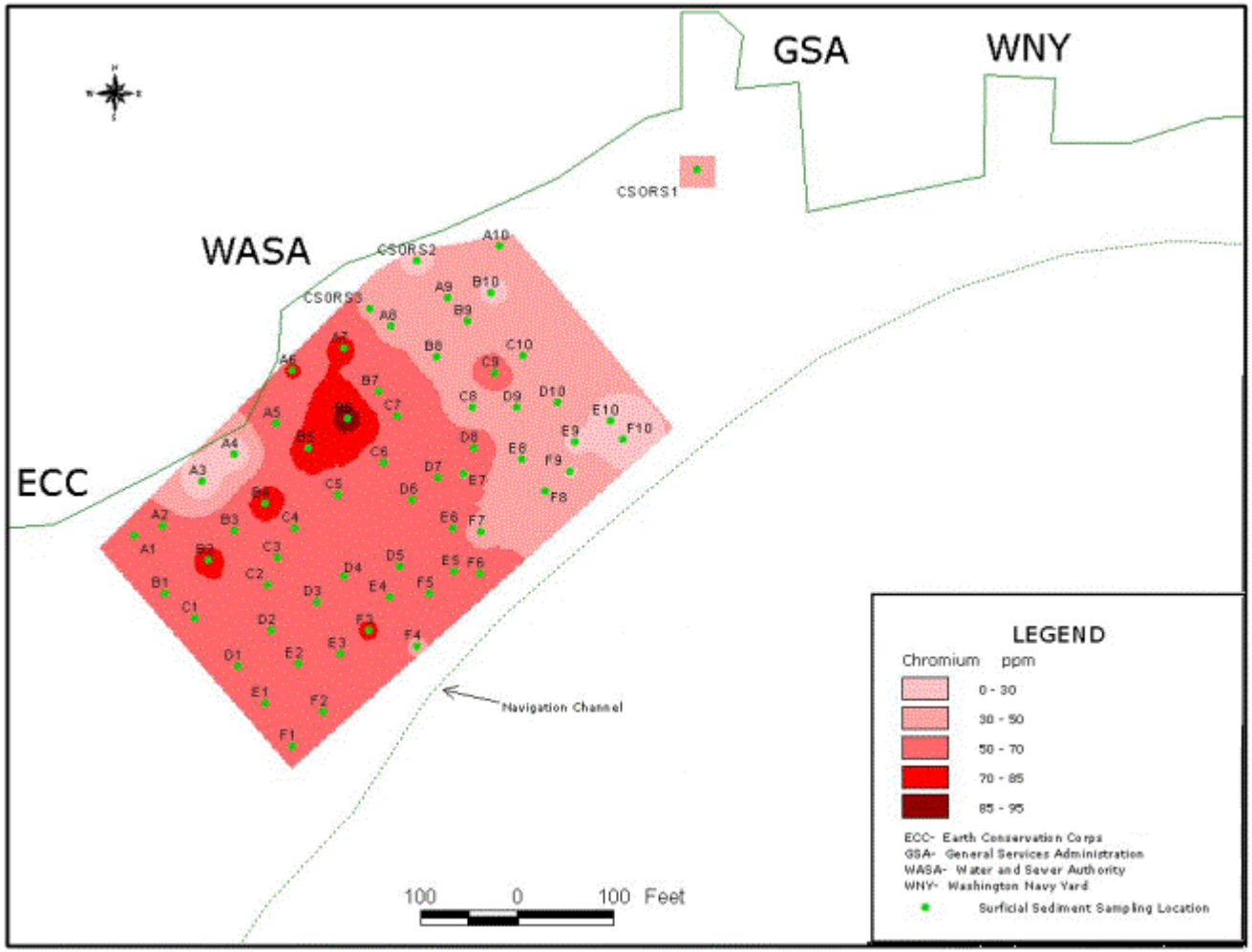

Figure 23. Chromium Concentration Distribution in the Surficial Sediment

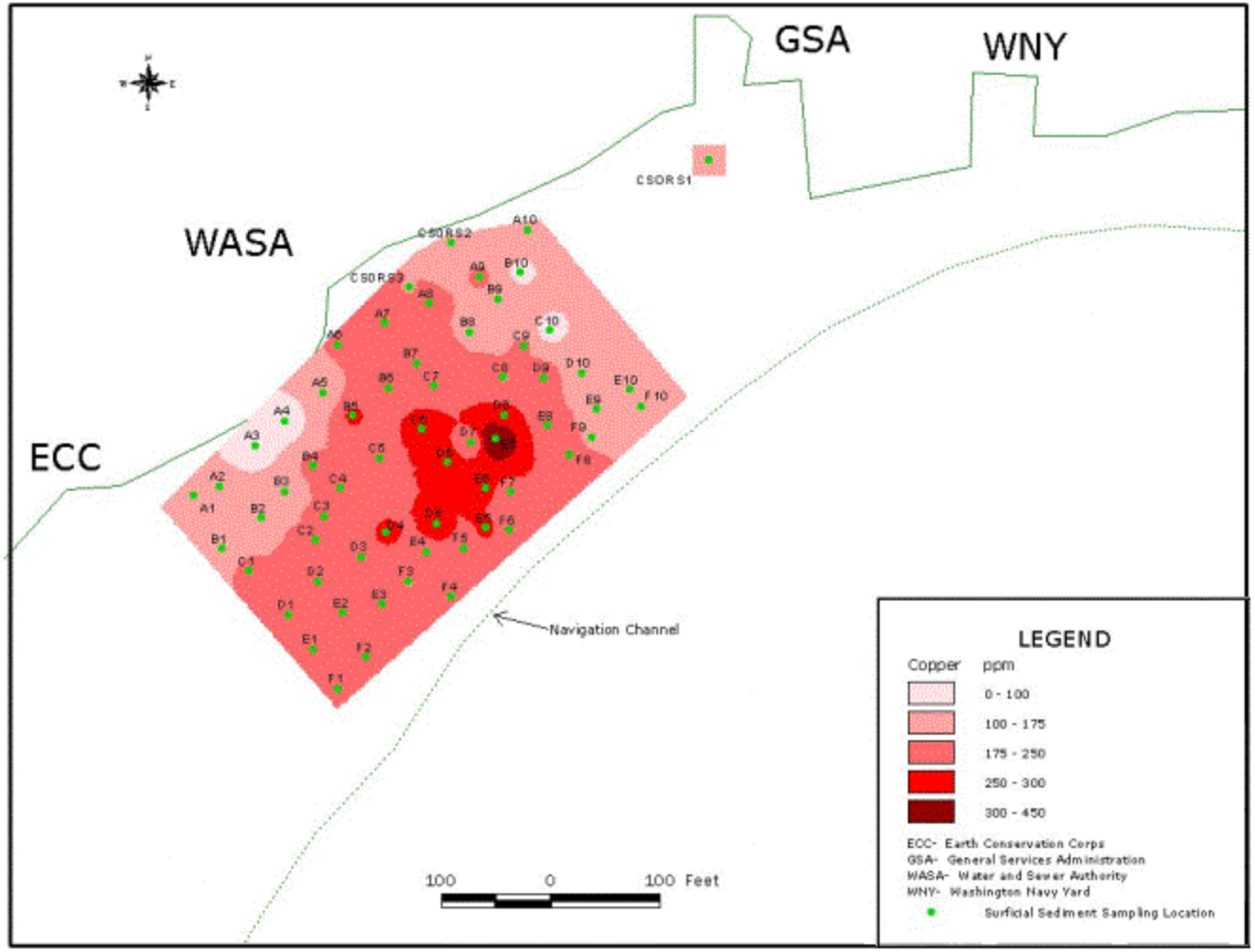

Figure 24. Copper Concentration Distribution in the Surficial Sediment

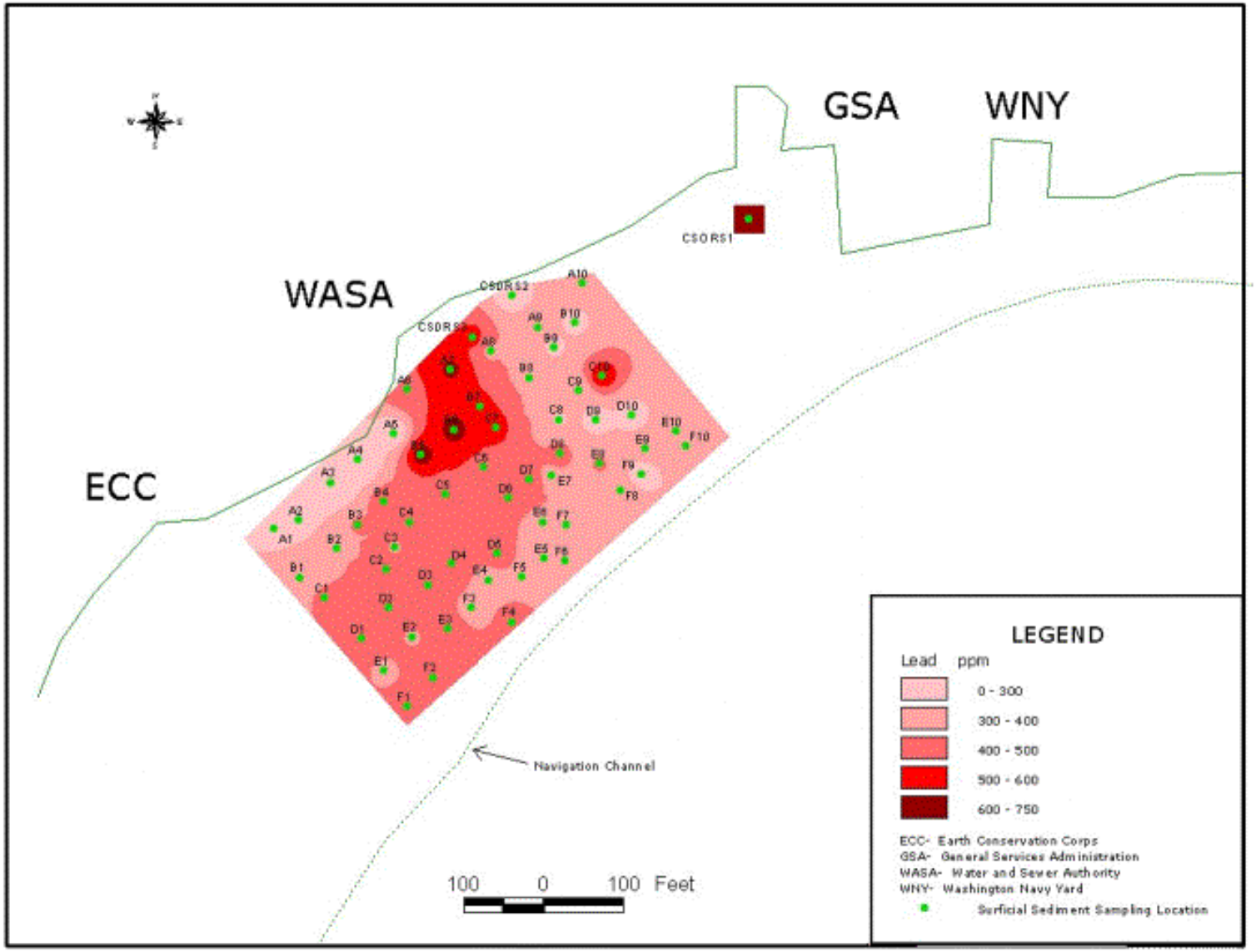

Figure 25. Lead Concentration Distribution in the Surficial Sediment

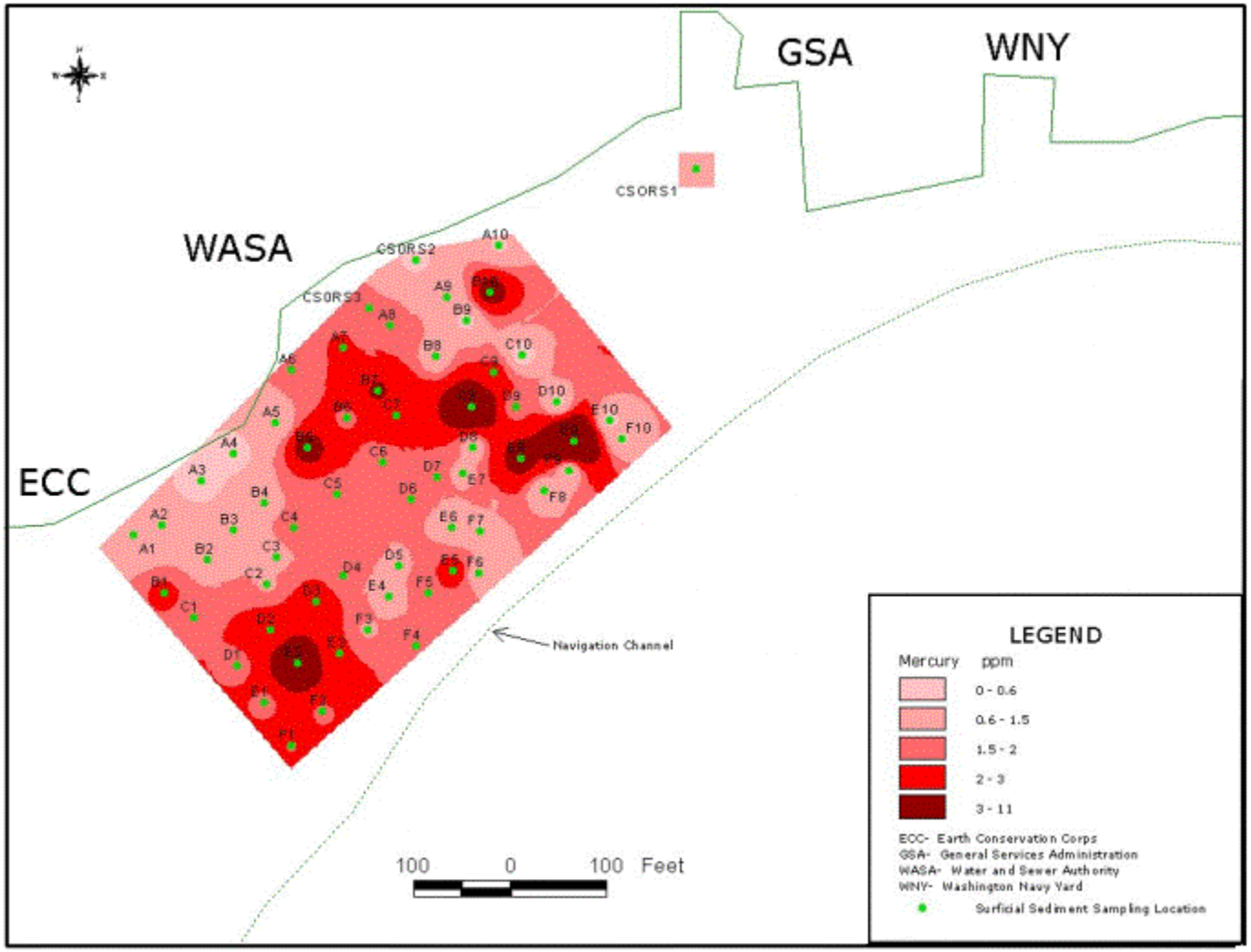

Figure 26. Mercury Concentration Distribution in the Surficial Sediment

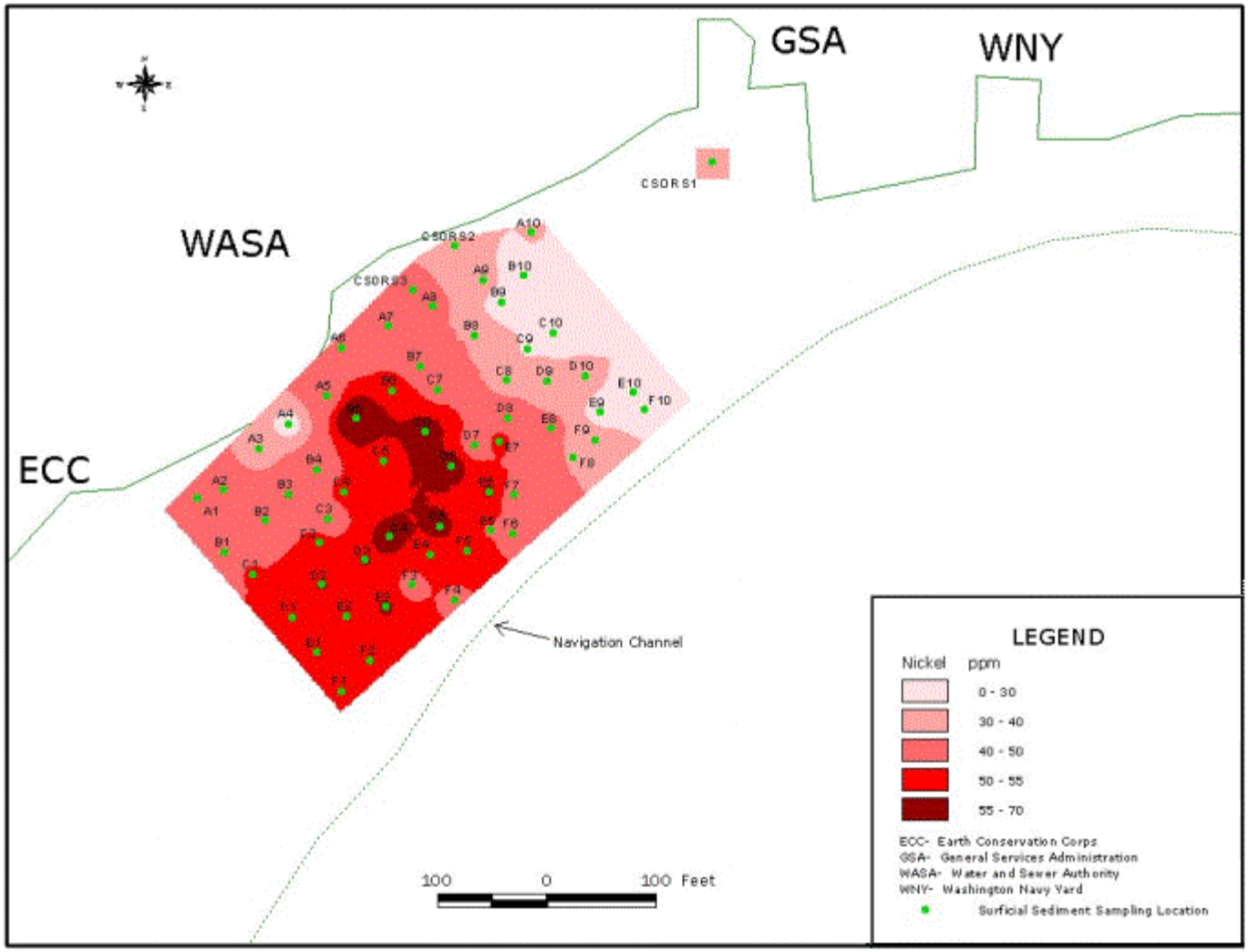

Figure 27. Nickel Concentration Distribution in the Surficial Sediment

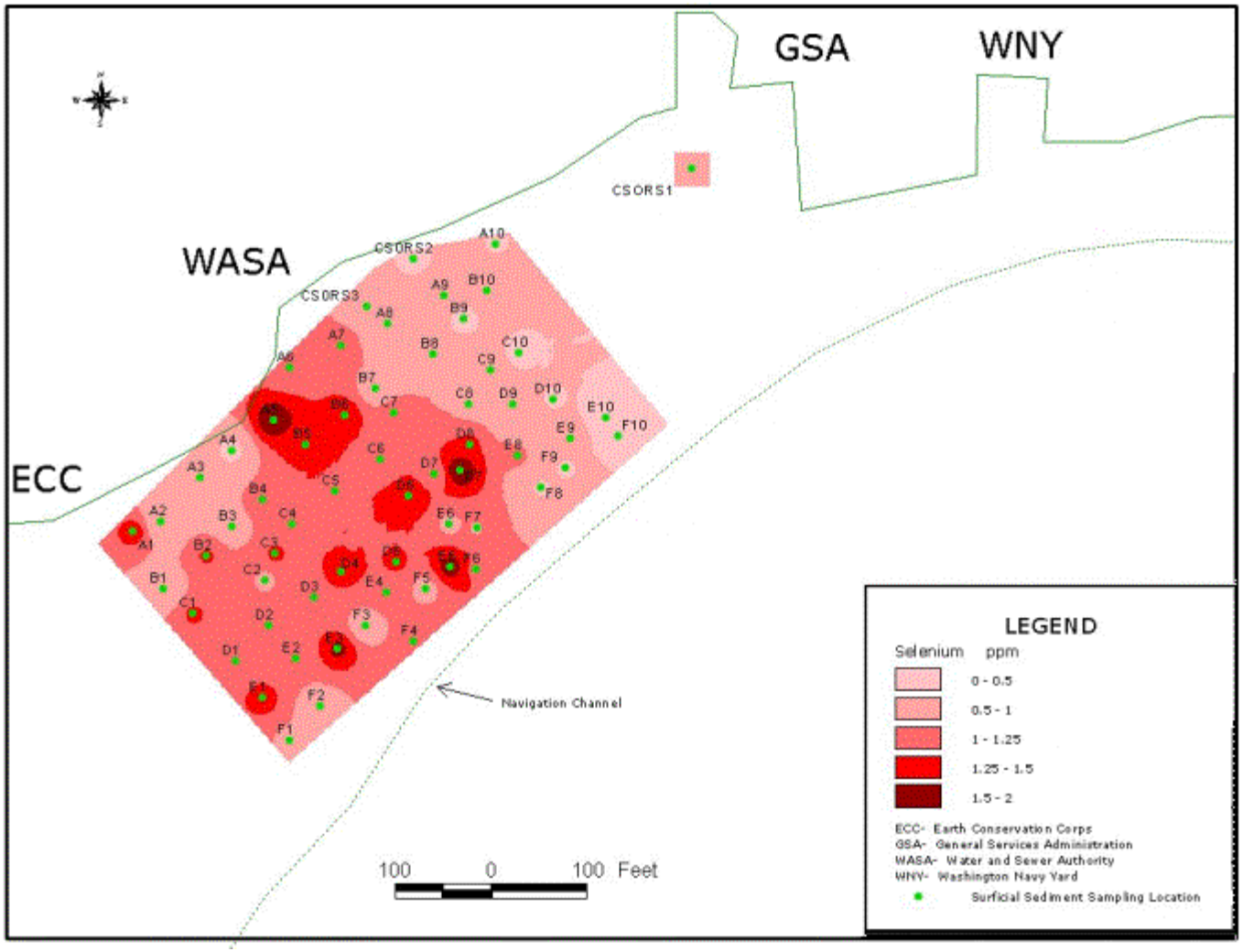

Figure 28. Selenium Concentration Distribution in the Surficial Sediment

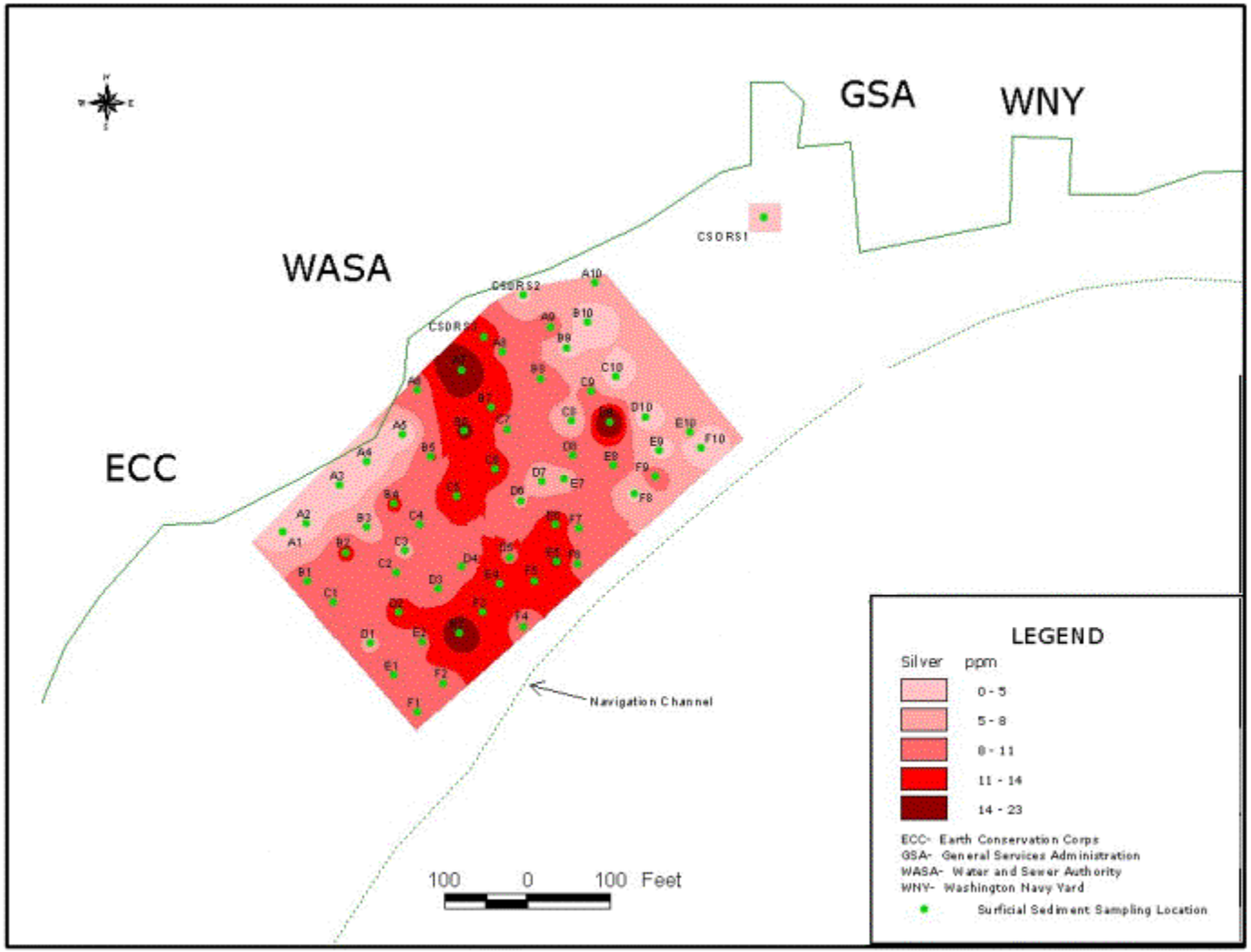

Figure 29. Silver Concentration Distribution in the Surficial Sediment

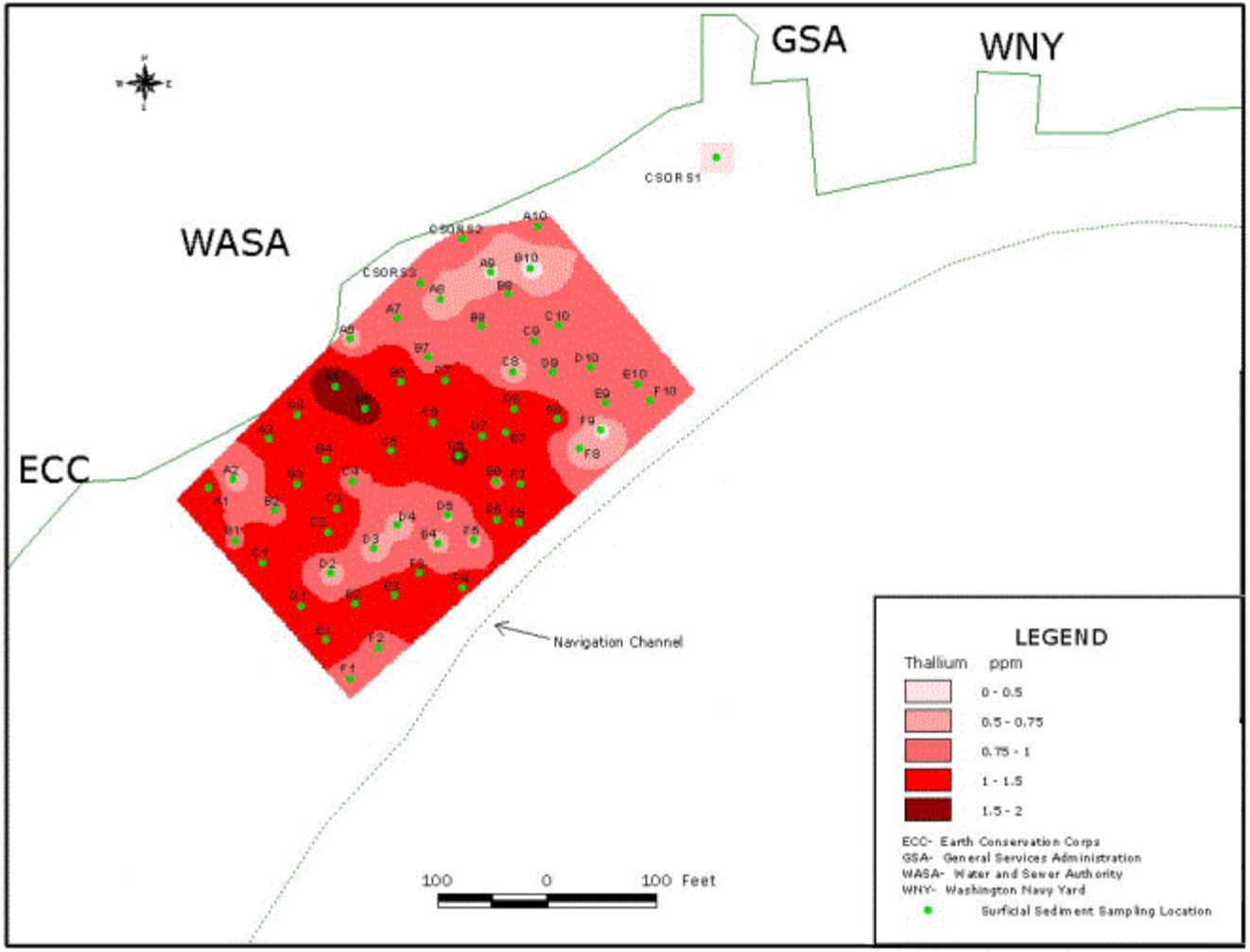

Figure 30. Thallium Concentration Distribution in the Surficial Sediment

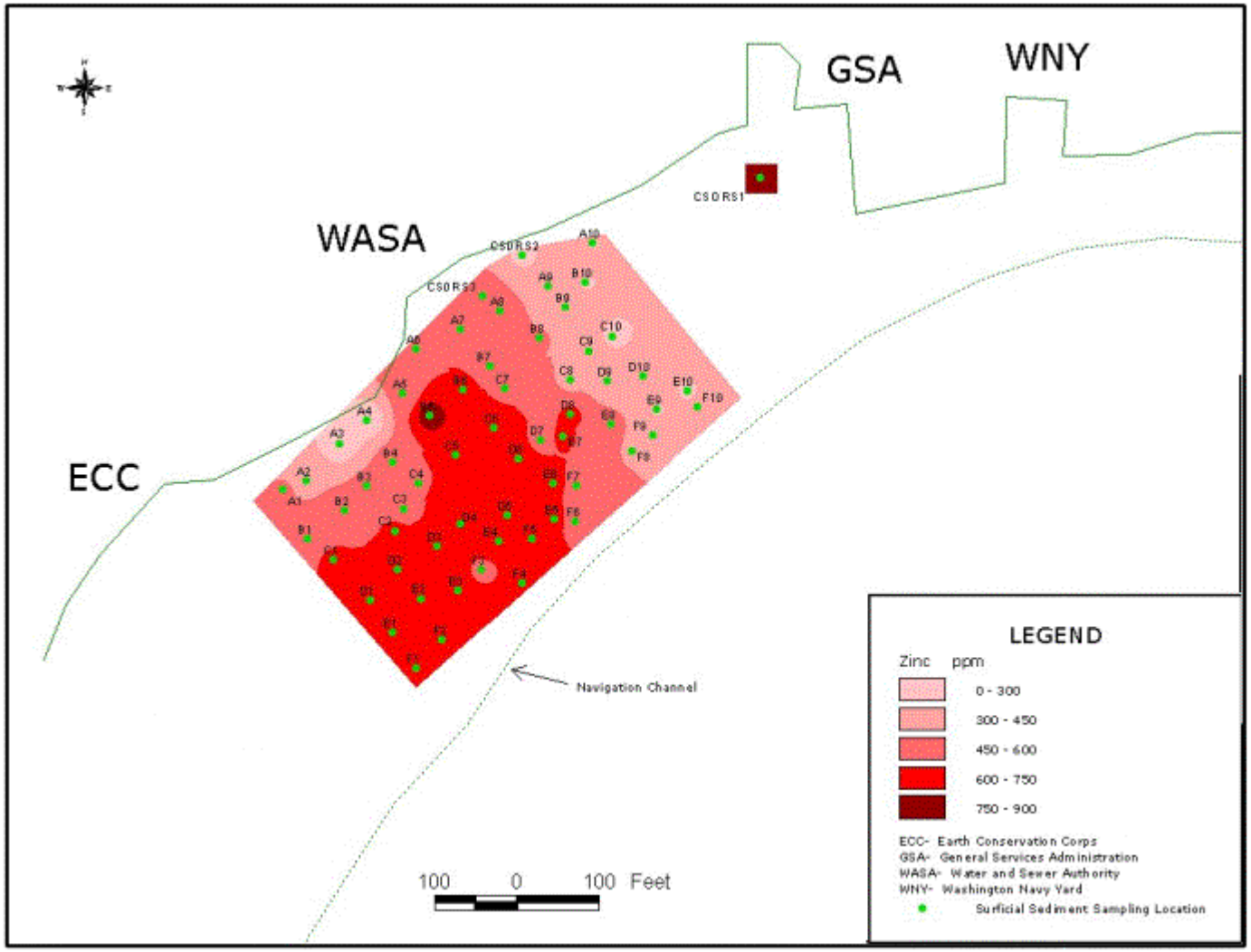

Figure 31. Zinc Concentration Distribution in the Surficial Sediment

Table 7. Surficial Sediment AVS, SEM and SEM/AVS Ratio

Sample Location	AVS (µmoles/g)	∑SEM (µmoles/g)	∑SEM/AVS
CSO-C5-SGC	8	4.7859	0.60
CSO-B2-SRGC	25	9.894	0.40

Cation Exchange Capacity: The sediment CEC data provides the chemical properties in sediment in which positively and negatively charged particles (ions) within the sediment react to one another. Two surficial sediment samples were analyzed for CEC, with a concentration of 16.6 and 16.3 milliequivalents/L, respectively. In general, the CEC of colloidal mineral is defined as the excess of counter ions in the zone adjacent to the charged surface or layer, which can be exchanged for other ions.

***Total Organic Carbon*:** TOC provides a measure of how much organic matter occurs in sediments. The TOC contents in surficial and core sediment (top 6 inches) samples ranged from 13,200 mg/kg (1.3%) to 143,000 mg/kg (14.3%), with an average of 70,464 mg/kg (7.0%) and a standard deviation of 27,521 mg/kg (2.8%). The proximity to the CSO and upland runoff probably explains the higher organic content.

Total Phosphorus and Total Kjeldahl Nitrogen: The phosphorus at Area 1 was analyzed and found to range from nondetected to 2,330 mg/kg, with an average concentration of 1,127 mg/kg. However, the total phosphorus concentrations had considerable observed variability in the sediment samples.

In addition, the TKN at the demonstration site was analyzed and found to range from 246 mg/kg to 6,020 mg/kg, with an average concentration of 3,648 mg/kg and a standard deviation of 1,276 mg/kg.

6.14.2 Core Sediment Characterization Results

Polychlorinated Biphenyls and Pesticides: Table 8 shows the tPCB in sediment core segments. The highest tPCB concentrations were found in the 6-to-12 inch core segment. In addition, all sediment core samples were analyzed for PCB congeners. Total PCB concentrations using 22 congeners (using EPA Region 2 methodology) were calculated and found to be comparable with the total PCBs calculated using aroclors (Table 8).

Pesticides were also detected in the sediment as well. DDT concentrations in the sediment samples ranged from nondetected to 47 µg/kg. Endrin concentrations in the sediment ranged from nondetected to 15.9 µg/kg. Lindane concentrations in the sediment ranged from nondetected to 8.38 µg/kg.

Polynuclear Aromatic Hydrocarbons: Table 9 shows the tPAH concentrations in the core segments. The tPAH concentrations in the core samples ranged from 5,110 µg/kg to 45,300 µg/kg, with the highest tPAH concentration detected in the shallower core samples segment.

Table 8. Gravity Core Sediment Total PCB with Aroclors and Congeners Concentrations

Sample Location	Total with Aroclors (µg/kg)	Total with 22 Congeners (µg/kg)
CSO-CORE 1 0-6	2680	5202
CSO-CORE 1 6-12	2220	3772
CSO-CORE 1 12-22	4200	4446
CSO-CORE 2 0-6	1560	1762
CSO-CORE 2 6-12	5500	3740
CSO-CORE 2 12-20	6400	4166
CSO-CORE 3 0-6	4000	2984
CSO-CORE 3 6-12	6000	3602
CSO-CORE 3 12-14	5300	3624
CSO-CORE 4 0-6	4800	3630
CSO-CORE 4 6-12	9100	6528
CSO-CORE 4 12-20	1120	165
CSO-CORE 5 0-6	2770	3577
CSO-CORE 5 6-12	4980	3396
CSO-CORE 5 12-18	1400	1271
CSO-CORE 6 0-6	6000	3434
CSO-CORE 6 6-12	4300	5328
CSO-CORE 6 12-15	400	689
CSO-CORE 7 0-6	2480	2062
CSO-CORE 7 6-12	3710	2693
CSO-CORE 7 12-14	1390	1179
CSO-CORE 8 0-6	3610	3134
CSO-CORE 8 6-12	4020	5634
CSO-CORE 8 12-17	2300	2942

Table 9. Gravity Core Sediment Total PAH, LPAH, and HPAH Concentrations

Sample Location	tPAH (µg/kg)	LPAH (µg/Kg)	HPAH (µg/Kg)
CSO-CORE1 0-6	17,820	2,510	15,310
CSO-CORE1 6-12	5,160	1,090	4,070
CSO-CORE1 12-22	5,110	730	4,380
CSO-CORE2 0-6	7,610	1,290	6,320
CSO-CORE2 6-12	7,290	1,440	5,850
CSO-CORE2 12-20	8,880	1,480	7,400
CSO-CORE3 0-6	19,870	3,020	16,850
CSO-CORE3 6-12	9,150	1,300	7,850
CSO-CORE3 12-14	15,040	2,560	12,480
CSO-CORE4 0-6	30,550	5,640	24,910
CSO-CORE4 6-12	10,520	1,890	8,630
CSO-CORE4 12-20	45,300	9,500	35,800
CSO-CORE5 0-6	26,610	4,280	22,330
CSO-CORE5 6-12	13,350	2,480	10,870
CSO-CORE5 12-18	28,840	6,490	22,350
CSO-CORE6 0-6	35,910	5,860	30,050
CSO-CORE6 6-12	19,140	3,020	16,120
CSO-CORE6 12-15	14,080	2,250	11,830
CSO-CORE7 0-6	12,650	2,200	10,450
CSO-CORE7 6-12	42,580	10,950	31,630
CSO-CORE 7 12-14	27,770	5,230	22,540
CSO-CORE8 0-6	28,810	5,480	23,330
CSO-CORE8 6-12	19,790	3,280	16,510
CSO-CORE8 12-17	19,280	3,140	16,140

PAH with a higher number of aromatic rings tend to be less soluble and more chemically stable than their low-molecular-weight counterparts. Once in the sediment, PAH may persist for decades. But despite their very low solubility, PAH have been shown to be toxic in a variety of bioassays. The concentrations of PAH in the sediment were found generally above the "Effects Range-Low" (ERL) and the "Effects Range-Median" (ERM) values, and are expected to cause adverse biological effects (NOAA 2001).

Metals: Detected metal concentration ranges in the 0-to-6 inch core segment samples were as follows, in mg/kg dry weight: antimony 0.47 to 1.3; arsenic 7.5 to 11.8; beryllium 0.59 to1.2; cadmium 2.3 to 3.6; chromium 96.2 to 110; copper 174 to 239; lead 430 to 724; mercury 1.2 to 4; nickel 37 to 62.3; selenium 1.1 to 1.7; silver 12.6 to 29.1; thallium 0.64 to 1.4; and zinc 484 to 662.

Detected metal concentration ranges in core segment samples below a depth of 6 inches core segment samples were as follows, in mg/kg dry weight: antimony nondetected to 1.6; arsenic 7.2 to 17.4; beryllium 0. 9 to1.4; cadmium 2.2 to 10.0; chromium 53.4 to 164; copper 130 to 533; lead 343 to 1040; mercury 1.6 to 6.9; nickel 19.8 to 42.9; selenium 1.1 to 2.1; silver 10.4 to 36.2; thallium nondetected to 1.1; and zinc 419 to 945.

Acid volatile sulfide/simultaneously extracted metals(AVS/SEM): Core sediment samples from 0-to-6 inch segment were analyzed for AVS and SEM. The bioavailability of SEM (i.e., cadmium, chromium, lead, mercury, and nickel) was correlated to the AVS concentrations in sediments with a SEM/AVS ratio (Table 10). The SEM/AVS ratios were calculated to be less than 1 at all sampling locations indicating that the metals cadmium, chromium, lead, mercury, and nickel are not available in bioavailable forms. It should be noted that the AVS/SEM ratio is not the only parameter to assess the metal toxicity. Other site conditions may need to be considered to assess the metal toxicity.

Table 10. Gravity Core Sediment AVS, SEM and SEM/AVS Ratio

Sample Location	AVS (µmoles/g)	∑SEM (µmoles/g)	∑SEM/AVS
CSO-CORE1 0-6	12.8	7.4157	0.58
CSO-CORE2 0-6	29.8	6.6409	0.22
CSO-CORE3 0-6	36.2	10.6450	0.29
CSO-CORE4 0-6	30.6	7.6287	0.25
CSO-CORE5 0-6	25.9	7.5223	0.29
CSO-CORE6 0-6	18.2	9.3860	0.52
CSO-CORE7 0-6	13.7	6.5663	0.48
CSO-CORE8 0-6	25.7	7.3406	0.29

6.14.3 Petroleum Product Characterization

Two sediment samples were analyzed for total petroleum hydrocarbon (TPH) and diesel total petroleum hydrocarbon (dTPH), as a result of encountering strong petroleum odors during the core sediment sample processing. The concentrations of both TPH and dTPH are included in Table 11.

To ascertain the petroleum product, two sediment samples (CSO-C9-SR and CSO-E9-SR) were analyzed for the number of carbon atoms. The carbon ranges in the samplers were found between C_{22} and C_{35}. Based on the carbon ranges, the petroleum product was characterized as diesel oil and/or waste oil. In addition, the STL technician noted oil sheens during the sample preparation.

Table 11. TPH and dTPH Concentrations

Sample Location	TPH (mg/kg)	dTPH (mg/kg)
CSO-CORE5 6-12	1,190	310
CSO-CORE7 6-12	658	540
CSO-CORE5 6-12 (Rerun)	1,400	N/A
CSO-CORE7 6-12 (Rerun)	1,410	N/A

6.14.4 Surficial Sediment Physical Properties

Surficial sediment physical properties were characterized by grain-size distribution, specific gravity, density, and porosity.

Grain-Size Distribution: Analysis of the grain-size distribution for the surficial sediments found to be predominantly sand and silt, with an average of 84.6% sand/silt and a standard deviation of 5.3%. On average, fine sand is about 50% of sediment.

Specific Gravity, Density, and Porosity: The surficial sediment was also analyzed for specific gravity and density. This data is essential to understanding the sediment's physical properties. The average specific gravity was determined to be 2.2, and the average wet density was found to be 0.53 g/cm^3. However, the sediment samples were highly disturbed, and this data should not be used as the geotechnical design data.

The sediment porosity is defined as the percentage of open space between sediment grains. The site surficial sediment porosity was approximately 75.3%, with a corresponding void ratio of 3.05. Porosity and void ratio information are important to evaluate the compressibility and consolidation behavior of the sediment under loading, as discussed in Section 8.0.

6.15 Deep Sediment Characterization Results

The deep sediment samples were analyzed for PCBs, PAHs, and metals. The characterization results are summarized below.

Polychlorinated Biphenyls: Table 12 shows the PCBs concentrations determined at the different depth below the mudline. Only trace PCBs (ranging from 29 µg/kg to 2,390 µg/kg) were detected in the samples collected at a depth of 5 to 7 feet below the mudline. No PCBs were detected in the samples collected at10 feet below the mudline.

Polynuclear Aromatic Hydrocarbons: Table 12 shows the tPAHs in deep sediment core segments. The tPAH concentrations (ranging from 929 µg/kg to 10,600 µg/kg) were determined in sediment samples collected at a depth of 5 to 7 feet below the mudline, but no PAHs were detected in the samples at 10 feet below the mudline.

Table 12. Deep Sediment Sample Total PCBs and PAHs Concentrations

Boring Location	Sample Location	Total PCBs with Aroclors (µg/kg)	Total PAH (µg/kg)
B1	**B1(B2)5-7.5**	29	929
	B1(B2)10.5-12.5	Non Detected	Non Detected
	BORING 1(B2)15.5-17.5	Non Detected	Non Detected
	BORING 1(B2)20-22	Non Detected	Non Detected
B2	**BR2(D3)5-7**	2,390	10,600

Metals: Sediment samples were analyzed and evaluated for the EPA13 priority metals including antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc.

Detected metals concentrations in the 5-to-7 (7.5) feet, 10.5-to-12.5 feet, 15.5-to-17.5 feet, and 20-to-22 feet segment samples were summarized in Table 13. In general, the detected metals concentrations were similar in all segments of sediment samples, with the exception of sample BR2(D3)5-7, which had relatively elevated metals concentrations.

6.16 Surface Water Results

6.16.1 Surface Water Samples Results

Two surface water samples were analyzed for the following parameters: PCBs, PCBs congeners, PAHs, metals, TKN, TP, TSS, TDS, and pH. The results of these analyses are summarized in Tables 14, 15, and 16.

In summary, no PCBs (aroclors) were detected in the surface water samples; however, trace PCBs congeners (Table 16) were detected in the surface water samples.

Table 13. Deep Sediment Metals Concentrations

Metal	B1(B2)5-7.5		B1(B2)10.5-12.5		BORING 1(B2)15.5-17.5		BORING 1(B2)20-22		BR2(D3)5-7	
	Conc. (mg/Kg)	Qualifier	Conc. (mg/Kg)	Qualifier	Conc. (mg/Kg)	Qualifier	Conc. (mg/Kg)	Qualifier	Conc. (mg/Kg)	Qualifier
Antimony	0.94	N U	0.93	N U	0.99	N U	0.99	N U	0.6	BN
Arsenic	3.8	N	3.6	N	3.1	N	3	N	8	N
Lead	15.7	NE	12.7	NE	10.2	NE	7	NE	439	NE
Nickel	16	E	17.2	E	17.8	E	12.7	E	32.3	E
Beryllium	1		1.1		1.4		0.8		1	
Selenium	0.57	N	0.69	N	0.79	N	0.59	N	1.4	N
Silver	0.47	U	0.47	U	0.5	U	0.49	U	17.1	
Thallium	0.94	N U	56.2	E	0.99	N U	0.99	N U	1	N U
Zinc	51.7	E	21	E	52.3	E	38.8	E	475	E
Chromium	20.7	E	0.47	N U	18.9	E	13.3	E	111	E
Cadmium	0.038	BN	19.1		0.5	N U	0.49	N U	3.8	N
Copper	19.6		1.9	N U	15.6		9.8		156	

Table 14. Surface Water Concentrations of TP, TKN, TSS, TDS, and pH, metals, and PCBs (Aroclors)

.

Parameter	CSO-W1		CSO-W2	
	Conc. (mg/L)	Qualifier	Conc. (mg/L)	Qualifier
TP	0.039	B	0.07	B
TKN	3	U	3	U
TSS	20.4		20.4	
TDS	280		278	
pH	7.2		7.2	
Metal (µg/L)				
Antimony	0.3	B	0.26	B
Arsenic	0.6	B	0.53	B
Lead	2.9	J	2.6	J
Nickel	5.4	J	5.2	J
Beryllium	1	U	1	U
Selenium	0.31	B	0.4	B
Silver	1	U	1	U
Thallium	1	U	1	U
Zinc	32.1	J	27.8	J
Chromium	1.9	B	1.8	B
Cadmium	1	U	1	U
Copper	4.6	J	4.6	J
Mercury	0.0002	U	0.0002	U
PCBs (µg/L)				
Aroclor 1016	1	U	1	U
Aroclor 1221	1	U	1	U
Aroclor 1232	1	U	1	U
Aroclor 1242	1	U	1	U
Aroclor 1248	1	U	1	U
Aroclor 1254	1	U	1	U
Aroclor 1260	1	U	1	U

Table 15. Surface Water PAHs Concentrations

Parameter	CSO-W1		CSO-W2	
	Conc. (µg/L)	Qualifier	Conc. (µg/L)	Qualifier
Naphthalene	0.02	U	0.021	
2-Methylnaphthalene	0.02	U	0.024	
1-Methylnaphthalene	0.02	U	0.011	J
Biphenyl	0.02	U	0.02	U
2,6 Dimethylnaphthalene	0.02	U	0.02	
Acenaphthylene	0.02	U	0.053	
Acenaphthene	0.02	U	0.017	J
2,3,5 Trimethylnaphthalene	0.02	U	0.011	J
Fluorene	0.02	U	0.022	
Dibenzothiophene	0.02	U	0.02	U
Phenanthrene	0.04		0.039	
Anthracene	0.02	U	0.02	U
1-Methylphenanthrene	0.02	U	0.02	U
Fluoranthene	0.14		0.15	
Pyrene	0.1		0.096	
Benzo(a)anthracene	0.019	J	0.019	J
Chrysene	0.061		0.06	
Benzo(b)fluoranthene	0.05		0.047	
Benzo(k)fluoranthene	0.029		0.029	
Benzo(e)pyrene	0.029		0.031	
Benzo(a)pyrene	0.027		0.028	
Perylene	0.02	U	0.02	U
Indeno(1,2,3-cd)pyrene	0.028		0.026	
Dibenz(a,h)anthracene	0.013	J	0.02	U
Benzo(g,h,i)perylene	0.034		0.034	
Naphthalene-d8(SS)	0.12		0.12	
Acenaphthene-d10(SS)	0.13		0.13	
Phenanthrene-d10(SS)	0.12		0.12	
Chrysene-d12(SS)	0.19		0.16	
Perylene-d12(SS)	0.16		0.15	

Table 16. Surface Water PCBs Congeners Concentrations

PCBs Congeners	CSO-W1		CSO-W2	
	Conc. (ng/L)	Qualifier	Conc. (ng/L)	Qualifier
1	0.035	J	0.036	KJ
3		U		U
5		U		U
8	0.12	KBJ	0.13	KBJ
15	0.09	KBJ	0.097	KBJ
18	0.12	BCJ	0.14	BCJ
28	0.21	B C20 J	0.21	B C20 J
31	0.18	BJ	0.19	BJ
37	0.037	J	0.039	J
44	0.26	KC	0.28	C
49	0.15	CJ	0.16	CJ
52	0.28		0.27	
66	0.15	KJ	0.15	J
70	0.26	K B C61	0.25	K B C61
74	0.26	K B C61	0.25	K B C61
77		U		U
81		U		U
87	0.081	K C86 J	0.084	K C86 J
90	0.18	CJ	0.19	CJ
99	0.058	KCJ	0.078	CJ
101	0.18	C90 J	0.19	C90 J
105	0.061	KJ	0.069	J
110	0.18	CJ	0.18	CJ
114		U		U
115	0.18	C110 J	0.18	C110 J
118	0.19	BJ	0.16	BJ
119	0.081	K C86 J	0.084	K C86 J
123		U		U
126		U		U
128	0.039	KCJ		U
138	0.35	C129	0.27	C129
141	0.082	J	0.055	J
149	0.22	C147 J	0.22	C147 J
151	0.097	C135 J	0.098	C135 J
153	0.32	C	0.29	C
156	0.034	KBCJ	0.046	BCJ
157	0.034	K B C156 J	0.046	B C156 J
158	0.026	KJ		U
167	0.016	KJ		U
168	0.32	C153	0.29	C153

Table 16. Surface Water PCBs Congeners Concentrations (Continued)

PCBs Congeners	CSO-W1	CSO-W2		
	Conc. (ng/L)	Qualifier	Conc. (ng/L)	Qualifier
169		U		U
170	0.073	KJ	0.084	KJ
177		U	0.043	KJ
180	0.22	CJ	0.2	CJ
183	0.037	KCJ	0.048	KCJ
184		U		U
187	0.098	J	0.072	KJ
189		U		U
194	0.047	KJ	0.039	KJ
195		U		U
199		U	0.035	K C198 J
202		U		U
206		U		U
207		U		U
209		U		U

6.16.2 Water Quality Monitoring Results

During the sampling events, the water quality parameters (temperature, salinity, pH, dissolved oxygen, and turbidity) were measured and recorded, using YSI 650 MDS instrumentation from March to June 2003. Appendix G provides the recorded water temperature, salinity, pH, dissolved oxygen, and turbidity measurements during the sampling events.

In summary, the surface water salinity was found to average 0.26 with a standard deviation of 0.006. The surface water pH was found to average 7.7 with a standard deviation of 0.07, and surface water conductivity was found to average 0.55 (ms/cm) with a standard deviation of 0.006 ms/cm. The surface water turbidity (NTu) was recorded higher at an average of 30 NTu in March 2003, which was one of the wettest months in the District of Columbia, compared with approximately 12 NTu found in June 2003. Also, higher level of dissolved oxygen (12.4 mg/L) was found in March 2003, compared with 6.5 mg/L found in June 2003.

6.17 Pore Water Sample Results

Two pore water samples were analyzed for the following parameters: PCBs, PCBs congeners, PAHs, metals, and pH. The results of these analyses are summarized in Tables 17, 18, and 19. In summary, both trace PCBs aroclors and congeners were detected in the pore water sample.

Table 17. Pore Water pH, Metals, and PCBs (Aroclors) Concentrations

Parameter	CSOPORE1		CSOPORE2	
pH	7.7		7.2	
	Conc. (µg/L)	QUALIFIER	Conc. (µg/L)	QUALIFIER
Metals				
Antimony	0.73	B	0.43	B
Arsenic	5.9		3.3	B
Lead	70.1	J	21.2	J
Nickel	9.5	J	4.7	J
Beryllium	0.2	B	1	U
Selenium	2.9	B	1.5	B
Silver	2.3		1.1	
Thallium	1	U	1	U
Zinc	74.4	J	38.8	J
Chromium	15.4		6.7	
Cadmium	0.49	B	0.23	B
Copper	31.1	J	13	J
PCBs (Aroclors)				
Aroclor 1016	1	U	1	U
Aroclor 1221	1	U	1	U
Aroclor 1232	1	U	1	U
Aroclor 1242	1	U	1	U
Aroclor 1248	1.5		1	U
Aroclor 1254	2.4		1	U
Aroclor 1260	2.9		0.96	J

Table 18. Pore Water PAHs Concentrations

Parameter	CSOPORE1		CSOPORE2	
	Conc. (µg/L)	QUALIFIER	Conc. (µg/L)	QUALIFIER
Naphthalene	0.39		0.075	
2-Methylnaphthalene	0.64		0.028	
1-Methylnaphthalene	1		0.031	
Biphenyl	0.071		0.02	U
2,6 Dimethylnaphthalene	1.5		0.22	
Acenaphthylene	0.083		0.041	
Acenaphthene	0.4		0.38	
2,3,5 Trimethylnaphthalene	1.4		0.64	
Fluorene	0.39		0.19	
Dibenzothiophene	0.19		0.089	
Phenanthrene	1.2		0.64	
Anthracene	0.17		0.12	
1-Methylphenanthrene	0.42		0.21	
Fluoranthene	0.68		0.55	
Pyrene	0.87		0.63	
Benzo(a)anthracene	0.17		0.13	
Chrysene	0.34		0.2	
Benzo(b)fluoranthene	0.18		0.13	
Benzo(k)fluoranthene	0.095		0.08	
Benzo(e)pyrene	0.18		0.1	
Benzo(a)pyrene	0.15		0.1	
Perylene	0.075		0.046	
Indeno(1,2,3-cd)pyrene	0.051		0.045	
Dibenz(a,h)anthracene	0.036	J	0.018	J
Benzo(g,h,i)perylene	0.095		0.066	
Naphthalene-d8(SS)	0.15		0.12	
Acenaphthene-d10(SS)	0.17		0.13	
Phenanthrene-d10(SS)	0.12		0.094	
Chrysene-d12(SS)	0.12		0.13	
Perylene-d12(SS)	0.12		0.14	

Table 19. Pore Water PCBs Congeners Concentrations

CSOPORE2					
PCBs Congeners	Conc. (ng/L)	Qualifier	PCBs Congeners	Conc. (ng/L)	Qualifier
1	4.5		167	2.9	
3	0.72		168	190	C153
5	0.28	KJ	169	0.25	KJ
8	8.6	B	170	30	
15	1.5	B	177	34	
18	11	BC	180	100	C
28	17	B C20	183	32	C
31	16	B	184	0.11	J
37	1.9		187	79	
44	34	C	189	1.3	
49	23	C	194	21	
52	48		195	8.2	
66	21		199	26	C198
70	47	B C61	202	5.3	
74	47	B C61	206	5.4	
77	0.95		207	1	
81		U	209	2.1	
87	32	C86			
90	96	C			
99	43	C			
101	96	C90			
105	11				
110	53	C			
114	1	K			
115	53	C110			
118	40	B			
119	32	C86			
123	0.49				
126	0.084	J			
128	12	C			
138	140	C129			
141	32				
149	150	C147			
151	92	C135			
153	190	C			
156	7.3	BC			
157	7.3	B C156			
158	12				

6.18 Sediment Deposition Rate

Historic information indicates the sediment deposition rate in the Anacostia River ranges from 0.016 to 0.14 feet per year (SRC and NOAA 2000). A study is currently being conducted by

LSU to elucidate patterns of sediment accumulation rates and what effect reworking of materials through physical and benthic processes have on mixing geologic timescales. The results will be discussed and summarized when the data becomes available. This report will be submitted separately.

An existing sediment transport model developed by the Interstate Commission on the Potomac River Basin (Schultz 2001) for sediment transportation output predicted the demonstration area was characterized as a depositional area. No significant erosion is expected.

7.0 HYDRODYNAMIC DATA

Measuring water column and near-bottom currents is important for two reasons: first, the potential for resuspension of contaminated material; second, the potential for the erosion of the cap that would reexpose the bottom sediments to the influence of the hydrodynamic regime. In addition, other influences on the bottom sediments come from normal channel flows, tidal fluctuations, and storm effects or floods. Therefore, in addition to gauging station information collected for the Anacostia additional measurements were collected over the month of April 2003 using ADCP to get a snapshot of the current dynamic.

7.1 River Flow Current Velocity

River flow current velocity was measured using a RD Instrument's 1200 kHz Workhorse Sentinel ADCP and was collected for four tide stages: maximum flood, maximum ebb, high slack, and low slack. The ADCP was mounted to the starboard gunwale of a 26-ft work vessel. The transducer face of the ADCP was placed one (1) foot below the water surface to avoid signal interference by turbulence or debris. To collect data in water depths ranging from 3 feet to 22 feet, the number of bins was set at 35. Each bin was set at 0.66 feet (or 20 cm) for the field flow velocity acquisition. Figure 32 shows the schematic diagram of an ADCP velocity measurement. The "averaged" velocity at different bin size or level was comprised of 10 ensembles averaged by the software, thus producing velocity data every 26 seconds during transect data collection. A typical transect cross-section velocity profile is shown in Figure 33. Appendix H contained the detailed method and results discussion.

Variability of magnitude between the four tide stages was not significant. Median magnitudes for the averaged ensemble data ranged from 0.13 ft/s for high slack to 0.21 ft/s for maximum flood. Maximum magnitudes ranged between 0.64 ft/s at high slack to 1.29 ft/s at maximum ebb while all minimum magnitudes for all tide stages were 0.01 ft/s. In general, velocity magnitudes were slightly higher towards the navigation channel, which is outside of the demonstration area. The tidal range during the field flow velocity data acquisition was 2.5 feet, which is the typical tidal range in the Anacostia River (The mean difference between high and low tidal levels (mean range) is 2.8 feet). Figure 34 shows the following environmental conditions during transect data collections from 6 March and 14 March 2003: wind speed, barometric pressure, precipitation, tide, and estimated river flow.

In addition, river flow velocity was acquired by mounting the ADCP to the northeast end of a floating dock located at the ECC pier on the Anacostia River for 6 days. Ensembles were collected every 10 minutes, with 45 pings per ensemble. The ADCP was configured to read 13 feet below the transducer face. Upon data download and post-processing, it was evident that the ADCP did not record data down to the river bottom because of high river water levels. An additional 2 or 3 bins should have been added in the configuration of the instrument before it was deployed to obtain velocity to the bottom of the river.

However, examination of the data showed an increase in magnitude near the bottom of the velocity profile, ranging from 0.1 to 3.24 ft/s. According to RD Instruments, this may be the

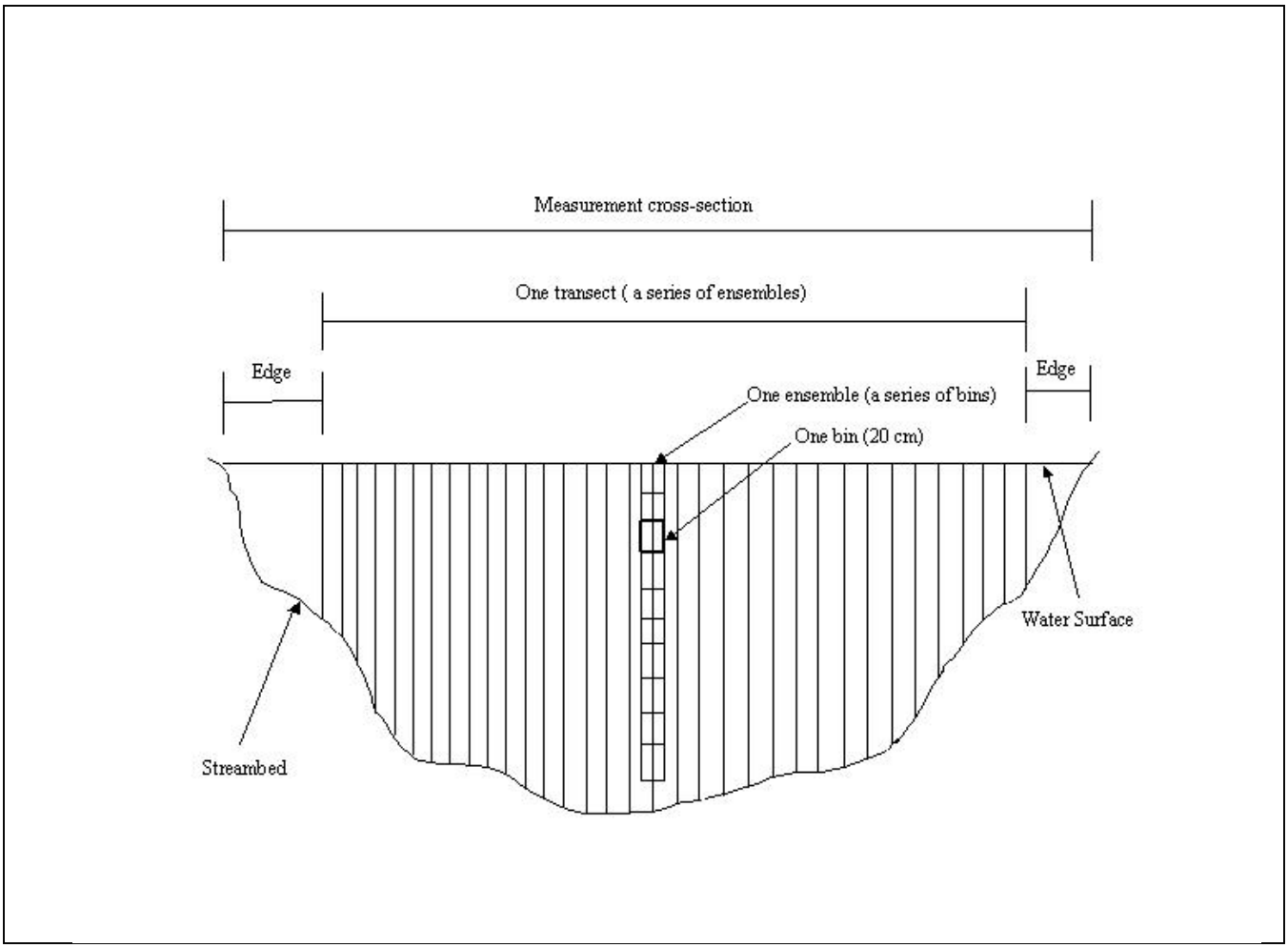

Figure 32. Schematic Diagram of an Acoustic Doppler Current Profiler Velocity Measurement

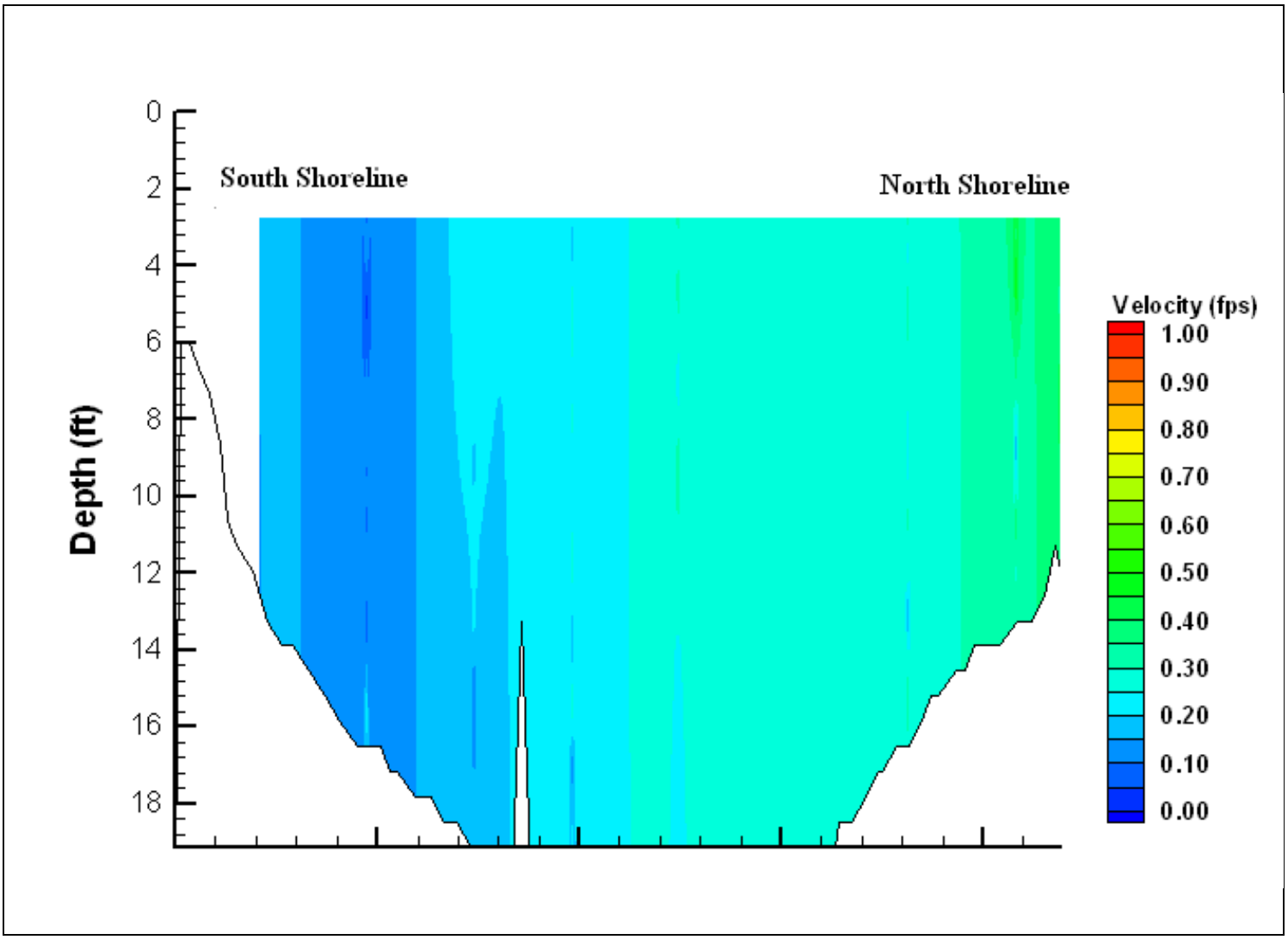

Figure 33. Averaged Velocities During Maximum Flood

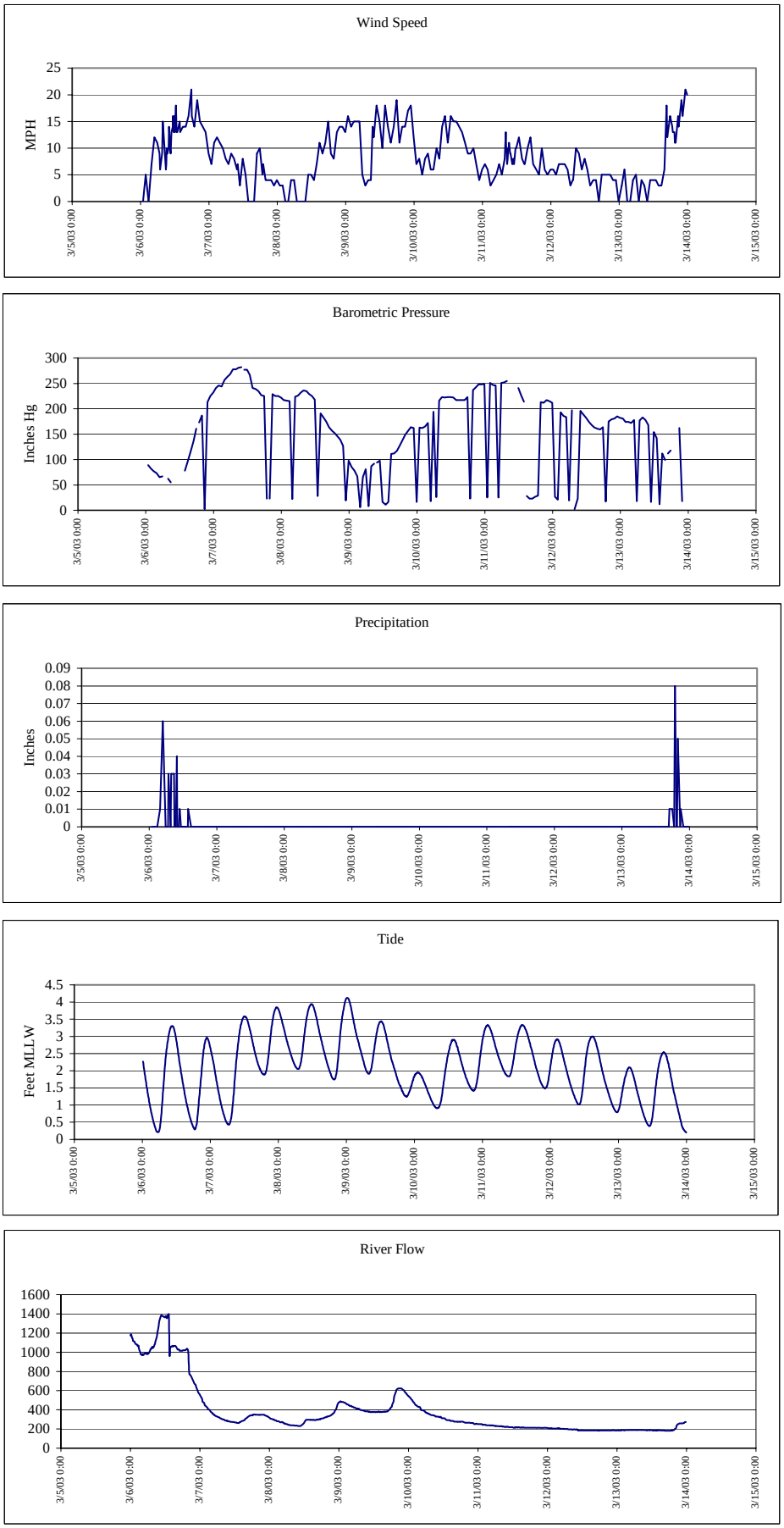

Figure 34. Environmental Conditions from 6 March and 14 March 2003

result of the ADCP reading two reflections off the bottom of the river bottom. When the ADCP pinged, it would record two velocities for the last depth cell and calculate velocity. Therefore the last depth cell velocity was a cumulative value of 2 sound signals. Other possible explanations for the high velocity data points could be debris or large fish passing under the ADCP during data collection. As a result, this data was determined to be unusable.

The measured velocities are comparable to the current velocities from previous studies, which were in the range of 0.07 to 0.66 ft/s along the axis of the channel and relatively homogeneous throughout the water column over a tidal cycle during non-storm conditions (Katz, et al. 2000). In addition, the model-simulated flow velocities over the course of the 3-year calibration period from 1988 to 1990 by ICPRB are generally less than 1.60 ft/sec (Schultz, 2001). The model did not predict a flow velocity greater than 2.80 ft/sec during the 3-year period.

7.2 Rainfall Data and Historical Flow Data

The average precipitation at the Ronald Reagan National Airport observation station for the last 30 years was obtained from the National Climatic Data Center. Table 20 shows the historical flow data for the Anacostia River, obtained from U.S. Geological Survey gauges at Riverdale Road on the Northeast Branch, Northwest Branch Near Hyattsville, MD, and Watts Branch at Washington, D.C.

7.3 Hydraulic and Sediment Transport Model

Several sediment transport and hydraulic model developed for the Anacostia River was reviewed and evaluated. Specifically, existing model developed by ICPRB (ICPRB 2000, Schultz, 2001) for sediment transportation were reviewed. Detailed discussion is not provided here.

7.4 Groundwater Seepage

The U.S. Navy Space and Warfare Systems Center (SPAWAR) conducted the in-situ measurements of aqueous flux, or seepage, across the river-bottom interface to the overlying water column at six locations in the Anacostia River (Chadwick et al. 2001). One of the groundwater seepage study locations was located at the Cement Plant site, which is just west of the ECC Pier along the northern shore of the river approximately 500 feet from the demonstration site. Based on the SPAWAR investigation, sediments at the Cement Plant site appeared to be a coarse-grained mixture of sand, gravel and rubble.

The SPAWAR study findings indicated that the mean seepage rate ranges from a weak (and negative) measurement of -0.049 cm/d, to a moderate measurement of 1.1 cm/d. The results showed a weak to moderate tidal influence, with tidal amplitude ranging from -0.049 cm/d to 2.7 cm/d. The phase shift of the seepage meter readings was similar showing strongest discharge seepage just after high water, continuing a trend of smaller phase shifts for the down-river sites. Both the tidal and mean seepage signals at this site ranged from weak to moderate among other sites along the river. These results indicate that there is only a weakly active groundwater

Table 20. Rainfall Data and Flow Data

Year	Total Precipitation (in)	Average Northeast Branch Flows(cfs)	Average Northwest Branch Flow (cfs)	Watts Branch Flow (cfs)	Combined Flow (cfs)
1973	34.98	119	68.6	Not available	187.6
1974	35.96	85.7	45.6	Not available	131.3
1975	50.5	144	88.2	Not available	232.2
1976	38.07	99	56.8	Not available	155.8
1977	36.14	70.1	42.6	Not available	112.7
1978	39.56	111	65.4	Not available	176.4
1979	47.33	161	108	Not available	269
1980	29.32	78.9	46.6	Not available	125.5
1981	30.67	47.1	29	Not available	76.1
1982	35.77	63.2	37.6	Not available	100.8
1983	51.87	130	69.2	Not available	199.2
1984	37.73	94	58.4	Not available	152.4
1985	35.86	56.1	37.8	Not available	93.9
1986	32.57	59.3	38	Not available	97.3
1987	36.63	70.1	48.3	Not available	118.4
1988	31.74	72.4	43.9	Not available	116.3
1989	50.32	111	67	Not available	178
1990	40.84	93.2	60.4	Not available	153.6
1991	29.62	67	41.1	Not available	108.1
1992	36.38	83.8	50	Not available	133.8
1993	41.41	118	66.5	4.75	189.25
1994	37.57	107	63.8	5.07	175.87
1995	39.8	81.8	44.8	3.95	130.55
1996	51.05	151	89.6	6.05	246.65
1997	33.82	89.4	50.3	3.74	143.44
1998	35.94	101	58.3	4.71	164.01
1999	40.23	82.3	46.6	4.3	133.2
2000	40.66	80.2	49.8	3.8	133.8
2001	29.95	68.4	42.8	3.5	114.7

migration to the Anacostia River, in spite of the porous sediments observed in the deployment area.

Based on the seepage findings at the Cement Plant site regarding the groundwater seepage rate and the tidal influence and approximation between the Cement Plant and the demonstration site, it may be reasonably concluded that similar findings may be found at the demonstration site. To ascertain the potential impact of the seepage rate on the cap demonstration project, a groundwater seepage study at the demonstration site was conducted between 5 September 2003 and 12 September 2003. The report will be submitted separately.

8.0 SEDIMENT GEOTECHNICAL CHARACTERIZATION

Geotechnical testing was done to gather sufficient sediment geotechnical data to assist in the design and construction of the "active caps". Geotechnical samples were collected following the American Society for Testing and Materials (ASTM) standards. Five deep borings were drilled across each demonstration area. The five borings were located in a staggered arrangement across the study area (Figure 35). The borings were advanced using steel casings and drill bit. All borings were terminated between 20 and 26 feet below the mudline. . Sediment samples were be collected at 2-foot intervals in the top 12 feet continuously using 2-foot split spoons, and at 5-foot intervals to termination. In addition, where clay was expected to be present, based on split-spoon recovery, a Shelby tube was pushed and sediment collected for laboratory analysis. Each boring location was relocated using GPS, and in-situ vane shear tests were conducted at 5-foot intervals. The samples were analyzed for the geotechnical tests.

8.1 Site Geology

The site geology information was derived from the test borings completed during the geotechnical investigation. The surficial sediment consisted of high plasticity silty clay, which classifies as CH, according to the USCS. From the mud line to at least 10 feet below this elevation, these soils were very soft, extremely weak, and highly compressible.

Stratum 1 – High Plasticity Silty Clay: The surficial stratum at all five boring locations consisted of high plasticity silty clay, which classifies as CH according to the Unified Soil Classification System (USCS). From the mud line to at least 10 feet below this elevation, these soils were very soft, extremely weak, and highly compressible.

Stratum 2 – Silty Clayey Medium to Fine Sand: At boring locations B-1, B-2 and B-3, the Stratum 1 soils were underlain by a thin layer of silty clayey medium to fine sand, which ranged in thickness from 2.5 to 9.0 feet, averaging 4.8 feet. The soil within this stratum classifies as SM (silty sand) and SC (clay sand), according to the USCS.

Stratum 3 – Medium to Fine Sandy Clayey Silt: A localized 6-foot-thick layer of medium to fine sandy clayey silt was encountered beneath the Stratum 1 soils in Boring B-4. This material classifies as ML (low plasticity clayey silt) according to the USCS and contains 46.7% sand, 40.5% silt and 12.8% clay. The maximum particle size of this material is 4.76 mm (i.e. the No. 4 sieve size). A single measured Standard Penetration Test value of five blows per foot is indicative of a "firm" consistency for this material.

Stratum 4 – Low Plasticity Silty Clay: A localized 5-foot-thick layer of low plasticity silty clay was encountered beneath the Stratum 3 soils in Boring B-4. A localized pocket of this same material was also encountered beneath the Stratum 2 soils in Boring B-1 and extended to the completion depth of this boring. The soils within this stratum classify as CL (low plasticity silty clay) according to the USCS.

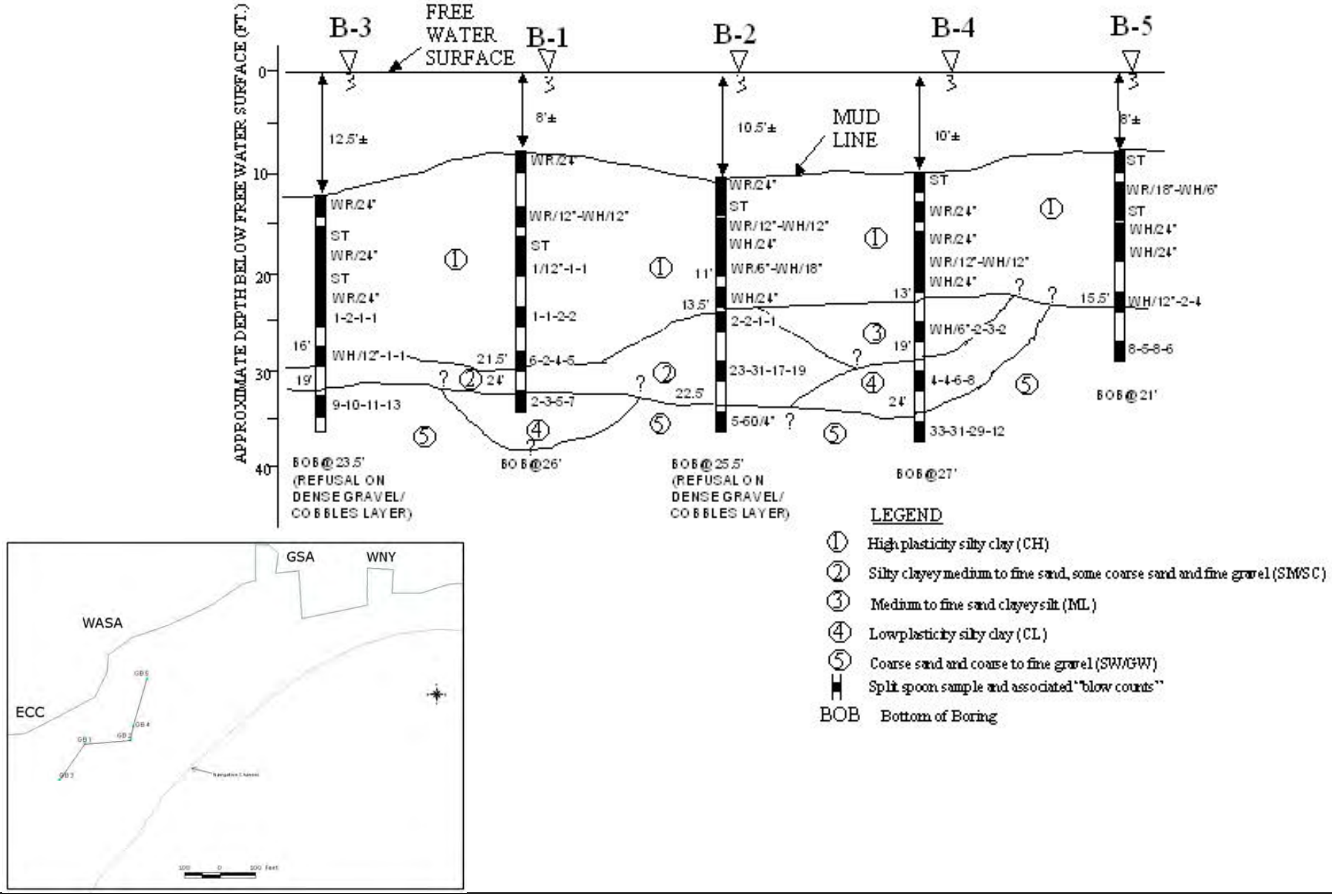

Figure 35. Geotechnical Survey Location and Cross-Section

Stratum 5 – Coarse Sand and Coarse to Fine Gravel: This material was encountered as the lowest level soil stratum in all borings except B-1. The top of this stratum was encountered at depths below the mud line ranging from 15.5 to 24.0 feet, averaging 20.3 feet. The material classifies as SW/GW (well-graded sandy to well-graded gravelly soils) according to the USCS.

8.2 Sediment Bearing Capacity and Slope Stability

The geotechnical analysis provides the evaluation of the geotechnical design of the active capping systems proposed for construction within the Anacostia River. With the current design and layout, the active caps will satisfy both bearing capacity and settlement considerations. A geotechnical report detailing calculation and specifics to the proposed capping project is included Appendix I of this document.

The findings of the geotechnical analysis suggested using a "thin lift (approximately 6 inches), staged construction" approach that will avoid localized bearing capacity failures of the very soft, weak river bottom sediments during placement of the active cap materials.

9.0 BENTHIC COMMUNITY SURVEY

The Stage 2 field investigations was originally scheduled to include both a SAV and a benthic community survey. However, the originally proposed SAV sampling was determined to be unnecessary, based on water conditions and the results of the sediment-profiling imaging review (Appendix A) After a consultation with the DOH, a decision was reached to abandon this survey. The Stage 2 benthic community sampling activities were conducted on 5 June 2003.

9.1 Benthic Community Sampling and Findings

Four stations (B1, B2, B3, and B4) were selected for benthic macroinvertebrate sampling (Figure 16) within the demonstration area. Triplicates per sampling location were collected for benthic macroinvertebrate community analyses, following the methodology described in the *Macroinvertebrate Field and Laboratory Methods for Evaluation of Biological Integrity of Surface Waters* (USEPA 1990). The content of each grab sample was sieved through a 500-µm mesh. Materials retained on the sieve were captured and preserved with a 10-percent formalyn solution until processing. The preserved benthic samples were processed for sorting, identification, and enumeration at an offsite laboratory.

Oligochaete worms were found to be dominated at all stations: B3 (11 taxa), B1 and B4 (9 taxa), and B2 (10 taxa). The remaining groups Nematoda, Nemertean, Hirudinea, Gastropoda, Pelecypoda, and Insecta were only represented by one or two taxa. Thirteen total taxa were found at Stations B3 and B2 and 14 taxa were found at B1 and B4. The detailed method and results discussion is included in Appendix J.

Table 21 lists the each location sample abundance, Shannon-Weaver and Pielou Index. Station B2 had the lowest diversity, evenness, taxa richness, and abundance of the stations sampled from the Anacostia River. Station B4 had the highest diversity, evenness, and taxa richness. The only statistically significant finding is that Station B4 has significantly greater diversity and evenness than Station B2, but no station was statistically different from all others for any of the metrics calculated.

Grain sizes at the benthic locations were not variable. Sediment at the stations was comprised of fine sands (45.7% to 74.2%), silts (6% to 34.2%), and clays (10% to 16.1%). Total organic carbons (TOCs) also did not show much variability, ranging from 6.13% (61,300 mg/kg) to 10.41% (104,100 mg/kg). Organism abundance and diversity reflects the lack of variability in sediment types in the study area.

9.2 Submerged Aquatic Vegetation

As previously discussed, a determination had been made that SAV sampling was unnecessary, based on the results from the Stage 1 findings. The removal of this sampling plan was done in consultation with Ira Palmer, Program Manager, the Environmental Health Administration's Fisheries and Wildlife Division of the DOH.

Table 21. Station Comparison of Sample Abundance, Shannon-Weaver and Pielou Index

Station	Average Abundance (#)	N	Mean Grouping
B1	2189	3	A
B4	2067	3	A
B3	1619	3	A
B2	1531	3	A

Station	Average #Taxa	N	Mean Grouping
B4	12.33	3	A
B1	12.00	3	A
B3	11.67	3	A
B2	9.67	3	A

Station	Average Shannon-Weaver Diversity	N	Mean Grouping
B4	2.83	3	A
B1	2.51	3	AB
B3	2.39	3	AB
B2	1.93	3	B

Station	Pielou Evenness	N	Mean Grouping
B4	0.54	3	A
B1	0.48	3	AB
B3	0.47	3	AB
B2	0.41	3	B

10.0 REFERENCE

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Appendix A Geophysical and Sediment Profile Imaging (SPI) Surveys Report

Appendix B Field Notes

Gravity Core Logs

Project Name: Anacostia Capping Project			
Sample Number: CSO Core 1			
Date of Sample Collection: March 11, 2003			
Time of Collection: 12:00			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Percent Recovery**	**Comments**
0-6	Mud – dark olive green organic rich, abundant leaf debris, high water content, some silt and sand.	100	Organic matter, decay - septic odor
6-12	As above	100	
12-24(12-22)	As above	83	

***Gravity Core - Soil recovered in acetate sleeve.**

Project Name: Anacostia Capping Project			
Sample Number: CSO Core 2			
Date of Sample Collection: March 11, 2003			
Time of Collection: 13:45			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Percent Recovery**	**Comments**
0-6	Mud – dark olive green, organic rich, abundant leaf debris, high water content, some silt and sand.	100	Organic matter, decay - septic odor
6-12	As above	100	
12-24(12-20)	As above	66	

***Gravity Core - Soil recovered in acetate sleeve.**

Gravity Core Logs

Project Name: Anacostia Capping Project			
Sample Number: CSO Core 3			
Date of Sample Collection: March 11, 2003			
Time of Collection: 15:05			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Percent Recovery**	**Comments**
0-6	Mud – dark olive green, organic rich, abundant leaf debris, high water content, little silt and sand.	100	Organic matter, decay - septic odor
6-12	As above leaf layers forming distinct bands (varve like), no silt or sand present.	100	
12-24(12-14)	As above but at base a zone of black stained and petrolific	16	Strong petroleum odor

***Gravity Core - Soil recovered in acetate sleeve.**

Project Name: Anacostia Capping Project			
Sample Number: CSO Core 4*			
Date of Sample Collection: March 11, 2003			
Time of Collection: 14:45			
Soil Interval Sampled (in Inches)**	**Lithologic Description**	**Percent Recovery**	**Comments**
0-6	Mud – dark olive green, organic rich, abundant leaf debris, high water content, little silt and sand.	100	Organic matter, decay - septic odor
6-12	As above	100	
12-24(12-20)	As above with dark staining at base petrolific.	66	Strong petroleum odor

* **Duplicate Samples Collected**
****Gravity Core - Soil recovered in acetate sleeve.**

Gravity Core Logs

Project Name: Anacostia Capping Project			
Sample Number: CSO Core 5			
Date of Sample Collection: March 12, 2003			
Time of Collection: 12:30			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Percent Recovery**	**Comments**
0-6	Mud – dark olive green, organic rich, abundant leaf and grass debris, high water content, little silt and sand.	100	Organic matter, decay - septic odor
6-12	As above, some silt and sand, oil stained, petrolific	100	
12-24(12-18)	As above, petrolific, rubber band found present.	50	

***Gravity Core - Soil recovered in acetate sleeve.**

Project Name: Anacostia Capping Project			
Sample Number: CSO Core 6			
Date of Sample Collection: March 11, 2003			
Time of Collection: 9:30			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Percent Recovery**	**Comments**
0-6	Mud – dark olive green, organic rich, abundant leaf matter and more leaf stems, high water content, little silt and sand.	100	Organic matter, decay - septic odor
6-12	As above	100	
12-24(12-15)	As above	25	

*** Gravity Core - Soil recovered in acetate sleeve. This was the first location sampled using the gravity core. Three drops were made using different variations on the weight of the gravity core. The first drop was made with just the weight of the gravity core itself result 1.5 foot recovery. The second drop made with 75 kilograms of additional weight added to the gravity core appeared to cause either reduced penetration or reduced recovery – result 1.0 feet recovered. The third drop was again made with out additional weight and resulted in a recovery of 1.25 feet.**

Gravity Core Logs

Project Name: Anacostia Capping Project			
Sample Number: CSO Core 7			
Date of Sample Collection: March 12, 2003			
Time of Collection: 11:30			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Percent Recovery**	**Comments**
0-6 3-6	Mud – dark olive green, organic rich, abundant leaf, high water content. As above with high 50% silt/sand content, leaf debris stratified.	100	Organic matter, decay - septic odor
6-12	As above, more silt and sand, oil stained, petrolific	100	Slight petroleum odor
`12-24(12-14)	As above, petrolific	16	Slight petroleum odor

***Gravity Core - Soil recovered in acetate sleeve.**

Project Name: Anacostia Capping Project			
Sample Number: CSO Core 8			
Date of Sample Collection: March 12, 2003			
Time of Collection: 11:30			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Percent Recovery**	**Comments**
0-6 3-6	Mud – dark olive green, organic rich, abundant leaf, high water content. As above with higher 50% silt/sand content, leaf debris stratified.	100	Organic matter, decay - septic odor
6-12	As above, more silt and sand	100	As Above
`12-24(12-17)	As above, oil stained, petrolific	41	Strong petroleum odor

*** Gravity Core - Soil recovered in acetate sleeve. Original sample location offset due to poor sample recovery.**

Ponar Sample Soil Logs
A Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-A1-SR			
Date of Sample Collection: March 9, 2003			
Time of Collection: 16:15			
Bottom Depth: 3 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud – dark olive green, organic rich, abundant leaf and twig material, blebs of sheen, silt/sand, high water content, pudding consistency.	5	Organic matter, decay - septic odor

*Note: * - Target soil (sediment) interval*

Project Name: Anacostia Capping Project			
Sample Number: CSO-A2-S			
Date of Sample Collection: March 9, 2003			
Time of Collection: 14:45			
Bottom Depth: 4 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud – dark olive green, organic rich, abundant leaf and twig material, blebs of sheen, silt/sand, high water content, pudding consistency.	5	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-A3-SR			
Date of Sample Collection: March 9, 2003			
Time of Collection: 12:45			
Bottom Depth: 3 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sand with some rounded gravel, (1) live bivalve present in sample.	2	

Ponar Sample Soil Logs
A Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-A4-S			
Date of Sample Collection: March 9, 2003			
Time of Collection: 14:45			
Bottom Depth: 4 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sand with some rounded gravel, (2) live clams, (2) live mussels and (2) live snails present in sample.	2	Fairly well sorted - no septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-A5-SR			
Date of Sample Collection: March 9, 2003			
Time of Collection: 8:30			
Bottom Depth: 4 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sand with high organic content, matted leaf debris in upper inch, leaf stems throughout, high water content	5	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-A6-S			
Date of Sample Collection: March 8, 2003			
Time of Collection: 17:10			
Bottom Depth: 6 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud, dark olive green, with silt, high organic and water content.	5	Organic matter, decay - septic odor

Ponar Sample Soil Logs
A Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-A6-S			
Date of Sample Collection: March 8, 2003			
Time of Collection: 17:10			
Bottom Depth: 6 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sand, dark olive green, abundant leaf debris, high organic and water content.	5	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-A7-SR			
Date of Sample Collection: March 8, 2003			
Time of Collection: 15:30			
Bottom Depth: 5 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sand, dark olive green, abundant leaf debris, high organic and water content.	4	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-A8-S			
Date of Sample Collection: March 8, 2003			
Time of Collection: 13:45			
Bottom Depth: 4 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sand, dark olive green, abundant leaf debris, high organic and water content.	3	Organic matter, decay - septic odor

Ponar Sample Soil Logs
A Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-A9-SR			
Date of Sample Collection: March 8, 2003			
Time of Collection: 11:00			
Bottom Depth: 5 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sand, dark olive green, abundant leaf debris, twigs and stems, high organic and water content.	3	Three sample attempts in this location. Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-A10-S			
Date of Sample Collection: March 8, 2003			
Time of Collection: 8:35			
Bottom Depth: 6 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with some silt sand, dark olive green, abundant leaf debris, high organic and water content.	3	Organic matter, decay - septic odor

Ponar Sample Soil Logs
B Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-B1-S			
Date of Sample Collection: March 9, 2003			
Time of Collection: 15:20			
Bottom Depth: 8 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sand, dark olive green, abundant leaf debris, twigs and stems, high organic and water content.	5	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-B2-SRGC			
Date of Sample Collection: March 9, 2003			
Time of Collection: 15:00			
Bottom Depth: 9 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silt sand, dark olive green, abundant leaf debris, high organic and water content, pudding like consistency, abundant bubbles when Ponar struck bottom.	5	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-B3-S			
Date of Sample Collection: March 9, 2003			
Time of Collection: 13:05			
Bottom Depth: 8 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silt sand, dark olive green, abundant leaf debris, high organic and water content, pudding like consistency	5	Organic matter, decay - septic odor

Ponar Sample Soil Logs
B Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-B4-SR			
Date of Sample Collection: March 9, 2003			
Time of Collection: 11:45			
Bottom Depth: 9 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silt and sand, dark olive green, abundant leaf debris, high organic and water content, pudding like consistency	5	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-B5-S			
Date of Sample Collection: March 9, 2003			
Time of Collection: 8:40			
Bottom Depth:7 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sand greater than 50%, dark olive green, abundant leaf debris, high organic and water content	5	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-B6-SR			
Date of Sample Collection: March 9, 2003			
Time of Collection: 7:30			
Bottom Depth: 5 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silt and sand, dark olive green, abundant leaf debris, high organic and water content, pudding like consistency	3	Organic matter, decay - septic odor

Ponar Sample Soil Logs
B Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-B7-SR			
Date of Sample Collection: March 9, 2003			
Time of Collection: 7:30			
Bottom Depth: 5 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sand, dark olive green, abundant leaf debris, high organic and water	5	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-B8-SR			
Date of Sample Collection: March 8, 2003			
Time of Collection: 14:00			
Bottom Depth: 5 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silt sand, dark olive green, abundant leaf debris, high organic and water content, pudding like consistency, abundant bubbles when Ponar struck bottom.	3	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-B9-SR			
Date of Sample Collection: March 8, 2003			
Time of Collection: 11:30			
Bottom Depth: 9 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silt sand, dark olive green, abundant leaf debris, plastic detritus, high organic and water content (gutter mix).	3	Organic matter, decay - septic odor

Ponar Sample Soil Logs
B Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-B10-SR			
Date of Sample Collection: March 8, 2003			
Time of Collection: 11:30			
Bottom Depth: 8 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sand, dark olive green, abundant leaf debris, high organic and water content	2	Three sample attempts, Organic matter, decay - septic odor

Ponar Sample Soil Logs
C Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-C1-SR(D)			
Date of Sample Collection: March 9, 2003			
Time of Collection: 16:25			
Bottom Depth: 10 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sand, dark olive green, abundant leaf and twig debris, high organic and water content, abundant bubble from Ponar strike	4	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-C2-S			
Date of Sample Collection: March 9, 2003			
Time of Collection: 15:15			
Bottom Depth: 9 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sandy mud, dark olive green, abundant leaf and twig debris, high organic and water content, abundant bubble from Ponar strike	5	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-C3-SRG			
Date of Sample Collection: March 9, 2003			
Time of Collection: 13:20			
Bottom Depth: 14 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silt sand, dark olive green, abundant leaf, twig and plastic debris, high organic and water content, pudding like consistency	4	Organic matter, decay - septic odor

Ponar Sample Soil Logs
C Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-C4-S			
Date of Sample Collection: March 9, 2003			
Time of Collection: 11:55			
Bottom Depth: 9 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sand, dark olive green, abundant leaf and twig debris, high organic and water content, large live mussel present, some bubbles released from Ponar strike	5	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-C5-SRGC			
Date of Sample Collection: March 9, 2003			
Time of Collection: 11:55			
Bottom Depth: 9 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silt and sand, dark olive green, abundant leaf and twig debris, high organic and water content, some bubbles released from Ponar strike	4	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-C6-S			
Date of Sample Collection: March 9, 2003			
Time of Collection: 7:45			
Bottom Depth: 8 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud, little silt/sand present, dark olive green, abundant leaf and twig debris, high organic and water content	4	Organic matter, decay - septic odor

Ponar Sample Soil Logs
C Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-C7-SRG			
Date of Sample Collection: March 8, 2003			
Time of Collection: 16:10			
Bottom Depth: 6 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sand, dark olive green, abundant leaf debris, high organic and water content	5	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-C8-S			
Date of Sample Collection: March 8, 2003			
Time of Collection: 14:30			
Bottom Depth: 8 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Fine grained silty sand, dark olive green, abundant leaf debris, high organic and water content	3	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-C9-SRG			
Date of Sample Collection: March 8, 2003			
Time of Collection: 11:45			
Bottom Depth: 8 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sand, sand fine to coarse, dark olive green, abundant leaf debris, high organic and water content	3	Organic matter, decay - septic odor

Ponar Sample Soil Logs
C Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-C10-S			
Date of Sample Collection: March 8, 2003			
Time of Collection: 9:35			
Bottom Depth: 5 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Sand and gravel (2cm)present, dark olive green, some leaf debris, high organic content	3	Organic matter, decay - septic odor

Ponar Sample Soil Logs
D Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-D1-S			
Date of Sample Collection: March 9, 2003			
Time of Collection: 16:35			
Bottom Depth: 12 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silt to sand size material, dark olive green, abundant leaf, twig and plastic debris, high organic and water content, pudding like consistency	5	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-D2-SR			
Date of Sample Collection: March 9, 2003			
Time of Collection: 15:30			
Bottom Depth: 12 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silt to sand size material, dark olive green, abundant leaf and twigs debris, high organic and water content, pudding like consistency, bubbles from Ponar striking bottom sediments	5	Organic matter, decay - septic odor

Ponar Sample Soil Logs
D Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-D3-S			
Date of Sample Collection: March 9, 2003			
Time of Collection: 13:45			
Bottom Depth: 13 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silt to sand size material, dark olive green, abundant leaf, stems and twigs debris, high organic and water content, pudding like consistency, live clam present	5	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-D4-SRG			
Date of Sample Collection: March 9, 2003			
Time of Collection: 12:10			
Bottom Depth: 13 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silt to sand size material, dark olive green, few leaves mainly stems and twigs, high organic matter	5	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-D5-S			
Date of Sample Collection: March 9, 2003			
Time of Collection: 9:10			
Bottom Depth: 11 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silt to sand size material, dark olive green, abundant leaf and twigs debris, high organic and water content, pudding like consistency, bubbles from Ponar striking bottom sediments	5	Organic matter, decay - septic odor

Ponar Sample Soil Logs
D Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-D6-SR			
Date of Sample Collection: March 9, 2003			
Time of Collection: 7:50			
Bottom Depth: 9 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silt to sand size material, dark olive green, abundant leaf and stem debris, high organic and water content, pudding like consistency	4	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-D7-S			
Date of Sample Collection: March 8, 2003			
Time of Collection: 16:20			
Bottom Depth: 9 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silt to sand size material, dark olive green, abundant leaf and twigs debris, high organic and water content, pudding like consistency	4	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-D8-SR			
Date of Sample Collection: March 8, 2003			
Time of Collection: 14:50			
Bottom Depth: 10 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silt to sand size material, dark olive green, abundant leaf debris and whole leaves, high organic matter	4	Organic matter, decay - septic odor

Ponar Sample Soil Logs
D Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-D9-S			
Date of Sample Collection: March 9, 2003			
Time of Collection: 11:55			
Bottom Depth: 10 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sand with pebbles and "clinkers from coal fired boil", 1 mussel and 2 clams recovered from sediment largest 3"	1.5	Three attempts to gain sufficient sample for duplicate, bottom sediment was very well armored

Project Name: Anacostia Capping Project			
Sample Number: CSO-D10-SR			
Date of Sample Collection: March 8, 2003			
Time of Collection: 9:50			
Bottom Depth: 12 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silt to sand size material, dark olive green, abundant leaf debris	4	Organic matter, decay - septic odor

Ponar Sample Soil Logs
E Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-E1-SR			
Date of Sample Collection: March 9, 2003			
Time of Collection: 16:45			
Bottom Depth: 13 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silt to sand size material, dark olive green, abundant leaf and stem debris, pudding like consistency	5	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-E2-S			
Date of Sample Collection: March 9, 2003			
Time of Collection: 15:45			
Bottom Depth: 13 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silt to sand size material, dark olive green, abundant leaf debris, abundant biogenic bubbles from Ponar striking bottom sediments	5	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-E3-SR			
Date of Sample Collection: March 9, 2003			
Time of Collection: 14:05			
Bottom Depth: 14 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silt to sand size material, dark olive green, abundant leaf and stem debris, pudding like consistency	5	Organic matter, decay - septic odor

Ponar Sample Soil Logs
E Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-E4-S (Duplicate)			
Date of Sample Collection: March 9, 2003			
Time of Collection: 16:45			
Bottom Depth: 13 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silt to sand size material, dark olive green, abundant leaf, stem, and plastic debris	5	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-E5-SR (Duplicate)			
Date of Sample Collection: March 9, 2003			
Time of Collection: 9:30			
Bottom Depth: 15 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silt to sand size material, dark olive green, abundant leaf plastic debris	5	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-E6-S			
Date of Sample Collection: March 9, 2003			
Time of Collection: 8:10			
Bottom Depth: 11 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sand size material, dark olive green, abundant leaf, stem, and plastic debris	4	Organic matter, decay - septic odor

Ponar Sample Soil Logs
E Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-E7-SR			
Date of Sample Collection: March 8, 2003			
Time of Collection: 16:40			
Bottom Depth: 9 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sand size material, dark olive green, abundant leaf debris, abundant biogenic bubbles from Ponar striking bottom sediments	3	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-E8-S			
Date of Sample Collection: March 8, 2003			
Time of Collection: 15:10			
Bottom Depth: 12 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silty sand size material, dark olive green, abundant leaf debris	2	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-E9-SR (Duplicate)			
Date of Sample Collection: March 8, 2003			
Time of Collection: 12:15			
Bottom Depth: 14 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sand, dark olive green, abundant leaf debris, live bivalve	3	Organic matter, decay - septic odor

Ponar Sample Soil Logs
E Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-E10-S			
Date of Sample Collection: March 8, 2003			
Time of Collection: 10:15			
Bottom Depth: 15 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with some silt sized material, dark olive green, abundant leaf debris, abundant biogenic bubbles from Ponar striking bottom sediments	4	Organic matter, decay - septic odor

Ponar Sample Soil Logs
F Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-F1-S			
Date of Sample Collection: March 9, 2003			
Time of Collection: 17:00			
Bottom Depth: 17 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with some silt sized material, dark olive green, abundant leaf debris, abundant biogenic bubbles from Ponar striking bottom sediments	6	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-F2-S			
Date of Sample Collection: March 9, 2003			
Time of Collection: 16:00			
Bottom Depth: 16 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with some silt sized material, dark olive green, abundant leaf, stem, twig debris, plastic bag, abundant biogenic bubbles from Ponar striking bottom sediments	5	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-F3-S			
Date of Sample Collection: March 9, 2003			
Time of Collection: 14:20			
Bottom Depth: 14 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with some silt sized material, dark olive green, abundant leaf debris, pudding like consistency	5	Organic matter, decay - septic odor

Ponar Sample Soil Logs
F Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-F4-S			
Date of Sample Collection: March 9, 2003			
Time of Collection: 12:30			
Bottom Depth: 16 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with silt and sand sized material, dark olive green, abundant leaf debris	4	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-F5-S			
Date of Sample Collection: March 9, 2003			
Time of Collection: 9:40			
Bottom Depth: 14 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sand, dark olive green, abundant leaf, stem, twig debris, plastic, abundant biogenic bubbles from Ponar striking bottom sediments	5	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-F6-S			
Date of Sample Collection: March 9, 2003			
Time of Collection: 8:20			
Bottom Depth: 14 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with some silt sized material, dark olive green, abundant leaf debris, high water content	2	Organic matter, decay - septic odor

Ponar Sample Soil Logs
F Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-F7-S			
Date of Sample Collection: March 9, 2003			
Time of Collection: 17:00			
Bottom Depth: 17 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Mud with some silt sized material, dark olive green, abundant leaf debris, abundant biogenic bubbles from Ponar striking bottom sediments	5	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-F8-S			
Date of Sample Collection: March 8, 2003			
Time of Collection: 15:20			
Bottom Depth: 14 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sand, dark olive green, abundant leaf debris	3	Organic matter, decay - septic odor

Project Name: Anacostia Capping Project			
Sample Number: CSO-F9-S			
Date of Sample Collection: March 8, 2003			
Time of Collection: 12:40			
Bottom Depth: 16 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sand, dark olive green, abundant leaf debris, some biogenic bubbles released from sediment when Ponar struck bottom	2.5	Organic matter, decay - septic odor

Ponar Sample Soil Logs
F Line

Project Name: Anacostia Capping Project			
Sample Number: CSO-F10-S			
Date of Sample Collection: March 8, 2003			
Time of Collection: 10:45			
Bottom Depth: 18 feet			
Soil Interval Sampled* (in Inches)	**Lithologic Description**	**Recovery in Inches**	**Comments**
0-6	Silty sand, dark olive green, abundant leaf debris	3	Organic matter, decay - septic odor

Appendix C Copies of Chain-of-Custody Records

Chain of Custody Record

Client: Horne Engineering Services, Suite 450, Fairfax, VA 22031

Project Manager: Yuewei Zhu; Phone: 703-364-1100; Quote: 51918

Project Name: Anacostia River; Project#: 3288

Page 1 of 1

Laboratory: STL - Pittsburgh, 450 William Pitt Way, Pittsburgh, PA 15238; phone: 410-820-8380; fax: 412-820-2080; Lab Contact: Carrie Gamber

SEVERN TRENT STL

Date	Time	Water	Sediment	Sample Identification	No. of Containers	Metals-PPL (SW846 6010/7471A)	PCB aroclors (SW846 8082)	PAHs (SW846 8270C)	TKN (EPA 351.3)	Total Phosphorus (EPA 365.2)	Pesticides - TCL (SW846 8081A)	PCB Congeners (56) (SW846 8082)	TOC (Lloyd Kahn)	Grain Size w/hydrometer (ASTM D422)	AVSSEM EPA DRAFT 1991	Bulk Density	Specific Gravity	Remarks
3/6/03	1615		x	C50-A1SR	8oz													
	1615			C50-A1SR	4oz	1	1	1	1	1			1					
	1445			C50-A2S	8oz		1	1										
	1445			C50-A2S	4oz	1								1				
	1500			C50-B2SRGC	16oz	1												
	1500			C50-B2SRGC	8oz		1	1							1	1	1	
	1500			C50-B2SRGC	4oz	3			1	1			1					
	1515			C50-C2S	8oz		1	1										
	1515			C50-C2S	4oz	1												
	1530			C50-D2SR	8oz	1	1	1										
	1530			C50-D2SR	4oz	1			1	1			1					
	1545			C50-E2S	8oz		1	1										
	1545			C50-E2S	4oz	1												
	1400			C50-F2S	8oz	1		1										
	1400			C50-F2S	4oz	1												

Sampled by: (Signature) — Date/Time 3/6/03 1425

Relinquished by: (Signature) — Date/Time

Relinquished by: (Signature) — Date/Time

Received by Laboratory: (Signature) — Date/Time 3/11/03 10:35

STL Pittsburgh 6

STL Pittsburgh

Client:
Horne Engineering Services
Suite 450
Fairfax, VA 22031

Project Manager:
Yuewei Zhu

Phone: 703-364-1100
Quote: 51918

Project Name: Anacostia River
Project#: 3288

Page 1 of 1

Chain of Custody Record

Laboratory:
STL - Pittsburgh
450 William Pitt Way
Pittsburgh, PA 15238

phone: 410-820-8380
fax: 412-820-2080

Lab Contact: Carrie Gamber

SEVERN TRENT STL

Parameters/Method Numbers for Analysis

Date	Time	Water	Sediment	Sample Identification		No. of Containers	Metals-PPL (SW846 6010/7471A)	PCB aroclors (SW846 8082)	PAHs (SW846 8270C)	TKN (EPA 351.3)	Total Phosphorus (EPA 365.2)	Pesticides - TCL (SW846 8081A)	PCB Congeners (36) (SW846 8082)	TOC (Lloyd Kahn)	Grain Size w/hydrometer (ASTM D422)	AVSSEM EPA DRAFT 1991				Remarks
3/9/03	1620		x	CSO - ~~A1SR~~ B1S	8oz	1		1	1											
	1620			CSO - B1S	4oz	1	1													
	1625			CSO - C1SR	8oz	1		1	1											
	1625			CSO - C1SR	4oz	3	1			1	1			1						
	1625			CSO - C1SR-D	8oz	1		1	1											
	1625			CSO - C1SRD	4oz	1	1													
	1635			CSO - D1S	8oz	1		1	1											
	1635			CSO - D1S	4oz	1	1													
	1645			CSO - E1SR	8oz	1		1	1											
	1645			CSO - E1SR	4oz	3	1			1	1			1						
	1700			CSO - F1S	8oz	1		1	1											
	1700			CSO - F1S	4oz	1	1													
				~~CSO -~~																
				~~CSO -~~																
				CSO -																

Sampled by: (Signature) [signature] Date/Time 3/10/03 14:25
Relinquished by: (Signature) Date/Time
Relinquished by: (Signature) Date/Time
Received by Laboratory: (Signature) [signature] Date/Time 3/10/03 10:35

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STL Pittsburgh

Client:
Horne Engineering Services
Suite 450
Fairfax, VA 22031

Project Manager:
Yuewei Zhu

Phone: 703-364-1100
Quote: **51918**

Project Name: **Anacostia River**
Project#: 3288

Page 1 of 1

Parameters/Method Numbers for Analysis

Date	Time	Water	Sediment	Sample Identification		No. of Containers	Metals-PPL (SW846 6010/7471A)	PCB aroclors (SW846 8082)	PAHs (SW846 8270C)	TKN (EPA 351.3)	Total Phosphorus (EPA 365.2)	Pesticides - TCL (SW846 8081A)	PCB Congeners (56) (SW846 8082)	TOC (Lloyd Kahn)	Grain Size w/hydrometer (ASTM D422)	AVSSEM EPA DRAFT 1991				Remarks
3/9/03	1243		x	CSO- A3SR	8oz	1		1	1											
	1243			CSO - A3SR	4oz	3	1			1	1			1						
	1305			CSO - B3S	8oz	1		1	1											
	1305			CSO - B3S	4oz	1	1													
	1320			CSO - C3SRG	16oz	1									1					
	1320			CSO - C3SRG	8oz	1		1	1											
	1320			CSO - C3SRG	4oz	3	1			1	1			1						
	1345			CSO - ~~D3S~~ D3S	8oz	1		1	1											
	1345			CSO - D3S	4oz	1	1													
	1405			CSO - E3SR	8oz	1		1	1											
	1405			CSO - E3SR	4oz	3	1			1	1			1						
	1405			CSO - E3SRD	4oz	2				1	1			1						
	1420			CSO - F3S	8oz	1		1	1											
	1420			CSO - F3S	4oz	1	1													
				CSO																

Sampled by: (Signature) — Date/Time 3/03 1635
Relinquished by: (Signature) — Date/Time
Relinquished by: (Signature) — Date/Time
Received by Laboratory: (Signature) — Date/Time 3/11/03 10:35

Chain of Custody Record

Laboratory:
STL - Pittsburgh
450 William Pitt Way
Pittsburgh, PA 15238

phone: 410-820-8380
fax: 412-820-2080

Lab Contact: Carrie Gamber

SEVERN TRENT STL

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STL Pittsburgh

Client:
Horne Engineering Services
Suite 450
Fairfax, VA 22031

Project Manager:
Yuewei Zhu

Phone: 703-364-1100
Quote: 51918

Project Name: Anacostia River
Project#: 3288

Page 1 of 1

Parameters/Method Numbers for Analysis

Chain of Custody Record

Laboratory:
STL - Pittsburgh
450 William Pitt Way
Pittsburgh, PA 15238

phone: 410-820-8380
fax: 412-820-2080

Lab Contact: Carrie Gamber

SEVERN TRENT STL

Date	Time	Water	Sediment	Sample Identification	No. of Containers	Metals-PPL (SW846 6010/7471A)	PCB aroclors (SW846 8082)	PAHs (SW846 8270C)	TKN (EPA 351.3)	Total Phosphorus (EPA 365.2)	Pesticides - TCL (SW846 8081A)	PCB Congeners (56) (SW846 8082)	TOC (Lloyd Kahn)	Grain Size w/hydrometer (ASTM D422)	AVSSEM EPA DRAFT 1991				Remarks
3/8/03	1710		x	CSO-A6S 8oz	1		1	1											
3/8/03	1710			CSO-A6S 4oz	1	1													
3/9/03	0730			CSO-B6SR 8oz	1		1	1											
	0730			CSO-B6SR 4oz	3	1			1	1	*		1						
	0745			CSO-C6S 8oz	1		1	1											
	0745			CSO-C6S 4oz	1	1													
	0750			CSO-D6SR 8oz	1		1	1											
	0750			CSO-D6SR 4oz	3	1			1	1	*		1						
	0810			CSO-E6S 8oz	1		1	1											
	0810			CSO-E6S 4oz	1	1													
	0820			CSO-F6S 8oz	1		1	1											
	0820			CSO-F6S 4oz	1	1													
				CSO-															

Sampled by: (Signature) [signature] Date/Time 3/10/03 1635
Relinquished by: (Signature) Date/Time
Relinquished by: (Signature) Date/Time
Received by Laboratory: (Signature) [signature] Date/Time 3/11/03 10:35

STL Pittsburgh

Client:
Horne Engineering Services
Suite 450
Fairfax, VA 22031

Project Manager:
Yuewei Zhu

Phone: 703-364-1100
Quote: 51918

Project Name: Anacostia River
Project#: 3288

Page 1 of 1

Parameters/Method Numbers for Analysis

Chain of Custody Record

Laboratory:
STL - Pittsburgh
450 William Pitt Way
Pittsburgh, PA 15238

phone: 410-820-8380
fax: 412-820-2080

Lab Contact: Carrie Gamber

SEVERN TRENT STL

Date	Time	Water	Sediment	Sample Identification	No. of Containers	Metals-PPL (SW846 6010/7471A)	PCB aroclors (SW846 8082)	PAHs (SW846 8270C)	TKN (EPA 351.3)	Total Phosphorus (EPA 365.2)	Pesticides - TCL (SW846 8081A)	PCB Congeners (36) (SW846 8082)	TOC (Lloyd Kahn)	Grain Size w/hydrometer (ASTM D422)	AVSSEM EPA DRAFT 1991				Remarks
3/3	1710		x	CSO-RS1-SP 8oz	1	1	1	1			1								
	1710			CSO-RS1-SP 4oz	1	1													
	1715			CSO-RS2-SP 8oz	1		1	1			1								
	1715			CSO RS2-SP 4oz	1	1													
	1730			CSO-RS3-SP 8oz	1		1	1			1								
	1730			CSO RS3-SP 4oz	1	1													

Sampled by: (Signature) [signature] Date/Time 3/3/8:00

Relinquished by: (Signature) Date/Time

Relinquished by: (Signature) Date/Time

Received by Laboratory: (Signature) [signature] Date/Time 3/4/03 10:35

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Client:	Project Manager:
Horne Engineering Services Suite 450 Fairfax, VA 22031	Yuewei Zhu Phone: 703-364-1100 Quote: 51918

Project Name: Anacostia River

Project#: 3288

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Parameters/Method Numbers for Analysis

Date	Time	Water	Sediment	Sample Identification		No. of Containers	Metals-PPL (SW846 6010/7471A)	PCB aroclors (SW846 8082) (Waste Tumaround)	PAHs (SW846 8270C)	TKN (EPA 351.3)	Total Phosphorus (EPA 365.2)	Pesticides - TCL (SW846 8081A)	PCB Congeners (56) (SW846 8082)	TOC (Lloyd Kahn)	Grain Size w/hydrometer (ASTM D422)	AVSSEM EPA DRAFT 1991				Remarks
3/9/03	1130		x	CSO-A4S	8 oz	1		1	1											
	1130			CSO A4S	4 oz	1	1													
	1145			CSO B4SR	8 oz	1		1	1											
	1145			CSO B4SR	4 oz	3	1			1	1			1						
	1155			CSO C4S	8 oz	1		1	1											
	1155			CSO C4S	4 oz	1	1													
	1210			CSO D4SRG	16 oz	1									1					
	1210			CSO D4SRG	8 oz	1		1	1											
	1210			CSO D4SRG	4 oz	3	1			1	1			1						
	1225			CSO E4S	8 oz	1		1	1											
	1225			CSO E4S	4 oz	1	1													
	1225			CSO E4SD	8 oz	1		1	1											
	1225			CSO E4SD	4 oz	1	1													
	1230			CSO F4S	8 oz	1		1	1											
	1230			CSO F4S	4 oz	1	1													

Chain of Custody Record

Laboratory:
STL - Pittsburgh
450 William Pitt Way
Pittsburgh, PA 15238

phone: 410-820-8380
fax: 412-820-2080

Lab Contact: Carrie Gamber

SEVERN TRENT STL

Sampled by: (Signature)	Date/Time 3/09/03 15:40	Relinquished by: (Signature)	Date/Time
Relinquished by: (Signature)	Date/Time	Received by Laboratory: (Signature)	Date/Time 3/11/03 10:35

STL Pittsburgh

Client:
Horne Engineering Services
Suite 450
Fairfax, VA 22031

Project Manager:
Yuewei Zhu

Phone: 703-364-1100
Quote: 51918

Project Name: Anacostia River
Project#: 3288

Page 1 of 1

Parameters/Method Numbers for Analysis

Chain of Custody Record

Laboratory:
STL - Pittsburgh
450 William Pitt Way
Pittsburgh, PA 15238

phone: 410-820-8380
fax: 412-820-2080

Lab Contact: Carrie Gamber

SEVERN TRENT STL

Date	Time	Water	Sediment	Sample Identification		No. of Containers	Metals-PPL (SW846 6010/7471A)	PCB aroclors (SW846 8082) (1 tu-zer Tumbling)	PAHs (SW846 8270C)	TKN (EPA 351.3)	Total Phosphorus (EPA 365.2)	Pesticides - TCL (SW846 8081A)	PCB Congeners (56) (SW846 8082)	TOC (Lloyd Kahn)	Grain Size w/hydrometer (ASTM D422)	AVSSEM EPA DRAFT 1991	Bulk Density	Specific Gravity		Remarks
3/9/03	830		x	CSO-A5SR	8oz	1		1	1											
	830			CSO-A5SR	4oz	3	1			1	1			1						
	840			CSO-B5S	8oz	1		1	1											
	840			CSO-B5S	4oz	1	1													
	850			CSO-C5SGC	1/4 oz	1									1					
	850			CSO-C5SGC	8oz	6		1	1							1	1	1		
	850			CSO-C5SGC	4oz	3	1			1	1			1						
	910			CSO-D5S	8oz	1		1	1											
	910			CSO-D5S	4oz	1	1													
	930			CSO-E5SR	8oz	1		1	1											
	930			CSO-E5SR	4oz	3	1			1	1			1						
	930			CSO-E5SRD	8oz	1		1	1											
	930			CSO-E5SRD	4oz	1	1													
	940			CSO-F5S	8oz	1		1	1											
	940			CSO-F5S	4oz	1	1													

Sampled by: (Signature) [signature] Date/Time 3/03 15:40
Relinquished by: (Signature) Date/Time
Relinquished by: (Signature) Date/Time
Received by Laboratory: (Signature) [signature] Date/Time 3/11/03 10:35

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STL Pittsburgh

Client:	Project Manager:
Horne Engineering Services Suite 450 Fairfax, VA 22031	Yuewei Zhu Phone: 703-364-1100 Quote: 51918

Project Name: Anacostia River
Project#: 3288
Page 1 of 1

Chain of Custody Record

Laboratory:
STL - Pittsburgh
450 William Pitt Way
Pittsburgh, PA 15238

phone: 410-820-8380
fax: 412-820-2080

Lab Contact: Carrie Gamber

SEVERN TRENT STL

Parameters/Method Numbers for Analysis

Date	Time	Water	Sediment	Sample Identification	No. of Containers	Metals-PPL (SW846 6010/7471A)	PCB aroclors (SW846 8082)	PAHs (SW846 8270C)	TKN (EPA 351.3)	Total Phosphorus (EPA 365.2)	Pesticides - TCL (SW846 8081A)	PCB Congeners (56) (SW846 8082)	TOC (Lloyd Kahn)	Grain Size w/hydrometer (ASTM D422)	AVSSEM EPA DRAFT 1991				Remarks
3/3	1400		x	CSO B8 SR 8oz	1		1	1											
	1400			CSO B8 SR 4oz	3	1			1	1			1						
	1400			CSO B8 SRD 4oz	2				1	1			1						
	1430			CSO C8 S 8oz	1		1	1											
	1430			CSO C8 S 4oz	1	1													
	1450			CSO D8 SR 8oz	1		1	1											
	1450			CSO D8 SR 4oz	3	1			1	1			1						
	1510			CSO E8 S 8oz	1		1	1											
	1510			CSO E8 S 4oz	1	1			1	1			1						
	1520			CSO F8 S 8oz	1		1	1											
	1520			CSO F8 S 4oz	1	1													
	1520			CSO A7 SR 8oz	1		1	1											
	1530			CSO A7 SR 4oz	3	1			1	1			1						
	1545			CSO B7 S 8oz	1		1	1											
	1545			CSO B7 S 4oz	1	1													

Sampled by: (Signature)	Date/Time 3/3/03 1815	Relinquished by: (Signature)	Date/Time
Relinquished by: (Signature)	Date/Time	Received by Laboratory: (Signature)	Date/Time 3/11/03 10:35

STL Pittsburgh

Client:
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Fairfax, VA 22031

Project Manager:
Yuewei Zhu

Phone: 703-364-1100
Quote: 51918

Project Name: Anacostia River
Project#: 3288

Page 1 of 1

Parameters/Method Numbers for Analysis

Chain of Custody Record

Laboratory:
STL - Pittsburgh
450 William Pitt Way
Pittsburgh, PA 15238

phone: 410-820-8380
fax: 412-820-2080

Lab Contact: Carrie Gamber

SEVERN TRENT STL

Date	Time	Water	Sediment	Sample Identification	No. of Containers	Metals-PPL (SW846 6010/7471A)	PCB aroclors (SW846 8082)	PAHs (SW846 8270C)	TKN (EPA 351.3)	Total Phosphorus (EPA 365.2)	Pesticides - TCL (SW846 8081A)	PCB Congeners (56) (SW846 8082)	TOC (Lloyd Kahn)	Grain Size w/hydrometer (ASTM D422)	AVSSEM EPA DRAFT 1991				Remarks
3/3/3	1545		x	CSO B7 SD 8oz	1		1	1											
	1545			CSO B7 SD 4oz	1	1													
	1610			CSO C7 SRG 8oz	1		1	1											
	1610			CSO C7 SRG 4oz	3	1			1	1			1						
	1610			CSO C7 SRG 16oz	1									1					
	1620			CSO D7 S 8oz	1		1	1											
	1620			CSO D7 S 4oz	1	1													
	1640			CSO E7 SR 8oz	1		1	1											
	1640			CSO E7 SR 4oz	3	1			1	1			1						
	1700			CSO F7 S 8oz	1		1	1											
	1700			CSO F7 S 4oz	1	1													
	1710			CSO A6 S 8oz	1		1	1											
	1710			CSO A6 S 4oz	1	1													

Sampled by: (Signature) [signature] Date/Time 3/3/03 18:20
Relinquished by: (Signature) Date/Time
Relinquished by: (Signature) Date/Time
Received by Laboratory: (Signature) [signature] Date/Time 3/11/03 10:35

STL Pittsburgh

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Project Name: Anacostia River
Project#: 3288 D02

Page 1 of 1

Parameters/Method Numbers for Analysis

Chain of Custody Record

Laboratory:
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450 William Pitt Way
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phone: 410-820-8380
fax: 412-820-2080

Lab Contact: Carrie Gamber

SEVERN TRENT STL

Date	Time	Water	Sediment	Sample Identification	No. of Containers	Metals-PPL (SW846 6010/7471A)	PCB arocolors (SW846 8082)	PAHs (SW846 8270C)	TKN (EPA 351.3)	Total Phosphorus (EPA 365.2)	Pesticides - TCL (SW846 8081A)	PCB Congeners (56) (SW846 8082)	TOC (Lloyd Kahn)	Grain Size w/hydrometer (ASTM D422)	AVSSEM EPA DRAFT 1991				Remarks
3/8/3	835		x	CSO A10 S 8oz	1		1	1											
	835		X	CSO A10 S 4oz	1	1													
	850		X	CSO B10 SR 8oz	1		1	1											
	850		X	CSO B10 SR 4oz	3	1			1	1			1						
	935		X	CSO C10 S 8oz	1		1	1											
	935		X	CSO C10 S 4oz	1	1													
	950		X	CSO D10 SR 8oz	1		1	1											
	950		X	CSO D10 SR 4oz	3	1			1	1			1						
	1015		X	CSO E10 S 8oz	1		1	1											
	1015		X	CSO E10 S 4oz	1	1													
	1045		X	CSO F10 S 8oz	1		1	1											
	1045		X	CSO F10 S 4oz	1	1													
	1100		X	CSO A 9 SR 8oz	1		1	1											
	1100		X	CSO A 9 SR 4oz	3	1			1	1			1						
			~~X~~	~~CSO~~	~~1~~														

Sampled by: (Signature) [signature] Date/Time 18:00

Relinquished by: (Signature) Date/Time

Relinquished by: (Signature) Date/Time

Received by Laboratory: (Signature) [signature] Date/Time 3/11/03 10:55

STL Pittsburgh

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Project Name: Anacostia River
Project#: 3288

Page 1 of 1

Chain of Custody Record

Laboratory:
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Lab Contact: Carrie Gamber

SEVERN TRENT STL

Parameters/Method Numbers for Analysis

Date	Time	Water	Sediment	Sample Identification	No. of Containers	Metals-PPL (SW846 6010/7471A)	PCB arocolors (SW846 8082)	PAHs (SW846 8270C)	TKN (EPA 351.3)	Total Phosphorus (EPA 365.2)	Pesticides - TCL (SW846 8081A)	PCB Congeners (56) (SW846 8082)	TOC (Lloyd Kahn)	Grain Size w/hydrometer (ASTM D422)	AVSSEM EPA DRAFT 1991				Remarks
3/3/03	1130		x	CSO-B9-S 8oz	1		1	1											
	1130			CSO-B9-S 4oz	1	1													
	1145			CSO C9-SR 8oz	1		1	1											
	1145			CSO C9-SR 4oz	3	1			1	1			1						
	1155			CSO D9-S 8oz	1		1	1											
	1155			CSO D9-S 4oz	1	1			1	1			1						
	1215			CSO E9-SR 8oz	1		1	1											
	1215			CSO E9-SR 4oz	3	1			1	1			1						
	1215			CSO E9-SRD 8oz	1		1	1											
	1215			CSO E9-SRD 4oz	1	1			1	1			1						
	1240			CSO F9-S 8oz	1		1	1											
	1240			CSO F9-S 4oz	1	1			1	1			1						
	1345			CSO A8-S 8oz	1		1	1											
	1345			CSO A8-S 4oz	1	1			1	1			1						

Sampled by: (Signature) — Date/Time 3/3/03 18:10
Relinquished by: (Signature) — Date/Time
Relinquished by: (Signature) — Date/Time
Received by Laboratory: (Signature) — Date/Time 10:35 3/4/03

STL Pittsburgh

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Project Name: Anacostia River
Project#: 3288 D02

Page 1 of 1

Parameters/Method Numbers for Analysis

Chain of Custody Record

Laboratory:
STL - Pittsburgh
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Pittsburgh, PA 15238

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Lab Contact: Carrie Gamber

SEVERN TRENT STL

Date	Time	Water	Sediment	Sample Identification	No. of Containers	Metals-PPL (ICP/MS) (SW846 6020/7471A)	PCB aroclors (SW846 8082)	PAHs (SW846 8270C SIM - NOAA S&T)	TKN (EPA 351.3)	Total Phosphorus (EPA 365.2)	PCB Congeners (56) (EPA 1668)	TOC (EPA 415.1)	Total Suspended Solids (TSS) (EPA 160.2)	Total Dissolved Solids (TDS) (160.1)	pH (EPA 150.1)	Remarks
3/10/3	9:30	X		CSO W1 Glass Amber 1 Liter	1		1	1			1					
				CSO W1 Plastic 1 Liter	2								1	1	1	
				CSO W1 500mL	2	1										HNO3
				CSO W1 500mL	3				1	1						H2SO4
				CSO W1 250mL	1											
				CSO W1 40ml	3							1				H2SO4
					11											

Sampled by: (Signature) [signature] Date/Time 3/10/03 15:00

Relinquished by: (Signature) Date/Time

Relinquished by: (Signature) Date/Time

Received by Laboratory: (Signature) [signature] Date/Time 3/11/03 10:35

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STL Pittsburgh

Client:
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Project Name: Anacostia River
Project#: 3288

Page 1 of 1

Chain of Custody Record

Laboratory:
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SEVERN TRENT STL

Parameters/Method Numbers for Analysis

Date	Time	Water	Sediment	Sample Identification		No. of Containers	Metals-PPL (ICP/MS) (SW846 6020/7471A)	PCB aroclors (SW846 8082)	PAHs (SW846 8270C SIM - NOAA S&T)	TKN (EPA 351.3)	Total Phosphorus (EPA 365.2)	PCB Congeners (56) (EPA 1668)	TOC (EPA 415.1)	Total Suspended Solids (TSS) (EPA 160.2)	Total Dissolved Solids (TDS) (160.1)	pH (EPA 150.1)				Remarks
3/10/3		x		CSOW2	Glass 1 liter	1		1	1			1								
				CSOW2	Plastic 1 liter	2								1	1	1				
				CSOW2	500mL	3	1													HNO_3
				CSOW2	500mL					1	1									H_2SO_4
				CSOW2	250mL	~~1~~														
				CSOW2	40mL	3							1							H_2SO_4
				~~CSOW2~~																

Sampled by: (Signature) [signature] Date/Time 3/03 16:00
Relinquished by: (Signature) Date/Time
Relinquished by: (Signature) Date/Time
Received by Laboratory: (Signature) [signature] Date/Time 3/11/03 10:55

STL Pittsburgh

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Yuewei Zhu

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Quote: **51918**

Project Name: **Anacostia River**
Project#: 3288

Page 1 of 1

Parameters/Method Numbers for Analysis

Chain of Custody Record

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fax: 412-820-2080

Lab Contact: Carrie Gamber

SEVERN TRENT STL

Date	Time	Water	Sediment	Sample Identification	No. of Containers	Metals-PPL (SW846 6010/7471A)	PCB aroclors (SW846 8082)	PAHs (SW846 8270C)	TKN (EPA 351.3)	Total Phosphorus (EPA 365.2)	Pesticides - TCL (SW846 8081A)	PCB Congeners (56) (SW846 8082)	TOC (Lloyd Kahn)	Grain Size w/hydrometer (ASTM D422)	AVSSEM EPA DRAFT 1991				Remarks
3/11/03	1345		x	CSO - CORE 2 0-6 8oz	1		1	1			1	✓							
				CSO - CORE 2 0-6 4oz	4	1			1	1			1		1				
				CSO - CORE 2 6-12 8oz	1		1	1											
				CSO - CORE 2 6-12 4oz	1	1	X												
				CSO - CORE 2 12-20 8oz	1		1	1											
				CSO - CORE 2 12-20 4oz	1	1													
	1500			CSO - CORE 3 - 06	1		1	1			1								
				CSO - CORE 3 - 06	4	1			1	1			1		1				
				CSO - CORE 3 - 6-12	1		1	1											
				CSO - CORE 3 - 6-12	1	1													
				CSO - CORE 3 - 12-14	1		1	1											
				CSO - CORE 3 - 12-14	1	1													
				CSO -															
				CSO -															
				CSO -															

Sampled by: (Signature)	Date/Time 3/11/3 15:30	Relinquished by: (Signature)	Date/Time 3/12/3 16:00
Relinquished by: (Signature)	Date/Time	Received by Laboratory: (Signature)	Date/Time 3-13-03 9:00

6

STL Pittsburgh

Client:
Horne Engineering Services
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Fairfax, VA 22031

Project Manager:
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Phone: 703-364-1100
Quote: 51918

Project Name: Anacostia River
Project#: 3288

Page 1 of 1

Chain of Custody Record

Laboratory:
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fax: 412-820-2080

Lab Contact: Carrie Gamber

SEVERN TRENT STL

Parameters/Method Numbers for Analysis

Date	Time	Water	Sediment	Sample Identification	No. of Containers	Metals-PPL (SW846 6010/7471A)	PCB aroclors (SW846 8082)	PAHs (SW846 8270C)	TKN (EPA 351.3)	Total Phosphorus (EPA 365.2)	Pesticides - TCL (SW846 8081A)	PCB Congeners (56) (SW846 8082)	TOC (Lloyd Kahn)	Grain Size w/hydrometer (ASTM D422)	AVSSEM EPA DRAFT 1991				Remarks
3/13	1445		x	CSO CORE 4 06 8-02	1		1	1			1								
				CSO CORE 4 D 06 8-02	1		1	1			1								
				CSO CORE 4 06 4-2	4	1			1	1			1		1				
				CSO CORE 4 D 06 4-2	4	1			1	1			~~1~~		1				
				CSO CORE 4 6-12 8-02	1		1	1	~~1~~										
				CSO CORE 4 D 6-12 8-02	1		1	1											
				CSO CORE 4 6-12 4-02	1	1													
				CSO CORE 4 D 6-12 4-02	1	1													
				CSO CORE 4 12- 8-02	1		1	1											
				CSO CORE 4 12- 4-02	1	1													

Sampled by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time
[signature]	3/23 15:30	[signature]	3/23 16:00
Relinquished by: (Signature)	Date/Time	Received by Laboratory: (Signature)	Date/Time
		[signature]	3-13-03 8:05

STL Pittsburgh

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Project Name: Anacostia River
Project#: 3288

Page 1 of 1

Chain of Custody Record

Laboratory:
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Lab Contact: Carrie Gamber

SEVERN TRENT STL

Date	Time	Water	Sediment	Sample Identification	No. of Containers	Metals-PPL (SW846 6010/7471A)	PCB aroclors (SW846 8082)	PAHs (SW846 8270C)	TKN (EPA 351.3)	Total Phosphorus (EPA 365.2)	Pesticides - TCL (SW846 8081A)	PCB Congeners (36) (SW846 8082)	TOC (Lloyd Kahn)	Grain Size w/hydrometer (ASTM D422)	AVSSEM EPA DRAFT 1991				Remarks
3/11/03	930		x	CSO-CORE6 0-6 8oz	1		1	1			1								
	930			CSO-CORE6-0-6 4oz	4	1			1	1			1		1				
	930			CSO-CORE6 6-12 8oz	1		1	1											
	930			CSO-CORE6 6-12 4oz	1	1													
	930			CSO-CORE6 12-15 8oz	1		1	1											
	1200			CSO-CORE6 12-15 4oz	1	1													
	1200			CSO-CORE1 0-6 8oz	1		1	1			1								
	1200			CSO-CORE1 0-6 4oz	4	1			1	1			1		1				
	1200			CSO-CORE1 6-12	1		1	1											
	1200			CSO-CORE1 6-12	1	1													
				CSO-CORE1 12-22	1		1	1											
				CSO-CORE1 12-22	1	1													
				CSO-															
				CSO-															
				CSO-															

Sampled by: (Signature) [signature] Date/Time 15:30 3/11/3

Relinquished by: (Signature) [signature] Date/Time 3/12/3 16:00

Relinquished by: (Signature) Date/Time

Received by Laboratory: (Signature) [signature] Date/Time 3-13-03 9:00

STL Pittsburgh

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Quote: 51918

Project Name: Anacostia River
Project#: 3288
Page 1 of 1

Chain of Custody Record

Laboratory:
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fax: 412-820-2080

Lab Contact: Carrie Gamber

SEVERN TRENT STL

Parameters/Method Numbers for Analysis

Date	Time	Water	Sediment	Sample Identification	No. of Containers	Metals-PPL (SW846 6010/7471A)	PCB aroclors (SW846 8082)	PAHs (SW846 8270C)	TKN (EPA 351.3)	Total Phosphorus (EPA 365.2)	Pesticides - TCL (SW846 8081A)	PCB Congeners (56) (SW846 8082)	TOC (Lloyd Kahn)	Grain Size w/hydrometer (ASTM D422)	AVSSEM EPA DRAFT 1991				Remarks
3 12 3	10:20		x	CSO CORE 8 0-6 8oz	1		1	1			1								
				CSO CORE 8 0-6 4oz	4	1			1	1			1		1				
				CSO CORE 8 6-12 8oz	1		1	1											
				CSO CORE 8 6-12 4oz	1	1			1	1									
				CSO CORE 8 12-14 8oz	1		1	1											Petroleum
				CSO CORE 8 12-14 4oz	1	1													
	11:30			CSO CORE 7 0-6 8oz	1		1	1			1								
				CSO CORE 7 0-6 4oz	4	1			1	1			1		1				
				CSO CORE 7 6-12 8oz	1		1	1											
				CSO CORE 7 6-12 4oz	1	1													
				CSO CORE 7 12-14 8oz	1	1	1	1											Please ~~[illegible]~~ call if not enough quantity for 3 parameters
				~~CSO CORE 12 4oz~~	~~1~~	~~1~~													
				CSO CORE															
				CSO CORE															
				CSO CORE															

Sampled by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time
[signature]	3/12/03 1530	[signature]	16:00 3/12/03
Relinquished by: (Signature)	Date/Time	Received by Laboratory: (Signature)	Date/Time
		[signature]	3-13-03 8:00

STL Pittsburgh

Client:	Project Manager:	Parameters/Method Numbers for Analysis	Chain of Custody Record
Horne Engineering Services Suite 450 Fairfax, VA 22031	Yuewei Zhu Phone: 703-364-1100 Quote: 51918		Laboratory: STL - Pittsburgh 450 William Pitt Way Pittsburgh, PA 15238 phone: 410-820-8380 fax: 412-820-2080 Lab Contact: Carrie Gamber SEVERN TRENT STL
Project Name: Anacostia River Project#: 3288 Page 1 of 1			

Date	Time	Water	Sediment	Sample Identification	No. of Containers	Metals-PPL (SW846 6010/7471A)	PCB aroclors (SW846 8082)	PAHs (SW846 8270C)	TKN (EPA 351.3)	Total Phosphorus (EPA 365.2)	Pesticides - TCL (SW846 8081A)	PCB Congeners (56) (SW846 8082)	TOC (Lloyd Kahn)	Grain Size w/hydrometer (ASTM D422)	AVSSEM EPA DRAFT 1991				Remarks
3/12/3	12:37		X	CSO CORE 5 0-6 SS	1		1	1			1								
				CSO CORE 5 0-6 4oz	4	1			1	1			1		1				
				CSO CORE 5 6-12 8oz	1		1	1											
				CSO CORE 5 6-12 4oz	1	1													
				CSO CORE 5 12-18 8oz	1		1	1											
				CSO CORE 5 12-18 4oz	1	1													

Sampled by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time
[signature]	3/12/3 15:30	[signature]	3/12/3 16:00
Relinquished by: (Signature)	Date/Time	Received by Laboratory: (Signature)	Date/Time
		[signature]	3.15.03 9:00

10

Appendix D Brief Analytical Method Discussion

Chlorinated Pesticides (SW846 8081A)

Water samples are extracted with methylene chloride and sediment samples are extracted with 1:1 methylene chloride:acetone. The extracts are concentrated and solvent exchanged to hexane. Appropriate cleanups are performed on the extracts as necessary. The extracts are analyzed by Gas Chromatography (GC) using Electron Capture Detectors (ECDs). Quantitation of the project pesticides is perfomed using the external standard procedure.

PCB Aroclors (SW846 8082)

Water samples are extracted with methylene chloride and sediment samples are extracted with 1:1 methylene chloride:acetone. The extracts are concentrated and solvent exchanged to hexane. Appropriate cleanups are performed on the extracts as necessary. The extracts are analyzed by Gas Chromatography (GC) using Electron Capture Detectors (ECDs). Quantitation of the project PCB Aroclors is perfomed using the external standard procedure.

PCB Congeners (SW846 8082)

Sediment samples are extracted with 1:1 methylene chloride:acetone. The extracts are concentrated and solvent exchanged to hexane. Appropriate cleanups are performed on the extracts as necessary. The extracts are analyzed by Gas Chromatography (GC) using Electron Capture Detectors (ECDs). Quantitation of the project PCB congeners is perfomed using the external standard procedure.

PCB Congeners (EPA 1668A)

For aqueous samples (samples containing less than one percent solids), stable isotopically labeled analogs of the toxic PCBs plus additional labeled PCB's are spiked into a 1-L sample, and the sample is extracted with methylene chloride using separatory funnel techniques. After extraction, samples may be cleaned up using back-extraction with sulfuric acid and florisil column chromatography. After cleanup, the extract is concentrated to either 100 uL or 20 uL. Recovery standards are added to each extract, and an aliquot of the extract is injected into the gas chromatograph. The analytes are separated by the GC and detected by a high-resolution (=10,000) mass spectrometer. Two exact m/z's are monitored for each analyte. An individual PCB congener is identified by comparing the GC retention time of an authentic standard and the theoretical or acquired ion-abundance ratio of the two exact m/z's with the corresponding retention time of an authentic standard and the theoretical or acquired ion-abundance ratio of the two exact m/z's. Quantitative analysis is performed using selected ion current profile (SICP) areas, in one of two ways:

- For PCBs with labeled analogs, the GC/MS system is calibrated, and the concentration of each compound is determined using the isotope dilution technique.
- For PCBs without labeled compounds, the GC/MS system is calibrated and the concentration of each compound is determined using the internal standard technique.

Polynuclear Aromatic Hydrocarbons – PAHs (SW846 8270C/8270C SIM)

Water samples are extracted with methylene chloride and sediment samples are extracted with 1:1 methylene chloride:acetone. The extract is concentrated to a volume of 1.0 mL. Identification and quantitation of the project analytes is performed by GC/MS using the internal standard procedure. Water samples are analyzed by GC/MS in the selected ion monitoring (SIM) mode. The sediment samples were analyzed by full scan GC/MS.

Metals (SW846 6010B)

Water samples are acid digested per SW-846 Method 3010A and the sediment samples are acid/peroxide digested per SW-846 Method 3050B. The digestates are analyzed for the project elements by ICP-AES. The basis of the method is the measurement of atomic emission by an optical spectroscopic technique. Samples are nebulized and the aerosol that is produced is transported to the plasma torch where excitation occurs. Characteristic atomic-line emission spectra are produced by a radio frequency inductively coupled plasma (ICP). The spectra are dispersed by a grating spectrometer and the intensities of the emission lines are monitored by photomultiplier tubes. The photocurrents from the photomultiplier tubes are processed and controlled by a computer system. A background correction technique is required to compensate for variable background contribution to the determination of trace elements. Background must be measured adjacent to analyte lines during analysis.

Mercury (SW846 7470A/7471A)

A representative portion of the water or sediment sample is digested in sulfuric and nitric acids. Organic mercury compounds are oxidized with potassium permanganate and potassium persulfate and the mercury reduced to its elemental state with stannous chloride and aerated from solution in a closed system. The mercury vapor passes through a cell positioned in the light path of an atomic absorption spectrophotometer. Absorbance is measured as a function of mercury concentration. Concentration of the analyte in the sample is determined by comparison of the sample absorbance to the calibration curve (absorbance vs. concentration).

AVS/SEM

The AVS in the sample is first converted to hydrogen sulfide (H2S) by acidification with hydrochloric acid at room temperature. The H_2S is then purged from the sample and trapped. The amount of sulfide that is trapped is then determined titrimetrically following SW-846 Method 9034. The SEM is metals liberated from the sediment during the acidification. These are determined following Method 6010B after filtration of the sample. A molar ratio of total SEM/AVS is reported to evaluate the potential bioavailability of the metals. If the ratio is greater than 1, the metals may be bioavailable. If the ratio is less than 1, the metal were probably not bioavailable.

Total Organic Carbon – TOC (Lloyd Kahn / EPA 415.1)

Lloyd Kahn (Sediments): A small aliquot of sample is transferred to a tin capsule and treated with phosphoric acid to separate the inorganic carbon from carbonates and bicarbonates. The sample is placed in an oven and dried at 105°C. The sample is then transferred to an instrument where the sample is pyrolyzed in an inductive type furnace, where the carbon is converted to carbon dioxide. The carbon dioxide is measured by a differential thermal conductivity detector. EPA 415.1 (Water): Inorganic Carbon from carbonates and bicarbonates is removed by acid treatment. Organic carbon is converted to carbon dioxide (CO2) using chemical oxidation. The CO2 is then measured by an infrared detector.

Total Petroleum Hydrocarbons – TPH (SW846 8015B or SW846 9071A/ EPA 1664A)

SW 8015B (DRO): This method provides gas chromatographic conditions for the detection of various nonhalogenated organic compounds. Samples are introduced to the GC and detection is achieved by a flame ionization detector (FID).

SW 9071A/1664A: The sediment sample is extracted using hexane. The extract is dried with sodium sulfate, filtered, and concentrated to dryness. The total milligrams of Hexane Extractable Material (HEM or Oil and Grease) in the sample is determined gravimetrically. The residue is then re-dissolved in hexane and silica gel treated by adding 3 gram of silica gel for every 100 mg of HEM in the sample. The extract is again filtered and concentrated to dryness. The remaining residue in the extract represents the Silica Gel Treated Hexane Extractable Material (SGT-HEM or TPH). The concentration is determined gravimetrically.

Total Phosphorus (EPA 365.2)

Ammonium molybdate and antimony potassium tartrate react in an acid medium with Phosphorus to form a blue-colored complex which is analyzed photometrically.

Total Kjedahl Nirtogen – TKN (EPA 351.3)

This method determines Total Kjeldahl Nitrogen which is the sum of free ammonia and organic nitrogen compounds. The sample is digested to convert nitrogen compounds into ammonia. The digested sample is then neutralized to an alkaline state and distilled for ammonia. The distillate is analyzed by titration to a color-determined endpoint.

Total Suspended Solids – TSS (EPA 160.2) / Total Dissolved Solids – TDS (EPA 160.1)

TSS: A well-mixed sample is filtered through a pre-weighed glass fiber filter. The residue on the filter is dried to constant weight at 103-105 degrees C. The increase in weight over that of the pre-weighed filter represents the TSS content.

TDS: A well-mixed sample is filtered through a glass fiber filter. The filtrate is quantitatively transferred into a preweighed evaporating dish and is evaporated to dryness and then dried to constant weight at 180 degrees C. The increase in weight over that of the empty dish represents the total dissolved solids.

Grain Size (ASTM D422)

This test determines the particle size distribution in a soil. Particles greater than 75 um (Gravel to fine Sands) are determined by sieving, and particles less than 75 um (Silts and Clays) are determined by sedimentation using a hydrometer. This method can be modified for sieve only data. Specific sieves can be substituted to meet project needs and hydrometer readings can be timed to target a specific particle size. These data are useful in soil classification, silt and clay content for Atterberg Limits, porosity, permeability, etc.

Cation Exchange Capacity (SW846 9081)

The soil sample is mixed with an excess of sodium acetate solution, resulting in an exchange of the added sodium cations for the matrix cations. Subsequently, the sample is washed with isopropyl alcohol. An ammonium acetate solution is then added, which replaces the adsorbed sodium with ammonium. The concentration of displaced sodium is then determined by atomic adsorption, emission spectroscopy, or an equivalent means.

Bulk Density (ASTM D2937)

This test method determines the in-situ density of an undisturbed soil. The in-place dry density of the soil' is expressed in pounds per cubic feet or kilograms per cubic meter and is a ratio of the dry mass of soil divided by its volume.

Specific Gravity (ASTM D854)

This test determines the specific gravity of soil by pyenometer for a given soil. A 100ml (or 500 ml) volumetric flask, which has been calibrated with 100 ml of RO water, is weighed with 25 to 30 grams of soils and RO Water filled to the volume mark. Specific gravity is a ratio of the soil mass to the water mass that the soil displaces. This test is used to compare the relationship of soil, water and air in a given volume of soil. These data are used to calculate the hydrometer data in ASTM D422 and determining porosity of a soil.

Appendix E STL Laboratory Data Qualifiers

Attachment 1. Organic and Inorganic Qualifiers
Attachment 2. EPA 1668A Mod HRMS PCBs Congeners Qualifiers

Attachment 1. Organic and Inorganic Qualifiers

Organic Qualifiers

A - Tentatively identified compound is a suspected aldol condensation.

U - Compound analyzed but not detected.

E - Compound was over the calibration range.

D - Compound analyzed at a secondary dilution factor.

J - Compound detected but below the reporting limit (the value given is an estimate).

N - Identification of tentatively identified compound is based on a mass spectral library search.

B - Compound was detected in the method blank. All associated samples are flagged with a "B". Blank values below the RL are not narrated.

C - GC target hit confirmed by Mass spec.

PG/ P - The % difference between the results from both columns is >25% (OLMO) or >~~50%~~ 40% (SW846).

NC- The recovery and or RPD was not calculated.

M - Result was measured against nearest internal standard assuming a response factor of 1 (TICs).

* - Value outside QC limits.

p - RPD outside QC limits.

a - MS/MSD, LCS/LCSD percent recovery outside QC limits.

Inorganic Qualifiers

B - The reported values is less than the Contract Required Detection Limit (CRDL) but greater than the Instrument Detection Limit (IDL) or Method Detection Limit (MDL).

E - The reported value is estimated because of the presence of interference.

NC - The recovery was not calculated due to the concentration of analyte in the sample being >4 times the concentration of spike added.

N - Spiked sample recovery is not within control limits.

S - The reported value was determined by the Method of Standard Additions (MSA).

U - The analyte was analyzed but not detected.

W - Post digestion spike for furnace AA analysis is out of control limits (85-115%) while sample absorbance is less than 50% of spike absorbance.

* - Duplicate analysis and or RPD is not within control limits.

\+ - Correlation coefficient for the MSA is less than 0.995.

J - Same as "B" in organics

Organic/Inorganic Qualifiers

G - Reporting limit elevated due to matrix interference

DIL- Results were diluted out

I - Matrix interference

X - Recovered amount of spike is less than the project reporting limit

Attachment 2. EPA 1668A Mod HRMS PCBs Conggeners Qualifiers

J The reported result is an estimate. The amount reported is below the Estimated Minimum Level (EML) – The lowest concentration at which an analyte can be measured reliably with common laboratory interferences present assuming a sample is extracted at the recommended weight or volume and is carried through all normal extraction and analysis procedures.

The EML was introduced in EPA Method 1668 Revision A. For the purposes of this report the EML is qualitatively defined as described above, and quantitatively defined as follows: Estimated Minimum Level: The concentration or mass of analyte in the sample that corresponds to the historically determined reliable quantitation level. A calibration point at or below the EML is required in the initial calibration. It represents a concentration (in the sample extract) which is at or above the lowest calibration standard, after corrections for method-specified sample weights, volumes and cleanup procedures has been employed.

Example: The lowest calibration point for PCB 77 is 0.2 ng/mL. However, the EML for PCB 77 in the initial calibration is 2.5 ng/mL. A mass of 0.25 ng of PCB 77 in the sample would result in a concentration of 2.5 ng/mL in the sample extract (at a final volume of 0.1 mL). Since the concentration in the sample extract corresponds to the concentration in the lowest calibration standard, the 0.25 ng mass in the sample components is the EML. If the sample extract is further diluted, the EML will increase by the dilution factor.
Example: A 1/10 dilution is performed on the sample extract described above. The EML for PCB 77 becomes 2.5 ng rather than the default of 0.25 ng.

E The reported result is an estimate. The amount reported is above the UCL described below.
The E qualifier is applied on the basis of the Upper Calibration Level (UCL). The quantitative definition of the UCL is listed below:
Upper Calibration Level: The concentration or mass of analyte in the sample that corresponds to the highest calibration level in the initial calibration. It is equivalent to the concentration of the highest calibration standard, assuming that all method-specified sample weights, volumes, and cleanup procedures have been employed.
Example:
The maximum calibration level for PCB 77 in the initial calibration is 2000 ng/mL. A mass of 200 ng of PCB 77 in the sampling components would result in a concentration of 2000 ng/mL in the sample extract (at a final volume of 0.1 mL). Since the concentration in the sample extract corresponds to the concentration in the highest calibration standard, the 200 ng mass in the sample components is the UCL. If the sample extract is further diluted, the ML will increase by the dilution factor.
Example:
A 1/10 dilution is performed on the sample extract described above. The UCL for PCB 77 becomes 2000 ng rather than the default of 200 ng. In this example all positive PCB 77 results above 2000 pg are flagged with an E.

B The analyte is present in the associated method blank at a reportable level. For this analysis, there is no method specified reporting level, other than the qualitative criterion that peaks must exhibit a signal-to-noise ratio of 2.5-to-1. Therefore, the presence of any amount of the analyte present in the blank will result a B qualifier on all associated samples.

If the blank has analytes present above the EML (described above) the need for corrective action beyond qualifying the associated data is evaluated. The determination is made whether the amount in the blank is less than 5% of the lowest amount in associated client samples or regulatory limit. If this is the case, sample processing may continue with the qualification of the data. If the amount in the blank is greater than 5% of the lowest amount in associated client samples or regulatory limit, corrective action must be taken. The corrective actions may include extracting a second aliquot of sample if available, or notifying the client to assess the impact on the project objectives.
Note: Some laboratories do not report contamination in the blank unless it is above their lower calibration limit, or an established percentage of the level in the samples, or an established percentage of the regulatory limit. Likewise, some laboratories set a reporting limit at one half the lower calibration limit.

Q Estimated maximum possible concentration. This qualifier is used when the result is generated from chromatographic data that does not meet all the qualitative criteria for a positive identification given in the method. The criteria include the following areas:

- Ion abundance ratios must be within specified limits (+/-15% of theoretical ion abundance ratio.)
- Retention time criteria (relative to the method-specified isotope labeled retention time standard).
- Co-maximization criterion. The two quantitation ion peaks must reach their maxima within 2 seconds of each other.

S Ion suppression evident. The trace indicating the signal from the lock mass of the calibration compound shows a deflection at the retention time of the analyte. This may indicate a temporary suppression of the instrument sensitivity, due to a matrix-borne interference.

C Coeluting Isomer. The isomer is known to coelute with another member of its homologue group, or the peak shape is shouldered, indicating the likelihood of a coeluting isomer. When the C flag is followed by a number, the number indicates the lowest numbered congener among the coelution set. For example, if 100 pg/L is detected at the retention time of PCB 26, and PCB 29 is known to coelute with PCB 26, the results will be flagged as follows:

PCB 26	100 pg/L C
PCB 29	100 pg/L C26

Appendix F Detailed Analytical Data

Metals Concentration in Core Sediment from 0 to 6 inch Segment

	Antimony		Arsenic		Beryllium		Cadmium		Chromium	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
CSO-CORE1 0-6	0.57	BN	9	N	0.92		2.8		80.4	E
CSO-CORE2 0-6	0.47	BN	7	N	0.93		2.7		96.6	E
CSO-CORE3 0-6	0.7	BN	9.3	N	1.2		3.6		109	E
CSO-CORE4 0-6	0.72	BN	8.1	N	0.95		2.9		101	E
CSO-CORE4D 0-6	1	BN	7.5	N	0.97		2.8		101	E
CSO-CORE5 0-6	0.52	BN	9.2	N	1.1		2.8		110	E
CSO-CORE6 0-6	1.3	N	10.8	N	0.74		3.9		96.2	E
CSO-CORE7 0-6	0.83	BN	7.5	N	0.59		2.3		97.8	E
CSO-CORE8 0-6	0.66	BN	11.8	N	0.97		3.4		101	E
	Copper		**Lead**		**Mercury**		**Nickel**		**Selenium**	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
CSO-CORE1 0-6	205	E	542	E	2		62.3	NE	1.7	N
CSO-CORE2 0-6	194	E	430	E	1.8		42.7	NE	1.1	N
CSO-CORE3 0-6	223	E	552	E	1.8		56.3	NE	1.7	N
CSO-CORE4 0-6	216	E	500	E	2.1		48.9	NE	1.3	N
CSO-CORE4D 0-6	187	E	500	E	2		47.9	NE	1.4	N
CSO-CORE5 0-6	177	E	523	E	1.6		43.9	NE	1.4	N
CSO-CORE6 0-6	183	E	724	E	4		37	NE	1.7	N
CSO-CORE7 0-6	174	E	599	E	1.2		36.5	NE	1.2	N
CSO-CORE8 0-6	239	E	617	E	3.6		45.8	NE	1.7	N

Metals Concentration in Core Sediment from 0 to 6 inch Segment (Continued)

	Thallium		Silver		Zinc	
PARAMETER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
CSO-CORE1 0-6	0.66	BN	12.6	E	662	E
CSO-CORE2 0-6	0.98	N	22.4	E	484	E
CSO-CORE3 0-6	1.4	N	26.3	E	662	E
CSO-CORE4 0-6	0.88	BN	18.2	E	587	E
CSO-CORE4D 0-6	0.82	BN	17.9	E	587	E
CSO-CORE5 0-6	0.89	BN	20.7	E	559	E
CSO-CORE6 0-6	0.64	BN	17.2	E	643	E
CSO-CORE7 0-6	1	N U	16.7	E	587	E
CSO-CORE8 0-6	0.92	BN	29.1	E	585	E

Metals Concentration in Core Sediment Below 6 inch Segments

	Antimony		Arsenic		Beryllium		Cadmium		Chromium	
PARAMETER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
CSO-CORE 4 12-20D	1.5	N	17.4	E	1.1		2.2	N	55.6	NE
CSO-CORE 7 12-14	1.2	N	12.7	N	1.2		6.7	NE	61.9	E
CSO-CORE1 12-22	1	N U	9.6	N	1.3		2.6	NE	128	E
CSO-CORE1 6-12	0.34	BN	7.2	N	1.2		2.5	NE	94.9	E
CSO-CORE2 12-20	0.66	BN	10.7	N	1.2		3.8	NE	128	E
CSO-CORE2 6-12	0.54	BN	9	N	1.4		2.9	NE	136	E
CSO-CORE3 12-14	0.61	BN	12.2	N	1.3		4.3	NE	151	E
CSO-CORE3 6-12	0.52	BN	9.3	N	1.4		3.3	NE	134	E
CSO-CORE4 12-20	0.65	BN	16.3	N	1		2.4	NE	53.4	E
CSO-CORE4 6-12	0.58	BN	10.7	N	1.3		3.4	NE	164	E
CSO-CORE4D 6-12	0.62	BN	10.4	N	1.3		3.3	NE	157	E
CSO-CORE5 12-18	0.73	BN	12.5	N	1.2		5.5	NE	74.2	E
CSO-CORE5 6-12	0.84	BN	11.7	N	1.2		3.8	NE	113	E
CSO-CORE6 12-15	0.76	BN	12.4	N	1.1		10	NE	69.7	E
CSO-CORE6 6-12	1.6	N	13.3	N	1.1		6	NE	95.3	E
CSO-CORE7 6-12	0.96	BN	9.7	N	0.9		4	NE	85.9	E
CSO-CORE8 12-17	1.1	N	13.7	N	1.1		6.1	NE	134	E
CSO-CORE8 6-12	0.97	BN	14.3	N	1.2		4.8	NE	118	E

Metals Concentration in Core Sediment Below 6 inch Segments (Continued)

	Copper		Lead		Mercury		Nickel		Selenium	
PARAMETER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
CSO-CORE 4 12-20D	177	E	1040		6.3		20.1	E	1.7	N
CSO-CORE 7 12-14	187	E	612	E	2.9		25.8	E	1.5	N
CSO-CORE1 12-22	130	E	389	E	1.6		35.3	E	1.9	N
CSO-CORE1 6-12	135	E	343	E	1.9		35.5	E	1.1	N
CSO-CORE2 12-20	165	E	476	E	2.9		32.4	E	1.4	N
CSO-CORE2 6-12	159	E	455	E	1.7		41.2	E	1.7	N
CSO-CORE3 12-14	182	E	617	E	3.2		32.3	E	1.7	N
CSO-CORE3 6-12	174	E	460	E	2.3		40.5	E	1.3	N
CSO-CORE4 12-20	165	E	1030	E	6.9		19.8	E	2.1	N
CSO-CORE4 6-12	176	E	628	E	3		42	E	1.7	N
CSO-CORE4D 6-12	180	E	631	E	3		42.9	E	1.7	N
CSO-CORE5 12-18	533	E	577	E	3.2		26.2	E	1.6	N
CSO-CORE5 6-12	192	E	626	E	3.5		30.7	E	1.9	N
CSO-CORE6 12-15	230	E	614	E	3.3		21.1	E	1.8	N
CSO-CORE6 6-12	222	E	904	E	4.4		27.1	E	1.9	N
CSO-CORE7 6-12	181	E	878	E	2.7		27.9	E	1.2	N
CSO-CORE8 12-17	256	E	896	E	4.2		28.6	E	1.6	N
CSO-CORE8 6-12	221	E	778	E	4.6		34.8	E	1.7	N

Metals Concentration in Core Sediment Below 6 inch Segments (Continued)

	Silver		Thallium		Zinc	
PARAMETER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
CSO-CORE 4 12-20D	10.5	E	1	N	753	E
CSO-CORE 7 12-14	25.2	E	0.98	N U	744	E
CSO-CORE1 12-22	16.7	E	1	N U	429	E
CSO-CORE1 6-12	16.5	E	0.96	N U	419	E
CSO-CORE2 12-20	18.8	E	0.98	N U	584	E
CSO-CORE2 6-12	19.4	E	1	N U	503	E
CSO-CORE3 12-14	21.5	E	1	N U	639	E
CSO-CORE3 6-12	22.3	E	1.1	N U	537	E
CSO-CORE4 12-20	10.4	E	0.97	N U	774	E
CSO-CORE4 6-12	20.7	E	1.1	N U	606	E
CSO-CORE4D 6-12	21.4	E	1.1	N U	596	E
CSO-CORE5 12-18	20.5	E	0.97	N U	811	E
CSO-CORE5 6-12	22.3	E	1	N U	615	E
CSO-CORE6 12-15	23.5	E	0.41	BN	801	E
CSO-CORE6 6-12	20.3	E	1.1	N U	945	E
CSO-CORE7 6-12	19.6	E	0.99	N U	547	E
CSO-CORE8 12-17	29.9	E	1	N U	851	E
CSO-CORE8 6-12	36.2	E	0.46	BN	724	E

Surficial Sediment Metals Concentrations

	Antimony		Arsenic		Beryllium		Cadmium	
PARAMETER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
CSO-A10S	0.61	BN	2.8		0.55		0.76	
CSO-A1-SR	1.9	N	8.7		1		1.4	
CSO-A2S	0.78	BN	8.2		1.3		1.4	N
CSO-A3-SR	1	N U	1.6		0.31	B	0.32	B
CSO-A4S	0.45	BN	2.8	N	0.34	B	0.63	BNE
CSO-A5SR	1.1	BN	8		1.3		1.4	
CSO-A6S	1.5	N	7.3		1		2.5	N
CSO-A7-SR	2.6	N	9.2		0.91		3.2	
CSO-A8S	1.3	N	5.5		0.92		2.1	
CSO-A9-SR	1.2	N	4.4		0.61		2.2	
CSO-B10-SR	0.41	BN	5.1		1		0.52	
CSO-B1S	0.59	BN	8.1		1.2		2.5	N
CSO-B2-SRGC	1.8	N	9.1		1.2		2.6	
CSO-B3S	0.68	BN	7.9		1.3		2	N
CSO-B4-SR	2.7	N	8.9		1.1		2.5	
CSO-B5S	1.2	BN	10.8	N	1.5		3.2	NE
CSO-B6-SR	1.7	N	7.2		1.1		2.9	
CSO-B7S	1.1	N	6.8		1		2.2	N
CSO-B7SD	2	N	6.4		0.95		2	
CSO-B8-SR	0.88	BN	4.8		0.81		1.5	
CSO-B9S	0.57	BN	2.7		0.53		0.7	N
CSO-C10S	1.3	N	3.7		0.49		0.98	N
CSO-C1SR	0.7	BN	9		1.1		3	
CSO-C1SRD	0.62	BN	8.7		1.3		3.2	N
CSO-C2S	0.77	BN	8.5		1.4		2.6	N
CSO-C3-SRG	0.64	BN	6.8		1		1.8	
CSO-C4S	1.2	N	7.4		1.1		2.5	
CSO-C5SGC	1.1	BN	7.1		0.97		2.3	
CSO-C6S	1.5	N	8.2		1.3		2.6	N
CSO-C7-SRG	1.6	N	6		0.97		2	
CSO-C8S	1.4	N	5.1		0.85		0.89	N
CSO-C9-SR	1.8	N	3.4		0.38	B	0.83	
CSO-D10-SR	0.73	BN	3		0.68		0.63	
CSO-D1S	0.98	BN	9.6		1.4		2.2	N
CSO-D2SR	0.86	BN	8.9		1.2		2.1	
CSO-D3S	1.2	N	7.9		1.2		2	
CSO-D4-SRG	2.8	N	9.3		1.1		2.1	
CSO-D5S	1.3	BN	8.4		1.1		1.8	
CSO-D6-SR	1.5	BN	8.7		1.4		2.9	
CSO-D7S	2.3	N	6.3		1		1.5	
CSO-D8-SR	1.2	BN	7.1		1.1		2.3	
CSO-D9S	0.64	BN	4.1		0.72		3.8	
CSO-E10S	0.33	BN	3.5		0.58		0.59	
CSO-E1SR	0.79	BN	10.4		1.2		1.9	

Surficial Sediment Metals Concentrations (Continued)

	Antimony		Arsenic		Beryllium		Cadmium	
PARAMETER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
CSO-E2S	0.83	BN	9		1.3		2.5	N
CSO-E3-SR	0.83	BN	8.9		1.3		2.7	
CSO-E4S	1.1	BN	7.9		1.2		1.6	
CSO-E4SD	1.1	BN	8.4		1.2		2.4	
CSO-E5SR	1.2	BN	8		1.2		1.8	
CSO-E5SRD	1.1	BN	7.5		1.2		1.4	
CSO-E6S	1.5	N	7.8		1.2		3.1	N
CSO-E7-SR	2.2	N	7.2		1.2		1.4	
CSO-E8-S	1.7	N	6.2		0.98		1.4	
CSO-E9-SR	1.1	N	3.6		0.52		0.56	
CSO-E9SRD	0.73	BN	4		0.67		0.81	
CSO-F10S	5	N	3.6		0.55		1	
CSO-F1S	1	BN	9.9		1.4		2.4	N
CSO-F2S	0.95	BN	9.3		1.5		2.4	N
CSO-F3S	0.62	BN	8		1.5		2.2	N
CSO-F4S	0.9	BN	7.4	N	0.93		1.8	NE
CSO-F5S	1.7	N	7.7		1.1		1.5	
CSO-F6S	0.85	BN	7		1.2		1.4	
CSO-F7S	1.4	N	6.6		0.96		1.3	N
CSO-F8S	1.2	N	5.3		0.78		2	N
CSO-F9S	0.61	BN	3.9		0.71		0.76	
CSO-RS1SP	4	N	4.8		0.63		0.81	
CSO-RS2-SP	0.53	BN	2.7		0.55		0.73	
CSO-RS3SP	1.2	N	6.5		0.97		2.5	N

Surficial Sediment Metals Concentrations (Continued)

	Chromium		Copper		Lead		Mercury	
PARAMETER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
CSO-A10S	36.5	E	111		360	E	0.5	
CSO-A1-SR	59.4	E	132		272	E	0.84	
CSO-A2S	51.3	N*	115		246	E	0.95	N*
CSO-A3-SR	11.3		18	N*	29.3	E*	0.035	N*
CSO-A4S	13.6	E	23.6	E	68.8	E	0.092	
CSO-A5SR	56.4		115	N*	185	E*	0.56	N*
CSO-A6S	70.6	N*	180		487	E	1.6	N*
CSO-A7-SR	74.4	E	222		627	E	2.1	
CSO-A8S	44.2	E	192		381	E	1.9	
CSO-A9-SR	48.4	E	190		344	E	0.68	
CSO-B10-SR	24.5		77.4	N*	274	E*	4	N*
CSO-B1S	54.5	N*	138		358	E	2.3	N*
CSO-B2-SRGC	78.8	E	153		394	E	1.2	
CSO-B3S	61.1	N*	141		415	E	1.2	N*
CSO-B4-SR	85.3	E	200		492	E	1.4	
CSO-B5S	82.4	E	267	E	658	E	3.9	
CSO-B6-SR	94.8		192	N*	655	E*	1.9	N*
CSO-B7S	62.3	N*	182		517	E	3.2	N*
CSO-B7SD	58.2	E	225		618	E	2	
CSO-B8-SR	42.2		164	N*	357	E*	0.89	N*
CSO-B9S	39.4	N*	161		280	E	0.36	N*
CSO-C10S	35	N*	54.9		619	E	0.033	N*
CSO-C1SR	67		189	N*	416	E*	1.8	N*
CSO-C1SRD	58.8	N*	184		434	E	1.6	N*
CSO-C2S	63.8	N*	204		450	E	1.4	N*
CSO-C3-SRG	56.2		181	N*	393	E*	1.3	N*
CSO-C4S	58.7	E	201		447	E	1.8	
CSO-C5SGC	61.6		205	N*	438	E*	1.5	N*
CSO-C6S	63.5	N*	298		474	E	1.5	N*
CSO-C7-SRG	69.7		236	N*	535	E*	2.7	N*
CSO-C8S	34	N*	173		288	E	7.1	N*
CSO-C9-SR	68.1	E	184		314	E	2.2	
CSO-D10-SR	30.6		133	N*	244	E*	0.29	N*
CSO-D1S	66.1	N*	197		443	E	1.7	N*
CSO-D2SR	60.9		193	N*	446	E*	2.4	N*
CSO-D3S	57.6	E	217		460	E	2.7	
CSO-D4-SRG	68.4	E	267		454	E	1.5	
CSO-D5S	62.4	E	266		442	E	1.4	
CSO-D6-SR	62.8		266	N*	408	E*	1.8	N*
CSO-D7S	53.4	E	191		423	E	1.5	
CSO-D8-SR	63.5		261	N*	436	E*	0.95	N*
CSO-D9S	41.8	E	220		236	E	1.5	
CSO-E10S	26.2	E	102		349	E	0.32	
CSO-E1SR	61.5		197	N*	389	E*	1.8	N*

Surficial Sediment Metals Concentrations (Continued)

	Chromium		Copper		Lead		Mercury	
PARAMETER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
CSO-E2S	63.6	N*	195		394	E	6	N*
CSO-E3-SR	68.2		242	N*	459	E*	2	N*
CSO-E4S	62.3	E	247		363	E	1	
CSO-E4SD	56.6	E	234		391	E	1.9	
CSO-E5SR	52.7		257	N*	351	E*	2.7	N*
CSO-E5SRD	52.5	E	202		323	E	1.3	
CSO-E6S	51.5	N*	253		396	E	1.1	N*
CSO-E7-SR	49.5		437	N*	381	E*	1.3	N*
CSO-E8-S	43.8		243	N*	415	E*	3.9	N*
CSO-E9-SR	27.9	E	105		355	E	10.7	
CSO-E9SRD	44.2	E	145		260	E	1.6	
CSO-F10S	24.9	E	123		323	E	0.47	
CSO-F1S	59	N*	220		414	E	2	N*
CSO-F2S	59.6	N*	217		402	E	1.9	N*
CSO-F3S	72.9	N*	172		355	E	1.4	N*
CSO-F4S	47.7	E	200	E	429	E	1.7	
CSO-F5S	53.9	E	248		389	E	2	
CSO-F6S	55.2	E	214		356	E	1	
CSO-F7S	46	N*	232		398	E	1.3	N*
CSO-F8S	46	N*	234		377	E	0.57	N*
CSO-F9S	29.2	E	158		229	E	0.38	
CSO-RS1SP	35.5	E	143		726	E	1.4	
CSO-RS2-SP	22	E	112		213	E	0.35	
CSO-RS3SP	48.5	N*	174		539	E	1.5	N*

Surficial Sediment Metals Concentrations (Continued)

	Nickel		Selenium		Silver		Thallium		Zinc	
PARAMETER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
CSO-A10S	30.8	E	0.47	B	6.5	N*	0.94	U	299	E
CSO-A1-SR	47.5	E	1.4		3.6	E	1.2	B	458	E
CSO-A2S	46.9		0.62	B	2.5	NE*	0.57	B	431	E
CSO-A3-SR	33.2		0.51	U	0.38	B	1	U	118	E
CSO-A4S	23.5	E	0.36	BN	0.29	BE	1.4	N U	109	E
CSO-A5SR	46.4		1.8		2		2	U	474	E
CSO-A6S	45.9		1		9.7	NE*	0.66	B	569	E
CSO-A7-SR	40.4	E	1.2		21.8	E	0.94	B	585	E
CSO-A8S	43.6	E	0.81		10.6	N*	0.52	B	513	E
CSO-A9-SR	35.9	E	0.84		10	E	0.45	B	402	E
CSO-B10-SR	15.3		0.91		1.6		0.38	B	291	E
CSO-B1S	44.3		0.65		9.4	NE*	0.99	B	497	E
CSO-B2-SRGC	46.8	E	1.3		12	E	0.95	B	526	E
CSO-B3S	50.4		0.78		6.8	NE*	1.3		504	E
CSO-B4-SR	47.9	E	1.2		11.9	E	1	B	554	E
CSO-B5S	69.8	E	1.4	N	11.1	E	1.7	N U	892	E
CSO-B6-SR	52.8		1.5		14.8		1.2	U	628	E
CSO-B7S	46.5		0.75		11.5	NE*	0.88	B	546	E
CSO-B7SD	47.3	E	0.89		18.1	N*	0.47	B	571	E
CSO-B8-SR	40.1		0.91		9.8		1	U	465	E
CSO-B9S	23		0.3	B	3.7	NE*	0.95	U	344	E
CSO-C10S	20.7		0.3	B	2.3	NE*	0.98	U	243	E
CSO-C1SR	50.6		1.3		9.6		1.2	U	653	E
CSO-C1SRD	48.9		0.66		11.6	NE*	1.2		608	E
CSO-C2S	51.6		0.94		10.3	NE*	1.4		624	E
CSO-C3-SRG	45		1.3		7.1		1.2	U	548	E
CSO-C4S	51.5	E	1.2		9.6	N*	0.87	B	589	E
CSO-C5SGC	51.5		1.2		13.3		1.2	U	635	E
CSO-C6S	59.5		1		12.6	NE*	1.1	B	677	E
CSO-C7-SRG	48.6		1.1		10		1.1	U	575	E
CSO-C8S	34.7		0.89		4.5	NE*	0.54	B	405	E
CSO-C9-SR	29.5	E	0.84		8.4	E	0.75	B	440	E
CSO-D10-SR	31.7		0.47	B	2.5		1	U	323	E
CSO-D1S	53.7		1		7.4	NE*	1.1	B	670	E
CSO-D2SR	55.3		1.1		11.9		0.57	B	684	E
CSO-D3S	55.3	E	1.1		9.3	N*	0.59	B	686	E
CSO-D4-SRG	58.1	E	1.4		10.3	E	0.67	B	756	E
CSO-D5S	56.6	E	1.3		10.8	N*	0.73	B	715	E
CSO-D6-SR	58.7		1.5		7.7		1.6	U	711	E
CSO-D7S	45.8	E	1		5.5	N*	1.4	U	541	E
CSO-D8-SR	49.8		1.3		10.3		1.4	U	646	E
CSO-D9S	36.7	E	0.56		22.5	N*	0.95	U	350	E

Surficial Sediment Metals Concentrations (Continued)

	Nickel		Selenium		Silver		Thallium		Zinc	
PARAMETER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
CSO-E10S	25	E	0.3	B	5.2	N*	0.96	U	287	E
CSO-E1SR	52.6		1.4		10.2		1.3	U	681	E
CSO-E2S	50.9		1		10.6	NE*	1.1	B	614	E
CSO-E3-SR	55.7		1.6		18.3		1.3	U	735	E
CSO-E4S	53.7	E	1.2		12.9	N*	0.66	B	652	E
CSO-E4SD	56.9	E	1		9.3	N*	0.96	B	657	E
CSO-E5SR	49.8		1.7		14.6		1.4	U	632	E
CSO-E5SRD	49.5	E	1.1		7.2	N*	0.58	B	588	E
CSO-E6S	55.8		0.9		13.9	NE*	0.95	B	634	E
CSO-E7-SR	51.5		1.9		6.8		1.4	U	629	E
CSO-E8-S	44.3		1.1		10.5		1.1	U	514	E
CSO-E9-SR	25.5	E	0.66		3.7	E	1	U	290	E
CSO-E9SRD	27.1	E	0.3	B	4.6	N*	0.96	U	458	E
CSO-F10S	26.4	E	0.33	B	3.3	N*	0.94	U	325	E
CSO-F1S	53.7		0.95		9.9	NE*	0.76	B	703	E
CSO-F2S	53.6		0.71		10.1	NE*	0.95	B	684	E
CSO-F3S	46.7		0.68		13.2	NE*	1.1	B	546	E
CSO-F4S	48.2	E	1.1	N	9.6	E	1.2	N U	601	E
CSO-F5S	54.6	E	0.83		11.1	N*	0.68	B	667	E
CSO-F6S	46.9	E	1.2		10.2	N*	1.5	U	529	E
CSO-F7S	46.2		0.98		9.4	NE*	1.1	B	544	E
CSO-F8S	40		0.46	B	4.2	NE*	0.57	B	439	E
CSO-F9S	32.5	E	0.46	B	10	N*	0.41	B	347	E
CSO-RS1SP	33.5	E	0.56		3.5	N*	0.42	B	850	E
CSO-RS2-SP	34.7	E	0.35	B	4.5	N*	0.97	U	254	E
CSO-RS3SP	44.5		0.76		11.9	NE*	0.84	B	539	E

PCBs (Aroclors) Concentration in Core Sediment from 0 to 6 inch Segment

	CSO-CORE1 0-6		CSO-CORE2 0-6		CSO-CORE3 0-6		CSO-CORE4 0-6		CSO-CORE4D 0-6	
Parameter	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
Aroclor 1016	200	U	160	U	210	U	180	U	190	U
Aroclor 1221	200	U	160	U	210	U	180	U	190	U
Aroclor 1232	200	U	160	U	210	U	180	U	190	U
Aroclor 1242	200	U	160	U	210	U	180	U	190	U
Aroclor 1248	980		560		1000		1400		1500	
Aroclor 1254	200	U	160	U	1500		1600		1700	
Aroclor 1260	1700		1000		1500		1800		1900	
	CS0-CORE5 0-6		CSO-CORE6 0-6		CS0-CORE7 0-6		CS0-CORE8 0-6			
Parameter	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER		
Aroclor 1016	190	U	180	U	170	U	180	U		
Aroclor 1221	190	U	180	U	170	U	180	U		
Aroclor 1232	190	U	180	U	170	U	180	U		
Aroclor 1242	190	U	180	U	170	U	180	U		
Aroclor 1248	620		1800		580		710			
Aroclor 1254	950		2000		1000		1500			
Aroclor 1260	1200		2200		900		1400			

PCBs (Aroclors) Concentration in Core Sediment below 6 inch Segments

	CSO-CORE1 6-12		CS0-CORE1 12-22		CSO-CORE2 6-12		CSO-CORE2 12-20		CSO-CORE3 6-12	
Parameter	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
Aroclor 1016	160	U	160	U	170	U	160	U	170	U
Aroclor 1221	160	U	160	U	170	U	160	U	170	U
Aroclor 1232	160	U	160	U	170	U	160	U	170	U
Aroclor 1242	160	U	160	U	170	U	160	U	170	U
Aroclor 1248	600		1400		1600		1400		1700	
Aroclor 1254	710		1300		1700		2200		2100	
Aroclor 1260	910		1500		2200		2800		2200	
	CSO-CORE3 12-14		CSO-CORE4 6-12		CSO-CORE4D 6-12		CSO-CORE4 12-20		CSO-CORE 4 12-20D	
Parameter	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
Aroclor 1016	170	U	170	U	170	U	160	U	32	U
Aroclor 1221	170	U	170	U	170	U	160	U	32	U
Aroclor 1232	170	U	170	U	170	U	160	U	32	U
Aroclor 1242	170	U	170	U	170	U	160	U	32	U
Aroclor 1248	1100		2300		2100		230		83	
Aroclor 1254	2000		2900		2500		420		32	U
Aroclor 1260	2200		3900		3400		470		280	

PCBs (Aroclors) Concentration in Core Sediment below 6 inch Segments (Continued)

	CS0-CORE5 6-12		CS0-CORE5 12-18		CSO-CORE6 6-12		CSO-CORE6 12-15		CS0-CORE7 6-12	
Parameter	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
Aroclor 1016	170	U	160	U	180	U	150	U	160	U
Aroclor 1221	170	U	160	U	180	U	150	U	160	U
Aroclor 1232	170	U	160	U	180	U	150	U	160	U
Aroclor 1242	170	U	160	U	180	U	150	U	160	U
Aroclor 1248	680		160	U	180	U	150	U	710	
Aroclor 1254	1700		600		1700		150	U	1400	
Aroclor 1260	2600		800		2600		440		1600	
	CS0-CORE7 12-14		CS0-CORE8 6-12		CS0-CORE8 12-17					
Parameter	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER				
Aroclor 1016	160	U	180	U	170	U				
Aroclor 1221	160	U	180	U	170	U				
Aroclor 1232	160	U	180	U	170	U				
Aroclor 1242	160	U	180	U	170	U				
Aroclor 1248	160	U	520		170	U				
Aroclor 1254	480		1400		1100					
Aroclor 1260	910		2100		1200					

PCBs (Aroclors) Concentration in Surficial Sediment

	CSO-A1-SR		CSO-A2S		CSO-B2SRGC		CSO-C2S		CSO-D2SR	
Parameter	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Aroclor 1016	160	U	220	U	200	U	190	U	200	U
Aroclor 1221	160	U	220	U	200	U	190	U	200	U
Aroclor 1232	160	U	220	U	200	U	190	U	200	U
Aroclor 1242	160	U	220	U	200	U	190	U	200	U
Aroclor 1248	95	J	140	J	350		400		330	
Aroclor 1254	160	U	220	U	200	U	190	U	200	U
Aroclor 1260	270		360		770		1000		710	
	CSO-E2S		CSO-F2S		CSO-A4S		CSO-B4SR		CSO-C4S	
Parameter	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Aroclor 1016	180	U	220	U	19	U	190	U	190	U
Aroclor 1221	180	U	220	U	19	U	190	U	190	U
Aroclor 1232	180	U	220	U	19	U	190	U	190	U
Aroclor 1242	180	U	220	U	19	U	190	U	190	U
Aroclor 1248	360		230		19	U	800		340	
Aroclor 1254	180	U	220	U	19	U	190	U	190	U
Aroclor 1260	720		530		25		1600		690	

PCBs (Aroclors) Concentration in Surficial Sediment (Continued)

	CSO-D4SRG		CSO-E4S		CSO-E4SD		CSO-F4S		CSO-A5SR	
Parameter	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Aroclor 1016	210	U	210	U	210	U	190	U	330	U
Aroclor 1221	210	U	210	U	210	U	190	U	330	U
Aroclor 1232	210	U	210	U	210	U	190	U	330	U
Aroclor 1242	210	U	210	U	210	U	190	U	330	U
Aroclor 1248	210		310		260		190		130	J
Aroclor 1254	210	U	210	U	210	U	190	U	330	U
Aroclor 1260	480		630		470		520		900	
	CSO-B5S		CSO-C5SGC		CSO-D5S		CSO-E5SR		CSO-E5SRD	
Parameter	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Aroclor 1016	280	U	200	U	210	U	230	U	210	U
Aroclor 1221	280	U	200	U	210	U	230	U	210	U
Aroclor 1232	280	U	200	U	210	U	230	U	210	U
Aroclor 1242	280	U	200	U	210	U	230	U	210	U
Aroclor 1248	340		700		240		200	J	190	J
Aroclor 1254	280	U	200	U	210	U	230	U	210	U
Aroclor 1260	810		900		590		470		400	

PCBs (Aroclors) Concentration in Surficial Sediment (Continued)

	CSO-F5S		CSO-B1S		CSO-C1SR		CSO-C1SR-D		CSO-D1S	
Parameter	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Aroclor 1016	200	U	180	U	190	U	190	U	210	U
Aroclor 1221	200	U	180	U	190	U	190	U	210	U
Aroclor 1232	200	U	180	U	190	U	190	U	210	U
Aroclor 1242	200	U	180	U	190	U	190	U	210	U
Aroclor 1248	210		250		240		290		300	
Aroclor 1254	200	U	180	U	190	U	190	U	210	U
Aroclor 1260	510		650		580		660		660	
	CSO-E1SR		CSO-F1S		CSO-A3SR		CSO-B3S		CSO-C3SRG	
Parameter	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Aroclor 1016	210	U	210	U	31	U	210	U	190	U
Aroclor 1221	210	U	210	U	31	U	210	U	190	U
Aroclor 1232	210	U	210	U	31	U	210	U	190	U
Aroclor 1242	210	U	210	U	31	U	210	U	190	U
Aroclor 1248	230		260		31	U	420		400	
Aroclor 1254	210	U	210	U	31	U	210	U	190	U
Aroclor 1260	490		610		27	J	810		970	

PCBs (Aroclors) Concentration in Surficial Sediment (Continued)

	CSO-D3S		CSO-E3SR		CSO-F3S		CSO-A6S		CSO-B6SR	
Parameter	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Aroclor 1016	200	U	210	U	190	U	170	U	200	U
Aroclor 1221	200	U	210	U	190	U	170	U	200	U
Aroclor 1232	200	U	210	U	190	U	170	U	200	U
Aroclor 1242	200	U	210	U	190	U	170	U	200	U
Aroclor 1248	290		360		430		220		600	
Aroclor 1254	200	U	210	U	190	U	170	U	200	U
Aroclor 1260	660		650		760		570		1000	
	CSO-C6S		**CSO-D6SR**		**CSO-E6S**		**CSO-F6S**		**CSO-RS1-SP**	
Parameter	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Aroclor 1016	220	U	260	U	190	U	240	U	160	U
Aroclor 1221	220	U	260	U	190	U	240	U	160	U
Aroclor 1232	220	U	260	U	190	U	240	U	160	U
Aroclor 1242	220	U	260	U	190	U	240	U	160	U
Aroclor 1248	270		230	J	140	J	210	J	150	J
Aroclor 1254	220	U	260	U	190	U	240	U	160	U
Aroclor 1260	590		440		350		480		260	

PCBs (Aroclors) Concentration in Surficial Sediment (Continued)

	CSO-RS2-SP		CSO-RS3-SP		CSO-B8-SR		CSO-C8-S		CSO-D8-SR	
Parameter	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Aroclor 1016	160	U	160	U	170	U	180	U	220	U
Aroclor 1221	160	U	160	U	170	U	180	U	220	U
Aroclor 1232	160	U	160	U	170	U	180	U	220	U
Aroclor 1242	160	U	160	U	170	U	180	U	220	U
Aroclor 1248	160	U	230		230		180	U	220	U
Aroclor 1254	160	U	160	U	170	U	560		740	
Aroclor 1260	180		530		370		380		540	
	CSO-E8-S		**CSO-F8-S**		**CSO-A7-SR**		**CSO-B7-S**		**CSO-B7-SD**	
Parameter	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Aroclor 1016	190	U	150	U	180	U	170	U	170	U
Aroclor 1221	190	U	150	U	180	U	170	U	170	U
Aroclor 1232	190	U	150	U	180	U	170	U	170	U
Aroclor 1242	190	U	150	U	180	U	170	U	170	U
Aroclor 1248	200		150	U	180	U	470		500	
Aroclor 1254	190	U	400		180	U	170	U	170	U
Aroclor 1260	390		320		1800		920		800	

PCBs (Aroclors) Concentration in Surficial Sediment (Continued)

	CSO-C7-SRG		CSO-D7-S		CSO-E7-SR		CSO-F7-S		CSO-A10-S	
Parameter	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Aroclor 1016	180	U	230	U	220	U	190	U	160	U
Aroclor 1221	180	U	230	U	220	U	190	U	160	U
Aroclor 1232	180	U	230	U	220	U	190	U	160	U
Aroclor 1242	180	U	230	U	220	U	190	U	160	U
Aroclor 1248	330		460		220	U	190	U	160	U
Aroclor 1254	180	U	230	U	390		190	U	350	
Aroclor 1260	520		570		380		400		230	
	CSO-B10-SR		CSO-C10-S		CSO-D10-SR		CSO-E10-S		CSO-F10-S	
Parameter	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Aroclor 1016	31	U	33	U	150	U	32	U	31	U
Aroclor 1221	31	U	33	U	150	U	32	U	31	U
Aroclor 1232	31	U	33	U	150	U	32	U	31	U
Aroclor 1242	31	U	33	U	150	U	32	U	31	U
Aroclor 1248	31	U	76		150	U	62		61	
Aroclor 1254	31	U	33	U	150	U	32	U	31	U
Aroclor 1260	16	J	99		560		140		120	

PCBs (Aroclors) Concentration in Surficial Sediment (Continued)

	CSO-A9-SR		CSO-B9-S		CSO-C9-SR		CSO-D9-S		CSO-E9-SR	
Parameter	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Aroclor 1016	160	U	160	U	160	U	160	U	160	U
Aroclor 1221	160	U	160	U	160	U	160	U	160	U
Aroclor 1232	160	U	160	U	160	U	160	U	160	U
Aroclor 1242	160	U	160	U	160	U	160	U	160	U
Aroclor 1248	160	U	160	U	160	U	160	U	160	U
Aroclor 1254	160	U	160	U	160	U	160	U	160	U
Aroclor 1260	220		400		330		240		310	
	CSO-E9-SRD		CSO-F9-S		CSO-A8-S					
Parameter	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**				
Aroclor 1016	160	U	160	U	160	U				
Aroclor 1221	160	U	160	U	160	U				
Aroclor 1232	160	U	160	U	160	U				
Aroclor 1242	160	U	160	U	160	U				
Aroclor 1248	160	U	130	J	280					
Aroclor 1254	160	U	160	U	160	U				
Aroclor 1260	190		210		390					

PAHs Concentration in Core Sediment from 0 to 6 inch Segment

	CSO-CORE1 0-6		CSO-CORE2 0-6		CSO-CORE3 0-6		CSO-CORE4 0-6	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Acenaphthene	2000	U	1600	U	210	J	420	J
Anthracene	350	J	190	J	400	J	930	J
Fluoranthene	4600		1900		5100		8100	
Fluorene	280	J	150	J	310	J	490	J
Indeno(1,2,3-cd)pyrene	290	J	200	J	310	J	400	J
Naphthalene	2000	U	1600	U	2100	U	1800	U
Benzo(a)anthracene	1300	J	630	J	1600	J	2500	
Benzo(b)fluoranthene	2500		710	J	2400		3000	
Benzo(k)fluoranthene	1200	J	380	J	1700	J	2500	
Benzo(ghi)perylene	320	J	220	J	340	J	370	J
Benzo(a)pyrene	1400	J	580	J	1700	J	2300	
Phenanthrene	1700	J	950	J	2100		3800	
Pyrene	2000		890	J	1800	J	2800	
Dibenzo(a,h)anthracene	2000	U	1600	U	2100	U	140	J
Acenaphthylene	180	J	1600	U	2100	U	1800	U
Chrysene	1700	J	810	J	1900	J	2800	

PAHs Concentration in Core Sediment from 0 to 6 inch Segment (Continued)

	CSO-CORE4D 0-6		CSO-CORE5 0-6		CSO-CORE6 0-6		CSO-CORE7 0-6		CSO-CORE8 0-6	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Acenaphthene	320	J	320	J	420	J	190	J	390	J
Anthracene	680	J	570	J	790	J	260	J	750	J
Fluoranthene	7800		7100		9800		3000		7600	
Fluorene	410	J	410	J	500	J	250	J	440	J
Indeno(1,2,3-cd)pyrene	410	J	420	J	540	J	220	J	450	J
Naphthalene	1900	U	1900	U	1800	U	1700	U	200	J
Benzo(a)anthracene	2100		1800	J	2600		1000	J	2000	
Benzo(b)fluoranthene	3500		2900		3900		1300	J	2800	
Benzo(k)fluoranthene	2500		2000		2900		1100	J	1900	
Benzo(ghi)perylene	430	J	440	J	530	J	230	J	460	J
Benzo(a)pyrene	2300		1900		2700		1100	J	2000	
Phenanthrene	3200		2800		3900		1500	J	3500	
Pyrene	2800		3300		3900		1200	J	3700	
Dibenzo(a,h)anthracene	140	J	170	J	180	J	1700	U	120	J
Acenaphthylene	1900	U	180	J	250	J	1700	U	200	J
Chrysene	2500		2300		3000		1300	J	2300	

PAHs Concentration in Core Sediment Below 6 inch Segments

	CSO-CORE1 6-12		CSO-CORE1 12-22		CSO-CORE2 6-12		CSO-CORE2 12-20		CSO-CORE3 6-12	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Acenaphthene	120	J	1300	U	120	J	140	J	3500	U
Anthracene	140	J	1300	U	160	J	190	J	3500	U
Fluoranthene	880	J	960	J	1400		1700		1800	J
Fluorene	120	J	110	J	180	J	110	J	3500	U
Indeno(1,2,3-cd)pyrene	220	J	240	J	250	J	350	J	340	J
Naphthalene	1300	U	1300	U	1400	U	970	U	3500	U
Benzo(a)anthracene	370	J	430	J	540	J	690	J	770	J
Benzo(b)fluoranthene	370	J	400	J	580	J	650	J	750	J
Benzo(k)fluoranthene	330	J	390	J	500	J	690	J	730	J
Benzo(ghi)perylene	190	J	230	J	250	J	300	J	350	J
Benzo(a)pyrene	360	J	410	J	550	J	710	J	710	J
Phenanthrene	710	J	620	J	980	J	930	J	1300	J
Pyrene	810	J	780	J	1000	J	1300		1400	J
Dibenzo(a,h)anthracene	1300	U	1300	U	1400	U	110	J	3500	U
Acenaphthylene	1300	U	1300	U	1400	U	110	J	3500	U
Chrysene	540	J	540	J	780	J	900	J	1000	J

PAHs Concentration in Core Sediment Below 6 inch Segments (Contined)

	CSO-CORE3 12-14		CSO-CORE4 6-12		CSO-CORE4 12-20		CSO-CORE4D 6-12		CSO-CORE 4 12-20D	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Acenaphthene	230	J	170	J	1100	J	320	J	2500	J
Anthracene	320	J	260	J	1100	J	320	J	2200	J
Fluoranthene	3100		2100		8600		3300		11000	
Fluorene	210	J	160	J	800	J	310	J	2000	J
Indeno(1,2,3-cd)pyrene	510	J	320	J	1200	J	470	J	2900	J
Naphthalene	1700	U	1700	U	300	J	260	J	980	J
Benzo(a)anthracene	1100	J	820	J	3500		1200	J	6600	
Benzo(b)fluoranthene	1200	J	830	J	5900		1200	J	7300	
Benzo(k)fluoranthene	1200	J	880	J	1600	U	1300	J	6400	U
Benzo(ghi)perylene	430	J	300	J	910	J	370	J	2100	J
Benzo(a)pyrene	1200	J	780	J	3700		1200	J	5500	J
Phenanthrene	1800		1300	J	5400		2200		11000	
Pyrene	2100		1500	J	6600		2100		13000	
Dibenzo(a,h)anthracene	140	J	1700	U	390	J	130	J	860	J
Acenaphthylene	1700	U	1700	U	800	J	1700	U	1800	J
Chrysene	1500	J	1100	J	5000		1700		7400	

PAHs Concentration in Core Sediment Below 6 inch Segments (Contined)

	CSO-CORE5 6-12		CSO-CORE5 12-18		CSO-CORE6 6-12		CSO-CORE6 12-15		CSO-CORE7 6-12	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Acenaphthene	210	J	580	J	220	J	190	J	870	J
Anthracene	370	J	860	J	410	J	280	J	1700	
Fluoranthene	2800		6300		4000		2900		8600	
Fluorene	200	J	550	J	170	J	190	J	860	J
Indeno(1,2,3-cd)pyrene	440	J	650	J	600	J	350	J	880	J
Naphthalene	1000	U	230	J	1800	U	110	J	440	J
Benzo(a)anthracene	1000		1900		1500	J	980		3200	
Benzo(b)fluoranthene	950	J	2000		1600	J	1200		2900	
Benzo(k)fluoranthene	1100		1700		1700	J	1200		3100	
Benzo(ghi)perylene	360	J	600	J	460	J	300	J	680	J
Benzo(a)pyrene	1100		1900		1600	J	1200		3000	
Phenanthrene	1700		4000		2000		1200		6800	
Pyrene	1800		4800		2700		2100		5400	
Dibenzo(a,h)anthracene	120	J	200	J	160	J	100	J	270	J
Acenaphthylene	1000	U	270	J	220	J	280	J	280	J
Chrysene	1200		2300		1800		1500		3600	

PAHs Concentration in Core Sediment Below 6 inch Segments (Contined)

	CSO-CORE8 6-12		CSO-CORE8 12-17	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Acenaphthene	280	J	370	J
Anthracene	470	J	470	J
Fluoranthene	4300		4200	
Fluorene	230	J	3400	U
Indeno(1,2,3-cd)pyrene	480	J	500	J
Naphthalene	1800	U	3400	U
Benzo(a)anthracene	1500	J	1500	J
Benzo(b)fluoranthene	1600	J	1400	J
Benzo(k)fluoranthene	1900		2000	J
Benzo(ghi)perylene	390	J	440	J
Benzo(a)pyrene	1600	J	1500	J
Phenanthrene	2300		2300	J
Pyrene	2700		2700	J
Dibenzo(a,h)anthracene	140	J	3400	U
Acenaphthylene	1800	U	3400	U
Chrysene	1900		1900	J

PAHs Concentration in Surficial Sediment

	CSO-C1SR		CSO-E1SR		CSO-A1-SR		CSO-F1S		CSO-B1S	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Acenaphthene	3900	U	360	J	10000	U	200	J	440	J
Anthracene	490	J	720	J	10000	U	510	J	4600	
Fluoranthene	5600		7700		2100	J	5100		170	J
Fluorene	3900	U	360	J	10000	U	200	J	670	J
Indeno(1,2,3-cd)pyrene	870	J	860	J	770	J	930	J	1800	U
Naphthalene	3900	U	2100	U	10000	U	2100	U	1900	
Benzo(a)anthracene	2200	J	2800		1100	J	2100		2600	
Benzo(b)fluoranthene	3000	J	3200		2000	J	2900		2600	
Benzo(k)fluoranthene	3300	J	5400		10000	U	2100		520	J
Benzo(ghi)perylene	680	J	730	J	960	J	810	J	2100	
Benzo(a)pyrene	2300	J	3100		1100	J	2300		1800	
Phenanthrene	2200	J	3700		1000	J	2400		3900	
Pyrene	4200		6200		2100	J	3300		180	J
Dibenzo(a,h)anthracene	3900	U	230	J	10000	U	330	J	1800	U
Acenaphthylene	3900	U	2100	U	10000	U	2100	U	2400	
Chrysene	2900	J	3800		1400	J	2900			

PAHs Concentration in Surficial Sediment (Continued)

	CSO-D1S		CSO-A2S		CSO-B2-SRGC		CSO-C2S		CSO-D2SR	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Acenaphthene	270	J	2200	U	9800	U	310	J	4000	U
Anthracene	600	J	400	J	9800	U	680	J	530	J
Fluoranthene	6300		3900		2300	J	6400		6000	
Fluorene	250	J	2200	U	9800	U	3800	U	4000	U
Indeno(1,2,3-cd)pyrene	1000	J	580	J	770	J	1100	J	800	J
Naphthalene	2100	U	2200	U	9800	U	3800	U	4000	U
Benzo(a)anthracene	2500		1600	J	1000	J	2500	J	2400	J
Benzo(b)fluoranthene	3200		2200		1800	J	3300	J	3300	J
Benzo(k)fluoranthene	3000		2400		9800	U	3300	J	3400	J
Benzo(ghi)perylene	890	J	460	J	1000	J	840	J	790	J
Benzo(a)pyrene	2900		1800	J	1000	J	2300	J	2700	J
Phenanthrene	2700		1400	J	1200	J	2700	J	2500	J
Pyrene	3900		3000		2000	J	4900		4800	
Dibenzo(a,h)anthracene	440	J	150	J	9800	U	260	J	4000	U
Acenaphthylene	2100	U	2200	U	9800	U	3800	U	4000	U
Chrysene	3200		2100	J	1500	J	3200	J	3200	J

PAHs Concentration in Surficial Sediment (Continued)

	CSO-E2S		CSO-F2S		CSO-A3-SR		CSO-B3S		CSO-C3-SRG	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Acenaphthene	240	J	230	J	3100	U	210	J	180	J
Anthracene	560	J	580	J	320	J	560	J	440	J
Fluoranthene	5000		5600		2100	J	5700		4700	
Fluorene	250	J	250	J	3100	U	240	J	210	J
Indeno(1,2,3-cd)pyrene	840	J	810	J	450	J	760	J	700	J
Naphthalene	1800	U	2200	U	3100	U	2100	U	1900	U
Benzo(a)anthracene	2000		2200		890	J	2100		1800	J
Benzo(b)fluoranthene	2300		3000		950	J	2600		2500	
Benzo(k)fluoranthene	2400		3100		1100	J	3600		2300	
Benzo(ghi)perylene	690	J	640	J	340	J	590	J	550	J
Benzo(a)pyrene	2100		2400		1100	J	2400		2000	
Phenanthrene	2500		2700		1100	J	2500		2100	
Pyrene	3200		4800		1500	J	4800		3400	
Dibenzo(a,h)anthracene	290	J	170	J	3100	U	210	J	180	J
Acenaphthylene	1800	U	2200	U	3100	U	2100	U	1900	U
Chrysene	2500		2800		1000	J	3000		2400	

PAHs Concentration in Surficial Sediment (Continued)

	CSO-E3-SR		CSO-F3S		CSO-A4S		CSO-F4S		CSO-B4-SR	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Acenaphthene	4200	U	190	J	4400	U	3900	U	9600	U
Anthracene	600	J	420	J	4400	U	470	J	9600	U
Fluoranthene	6100		4200		470	J	4400		2500	J
Fluorene	4200	U	240	J	4400	U	3900	U	9600	U
Indeno(1,2,3-cd)pyrene	930	J	650	J	4400	U	510	J	820	J
Naphthalene	4200	U	1900	U	4400	U	3900	U	9600	U
Benzo(a)anthracene	2300	J	1600	J	4400	U	1700	J	1200	J
Benzo(b)fluoranthene	3000	J	2300		4400	U	1900	J	1900	J
Benzo(k)fluoranthene	3000	J	1800	J	4400	U	2300	J	9600	U
Benzo(ghi)perylene	740	J	530	J	4400	U	480	J	9600	U
Benzo(a)pyrene	2500	J	1800	J	4400	U	1700	J	1200	J
Phenanthrene	2800	J	2100		4400	U	2100	J	1300	J
Pyrene	4200		2700		4400	U	2900	J	2300	J
Dibenzo(a,h)anthracene	4200	U	170	J	4400	U	3900	U	9600	U
Acenaphthylene	4200	U	1900	U	4400	U	3900	U	9600	U
Chrysene	3000	J	2300		4400	U	2000	J	1400	J

PAHs Concentration in Surficial Sediment (Continued)

	CSO-C4S		CSO-E4SD		CSO-E4S		CSO-D4-SRG		CSO-B5S	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Acenaphthene	180	J	170	J	2100	U	11000	U	5700	U
Anthracene	410	J	450	J	270	J	11000	U	5700	U
Fluoranthene	4000		4400		2700		5400	J	5200	J
Fluorene	250	J	200	J	2100	U	11000	U	5700	U
Indeno(1,2,3-cd)pyrene	450	J	870	J	300	J	1800	J	730	J
Naphthalene	1900	U	2100	U	2100	U	11000	U	5700	U
Benzo(a)anthracene	1700	J	2000	J	1200	J	2500	J	2000	J
Benzo(b)fluoranthene	3600		3000		2300		2500	J	2700	J
Benzo(k)fluoranthene	1900	U	2100	U	2100	U	2000	J	2700	J
Benzo(ghi)perylene	260	J	1100	J	310	J	2700	J	560	J
Benzo(a)pyrene	1700	J	1800	J	1100	J	2500	J	2100	J
Phenanthrene	1900		2200		1400	J	2800	J	2200	J
Pyrene	2500		3500		1800	J	5000	J	3600	J
Dibenzo(a,h)anthracene	1900	U	2100	U	2100	U	11000	U	5700	U
Acenaphthylene	1900	U	2100	U	2100	U	11000	U	5700	U
Chrysene	2100		2300		1300	J	3400	J	2600	J

PAHs Concentration in Surficial Sediment (Continued)

	CSO-A5SR		CSO-C5SGC		CSO-E5SR		CSO-E5SRD		CSO-B6-SR	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Acenaphthene	2600	U	240	J	310	J	240	J	390	J
Anthracene	670	J	600	J	720	J	490	J	1000	J
Fluoranthene	6400		6200		6800		5000		9100	
Fluorene	2600	U	240	J	310	J	230	J	430	J
Indeno(1,2,3-cd)pyrene	720	J	780	J	760	J	470	J	1300	J
Naphthalene	2600	U	2000	U	2300	U	2100	U	4000	U
Benzo(a)anthracene	2000	J	2300		2700		1900	J	3400	J
Benzo(b)fluoranthene	3200		2900		3200		3700		3900	J
Benzo(k)fluoranthene	3000		3300		3700		2100	U	4500	
Benzo(ghi)perylene	560	J	600	J	580	J	530	J	1000	J
Benzo(a)pyrene	1800	J	2500		2700		1800	J	3700	J
Phenanthrene	2100	J	2900		3300		2300		4200	
Pyrene	3500		4300		4900		2800		6600	
Dibenzo(a,h)anthracene	220	J	200	J	220	J	2100	U	340	J
Acenaphthylene	300	J	2000	U	2300	U	2100	U	4000	U
Chrysene	3500		3100		3400		2200		4400	

PAHs Concentration in Surficial Sediment (Continued)

	CSO-D6-SR		CSO-A6S		CSO-C6S		CSO-E6S		CSO-F6S	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Acenaphthene	5300	U	300	J	340	J	390	J	2400	U
Anthracene	770	J	810	J	940	J	920	J	370	J
Fluoranthene	7700		7200		9100		8200		4100	
Fluorene	5300	U	300	J	350	J	420	J	2400	U
Indeno(1,2,3-cd)pyrene	1000	J	1000	J	1200	J	990	J	410	J
Naphthalene	5300	U	1700	U	2200	U	1900	U	2400	U
Benzo(a)anthracene	2900	J	3000		3400		3000		1500	J
Benzo(b)fluoranthene	3800	J	3800		4100		3900		2600	
Benzo(k)fluoranthene	3700	J	3000		4200		3700		2400	U
Benzo(ghi)perylene	810	J	800	J	960	J	850	J	510	J
Benzo(a)pyrene	3000	J	3200		3600		3200		1400	J
Phenanthrene	3600	J	3100		4100		4200		1800	J
Pyrene	5500		4800		5700		6300		2200	J
Dibenzo(a,h)anthracene	5300	U	280	J	360	J	290	J	2400	U
Acenaphthylene	5300	U	190	J	2200	U	1900	U	2400	U
Chrysene	3700	J	3400		4200		3800		1700	J

PAHs Concentration in Surficial Sediment (Continued)

	CSO-B8-SR		CSO-D8-SR		CSO-E8-S		CSO-C7-SRG		CSO-E7-SR	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Acenaphthene	440	J	400	J	800	J	490	J	500	J
Anthracene	990	J	830	J	1600	J	1100	J	1100	J
Fluoranthene	9300		7600		13000		9900		9700	
Fluorene	480	J	360	J	810	J	480	J	490	J
Indeno(1,2,3-cd)pyrene	1100	J	900	J	1600	J	1300	J	1200	J
Naphthalene	3300	U	2200	U	3800	U	3600	U	2200	U
Benzo(a)anthracene	3500		3000		4900		3800		3700	
Benzo(b)fluoranthene	4000		3700		5500		4200		4400	
Benzo(k)fluoranthene	4200		3500		5600		5400		5200	
Benzo(ghi)perylene	830	J	720	J	1100	J	970	J	850	J
Benzo(a)pyrene	3400		3000		4600		3900		3800	
Phenanthrene	5000		3900		8000		5000		5100	
Pyrene	6700		5800		9900		7800		8300	
Dibenzo(a,h)anthracene	260	J	290	J	430	J	320	J	300	J
Acenaphthylene	3300	U	2200	U	3800	U	3600	U	2200	U
Chrysene	4300		3600		5800		4700		4600	

PAHs Concentration in Surficial Sediment (Continued)

	CSO-B7SD		CSO-F5S		CSO-D5S		CSO-A8S		CSO-B10-SR	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Acenaphthene	220	J	260	J	2100	U	130	J	6000	
Anthracene	530	J	650	J	2100	U	350	J	1700	J
Fluoranthene	4700		7000		1200	J	3600		10000	
Fluorene	300	J	270	J	2100	U	170	J	3100	
Indeno(1,2,3-cd)pyrene	690	J	570	J	300	J	340	J	980	J
Naphthalene	1700	U	2000	U	2100	U	1600	U	3800	
Benzo(a)anthracene	2200		2800		590	J	1500	J	4600	
Benzo(b)fluoranthene	3400		5500		940	J	3200		3300	
Benzo(k)fluoranthene	1700	U	2000	U	2100	U	1600	U	4000	
Benzo(ghi)perylene	770	J	600	J	430	J	400	J	850	J
Benzo(a)pyrene	2000		2500		560	J	1400	J	4400	
Phenanthrene	2500		3100		660	J	1700		15000	
Pyrene	3300		4000		1100	J	2100		13000	
Dibenzo(a,h)anthracene	190	J	170	J	2100	U	1600	U	260	J
Acenaphthylene	240	J	2000	U	2100	U	1600	U	1100	J
Chrysene	2400		3000		670	J	1700		4900	

PAHs Concentration in Surficial Sediment (Continued)

	CSO-D10-SR		CSO-D9S		CSO-A10S		CSO-F10S		CSO-E9SRD	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Acenaphthene	190	J	400	J	140	J	1500	U	140	J
Anthracene	510	J	680	J	300	J	1500	U	350	J
Fluoranthene	4700		6700		2900		1200	J	3100	
Fluorene	200	J	330	J	150	J	1500	U	160	J
Indeno(1,2,3-cd)pyrene	650	J	670	J	370	J	130	J	270	J
Naphthalene	1500	U	1600	U	1600	U	1500	U	1600	U
Benzo(a)anthracene	1700		2300		1300	J	480	J	1200	J
Benzo(b)fluoranthene	1800		3700		2300		900	J	2300	
Benzo(k)fluoranthene	1700		1600	U	1600	U	1500	U	1600	U
Benzo(ghi)perylene	530	J	720	J	430	J	150	J	310	J
Benzo(a)pyrene	1600		2100		1300	J	440	J	1100	J
Phenanthrene	2600		3900		1500	J	660	J	1700	
Pyrene	2800		4000		2100		830	J	1800	
Dibenzo(a,h)anthracene	170	J	170	J	100	J	1500	U	1600	U
Acenaphthylene	1500	U	1600	U	1600	U	1500	U	1600	U
Chrysene	2100		2500		1500	J	590	J	1300	J

PAHs Concentration in Surficial Sediment (Continued)

	CSO-F9S		CSO-D7S		CSO-D3S		CSO-E10S		CSO-C9-SR	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Acenaphthene	240	J	340	J	200	J	1600	U	7700	U
Anthracene	660	J	760	J	550	J	170	J	1100	J
Fluoranthene	5800		11000		7200		1700		6500	J
Fluorene	290	J	490	J	240	J	1600	U	7700	U
Indeno(1,2,3-cd)pyrene	460	J	620	J	580	J	460	J	1600	J
Naphthalene	1600	U	2300	U	2000	U	1600	U	7700	U
Benzo(a)anthracene	2200		2700		2500		770	J	2500	J
Benzo(b)fluoranthene	4400		6000		6300		1200	J	3800	J
Benzo(k)fluoranthene	1600	U	2300	U	2000	U	1600	U	7700	U
Benzo(ghi)perylene	520	J	760	J	640	J	580	J	1800	J
Benzo(a)pyrene	2000		2600		2500		710	J	2400	J
Phenanthrene	2900		3900		2400		920	J	4400	J
Pyrene	3400		4500		3600		1500	J	5000	J
Dibenzo(a,h)anthracene	1600	U	2300	U	2000	U	130	J	7700	U
Acenaphthylene	1600	U	2300	U	2000	U	1600	U	7700	U
Chrysene	2300		3100		2800		910	J	2900	J

PAHs Concentration in Surficial Sediment (Continued)

	CSO-E9-SR		CSO-A9-SR		CSO-A7-SR		CSO-F8S		CSO-F7S	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Acenaphthene	8300	U	7900	U	8700	U	450	J	390	J
Anthracene	1100	J	950	J	840	J	1600		1000	J
Fluoranthene	5900	J	5700	J	5900	J	9600		8500	
Fluorene	8300	U	7900	U	8700	U	550	J	440	J
Indeno(1,2,3-cd)pyrene	1400	J	1400	J	1600	J	1300		980	J
Naphthalene	8300	U	7900	U	8700	U	1200	U	3800	U
Benzo(a)anthracene	2400	J	2400	J	2600	J	3900		3100	J
Benzo(b)fluoranthene	3400	J	2100	J	3700	J	4400		3400	J
Benzo(k)fluoranthene	8300	U	1800	J	8700	U	2800		3700	J
Benzo(ghi)perylene	1700	J	1900	J	2300	J	1000	J	780	J
Benzo(a)pyrene	2100	J	2200	J	2400	J	3800		3100	J
Phenanthrene	3700	J	3700	J	3400	J	6000		4500	
Pyrene	4300	J	4500	J	4600	J	6200		5400	
Dibenzo(a,h)anthracene	8300	U	7900	U	8700	U	510	J	290	J
Acenaphthylene	8300	U	7900	U	8700	U	1200	U	3800	U
Chrysene	2800	J	2900	J	3000	J	4300		3800	

PAHs Concentration in Surficial Sediment (Continued)

	CSO-C8S		CSO-C10S		CSO-B7S		CSO-C1SRD		CSO-B9S	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Acenaphthene	410	J	250	J	390	J	1900	U	86	J
Anthracene	1100	J	290	J	1100	J	410	J	240	J
Fluoranthene	8400		2700		8800		4500		2200	
Fluorene	510	J	170	J	430	J	1900	U	94	J
Indeno(1,2,3-cd)pyrene	860	J	420	J	1100	J	620	J	440	J
Naphthalene	3600	U	1300	U	1700	U	1900	U	940	U
Benzo(a)anthracene	3100	J	1200	J	3600		1800	J	930	J
Benzo(b)fluoranthene	3300	J	1200	J	3900		2700		990	
Benzo(k)fluoranthene	3700		1200	J	4200		2600		910	J
Benzo(ghi)perylene	680	J	320	J	870	J	490	J	340	J
Benzo(a)pyrene	2900	J	1200	J	3500		2100		950	
Phenanthrene	4400		1000	J	4300		1800	J	1100	
Pyrene	5500		1900		6300		3900		1500	
Dibenzo(a,h)anthracene	260	J	120	J	340	J	1900	U	110	J
Acenaphthylene	3600	U	230	J	200	J	1900	U	940	U
Chrysene	3800		1300		4300		2300		1200	

PAHs Concentration in Surficial Sediment (Continued)

	CSO-RS1SP		CSO-RS2-SP		CSO-RS3SP	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Acenaphthene	1300	J	1600	U	250	J
Anthracene	2200		200	J	660	J
Fluoranthene	19000	E	2000		6700	
Fluorene	1600		1600	U	230	J
Indeno(1,2,3-cd)pyrene	1700		220	J	930	J
Naphthalene	280	J	1600	U	1600	U
Benzo(a)anthracene	5700		770	J	2600	
Benzo(b)fluoranthene	8500		1700		3200	
Benzo(k)fluoranthene	1600	U	1600	U	3500	
Benzo(ghi)perylene	2200		230	J	720	J
Benzo(a)pyrene	4700		740	J	2900	
Phenanthrene	16000	E	940	J	3000	
Pyrene	12000		1200	J	4700	
Dibenzo(a,h)anthracene	530	J	1600	U	250	J
Acenaphthylene	150	J	1600	U	150	J
Chrysene	6500		840	J	3300	

Pesticides Concentrations in Core Sediment from 0 to 6 inch Segment

	CSO-CORE1 0-6		CSO-CORE2 0-6		CSO-CORE3 0-6		CSO-CORE4 0-6		CSO-CORE4D 0-6	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Dieldrin	4	PG	4.3	J PG	6.8	J PG	7.3	PG	5.5	PG
Endosulfan I	4	U	6.5	U	8.6	U	7.3	U	3.8	U
Endosulfan II	6.7	PG	7.9	PG	13	PG	13	PG	8.6	PG
Endosulfan sulfate	4	U	6.5	U	8.6	U	7.3	U	3.8	U
Endrin	4.7	PG	6.5	PG	11	PG	11		8.3	PG
Endrin aldehyde	29		27		26	PG	27		31	
Endrin ketone	4	U	6.5	U	8.6	U	7.3	U	3.8	U
Heptachlor	4	U	6.5	U	8.6	U	7.3	U	3.8	U
Heptachlor epoxide	5.4		4.2	J PG	6.3	J PG	5.3	J	4.9	
Methoxychlor	7.9	U	13	U	3.1	J PG	14	U	2.7	J PG
alpha-BHC	4	U	6.5	U	8.6	U	7.3	U	3.8	U
beta-BHC	4	U	6.5	U	2.9	J PG	7.3	U	3.8	U
delta-BHC	4	U	6.5	U	8.6	U	7.3	U	3.8	U
gamma-BHC (Lindane)	4	U	6.5	U	8.6	U	7.3	U	3.8	U
Toxaphene	160	U	260	U	340	U	290	U	150	U
alpha-Chlordane	10		10		18		12		11	
gamma-Chlordane	7.8		5.9	J PG	14		7.7	PG	6.9	PG
Aldrin	3.3	J PG	1.9	J PG	2.8	J PG	3.4	J PG	3	J PG
4,4'-DDD	9.4	PG	7.3	PG	18	PG	18	PG	12	PG
4,4'-DDE	29		23		38		30		27	
4,4'-DDT	21		20	PG	24	PG	25		20	

	CSO-CORE5 0-6		CSO-CORE6 0-6		CSO-CORE7 0-6		CSO-CORE8 0-6		CSO-RS1SP	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Dieldrin	7.7	J	11	J PG	8.9	PG	7.9	J PG	3.4	J
Endosulfan I	7.9	U	19	U	8.6	U	9.3	U	6.7	U
Endosulfan II	11	PG	31	PG	11	PG	13	PG	3.2	J PG
Endosulfan sulfate	7.9	U	19	U	8.6	U	9.3	U	6.7	U
Endrin	9.4		20	PG	9.7		18		2.8	J PG
Endrin aldehyde	19	PG	61		25		27	PG	7.7	PG
Endrin ketone	7.9	U	19	U	8.6	U	9.3	U	6.7	U
Heptachlor	7.9	U	19	U	8.6	U	9.3	U	6.7	U
Heptachlor epoxide	5.3	J	5.7	J PG	8.1	J	6.1	J PG	6.7	U
Methoxychlor	15	U	37	U	2.8	J PG	18	U	1.9	J PG
alpha-BHC	7.9	U	19	U	8.6	U	9.3	U	6.7	U
beta-BHC	7.9	U	19	U	8.6	U	9.3	U	1.1	J PG
delta-BHC	7.9	U	19	U	8.6	U	9.3	U	6.7	U
gamma-BHC (Lindane)	7.9	U	19	U	8.6	U	9.3	U	6.7	U
Toxaphene	310	U	750	U	340	U	370	U	260	U
alpha-Chlordane	10	PG	13	J PG	19	PG	13	PG	7.3	
gamma-Chlordane	8.8	PG	11	J PG	22		11	PG	8.6	
Aldrin	1.9	J PG	4.1	J PG	4.2	J PG	2.3	J PG	3.3	J PG
4,4'-DDD	29		63		62		40		25	
4,4'-DDE	43		67		71		64		18	
4,4'-DDT	16	PG	47	PG	25	PG	22	PG	6.5	J PG

Pesticides Concentrations in the Surficial Sediment

	CSO-RS2-SP		CSO-RS3SP	
	RESULT	**QUALIFIER**	**RESULT**	**QUALIFIER**
Dieldrin	2.8	J	3.6	
Endosulfan I	6.6	U	3.2	U
Endosulfan II	3.7	J PG	4.6	PG
Endosulfan sulfate	6.6	U	3.2	U
Endrin	6.6	U	4.2	
Endrin aldehyde	4.1	J PG	8.2	PG
Endrin ketone	6.6	U	3.2	U
Heptachlor	6.6	U	3.2	U
Heptachlor epoxide	6.6	U	3.2	U
Methoxychlor	4	J PG	4.7	J PG
alpha-BHC	6.6	U	3.2	U
beta-BHC	6.6	U	1.8	J PG
delta-BHC	6.6	U	3.2	U
gamma-BHC (Lindane)	6.6	U	3.2	U
Toxaphene	260	U	130	U
alpha-Chlordane	6.4	J	8.6	
gamma-Chlordane	6	J	9.2	
Aldrin	1.2	J PG	2.4	J PG
4,4'-DDD	8.3	PG	20	
4,4'-DDE	8.5		22	
4,4'-DDT	7.5	PG	8.8	PG

PCBs Congeners in Sediments

	CSO-CORE 1 0-6		CSO-CORE 1 6-12		CSO-CORE 1 12-22		CSO-CORE 2 0-6		CSO-CORE 2 6-12		CSO-CORE 2 12-20	
PARAMETER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
PCB 1 (BZ)	110	J PG	110	J PG	75	J PG	68	J PG	100	J PG	66	J PG
PCB 3 (BZ)	200	U	160	U	170	U	81	U	170	U	170	U
PCB 5 (BZ)	20	U	16	U	17	U	8.1	U	17	U	17	U
PCB 8 (BZ)	100		44		58		20		47		37	PG
PCB 15 (BZ)	200	U	160	U	170	U	81	U	170	U	170	U
PCB 18 (BZ)	210		100		160		53		120		98	
PCB 28 (BZ)	240		140		210		66		150		120	
PCB 31 (BZ)	290		170		260		82		180		150	
PCB 37 (BZ)	87	PG	65	PG	98	PG	28	PG	70	PG	54	PG
PCB 44 (BZ)	110		81		120		35		88		74	
PCB 49 (BZ)	110	PG	66	PG	97	PG	32	PG	72	PG	58	PG
PCB 52 (BZ)	130		100		140		43		110		95	
PCB 66 (BZ)	94	PG	75	PG	110	PG	30	PG	80	PG	67	PG
PCB 70 (BZ)	150	PG	110	PG	160	PG	50	PG	120		100	
PCB 74 (BZ)	66	PG	56	PG	78	PG	22	PG	59	PG	49	PG
PCB 77 (BZ)	20	U	16	U	17	U	8.1	U	17	U	17	U
PCB 81 (BZ)	20	U	16	U	17	U	8.1	U	17	U	17	U
PCB 87 (BZ)	62		47		56		22		45		35	PG
PCB 90 (BZ)	20	U	16	U	17	U	8.1	U	17	U	17	U
PCB 99 (BZ)	140		90		120		53		96		130	
PCB 101 (BZ)	240		170		200		81		170		210	
PCB 105 (BZ)	52		41		46		21		40		39	
PCB 110 (BZ)	200	PG	140	PG	160	PG	67	PG	140		160	
PCB 114 (BZ)	20	U	22	PG	17	U	11	PG	20	PG	22	PG
PCB 115 (BZ)	8.7	J PG	5.1	J PG	6.8	J PG	2.4	J PG	5.1	J PG	7.1	J PG
PCB 118 (BZ)	170	PG	100	PG	120	PG	52	PG	110	PG	120	
PCB 119 (BZ)	20	U	16	U	17	U	8.1	U	17	U	17	U
PCB 123 (BZ)	20	U	9.3	J PG	9.1	J PG	4.6	J PG	8.2	J PG	11	J PG

PCBs Congeners in Sediments (Continued)

	CSO-CORE 1 0-6		CSO-CORE 1 6-12		CSO-CORE 1 12-22		CSO-CORE 2 0-6		CSO-CORE 2 6-12		CSO-CORE 2 12-20	
PARAMETER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
PCB 126 (BZ)	20	U	16	U	17	U	8.1	U	17	U	17	U
PCB 128 (BZ)	47	PG	37	PG	36	PG	19	PG	80	PG	38	PG
PCB 138 (BZ)	180	PG	150	PG	150	PG	73	PG	130	PG	180	PG
PCB 141 (BZ)	64	PG	56	PG	55	PG	25	PG	47	PG	69	
PCB 149 (BZ)	240	PG	180	PG	180	PG	78	PG	160	PG	250	
PCB 151 (BZ)	89		77		76	PG	32		66	PG	83	
PCB 153 (BZ)	280		210		210		98		190		290	
PCB 156 (BZ)	31		25		24		12		22		27	
PCB 157 (BZ)	20	U	16	U	17	U	8.1	U	17	U	17	U
PCB 158 (BZ)	20	U	16	U	17	U	8.1	U	17	U	17	U
PCB 167 (BZ)	7.2	J PG	16	U	7.8	J	4.7	J	17	U	7.6	J
PCB 168 (BZ)	20	U	16	U	17	U	8.1	U	17	U	17	U
PCB 169 (BZ)	20	U	16	U	17	U	8.1	U	17	U	17	U
PCB 170 (BZ)	91	PG	87		81		38	PG	73		100	
PCB 177 (BZ)	79		61		64		28		55		86	
PCB 180 (BZ)	200	PG	200		180	PG	87		160		230	
PCB 183 (BZ)	59	PG	52	PG	50	PG	24	PG	42	PG	61	PG
PCB 184 (BZ)	20	U	16	U	17	U	8.1	U	17	U	17	U
PCB 187 (BZ)	150		120		130		54		100		160	
PCB 189 (BZ)	20	U	16	U	17	U	8.1	U	17	U	17	U
PCB 194 (BZ)	45	PG	44		43		20		36		54	
PCB 195 (BZ)	21		20	PG	20		9		17		24	
PCB 201 (BZ)/199 (IUPAC)	20	U	16	U	17	U	8.1	U	17	U	8.9	J PG
PCB 202 (BZ)	20	U	16	U	17	U	8.1	U	17	U	17	U
PCB 206 (BZ)	15	J	14	J	15	J	7.6	J	12	J	20	
PCB 207 (BZ)	20	U	16	U	17	U	8.1	U	17	U	17	U
PCB 209 (BZ)	20	U	16	U	17	U	8.1	U	17	U	9.9	J

PCBs Congeners in Sediments (Continued)

	CSO-CORE 3 0-6		CSO-CORE 3 6-12		CSO-CORE 3 12-14		CSO-CORE 4 0-6		CSO-CORE 4-D 0-6		CSO-CORE 4 6-12	
PARAMETER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
PCB 1 (BZ)	100	J PG	84	J PG	61	J PG	110	J PG	93	J PG	250	J PG
PCB 3 (BZ)	120	U	180	U	180	U	180	U	96	U	720	U
PCB 5 (BZ)	12	U	18	U	18	U	18	U	9.6	U	72	U
PCB 8 (BZ)	30		40	PG	27	PG	62		56		92	PG
PCB 15 (BZ)	120	U	180	U	180	U	180	U	96	U	720	U
PCB 18 (BZ)	75		100		86		140		130		230	
PCB 28 (BZ)	95		120		110		160		150		250	
PCB 31 (BZ)	120	PG	150		130		200		190		310	
PCB 37 (BZ)	45	PG	62	PG	50	PG	66	PG	60	PG	100	PG
PCB 44 (BZ)	57		77		73		80		75		130	
PCB 49 (BZ)	51	PG	62	PG	59	PG	69	PG	62	PG	110	PG
PCB 52 (BZ)	71		93		96		97		91		160	
PCB 66 (BZ)	47	PG	68	PG	66	PG	69	PG	64	PG	120	PG
PCB 70 (BZ)	84	PG	100	PG	100		110	PG	100	PG	180	
PCB 74 (BZ)	40	PG	51	PG	48	PG	53	PG	51	PG	82	PG
PCB 77 (BZ)	12	U	18	U	18	U	18	U	9.6	U	72	U
PCB 81 (BZ)	12	U	18	U	18	U	18	U	9.6	U	72	U
PCB 87 (BZ)	43		39		42		43		35		60	J
PCB 90 (BZ)	12	U	18	U	18	U	18	U	9.6	U	72	U
PCB 99 (BZ)	86		110		130		88		85		170	
PCB 101 (BZ)	140		190		220		150		140		290	
PCB 105 (BZ)	40		41		38		41		36	PG	51	J PG
PCB 110 (BZ)	120	PG	130	PG	150		130	PG	120	PG	210	
PCB 114 (BZ)	25	PG	18	U	18	U	18	U	9.6	U	33	J PG
PCB 115 (BZ)	4.2	J PG	5.3	J PG	17	J PG	4.5	J PG	4.4	J PG	72	U
PCB 118 (BZ)	95	PG	100	PG	110	PG	100	PG	90	PG	160	
PCB 119 (BZ)	12	U	18	U	18	U	18	U	9.6	U	72	U
PCB 123 (BZ)	11	J PG	9.6	J PG	8.4	J PG	10	J PG	8.2	J PG	72	U

PCBs Congeners in Sediments (Continued)

	CSO-CORE 3 0-6		CSO-CORE 3 6-12		CSO-CORE 3 12-14		CSO-CORE 4 0-6		CSO-CORE 4-D 0-6		CSO-CORE 4 6-12	
PARAMETER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
PCB 126 (BZ)	12	U	18	U	18	U	18	U	9.6	U	72	U
PCB 128 (BZ)	36	PG	34	PG	37	PG	77	PG	31	PG	45	J PG
PCB 138 (BZ)	130	PG	140	PG	150	PG	130	PG	120	PG	220	PG
PCB 141 (BZ)	47	PG	53		52	PG	46	PG	42	PG	87	
PCB 149 (BZ)	140	PG	190	PG	200	PG	150	PG	130	PG	330	
PCB 151 (BZ)	59		76		77		62		55		140	
PCB 153 (BZ)	180		230		230		180		160		390	
PCB 156 (BZ)	22		22		24		20		19		72	U
PCB 157 (BZ)	12	U	18	U	18	U	18	U	9.6	U	72	U
PCB 158 (BZ)	12	U	18	U	18	U	18	U	9.6	U	72	U
PCB 167 (BZ)	6.8	J PG	18	U	6.9	J PG	8	J	7.1	J	72	U
PCB 168 (BZ)	12	U	18	U	18	U	18	U	9.6	U	72	U
PCB 169 (BZ)	12	U	18	U	18	U	18	U	9.6	U	72	U
PCB 170 (BZ)	69	PG	74		77	PG	68		61	PG	130	
PCB 177 (BZ)	47		68		69		50		43		110	
PCB 180 (BZ)	150	PG	160		170		150		130	PG	290	
PCB 183 (BZ)	41	PG	48	PG	44	PG	40	PG	35	PG	80	PG
PCB 184 (BZ)	12	U	18	U	18	U	18	U	9.6	U	72	U
PCB 187 (BZ)	92		120		120		96		85		210	
PCB 189 (BZ)	12	U	18	U	18	U	18	U	9.6	U	72	U
PCB 194 (BZ)	34		37	PG	36		34	PG	30	PG	68	J
PCB 195 (BZ)	15		18		16	J	16	J PG	14		30	J
PCB 201 (BZ)/199 (IUPAC)	6.4	J PG	18	U	18	U	18	U	5	J PG	72	U
PCB 202 (BZ)	12	U	18	U	18	U	18	U	9.6	U	72	U
PCB 206 (BZ)	11	J	11	J PG	13	J	11	J	10	PG	72	U
PCB 207 (BZ)	12	U	18	U	18	U	18	U	9.6	U	72	U
PCB 209 (BZ)	12	U	18	U	10	J	18	U	9.6	U	72	U

PCBs Congeners in Sediments (Continued)

	CSO-CORE 4-D 6-12		CSO-CORE 4 12-20		CSO-CORE 4 12-20D		CSO-CORE 5 0-6		CSO-CORE 5 6-12		CSO-CORE 5 12-18	
PARAMETER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
PCB 1 (BZ)	720	U	25	PG	26	PG	100	J PG	75	J PG	82	U
PCB 3 (BZ)	720	U	16	U	16	U	200	U	180	U	82	U
PCB 5 (BZ)	72	U	1.6	PG	1.8		20	U	18	U	13	
PCB 8 (BZ)	79		2.1		2.3	PG	34		18	U	8.2	U
PCB 15 (BZ)	720	U	16	U	16	U	200	U	180	U	82	U
PCB 18 (BZ)	240		4.7		5.2		91		51		8.2	U
PCB 28 (BZ)	290		5.2	PG	5.5	PG	120		60	PG	9.3	PG
PCB 31 (BZ)	360		6.5	PG	6.9	PG	150		74	PG	12	PG
PCB 37 (BZ)	110	PG	2.6	PG	3.4	PG	58	PG	30	PG	7.7	J PG
PCB 44 (BZ)	160		4	PG	4.4	PG	71		44		12	PG
PCB 49 (BZ)	140	PG	5.3	PG	4.8	PG	81		47	PG	13	PG
PCB 52 (BZ)	200		8		7.6		97		73		25	
PCB 66 (BZ)	150	PG	3	PG	3.3	PG	64	PG	37	PG	10	PG
PCB 70 (BZ)	210		4.9	PG	5.3	PG	110		62	PG	18	PG
PCB 74 (BZ)	100	PG	2.2	PG	2.5	PG	46	PG	30	PG	12	PG
PCB 77 (BZ)	72	U	15	PG	16	PG	20	U	18	U	8.2	U
PCB 81 (BZ)	72	U	1.6	U	1.6	U	20	U	18	U	8.2	U
PCB 87 (BZ)	80	PG	2.5		2.6		38		42	PG	13	
PCB 90 (BZ)	72	U	1.6	U	14		20	U	18	U	8.2	U
PCB 99 (BZ)	250		7.9	PG	9.6	PG	120		130	PG	48	PG
PCB 101 (BZ)	410		1.6	U	1.6	U	170		220		88	
PCB 105 (BZ)	55	J PG	2.1		2.5	PG	43		29	PG	14	
PCB 110 (BZ)	250		1.6	U	1.6	U	150	PG	130	PG	58	
PCB 114 (BZ)	72	U	0.64	J PG	0.79	J PG	20	U	18	U	3.1	J PG
PCB 115 (BZ)	72	U	0.44	J PG	0.56	J PG	5.9	J PG	7.1	J PG	7.5	J PG
PCB 118 (BZ)	190		5.5	PG	7.1	PG	120	PG	96		33	PG
PCB 119 (BZ)	72	U	2.1	PG	2.4	PG	20	U	18	U	8.2	U
PCB 123 (BZ)	22	J PG	1.6	U	1.6	U	15	J PG	16	J PG	8.2	U

PCBs Congeners in Sediments (Continued)

	CSO-CORE 4-D 6-12		CSO-CORE 4 12-20		CSO-CORE 4 12-20D		CSO-CORE 5 0-6		CSO-CORE 5 6-12		CSO-CORE 5 12-18	
PARAMETER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
PCB 126 (BZ)	72	U	1.6	U	1.6	U	20	U	18	U	8.2	U
PCB 128 (BZ)	52	J PG	2	PG	2.6	PG	83	PG	34	PG	13	PG
PCB 138 (BZ)	290	PG	4.6	PG	11	PG	140	PG	150	PG	64	PG
PCB 141 (BZ)	120		3.4	PG	3.9	PG	48	PG	58	PG	23	PG
PCB 149 (BZ)	520		13	PG	16	PG	170	PG	220	PG	76	PG
PCB 151 (BZ)	240	PG	5.8	PG	3.6	PG	70		85		17	PG
PCB 153 (BZ)	600		1.6	U	1.6	U	210		260		100	
PCB 156 (BZ)	39	J	1.5	J	1.8		23		23		8.2	U
PCB 157 (BZ)	72	U	1.6	U	1.6	U	20	U	18	U	8.2	U
PCB 158 (BZ)	72	U	1.6	U	1.6	U	20	U	18	U	8.2	U
PCB 167 (BZ)	72	U	0.54	J	1.6	U	8.2	J	7.6	J	8.2	U
PCB 168 (BZ)	72	U	14	PG	17	PG	20	U	18	U	8.2	U
PCB 169 (BZ)	72	U	1.6	U	1.6	U	20	U	18	U	8.2	U
PCB 170 (BZ)	200		5.7	PG	6.7	PG	70	PG	86	PG	36	PG
PCB 177 (BZ)	190		5		6.4		53		75		36	
PCB 180 (BZ)	450		1.6	U	1.6	U	150		190		76	
PCB 183 (BZ)	120	PG	3.6	PG	4	PG	42	PG	51	PG	8.2	U
PCB 184 (BZ)	72	U	1.6	U	1.6	U	20	U	18	U	8.2	U
PCB 187 (BZ)	360		10		13		100		140		57	
PCB 189 (BZ)	72	U	1.6	U	1.6	U	20	U	18	U	5.8	J PG
PCB 194 (BZ)	110		1.6	U	5.4	PG	34		42		17	PG
PCB 195 (BZ)	49	J	1.6	PG	1.9	PG	15	J	20		7.6	J
PCB 201 (BZ)/199 (IUPAC)	72	U	1.6	U	1.6	U	20	U	18	U	8.2	U
PCB 202 (BZ)	72	U	1.6	U	1.6	U	20	U	18	U	8.2	U
PCB 206 (BZ)	29	J	1.6	U	8.3	U	9.4	J PG	14	J	13	
PCB 207 (BZ)	72	U	1.6	U	1.6		20	U	18	U	8.2	U
PCB 209 (BZ)	72	U	4.5		5.5	U	20	U	18	U	19	

PCBs Congeners in Sediments (Continued)

	CSO-CORE 6 0-6		CSO-CORE 6 6-12		CSO-CORE 6 12-15		CSO-CORE 7 0-6		CSO-CORE 7 6-12		CSO-CORE 7 12-14	
PARAMETER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
PCB 1 (BZ)	100	J PG	720	U	36	J PG	61	J PG	90	J PG	30	J PG
PCB 3 (BZ)	190	U	720	U	78	U	78	U	150	U	76	U
PCB 5 (BZ)	19	U	72	U	4.1	J PG	7.8	U	8.7	J	4.1	J PG
PCB 8 (BZ)	58		72	U	7.8	U	19		14	J PG	7.6	U
PCB 15 (BZ)	190	U	720	U	78	U	78	U	150	U	76	U
PCB 18 (BZ)	140		72	U	7.8	U	59		15	U	4.4	J PG
PCB 28 (BZ)	160		72	U	7.8	U	76		43	PG	5.5	J PG
PCB 31 (BZ)	200		40	J PG	7.8	U	95		53	PG	6.8	J PG
PCB 37 (BZ)	73	PG	72	U	7.8	U	37	PG	32	PG	7.6	U
PCB 44 (BZ)	87		28	J	3.2	J PG	46		40		6.2	J PG
PCB 49 (BZ)	71	PG	55	J	4.9	J	50	PG	59	PG	11	
PCB 52 (BZ)	100		73		8.4		59		76		20	
PCB 66 (BZ)	67	PG	72	U	7.8	U	40	PG	32	PG	5.7	J PG
PCB 70 (BZ)	110		72	U	7.8	U	60	PG	51	PG	7.6	U
PCB 74 (BZ)	56	PG	72	U	6.7	J PG	26		25	PG	6.3	J PG
PCB 77 (BZ)	19	U	72	U	7.8	U	7.8	U	15	U	7.6	U
PCB 81 (BZ)	19	U	72	U	7.8	U	7.8	U	15	U	7.6	U
PCB 87 (BZ)	38		53	J	3.7	J	27		34		9.6	
PCB 90 (BZ)	19	U	72	U	7.8	U	7.8	U	15	U	7.6	U
PCB 99 (BZ)	93		200		12		76		110	PG	29	PG
PCB 101 (BZ)	160		310		23	PG	120		190		68	
PCB 105 (BZ)	36	PG	33	J PG	5.4	J	21		20	PG	7.4	J PG
PCB 110 (BZ)	130	PG	180		22		82	PG	120	PG	44	
PCB 114 (BZ)	19	U	72	U	7.8	U	7.8	U	11	J	7.6	U
PCB 115 (BZ)	4.8	J PG	72	U	11	PG	2.9	J PG	8.2	J PG	13	PG
PCB 118 (BZ)	99	PG	130		9.9	PG	57	PG	78	PG	26	PG
PCB 119 (BZ)	19	U	72	U	7.8	U	7.8	U	14	J PG	3.3	J PG

PCBs Congeners in Sediments (Continued)

	CSO-CORE 6 0-6		CSO-CORE 6 6-12		CSO-CORE 6 12-15		CSO-CORE 7 0-6		CSO-CORE 7 6-12		CSO-CORE 7 12-14	
PARAMETER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
PCB 123 (BZ)	11	J	24	J PG	7.8	U	6.2	J PG	9.3	J PG	7.6	U
PCB 126 (BZ)	19	U	72	U	7.8	U	7.8	U	15	U	7.6	U
PCB 128 (BZ)	32	PG	46	J PG	4.9	J PG	21	PG	26	PG	13	PG
PCB 138 (BZ)	120	PG	240	PG	28	PG	79	PG	120	PG	66	PG
PCB 141 (BZ)	43	PG	88	PG	9.3	PG	27	PG	42	PG	22	PG
PCB 149 (BZ)	150	PG	340	PG	32	PG	95	PG	180	PG	84	PG
PCB 151 (BZ)	61		140		7.8	U	37		77		7.6	U
PCB 153 (BZ)	170		420		44		120		210		100	
PCB 156 (BZ)	20		72	U	7.8	U	13		19		7.6	U
PCB 157 (BZ)	19	U	72	U	7.8	U	7.8	U	15	U	7.6	U
PCB 158 (BZ)	19	U	72	U	7.8	U	7.8	U	15	U	7.6	U
PCB 167 (BZ)	6.3	J PG	72	U	7.8	U	4	J PG	6	J	2.9	J
PCB 168 (BZ)	19	U	72	U	7.8	U	7.8	U	15	U	7.6	U
PCB 169 (BZ)	19	U	72	U	7.8	U	7.8	U	15	U	7.6	U
PCB 170 (BZ)	63	PG	130	PG	17	PG	39	PG	63	PG	38	PG
PCB 177 (BZ)	46		120		7.8	U	32		59		7.6	U
PCB 180 (BZ)	130	PG	270		43		83		140		81	
PCB 183 (BZ)	37	PG	80	PG	7.8	U	23	PG	38	PG	23	PG
PCB 184 (BZ)	19	U	72	U	7.8	U	7.8	U	15	U	7.6	U
PCB 187 (BZ)	87		220		28		60		100		49	
PCB 189 (BZ)	19	U	72	U	7.8	U	7.8	U	15	U	3	J PG
PCB 194 (BZ)	29	PG	56	J	12	PG	19	PG	28	PG	17	PG
PCB 195 (BZ)	13	J PG	72	U	4.1	J PG	8.8		13	J	7.4	J
PCB 201 (BZ)/199 (IUPAC)	19	U	72	U	7.8	U	7.8	U	15	U	7.6	U
PCB 202 (BZ)	19	U	72	U	7.8	U	7.8	U	15	U	7.6	U
PCB 206 (BZ)	11	J	72	U	25		7.6	J	11	J	14	
PCB 207 (BZ)	19	U	72	U	7.8	U	7.8	U	15	U	7.6	U
PCB 209 (BZ)	19	U	72	U	45		7.8	U	9.5	J	19	

PCBs Congeners in Sediments (Continued)

	CSO-CORE 8 0-6		CSO-CORE 8 6-12		CSO-CORE 8 12-17	
PARAMETER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
PCB 1 (BZ)	100	J PG	750	U	170	U
PCB 3 (BZ)	190	U	750	U	170	U
PCB 5 (BZ)	19	U	75	U	10	J PG
PCB 8 (BZ)	43	PG	75	U	17	U
PCB 15 (BZ)	190	U	750	U	170	U
PCB 18 (BZ)	69		75	U	17	U
PCB 28 (BZ)	84	PG	75	U	16	J PG
PCB 31 (BZ)	100	PG	59	J PG	20	PG
PCB 37 (BZ)	38	PG	75	U	17	U
PCB 44 (BZ)	56		43	J PG	29	
PCB 49 (BZ)	52	PG	64	J PG	29	PG
PCB 52 (BZ)	84		100		56	
PCB 66 (BZ)	46	PG	75	U	24	PG
PCB 70 (BZ)	82		75	PG	17	U
PCB 74 (BZ)	36	PG	29	J PG	30	PG
PCB 77 (BZ)	19	U	75	U	17	U
PCB 81 (BZ)	19	U	75	U	17	U
PCB 87 (BZ)	41		64	J	39	
PCB 90 (BZ)	19	U	75	U	17	U
PCB 99 (BZ)	120		200	PG	140	
PCB 101 (BZ)	180		340		190	
PCB 105 (BZ)	37		40	J PG	31	
PCB 110 (BZ)	150	PG	200		130	
PCB 114 (BZ)	19	U	75	U	11	J PG
PCB 115 (BZ)	6.8	J PG	75	U	8.4	J PG
PCB 118 (BZ)	110	PG	150		100	
PCB 119 (BZ)	19	U	75	U	13	J PG
PCB 123 (BZ)	12	J PG	75	U	9.4	J PG

PCBs Congeners in Sediments (Continued)

	CSO-CORE 8 0-6		CSO-CORE 8 6-12		CSO-CORE 8 12-17	
PARAMETER	RESULT	QUALIFIER	RESULT	QUALIFIER	RESULT	QUALIFIER
PCB 126 (BZ)	19	U	75	U	17	U
PCB 128 (BZ)	36	PG	51	J PG	31	PG
PCB 138 (BZ)	140	PG	250	PG	140	PG
PCB 141 (BZ)	44	PG	90	PG	48	PG
PCB 149 (BZ)	160	PG	370	PG	220	PG
PCB 151 (BZ)	69		130		94	PG
PCB 153 (BZ)	200		440		270	
PCB 156 (BZ)	19		34	J	22	
PCB 157 (BZ)	19	U	75	U	17	U
PCB 158 (BZ)	19	U	75	U	17	U
PCB 167 (BZ)	9.1	J	75	U	17	U
PCB 168 (BZ)	19	U	75	U	17	U
PCB 169 (BZ)	19	U	75	U	17	U
PCB 170 (BZ)	61	PG	130		68	
PCB 177 (BZ)	53		130		86	
PCB 180 (BZ)	130	PG	280		150	
PCB 183 (BZ)	36	PG	81	PG	43	PG
PCB 184 (BZ)	19	U	75	U	17	U
PCB 187 (BZ)	100		240		150	
PCB 189 (BZ)	19	U	75	U	17	U
PCB 194 (BZ)	29		60	J	39	
PCB 195 (BZ)	14	J	75	U	16	J
PCB 201 (BZ)/199 (IUPAC)	19	U	75	U	17	U
PCB 202 (BZ)	19	U	75	U	17	U
PCB 206 (BZ)	10	J PG	19	J	22	
PCB 207 (BZ)	19	U	75	U	17	U
PCB 209 (BZ)	19	U	75	U	16	J

AVS and SEM in Core and Surficial Sediment

Unit: µmoles/g	CSO-CORE1 0-6		CSO-CORE2 0-6		CSO-CORE3 0-6		CSO-CORE4 0-6		CSO-CORE4D 0-6		CSO-CORE5 0-6	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Lead	0.65	J	1.1	J	2.4	J	1.1	J	1.3	J	1.1	J
Nickel	0.25		0.22		0.3		0.21		0.22		0.2	
Zinc	6.5	J	5.3	J	7.6	J	6.3	J	6.7	J	6.2	J
Cadmium	0.013		0.017		0.025		0.017		0.018		0.016	
Copper	0.0027	B J	0.0039	B J	0.32	J	0.0017	B J	0.0039	B J	0.0063	B J
Acid Volatile Sulfide	12.8		29.8		36.2		30.6		32.8		25.9	

	CSO-CORE6 0-6		CSO-CORE7 0-6		CSO-CORE8 0-6		CSO-C5-SGC		CSO-B2-SRGC	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Lead	1.5	J	0.48	J	0.93	J	0.5	J E	0.94	J
Nickel	0.2		0.16		0.19		0.14	E	0.26	
Zinc	7.6	J	5.9	J	6.2	J	4.1	J E	8.6	J
Cadmium	0.017		0.0083		0.014		0.0059		0.012	
Copper	0.069	J	0.018	U	0.0066	B J	0.04	J	0.082	J
Acid Volatile Sulfide	18.2		13.7		25.7		8.0		25.0	

TN, TKN, and TOC in Surficial and Core Sediment Samples

Unit: mg/kg	TP		TKN		TOC	
PARAMETER	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**	**RESULT**	**QUALIFIER**
Surficial Sediment						
CSO-A5SR	500		5310	J	77300	
CSO-C5SGC	481		4700	J	59100	
CSO-E5SR	1790		6020	J	67900	
CSO-C1SR	1730		4270	J	61300	
CSO-E1SR	2330		4450		104100	
CSO-A3-SR	151		246		13200	
CSO-C3-SRG	145		4100		72000	
CSO-E3-SR	1620		5190		86000	
CSO-B6-SR	42		4310		68100	
CSO-D6-SR	971		5630		62300	
CSO-B8-SR	1710		3460	J	76200	
CSO-D8-SR	17.7	B	5310	J	111700	
CSO-E8-S	1360		3550	J	70900	
CSO-D2SR	5.1	B	4410			
CSO-A7-SR					93100	
CSO-C7-SRG	1090		4090	J	59900	
CSO-E7-SR	2120		5480	J	112300	
CSO-B10-SR	1430		2460	J	58300	
CSO-D10-SR	627		1740	J	22600	
CSO-D9S	1840		3600	J	94000	
CSO-A8S	19.3	U	2530	J	47100	
CSO-F9S	1100		1700	J	39000	
CSO-A1-SR	833		2960		34400	
CSO-C9-SR	1480		2290	J	143000	
CSO-E9-SR	1650		2480	J	52000	
CSO-A9-SR	1510		2410	J	55900	
CSO-B2-SRGC	737		3590		63900	
CSO-B4-SR	198		3350		71600	
CSO-A7-SR	2080		2400	J	63400	
CSO-D4-SRG	764		5050		133200	
Core Sediment						
CSO-CORE2 0-6	1800	J	3200		63400	
CSO-CORE3 0-6	1830	J	4500		71600	
CSO-CORE4 0-6	794	J	2580		83700	
CSO-CORE6 0-6	780	J	3370		64100	
CSO-CORE1 0-6	533	J	4380		46200	
CSO-CORE5 0-6	1970	J	3730		68900	
CSO-CORE8 0-6	2180	J	3480		96200	
CSO-CORE7 0-6	1470	J	2650		39300	

Appendix G Surface Water Quality Data

Date	Time	Location	Temperature	Salinity	pH	DO (Dissolved Oxygen)	Conductivity	Turbidity
	(0 to 2400)		(Degrees Celsius)	(%)		(mg/L)	(ms/cm)	(NTu)
3/8/03	836	A10	5.17	0.31	6.83	9.3	0.64	33.1
3/8/03	906	B10	5.27	0.31	6.91	8.9	0.642	30.6
3/8/03	940	C10	5.26	0.3	7.11	9.6	0.62	31.1
3/8/03	1007	D10	5.09	0.27	7.45	11.7	0.562	31.4
3/8/03	1037	E10	5.08	0.25	7.64	12	0.525	27.5
3/8/03	1051	F10	5.12	0.29	7.51	11.8	0.585	28.2
3/8/03	1122	A9	5.54	0.29	7.6	11.9	0.589	29.6
3/8/03	1136	B9	5.45	0.28	7.48	12.1	0.585	12.9
3/8/03	1151	C9	5.4	0.27	7.74	12.9	0.562	26.8
3/8/03	1210	D9	5.7	0.26	7.88	12.7	0.534	24.9
3/8/03	1233	E9	5.27	0.28	8.04	12.3	0.577	25.5
3/8/03	1247	F9	5.59	0.28	7.99	14.3	0.579	27.4
3/8/03	1357	A8	5.55	0.29	7.88	13.8	0.591	28.8
3/8/03	1421	B8	5.67	0.29	7.9	13.5	0.601	28.4
3/8/03	1442	C8	5.59	0.3	7.89	13.1	0.611	31.2
3/8/03	1503	D8	5.34	0.3	7.83	14.1	0.614	28.4
3/8/03	1519	E8	5.24	0.3	7.79	14.4	0.63	30.8
3/8/03	1529	F8	5.33	0.3	7.65	14.5	0.63	31.2
3/8/03	1544	A7	6.07	0.29	7.58		0.599	29.8
3/8/03	1557	B7	5.93	0.29	7.6		0.602	28.1
3/8/03	1616	C7	5.63	0.3	7.5		0.616	28.5
3/8/03	1650	E7	5.39	0.31	7.67	11.08	0.636	30.1
3/8/03	1706	F7	5.61	0.3	7.6	13.8	0.617	29.8
3/9/03	737	B6	5.37	0.26	8.08	9.4	0.539	28.9
3/9/03	750	C6	5.46	0.26	7.99	8.1	0.546	29.8
3/9/03	759	D6	5.56	0.27	7.86	9.83	0.558	28.1
3/9/03	812	E6	5.63	0.28	7.79	10.4	0.567	29.6
3/9/03	822	F6	5.49	0.27	7.74	12.2	0.551	30.3
3/9/03	832	A5	5.48	0.26	7.86	9.93	0.546	28.5
3/9/03	840	B5	5.48	0.26	7.78		0.545	29.8
3/9/03	852	C5	5.61	0.27	7.83		0.561	29.7
3/9/03	920	D5	5.7	0.27	7.8		0.55	27.9
3/9/03	935	E5	5.66	0.27	7.8		0.556	27.3
3/9/03	950	F5	5.7	0.27	7.77		0.564	27.2
3/9/03	1135	A4	5.96	0.28	7.96	11.6	0.57	27.5
3/9/03	1148	B4	5.92	0.28	7.9	11.78	0.572	26.2
3/9/03	1159	C4	5.83	0.28	7.82	12.5	0.58	32.4
3/9/03	1216	D4	5.99	0.28	7.83	12.89	0.579	28.7
3/9/03	1225	E4	6.01	0.28	7.71	12.93	0.579	30.7

Date	Time	Location	Temperature	Salinity	pH	DO (Dissolved Oxygen)	Conductivity	Turbidity
	(0 to 2400)		(Degrees Celsius)	(%)		(mg/L)	(ms/cm)	(NTu)
3/9/03	1239	F4	5.95	0.28	7.66	12.74	0.579	29.4
3/9/03	1258	A3	6.2	0.28	7.68	12.69	0.572	27.8
3/9/03	1314	B3	5.76	0.29	7.67	12.56	0.598	30.7
3/9/03	1334	C3	5.92	0.29	7.72	12.5	0.597	31.1
3/9/03	1352	D3	6.02	0.29	7.64	12.5	0.593	31.5
3/9/03	1407	E3	6.09	0.28	7.56	13.08	0.586	30.6
3/9/03	1437	F3	6.06	0.28	7.7	12.82	0.582	32.1
3/9/03	1446	A2	6.18	0.29	7.72	12.66	0.588	30.6
3/9/03	1457	B2	5.96	0.28	7.64	12.8	0.582	30.3
3/9/03	1517	C2	6.02	0.28	7.59	13.29	0.58	31.9
3/9/03	1529	D2	6.11	0.28	7.63	12.95	0.576	30.9
3/9/03	1543	E2	6.11	0.28	7.58	13.28	0.576	32.6
3/9/03	1552	F2	6.2	0.28	7.52	13.2	0.575	32.1
3/9/03	1605	A1	6.21	0.29	7.52	13.15	0.59	31.6
3/9/03	1609	B1	6.14	0.28	7.5	13.39	0.579	31.2
3/9/03	1621	C1	6.09	0.28	7.55	13.22	0.577	31.8
3/9/03	1639	D1	6.15	0.28	7.5	12.94	0.574	32.6
3/9/03	1644	E1	6.21	0.28	7.48	13.48	0.571	33.8
3/9/03	1700	F1	6.22	0.28	7.48	13.44	0.568	34.4
3/9/03	1710	CS0RS1-SP	6.21	0.28	7.52	14.03	0.568	34
3/9/03	1730	CSORS2-SP	6.12	0.28	7.47	13.4	0.571	37.3
3/9/03	1736	CSOR53-SP	6.08	0.28	7.45	14.06	0.572	34.3
3/10/03	1045	CS0W1	5.84	0.25	7.91	13.5	0.526	34.2
3/10/03	1130	CS0W2	6	0.25	7.92	14.05	0.525	36.2
3/11/03	1026	C-6	5.71	0.25	8.1	12.58	0.523	32.4
3/11/03	1235	C-1	5.69	0.25	8	11.5	0.511	32.3
3/11/03	1425	C-2	5.77	0.23	7.9	11.36	0.476	32.5
3/11/03	1533	C-3	5.82	0.23	7.8	12.29	0.476	31.4
3/11/03	1705	C-4	5.86	0.23	8	12.4	0.475	31.6
3/12/03	1139	C8	5.91	0.23	8.04	11.13	0.481	28.6
3/12/03	1220	C5	5.82	0.23	7.93	10.25	0.481	28.3
6/5/03	926	C6-Benthic	18.07	0.13	7.55	4.8	0.23	10.5
6/5/03	1235	D10-Benthic	17.94	0.12	7.61	6.44	0.222	12.8
6/5/03	1420	C3-Benthic	17.92	0.12	7.71	6.8	0.22	13.4
6/5/03	1625	D1-Benthic	18.8	0.13	7.65	7.93	0.232	10.6

Appendix H Draft Field Current Velocity Survey Report

Appendix I Draft Geotechnical Investigation Report

Appendix J Draft Benthic Survey Report

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Historical contamination of the Anacostia River, Washington, D.C.

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Abstract The tidal Anacostia River in Washington DC has long been impacted by various sources of chemical pollution over the past 200 years. To explore more recent inputs of various chemicals, six sediment cores were collected for dating and chemical analysis in the downstream section of the tidal Anacostia River. Profiles of contaminants in sediment cores can be useful in determining management direction and effectiveness of pollution controls over time. There were two main objectives for this investigation: (1) determine current sediment contaminant levels; (2) determine a historical perspective of the sediment changes in contamination using ^{137}Cs and ^{210}Pb dating. The determination of an age–depth relationship using ^{210}Pb and ^{137}Cs dating gave somewhat different results, suggesting that the assumptions of ^{210}Pb dating were not met. Using the ^{137}Cs horizon allowed an assignment of approximate sediment accumulation rates and hence an age–depth relationship to contaminant events in the upper portions of the cores. Total PAHs showed higher concentrations at depth and lower surface concentrations. In the upper sections, PAHs were a mixture of combustion and petrogenic sources, while at depth the signature appeared to be of natural origins. Total PCBs, DDTs and chlordane concentrations showed a maximum in recent sediments, decreasing towards the surface. PCBs had lower molecular weight congeners near the surface and higher molecular weights at depth. A phthalate ester, DEHP, appeared in the mid 1940–1950s, and decreased towards the surface. Trace elements fell roughly into three groups. Fe, Mn, and As were in approximately constant proportion to Al, except in some deeper, sandy sediments, where they showed enrichments linked to redox conditions. Ag, Cd, Cu, Hg, Pb, and Zn had low concentrations in the deepest sediments, high concentrations at mid-depths, and declines to intermediate levels at the surface. Ni

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and Cr followed neither of these patterns closely. We observed that many contaminants appeared in the Anacostia sediments at various times, and reached relatively high concentrations in the past, but are now showing declines in loadings. In some cases, such as PCBs, DDT, chlordane, and Pb from leaded gasoline, these declines can be clearly linked to the discontinuation of their use for environmental reasons. For other contaminants (e.g., PAHs, DEHP, selected metals) these declines are more likely the result of changes in production, usage and waste control.

Keywords Anacostia River · Washington D.C. · Sediment cores · Trace elements · Organic contaminants · Dating

Introduction

Due to the particle reactive nature of most trace metals and organic compounds, sediments within aquatic systems are sinks of contaminant loadings. Sediment cores can provide a powerful tool for determining the chronology of pollutant contamination in lakes, estuaries, and marine waters. They can also provide insight into the sources of pollutants in the contributing airshed, watershed, or ground water systems and provide knowledge regarding background or baseline conditions of chemical contaminants in an environment. Finally, they can be extremely useful in determining if various pollution control actions are successful and provide an indication of the time frames needed for restoration after changes in contaminant loads.

The Anacostia River is one of the largest tributaries of the Potomac River, with a watershed area of 456 km^2 (MDE 2010). It drains a portion of Maryland and the District of Columbia, and joins the tidal Potomac River in the southern part of the District. Within the District and up into Maryland as far as Bladensburg, the river is tidal, with a semidiurnal tide of approximately 1 m height. The shoreline of the tidal portion of the Anacostia is highly modified; most of its banks are hardened by bulkheads and seawalls, and it receives runoff from a large number of storm drains, combined sewer overflows, and urban drainage ditches. The lower portion of the tidal river (up to approximately 6 km) is relatively wide and lake-like and generally shallow, less than 2 m deep but with a dredged channel 3–5 m deep extending from the Potomac, while the upper portion is more constricted, and shallow, mostly less than 2 m deep, but navigable up to Bladensburg in a small boat. Fresh water flows from the NE and NW Branches of the Anacostia River into the tidal waters are relatively small, averaging 3.3 m^3 s^{-1} (USGS Stations 01649500 and 01650500; www.waterdata.usgs.gov). The sediments in the lower portion are dominated by sandy silts and muds, while the sediments of the upper portion are dominated by sands and gravels.

Since the selection and construction of Washington D.C. as the U.S. national capitol, starting in 1790, the tidal Anacostia River has become heavily urbanized (Williams 1942) and there has been an increase in contaminant loads to the river, e.g., trace metals, organochlorine pesticides (OCPs) including DDTs and chlordane, polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyl (PCBs). Numerous studies have documented elevated levels of chemical contaminants in sediments, surface waters and fish tissue throughout the river (Foster et al. 2000; McGee et al. 2009; Velinsky et al. 1994; Wade et al. 1994) and their impact to fish and benthic biota (McGee et al. 2009; Pinkney et al. 2004; Schlekat et al. 1994; Velinsky and Cummins 1996). In the past decade, the District of Columbia and State of Maryland have implemented assessments and control programs that are geared to reducing the inputs of many contaminants and begin to restore the river. Sediment cores can assist in this by providing information (i.e., response time) related to the changes in the sediment burden of contaminants with increasing or decreasing loadings and can help show whether pollution controls are effective.

In this study, six long (3 m+) cores in the tidal Anacostia River within Washington D.C. were collected, sectioned and subsequently analyzed for chemical contaminants. An important objective of this study was to determine current sediment contaminant accumulation rates; and gain a historical perspective of the sediment changes

in contamination using a combination of ^{137}Cs and ^{210}Pb dating. ^{137}Cs was used to date sediment horizons that correspond to the early 1950s. This anthropogenic tracer is a product of atmospheric nuclear weapons testing which began in earnest in the early 1950s after WWII, and peaked at the time of the atmospheric test ban which took effect in 1964 (Ritchie and McHenry 1990). ^{210}Pb dating was also carried out in all cores (Robbins 1978). Compared to the ^{137}Cs dating, ^{210}Pb can provide additional information on: (1) changes in accretion rates, (2) the extent of sediment mixing, and (3) sediment focusing (i.e., the preferential deposition of sediment at a site relative to other sites; Appleby and Oldfield 1978).

Methodology

Six 4- to 5-m cores were collected in the tidal portion of the Anacostia River, near Poplar Point, on Jun 24, 2003 (Fig. 1). Cores were collected from the R.V. Bay Eagle, (Virginia Institute of Marine Sciences; VIMS) using an 8.9 cm diameter vibracore. The core sites selected were all off the main, dredged channel of the river, where preliminary sampling had indicated accumulation of soft sediments, and away from likely obstructions. Water depths ranged from 4.1 m for Core 3 to 5.2 m for Cores 2 and 5.

Core sections were kept vertical in the dark at approximately 4°C in a refrigerator and transported to VIMS for examination, sectioning and sampling. Each core was sliced, photographed and visually described at the time of processing using standard soil descriptions (Casagrande 1948; Munsell Color 1990). Depending on the features noted, samples were taken at different increments. Samples were collected at least 1 cm away from the edges of the core to avoid areas that might have been mixed by the coring. Contaminant and radionuclide sampling was more intense near the surface of the cores where relatively modern changes in the pollutant concentrations are expected. Sub-samples were collected for subsequent analyses for grain size (gravel, sand, silt and

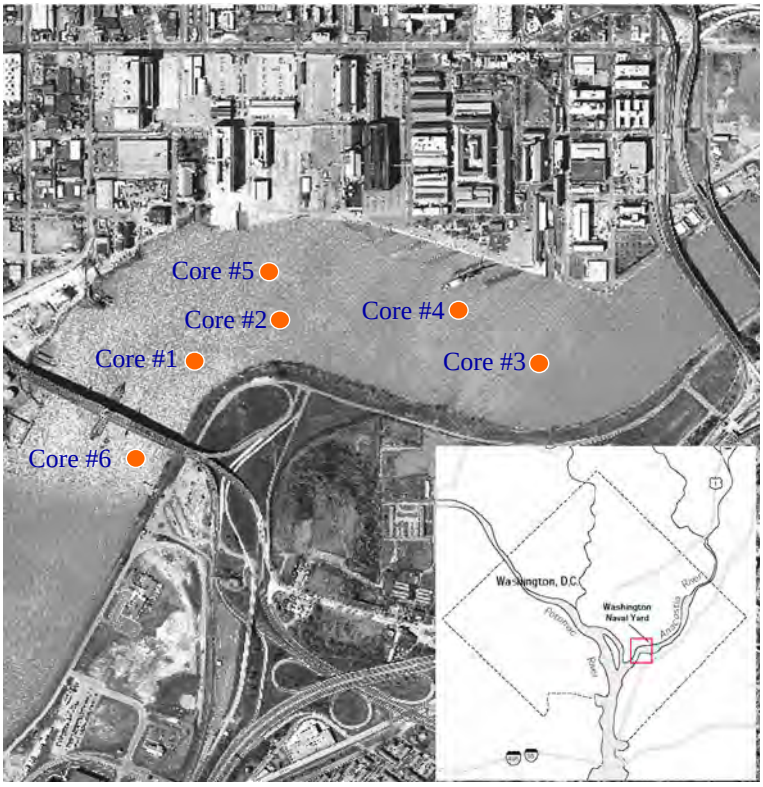

Fig. 1 An aerial photograph of the lower tidal region of the Anacostia River, showing the sites where cores were collected. Inset shows entire Washington D.C. region

clay), organic carbon, total trace metals (Al, As, Cd, Cr, Cu, Fe, Hg, Ni, Pb, and Zn), PAHs (polycyclic aromatic hydrocarbons, ~41 compounds), DEHP (di-(2-ethylhexyl) phthalate), total PCBs (polychlorinated biphenyls, ~100 congeners), and selected organochlorine pesticides (OCPs) including DDXs and chlordanes. DDX is comprised of parent DDT and its breakdown products (2,4'+4,4' forms of DDT (1,1'-(2,2,2-trichloroethylidene) bis[4-chlorobenzene]; DDE (1,1'-(2,2,2-trichloroethenylidene)bis[4-chlorobenzene]) and DDD (1, 1'-(2,2-dichloroethylidene)bis[4-chlorobenzene]). Chlordane is a multi-component mixture of polychloro-methanoindenes (e.g., oxy-, γ-, and α-chlordane, heptachlor, heptachlor epoxide and *cis*+*trans*-nonachlor). Alpha (α)-chlordane, gamma (γ)-chlordane, heptachlor and trans-nonachlor are the dominant constituents (Dearth and Hites 1991) while oxy-chlordane is a breakdown product). The cores were also analyzed at intervals for lead-210 (^{210}Pb) and cesium-137 (^{137}Cs), to determine sediment accumulation rates and an age–depth relationship. Samples for contaminants were stored in pre-cleaned ICHEM jars at −20°C while grain size samples were stored in plastic baggies at 4°C.

Sediment samples for organic contaminant analyses were extracted with dichloromethane using a Soxhlet apparatus and PAHs quantified using a capillary gas chromatograph coupled with a mass spectrometer (GC-MS; Ashley and Baker 1999). After PAH determination, the samples were further cleaned-up using Florisil, and congener specific PCBs and OCPs were analyzed using a gas chromatograph equipped with a ^{63}Ni electron capture detector (Ashley and Baker 1999; Kucklick et al. 1996). DEHP was analyzed by solvent extraction and GC-MS using EPA Method 8270 (semi-volatile organic compounds).

For all trace elements except Hg, dry sediment samples were digested with HCl, HNO_3, HF, and $HClO_4$ (Van Loon 1985). Silver and Cd were measured by graphite furnace atomic absorption spectrometry (Perkin Elmer 5100 PC), Cu, Fe, Mn, Ni, Pb, and Zn were analyzed by flame atomic absorption spectrometry, and Al and Cr were analyzed by ICP-MS using a Perkin Elmer Elan DRCII. Arsenic (As) was analyzed by hydride generation atomic absorption spectrometry (Andreae 1977; Braman et al. 1977). A separate H_2SO_4/HNO_3 wet digest was used for mercury. Total mercury was analyzed by cold vapor ICP-MS, using a using a Perkin Elmer FIAS 400 Hg analyzer. Extensive QA/QC was carried out in conjunction with the analysis of both trace organics and trace elements, including procedure blanks, duplicate preparations and analyses, standard reference materials, and spiked samples. All contaminant results are reported on a dry weight basis.

Selected samples were analyzed for ^{210}Pb and ^{137}Cs (see Fig. 4 for the sampling depths for ^{210}Pb). Dried sediments were non-destructively analyzed for ^{137}Cs on a Canberra germanium detector. After the extraction procedure of Flynn (1968), with some of the modifications by Benoit and Hemond (1988), the analysis of ^{210}Pb (T1/2 = 22.3 years) on these sediments was carried out via the analysis of its daughter radionuclide, ^{210}Po (polonium-210; T1/2 = 138 days).

Quality assurance

Analytical quality assurance was measured using surrogate analytes and spike recoveries to monitor degree of analyte loss during analytical preparation of samples, duplicate and triplicate analyses of samples to quantify analytical precision, and analyses of standard reference materials to assess analytical accuracy.

Each of the core samples was spiked with PCB congeners 14, 65, and 166, which were never industrially made and are not found in environmental matrices. These congeners were used as surrogates to assess analytical loss of PCBs throughout laboratory procedures. The average surrogate recoveries for 14, 65, and 166 were 79 ± 19%, 70 ± 12% and 83 ± 29%, respectively. Samples were also spiked with three per-deuterated PAH compounds to act as surrogates to quantify PAH loss. Recoveries of phenanthrene-d10, acenaphthene-d10, and anthracene-d10 were 67 ± 23%, 75 ± 24% and 83 ± 61%, respectively.

For PCBs and OCPs, the National Institute for Standards and Technology (NIST) standard reference material (SRM 1944, New York/New Jersey Waterway Sediment) was used to evaluate

extraction efficiency and analytical accuracy. Six SRM analyses were conducted throughout the study and an average value was used for comparison with certified NIST values. Average PCB recovery was 66% while average OCP recovery was 98%.

Duplicate analyses were performed at a frequency of approximately 10% for PCBs and OCPs. The mean relative percent difference (RPD) for t-PCBs in duplicates was 17%. The mean RPD for total DDXs and chlordanes was 13% and 12%, respectively. Duplicate analysis was also performed for PAHs with an average RPD for t-PAHs of 11%. Random triplicate analyses were conducted on two core sections. The average relative standard deviation (RSD) for these triplicates was 24% for t-PCBs, 14% for total DDXs, and 11% for chlordanes. The mean RSD value for PAHs was 3%. Additionally, the average RPD value for sediment organic carbon was 4% (excluding two samples with higher RPD).

Samples were analyzed for total metal content using digestion with HF. The following trace metals were analyzed: Ni, Cu, Zn, Mn, Cr, Al, Cd, Fe, Pb, and Ag. Two SRMs were used for calculating recoveries: NIST SRM 1646 (estuarine sediment) and National Research Council Canada MESS 2 (marine sediment). Seven analyses using SRM 1646 yielded average values that were compared to NIST values with recoveries for metals as follows: Ni (89 ± 1%), Cu (98 ± 5%), Zn (79 ± 6%), Mn (96 ± 2%), Cr (77 ± 8%), Al (93 ± 6%), Cd (79 ± 4%), Fe (97 ± 1%), Pb (57 ± 9%), and Ag (86 ± 65%, no HF). Comparatively, the MESS-2 SRM was analyzed five times with the following recovery values: Ni (93 ± 2%), Cu (88 ± 3%), Zn (85 ± 2%), Mn (93 ± 2%), Cr (83 ± 3%), Al (80 ± 9%), Cd (66 ± 1%), Fe (89 ± 2%), Pb (93 ± 1%), and Ag (39 ± 43%, no HF).

In addition to the use of standard reference materials, selected samples were spiked with known amounts of metals and used for recovery purposes. Average percent recoveries for spiked samples were as follows: Ni (100 ± 2%), Cu (108 ± 7%), Zn (0.5 ppm, 86 ± 13%), Zn (2.5 ppm, 94 ± 2%), Cr (105 ± 28%), Al (111 ± 6%), Cd (95 ± 4%), Fe (100 ± 3%), Pb (81 ± 1%), and Ag (88 ± 31%, no HF).

Results

Core descriptions, grain size, and total organic carbon

Color photographs, detailed descriptions of the cores, and summary tables of results of the analyses are available at: http://www.serc.si.edu/labs/trace_metals/poplar_point_data.aspx. Upper layers of the cores were largely fine grained mud, clay or mud/silt mixtures. Some areas of the fine grained sediments were visibly laminated, but others were mottled, suggesting vertical mixing. Gas pockets, ranging from small bubbles to large voids, were common in the fine grained sediments. All the cores except #3 penetrated to sand and even gravel layers suggesting that we reached zones below the modern era of sedimentation in the Anacostia (Fig. 2).

Sediment organic carbon (OC) concentrations ranged between <0.05 and 6.7% on a dry weight basis (dw) for all sediment samples with an average of 2.7 ± 0.8% OC (±standard deviation). The surface sediment OC content for all cores was similar averaging (±SD) 3.0 ± 0.3% OC. In all cores, the surface to 100–140 cm depth had similar distributions of OC with a very slight decrease or more variability with depth (Fig. 3). The increase in OC variability is most likely due to changes in sediment type (sand versus clay + silt) in the bottom sections of some cores.

Radiometric dating

^{137}Cs profiles did not display a classic onset, maximum and decline near the surface, instead showed rather steady increases from a depth in the sediment, then a broad and relatively constant region near the surface. This is likely due both to biological and tidal mixing, and possibly disturbance in the coring process. The tidal Anacostia River sediments are characterized by a layer of "fluid mud" which is quite mobile (Scatena 1987). We have tentatively assigned the depth of the first detection of ^{137}Cs to 1954, early in the cold war nuclear bomb testing period. Since it is likely that some ^{137}Cs mixed down into the sediment due to biological and tidal mixing as well as during

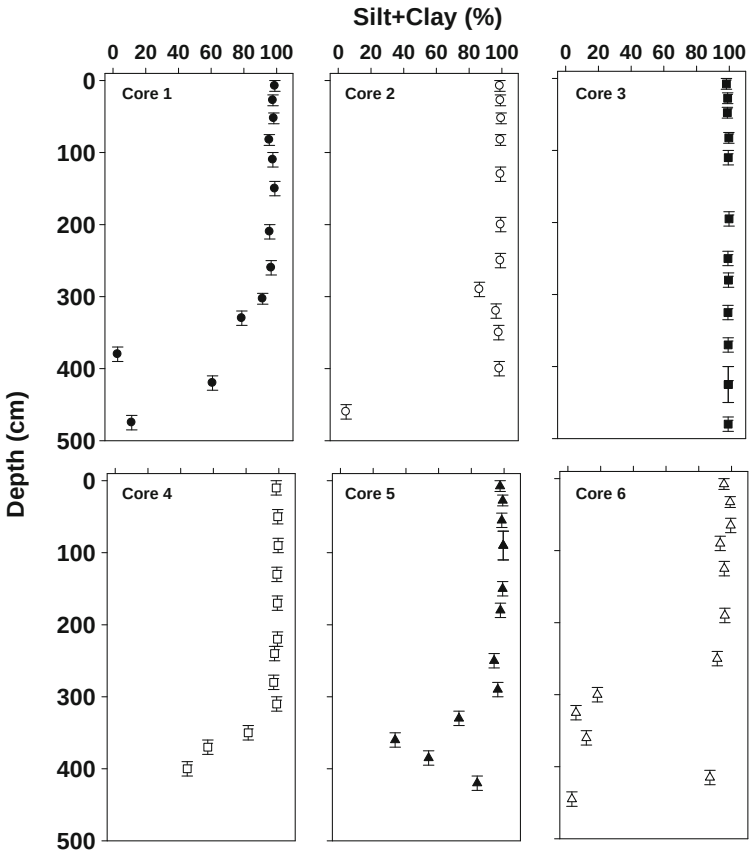

Fig. 2 Silt + clay (<63 μm) fractions in the sediments with depth. *Bars* show the interval sampled

the coring process, this likely overestimates the depth of the ^{137}Cs onset horizon, and thus, causes the ^{137}Cs based age–depth estimates and sedimentation rates to be biased (i.e., younger apparent age). On the other hand, ^{137}Cs may not be detected in the earliest sediment due to dilution and low concentration, which may tend to offset that bias. In short, while the ^{137}Cs horizons are a way to estimate an age for a particular depth horizon, it is not an ideal aging tool. Results of the analysis of ^{210}Po from the cores are shown in Fig. 4. In ideal circumstances (constant sedimentation rate and constant ^{210}Pb input, and no sediment mixing), ^{210}Pb should decline exponentially with the depth/age of the sediment, reaching an asymptote corresponding to the activity of ^{238}U in the sediment, which is called the "supported ^{210}Pb". Our cores do not clearly fit this model. We often see a more rapid exponential decline in the top 100–150 cm, followed by a lower exponential decline. It is not clear whether a constant asymptote is reached as the sandy strata contain very little ^{210}Pb, which not surprising, since they carry low levels of trace elements.

Other methods for dating sediments can be used to help reconstruct contaminant chronologies in high energy areas like the Anacostia River. Use of different radioisotopes (^{239,240}Pu; Santschi et al. 2001), storm deposits of sand layers (Benninger and Krishnaswami 1981; Scatena 1987); stable isotopes of Pb or other elements (Brännvall et al. 1997), and pollen (Brush 1984; Cooper and Brush 1991) have all been helpful in reconstructing historical changes of chemical contaminants. In the Anacostia, while there are some discrepancies between methods used, the dating method and contaminant profiles do provide a good historical assessment of contaminant changes over time and allow an appraisal of whether pollution controls have been effective.

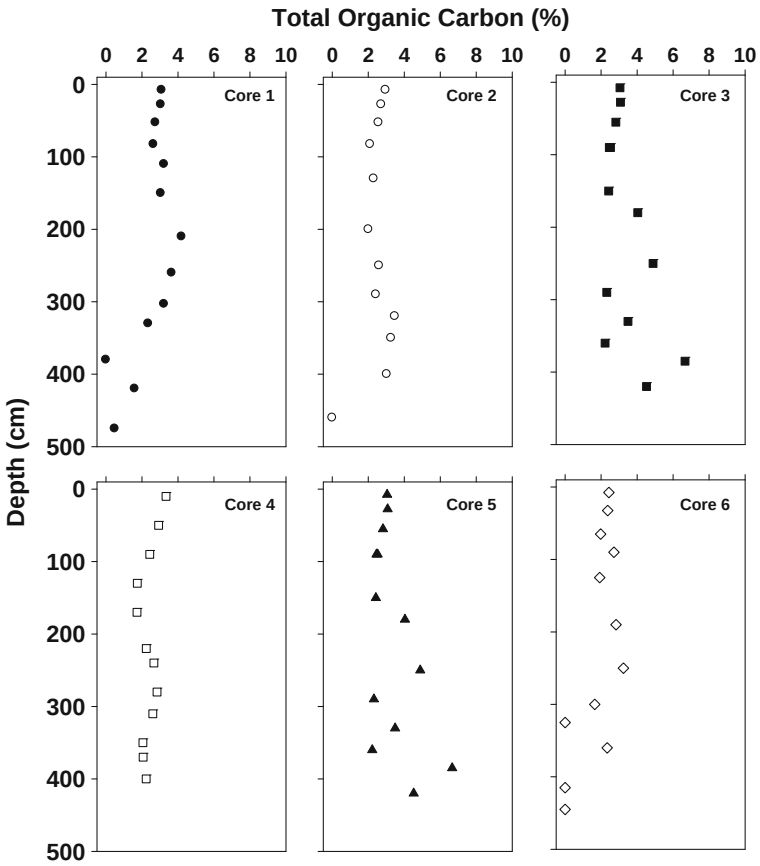

Fig. 3 Total organic carbon in the cores collected cores from the lower tidal Anacostia River

Sedimentation rates derived from the deepest occurrence of ^{137}Cs ranged from 4.0 to 6.5 cm years^{-1} (Table 1) and mass sedimentation rates were correspondingly higher. In general, our ^{137}Cs sedimentation rates are about 20% lower than our ^{210}Pb (results not shown). The fact that ^{210}Pb rates yield dates that indicate that sediments containing substantial quantities of PCBs (and other contaminants) were deposited before they were produced in mass quantities (see below), suggests that, though flawed, the ^{137}Cs estimated dates and sedimentation rates are probably better than the ^{210}Pb estimates, at least near the surface where the ^{137}Cs is found.

The rates of sedimentation in the lower Anacostia are, in general, three to ten times higher than mainstem Chesapeake Bay rates, generally 3–5 kg m^{-2} years^{-1} (Officer et al. 1984), much higher than "typical" tributary rates (1–2 kg m^{-2} years^{-1}; Brush 1984), somewhat higher than other reported upper Potomac rates (1.7 to >8.3 kg m^{-2} years^{-1}; DeFries 1986), higher than the non-dredged areas of Baltimore Harbor (~3 kg m^{-2} years; Cornwell and Halka, unpublished), and similar to rates in the lower Anacostia previously published (6 to 21 kg m^{-2} years^{-1}; Velinsky et al. 1997). Overall, the sedimentation rates in the Anacostia are comparatively high.

Core 6 seems to have been anomalous from the perspective of ^{210}Pb and ^{137}Cs dating and the distribution of contaminants. The activity of both isotopes was much lower than in all the other cores, and contaminant concentrations were similarly skewed. It appears that either a significant portion of the top of this core was lost in sampling, or that this area of the river is no longer accreting sediment and may even be losing sediment to erosion. For this reason, Core 6 is excluded from

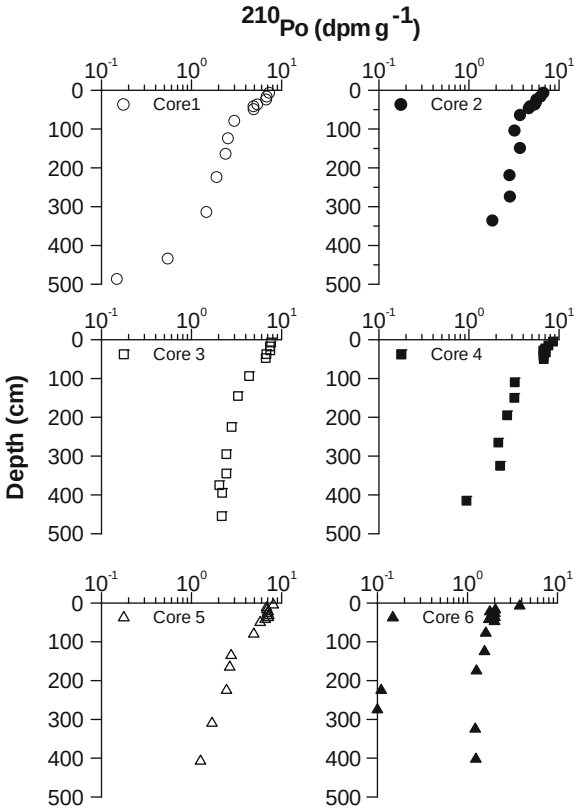

Fig. 4 Activities of ^{210}Po (surrogate for ^{210}Pb) in the cores collected cores from the lower tidal Anacostia River

most of our considerations of contaminant age and distributions below.

Sediment organic contaminants

Total PCB (tPCB) concentrations, the sum of 107 analyzed congeners, ranged from near or below the method detection limit (1.2 ng g^{-1} dry weight; mean plus three times the SD of the blanks) to approximately 2,900 ng g^{-1} dry weight (dw) with an overall average of 597 ng g^{-1} dw. Surface concentrations were similar (288 ± 25 ng g^{-1} dw; $n = 5$) in all cores increasing to a concentration maximum of 2,000–3,000 ng g^{-1} dw at depths ranging from 100 to 250 cm (Fig. 5). Except in Core 3, concentrations of tPCBs decreased to near the detection limit within the bottom sections.

The 107 congeners were placed into groups by the number of chlorine moieties (e.g., chlorination level Cl5 contains measured congeners with 5 chlorines). In addition, the chlorination levels were summarized into low molecular weight congeners (LMW; Cl1 to Cl5) and high molecular weight congeners (HMW; Cl6 to Cl10). Assessment of blank levels is important in this analysis; given an MDL for tPCBs of approximately1.2 ng g^{-1} dw, we assumed that the congener pattern would be significantly biased by the blank at concentrations below a value 10 times the MDL, or approximately 12 ng g^{-1} dw and disregarded samples below this concentration for pattern analysis. The changes in the LMW to tPCB ratio along with chlorination patterns revealed some interesting changes with depth which may be related to changes in source(s) or degradation of PCBs. The change in the chlorination distribution is illustrated for Core 1 in Fig. 6. The LMW/tPCB ratio was approximately 0.5 in the surface sections, decreasing with depth. This ratio was fairly constant with depth to just below the concentration maximum where it then decreased to a minimum value indicating that the sediments were dominated by higher molecular weight congeners. Below the tPCB peak, the chlorination pattern indicated a predominance of higher molecular weight congeners in the Cl6 and Cl7 group. In the sections above the peak in concentration, the pattern shifted to congeners with three to five chlorines on the PCB molecule (peak in Cl4

Table 1 Sedimentation and accumulation rates from cores taken in the lower tidal Anacostia River

Core	^{210}Pb-based mass accumulation (kg m^{-2} year^{-1})[a]	^{210}Pb Sedimentation Rate (cm year^{-1})	Depth interval for first detection of ^{137}Cs (cm)	^{137}Cs sedimentation rate (cm year^{-})
1	18.1	3.4	170–220	4.0 (3.5–4.5)
2	10.1	NC	>340	>6.9
3	22.1	4.6	300–340	6.5 (6.1–6.9)
4	10.2	3.3	200–260	4.7 (4.1–5.3
5	13.9	2.8	170–220	4.0 (3.5–4.5)

NC not calculated
[a]Rates not corrected for sediment focusing

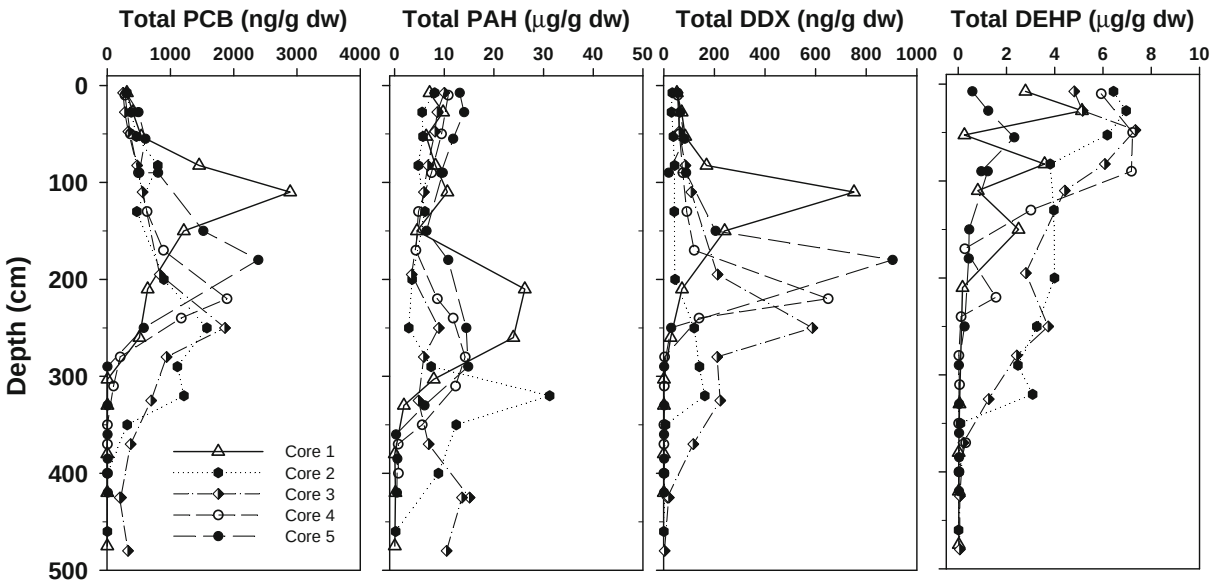

Fig. 5 Depth distribution of tPCBs, tPAH (39 compounds), tDDX (DDT, DDD, and DDE) and DEHP (bis (2-ethylhexy) phthalate)

group). Some degradation of the PCB molecule is expected, but it would tend to shift the higher molecular weight congeners to lower molecular weight congeners in the same group over time (Brown et al. 1984, 1987; Quensen et al. 1988, 1990). This is not evident in the patterns from the lower tidal river cores. It is possible that the shift in the PCB pattern towards the surface is related to increasing proportions of atmospherically derived PCBs with lower molecular weight congeners relative to runoff sources with greater amounts of higher molecular weight congeners (Foster et al. 2000; Hwang and Foster 2008). However, the watershed to water surface area ratio is large (i.e., small water surface compared to total watershed) and the loadings are dominated by watershed sources (Foster et al. 2000; MDE 2010). Therefore, we suspect that a shift in source has occurred over time with Aroclors containing more chlorines (possibly Arochlor 1254 and 1260)

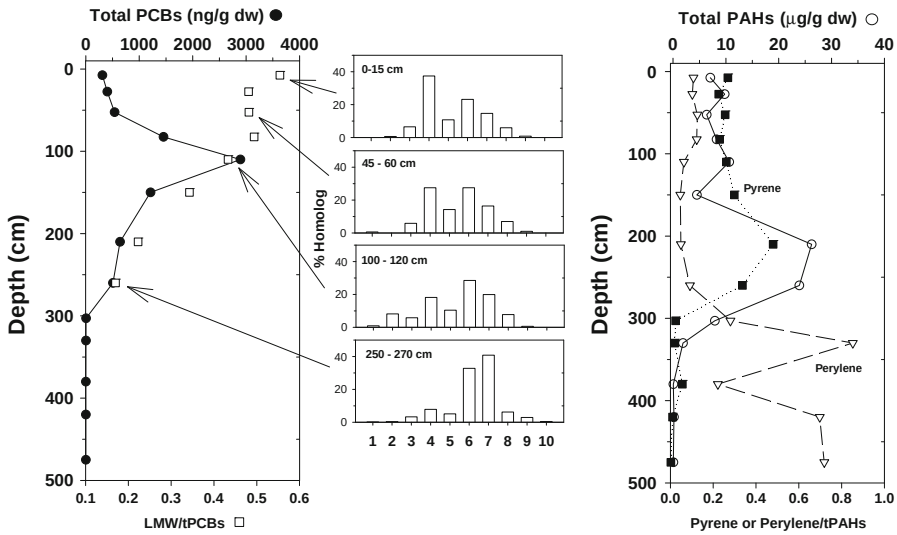

Fig. 6 Compositional distribution of PCBs and PAHs in Core 1

being used earlier and less chlorinated Aroclors (possibly Aroclor 1016 or 1242) being used later.

The PAHs for this analysis comprised 34 individual compounds ranging from the lower molecular weight naphthalene and phenanthrene (2- and 3-rings) to higher molecular weight compounds with 4- and 5-rings, including pyrene and dibenz[*a*,*h*]anthracene. Total PAHs (the sum of all methyl-substituted and unsubstituted forms quantified) ranged from 0.01 to 32 μg g^{-1} dw with generally similar profiles for most cores (Fig. 5); generally low concentrations at the bottom of the core, increasing to a mid depth maximum of 20–32 μg g^{-1} dw between 200 and 450 cm below the surface, a mid-depth minimum near 5 μg g^{-1} dw above, and a slight increase towards the surface values of circa 10 μg g^{-1} dw.

The composition of the total PAH by individual compounds is shown for Core 1 as a function of depth in Fig. 6 as an example. Differences in the distribution of parent PAHs and methyl-substituted PAHs can be used to determine the origins of hydrocarbons (i.e., pyrogenic versus petrogenic; Sanders and Scott 2002). The ratio of phenanthrene to anthracene was less than 10 (Sanders and Scott 2002; Wise et al. 1988) and fluoranthrene to pyrene ratios were greater than 1 (Budzinski et al. 1997) indicating more pyrogenic or combustion related sources.

Also notable was the presence of perylene (5-ring PAH) within all cores. Perylene has both anthropogenic and natural sources: it is thought to be a product of diagenesis of marine and terrestrial organic matter (Venkatesan 1988) and also may be produced through the incomplete combustion of fossil fuels (Reddy et al. 2002). The concentration of perylene remained relatively constant with depth for most cores with a slight increase towards the surface, especially after the PAH peak occurred. However, when each PAH was normalized to the total and expressed as a percent, a dramatic shift in the percentage of perylene was observed. In the deeper portions of each core, perylene accounted for between 80% and 95% of the total PAHs (Fig. 6). This pattern shift is similar to that found in Lake Washington cores (Wakeham et al. 1980) where the top of the cores (dated around 1965) contained many PAHs, with fluoranthene and pyrene being the two most abundant. In their core, perylene dominated in the pre-1850s decades. The relative paucity of other PAHs well below the PAH peak, and the fairly consistent perylene concentrations throughout the cores, suggests that an influx of PAHs occurred at some point to overwhelm the background 'pre-industrial' profile that is dominated by perylene.

Measurable concentrations of the phthalate ester (DEHP) were found in all cores. The highest concentrations of DEHP were in the upper 200 to 300 cm of each sediment core (Fig. 5). Subsurface maxima of up to 7,500 ng g^{-1} dw were observed, with concentrations decreasing to less than the MDL (50 ng g^{-1} dw) in deeper layers.

The parent and breakdown products of DDT (Fig. 5) and chlordane (not shown) were detectable in the upper sections of each core. DDT and its breakdown products DDE and DDD, are collectively designated as DDXs. Total DDXs (tDDX) ranged from <1 ng g^{-1} dw at the bottom of the cores to approximately 900 ng g^{-1} dw (average of 90 ng g^{-1} dw). There was a subsurface maximum in tDDX at depths from 100–250 cm, ranging from circa 600 to 900 ng g^{-1} dw. The concentrations of tDDX decreased towards the surface concentrations of 50 ± 9 ng g^{-1} dw ($n = 5$).

Chlordane had a distribution similar to DDXs, having low concentrations at the bottoms of the cores, and a subsurface maximum at depths ranging from 100 cm in Cores 1 and 3, to approximately 180 to 200 cm in Cores 4 and 5. Surface sediment concentrations were fairly consistent (48 ± 6 ng g^{-1} dw; $n = 5$). Peak concentrations of total chlordane reached as much as 98 ng g^{-1} dw (average $\pm 1\sigma$ of 81 ± 11 ng g^{-1} dw) at depths from 100–250 cm. In most cores (except Core 3), there was a sharp decrease below the peak concentration to levels below the method detection limit (ca., 1.5 ng g^{-1} dw), while concentrations in Core 3 broadly decreased to values <1.5 ng g^{-1} dw.

For all organic contaminants (i.e., PCBs, DDXs, DEHP and PAHs) there was no relationship between concentration and the amount of fine grain sediment present (<63 μm). In all cores, above approximately 300 cm, the majority of the sediment was fine grain material. Overall, the median grain size was 98% silt and clay material. In addition, as stated above, there was not a large variation in organic carbon abundance in

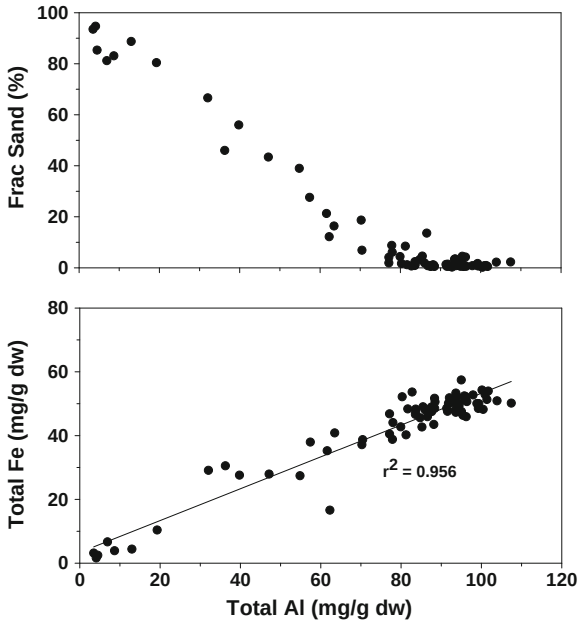

Fig. 7 Relationship between sand fraction and total aluminum (*top*) and total iron and total aluminum the sediments

each core (i.e., average and median concentration approximately 2.6% OC). As such, depth profiles of organic carbon normalized concentrations for each contaminant class were similar to profiles for dry weight concentrations. Therefore, grain size and organic carbon were not controlling the depth distribution of various organic contaminants.

Sediment trace metals

Aluminum Aluminum (Al) concentrations in the sediments ranged from about 3.5 to 107 mg g^{-1} dw, with an average ($\pm 1\sigma$) of 78 ± 27 mg g^{-1} dw. The sand and gravel regions of the cores had substantially lower Al concentrations. There was a strong negative correlation between Al and the % sand (Fig. 7). Aluminum was used to normalize sediment trace elements in order to reduce the effects of grain size (Schropp et al. 1990) and to help determine background concentrations.

Iron Iron (Fe) is the first in a group of three metals (Fe, Mn, and As) which showed a similar pattern; a roughly constant concentration with depth except for enrichment in some deep sandy layers. Iron ranged from 2 to 57 mg g^{-1} (average ± 1σ of 42 ± 14 mg g^{-1} dw) but the majority of the sediments collected were between 45 and 55 mg g^{-1} dw (Fig. 8). There were zones of low Fe in the same regions as zones of low Al, and the profiles of Fe and Al appear nearly parallel (i.e., the ratio of Fe:Al was approximately 0.55 wt:wt). After normalization to Al, vertical variations in Fe due to grain size were largely eliminated (Fig. 9). However, some regions of low total Al are seen to

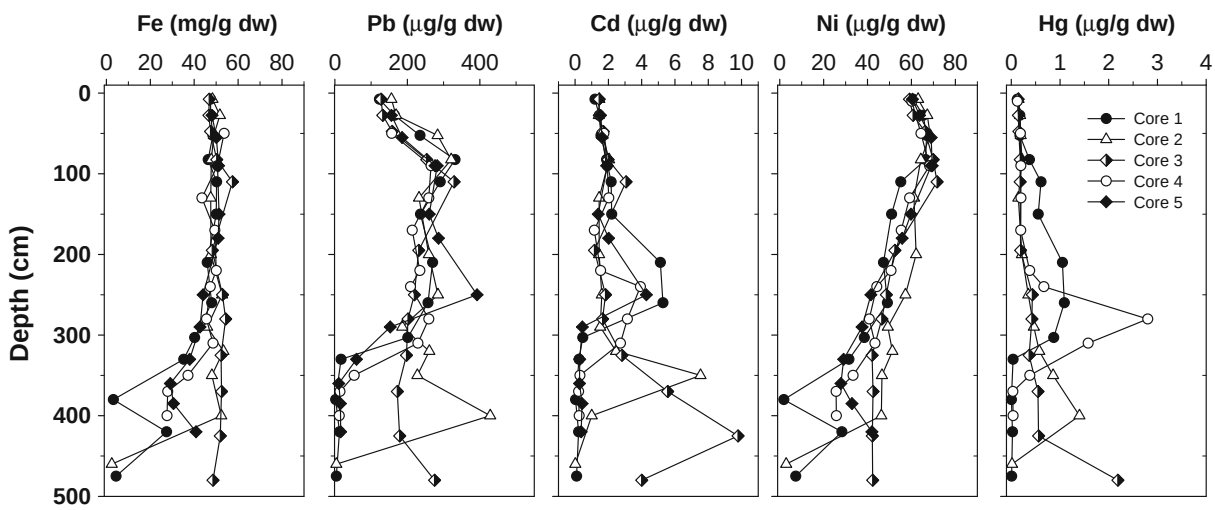

Fig. 8 Depth distribution of total sediment concentrations of iron (Fe), lead (Pb), cadmium (Cd), nickel (Ni) and mercury (Hg) in cores from the lower tidal Anacostia River

have enriched Fe:Al, e.g., the 370–390 cm depth of Core 1, and in lower sections of Cores 5 and 6.

Manganese Manganese (Mn) ranged from 12 to nearly 1,200 mg g^{-1} dw with the majority of sediments in the non-sandy regions ranging from 400 to 800 mg g^{-1} dw. The ratio of Mn to Al was nearly constant around 0.007 wt:wt, with high values occurring at the same sandy regions in which Fe was observed to be enriched (Fig. 9).

Arsenic Total arsenic (As) in non-sandy sediments ranged around 10–17 μg g^{-1} dw (average ± 1σ of 11.7 ± 4.8 μg g^{-1} dw) with higher values found generally deeper in the cores. Low concentrations of As occurred in the sandy sediments with low Al values and when normalized for Al content, there is a pattern of enrichments resembling Fe and Mn (Fig. 9).

Cadmium Cadmium (Cd) is the first in a group of elements (Cd, Cu, Hg, Pb, Ag, and Zn) to show a three-layer profile related to anthropogenic contamination. Cd concentrations in the sediment ranged from less than 0.05 μg g^{-1} dw to slightly less than 10 μg g^{-1} dw. Surface Cd concentrations of about 2 μg g^{-1} dw were above a high region (4–10 μg g^{-1} dw) and above a low level (<0.5 μg g^{-1} dw), at different depths in different cores (Fig. 8). Normalization to Al did not substantially alter the profiles (Fig. 9).

Copper Copper (Cu) in the surface sediments ranged from 90 to 107 μg g^{-1} dw, with an overall average (±1σ) of 89 ± 51 μg g^{-1} dw. Cu generally followed the pattern of cadmium, with the surface layer averaging nearly 100 μg g^{-1} dw, the subsurface maximum between 150 to 200 μg g^{-1} dw and a deep "clean" layer between 15–40 μg g^{-1} dw. Normalization with Al did not alter the general shape of the profiles, although there was slight enrichment at the same sandy depths where Fe, Mn, and As were enriched (see Fig. 9).

Mercury Mercury (Hg) concentrations ranged from <0.01 to 3.0 μg g^{-1} dw with an average (±1σ) of 0.44 ± 0.60 μg g^{-1} dw. Surface Hg concentrations were circa 0.2 μg g^{-1} dw, rising to 1–3 μg g^{-1} dw in the middle regions, and declined to less than 0.05 μg g^{-1} dw in the bottom, except Core 3 (Fig. 8). Normalization of Hg to Al produced little change in the shapes of the profiles (Fig. 9).

Lead Lead (Pb) concentrations in all sections ranged from <1 to 428 μg g^{-1} dw, with surface sediment concentrations ranging from approximately 120 to 150 μg g^{-1} dw, mid depth maxima

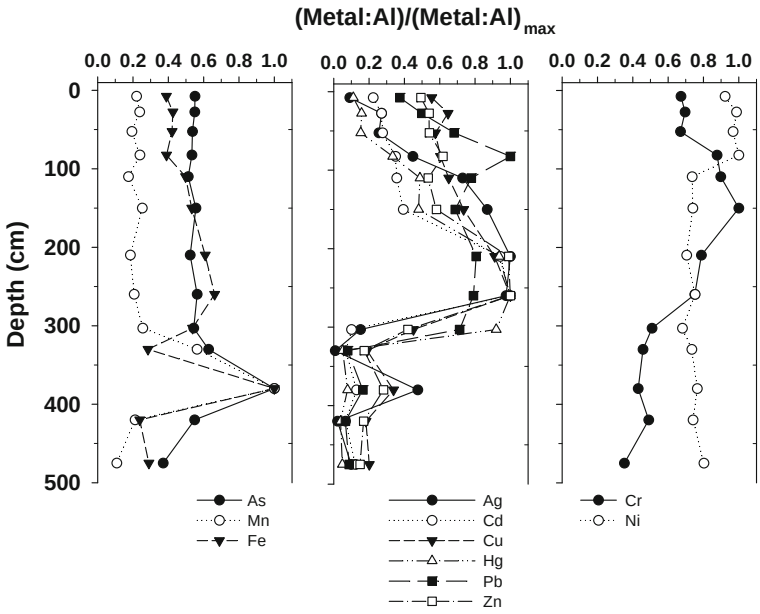

Fig. 9 Metal to Al ratio for all metals in Core 1. The metal:Al ratios were normalized to the maximum ratio $(metal:Al)_{max}$ for each metal so that 1 is the highest value for each metal

of up to 350 μg g^{-1} dw and concentrations of circa 5–20 μg g^{-1} dw in the bottoms layers. Unique even among the six "three layer elements", Pb frequently had two maxima with depth (Fig. 8). Normalization to Al produced little apparent change in the shapes of the Pb profiles except for a slight enrichment in the "Fe, Mn" zone (Fig. 9).

Silver Silver (Ag) near-surface concentrations of Ag were circa 2–5 μg g^{-1} dw, above a high level, circa 10–20 μg g^{-1} dw above a low level, <0.5 μg g^{-1} dw. Normalizing Ag to Al produced few changes in the profiles, except for the common slight enrichment in the same region where Fe, Mn, and As were strongly enriched (Fig. 9). However, the limit of detection for Ag (0.2 μg g^{-1} dw) was often approached and caution is warranted when interpreting the ratios under these circumstances.

Zinc Zinc (Zn) ranged from 2 to 753 μg g^{-1} dw. Surface sediment concentrations were generally around 400 μg g^{-1} dw. Zinc concentrations in the mid-core maximums reached 700 μg g^{-1} dw and concentrations in the lower "clean" zone were generally less than 100 μg g^{-1} dw. Normalization to Al did not produce distinctive changes in the shape of the profile except to show a slight enrichment in the "Fe–Mn" zones (Fig. 9).

Chromium Chromium (Cr) and nickel (Ni) were two elements that did not conform closely to the patterns seen for the previous elements. Chromium showed a pattern similar to the "three layer pattern", but much less distinctive. Concentrations ranged from <1 to 224 μg g^{-1} dw, averaging ($\pm 1\sigma$) 96 ± 49 μg g^{-1} dw. Surface sediments concentrations ranged from 90–100 μg g^{-1} dw, and generally increased with depth to a mid-depth maximum of 150–200 μg g^{-1} dw, then decreased to concentrations of circa 50 μg g^{-1} dw at the bottom of the cores. Normalizing the concentrations of Cr to Al moderated, but did not eliminate many of the features observed with total concentrations (Fig. 9). In a few very sandy sediments, the Cr concentrations were below our MDL.

Nickel Overall average ($\pm 1\sigma$) nickel (Ni) for all sediments was 46 ± 16 μg g^{-1} dw, with surface concentrations of approximately 50–60 μg g^{-1} dw. Ni profiles were unlike any other element and did not reveal substantial contamination. The highest values generally occurred at or near the surface, with values declining to approximately 40 μg g^{-1} dw in deeper sediments (Fig. 8). Normalization to Al removed much of the apparent variation in Ni concentrations, except for a moderate (circa 40%) enrichment in the top layers (Fig. 9).

Discussion

Dating

Assigning valid dates to the sediment profiles with ^{210}Pb proved to be difficult in the lower portion of the tidal Anacostia River. The ideal asymptote with unvarying ^{210}Pb activity at depth was not observed in these cores and the dates obtained by fitting them to the CRS model did not agree with the single ^{137}Cs marker. This is likely a result of changes in the input of ^{210}Pb in the Anacostia as a result of land use changes which would violate the essential assumption of constant ^{210}Pb input in the CRS model (Appleby and Oldfield 1978). Increased inputs of the ^{210}Pb input from the land probably occurred with increased coverage of hard surfaces resulting in a poor retention of atmospheric ^{210}Pb delivered to the watershed. With the watershed and upper tidal river becoming hydrologically less retentive and "flashy", recent ^{210}Pb inputs to the lower river would be higher (i.e., not constant over time).

Evidence for focusing of ^{210}Pb into the lower Anacostia River depositional zones is shown by the cumulative excess ^{210}Pb (Table 1). Based on atmospheric deposition studies, the expected cumulative excess ^{210}Pb in the mid-Atlantic region would be ~25 dpm cm^{-2} (Kim et al. 2000). Thus, the cumulative ^{210}Pb inventory is 12–27 times higher than direct atmospheric deposition. If a focusing correction is applied to the four cores with estimated inventories, the normalized sedimentation rates (0.5–1.5 kg m^{-2} $year^{-1}$) are similar to other Chesapeake Bay sites (i.e., Cornwell et al. 1996; Officer et al. 1984). There may be a temporal disconnect between the inventory data and the

mass accumulation data, so these rates must be viewed as broad estimates.

Except for Core 1, the correspondence between the depths estimated for first ^{137}Cs occurrence (1954) and the CRS model-predicted depth of that age is poor. In general, the ^{210}Pb-based depth is significantly shallower. Moreover, the ^{210}Pb-based depths suggest the occurrence of PCBs prior to their initial introduction to the environment. The under-prediction of sedimentation rate results in an overestimate of sediment age. The potential impact of changing ^{210}Pb inputs is a serious challenge to the use of ^{210}Pb dating in systems with changing land use.

Because of the volume of sediments collected for contaminant analysis, the age-depth resolution of first occurrence of ^{137}Cs is coarse. The low resolution results in an imprecise estimate of age; however, these ^{137}Cs-based ages are consistent with known contaminant histories. All evidence indicates that recent sedimentation rates are high, circa 3–7 cm per year; similar to estimates by Scatena (1987). On the basis of the likelihood that ^{210}Pb dating is biased by changing ^{210}Pb inputs, and the apparent agreement of ^{137}Cs dates with the general timing of certain contaminants, we have used the ^{137}Cs sedimentation rate to assign dates within the cores, rather than the ^{210}Pb. However, it should be kept in mind that the further down the cores below the ^{137}Cs horizon we extrapolate, the greater the potential error and the greater the possibility that changes in sedimentation rate invalidates those estimates.

Contaminant history

A number of points of commonality between Cores 1 through 5 with respect to different contaminants have been assigned dates based on the ^{137}Cs sedimentation rates (Table 2). Given the coarseness of the sampling for ^{137}Cs dating and contaminants, the variation in dates for pollution horizons across the cores is reasonable.

The phthalate ester DEHP was first synthesized in 1933 and became an important component of polyvinyl chloride in the 1950s, with worldwide production increasing to 600–700,000 metric tons/year in the 1990s (ATSDR 1993; Harris et al. 1997). This is consistent with its appearance at approximately 1959 ± 6 years. Higher concentrations were still present in the near surface sediments showing only a slight decrease towards the sediment–water interface.

The maximum values of tPAH occurred at or below the onset of ^{137}Cs in 1954, with a mean estimated date of 1945 ± 9 years, suggesting that sources of PAHs have decreased since that period. In the more recent sections of all cores (i.e., top 200 to approximately 300 cm), fluoranthene and pyrene were the dominant aromatic hydrocarbons and accounted for between 20% to 60% of the total parent (unsubstituted) PAHs. Below approximately 250 cm, perylene (a 5 ring PAH) was dominant and at some depths accounted for between 80% and 95% of the tPAHs. The phenanthrene to anthracene (P/A) ratios were 0.7 to 3.8 (average ± 1 s of 2.1 ± 0.8) in the upper sections of all cores with somewhat higher values near the bottom sections of all cores. While these P/A ratios suggest combustion sources throughout the cores, there does appear to be more petroleum residues in the surface sediments and a shift to more combustion products in deeper sediment (Fig. 6).

Van Metre et al. (2000) found similar results within cores collected from older urban lakes with peaks corresponding to the 1950s. The overall decreasing trend post-1950 likely reflects the combined effects of the switch from coal and wood

Table 2 ^{137}Cs based dates for common identifiable horizons in the cores

Core #	PCB Peak	Chlordane Onset	DDX Peak	DEHP Onset	PAH Peak	Cd Peak	Cd Onset	Pb 2nd Peak
1	1973	1960	1973	1960	1949	1938	1932	1983
2	1966	1957	1957	1956	1957	1953	1942	1991
3	1964	1958	1966	1951	1939	1939	1928	1985
4	1957	1946	1957	1956	1945	1955	1934	1978
5	1959	1948	1960	1972	1935	1943	1935	1981
Mean ($\pm 1\sigma$)	1964 ± 6	1954 ± 6	1963 ± 7	1959 ± 8	1945 ± 9	1946 ± 8	1934 ± 5	1984 ± 5

to oil and natural gas in homes as well as improved air quality emissions after the implementation of the Clean Air Act in 1963 (amended in 1970 and 1990). In cores from this study and other studies (e.g., Lima et al. 2003; Van Metre et al. 2000), the decreasing trend in PAH levels over the past 50 to 60 years is offset by a slight but noticeable increase in concentration in more recent years. The increase in the number of vehicles driven in the watershed coupled with the longer commuting times may partially explain the greater input of PAHs. However, recent studies by Mahler et al. (2005) and Van Metre et al (2009) indicate that parking lot sealant (coal or asphalt based) is a major source to aquatic systems. Using ratios of fluoranthene to pyrene and benzo[*a*]pyrene to benzo[*e*]pyrene, among others, sealant material was suggested as a source. In the near-surface sediments of this study and previous studies (Velinsky and Ashley 2001), parking lot sealant was indicated as a recent source to the tidal Anacostia River, although not the only PAH source.

The peaks in tPCBs date from 1957 to 1973, with a mean of 1964 ± 6 years using ^{137}Cs onset in each core. Although PCBs were first synthesized in the 1880s, commercial production did not start until 1927 (Panero et al. 2005). US production was halted in 1977, although many items containing PCBs are still in use today. PCB production around the world has been largely discontinued since the mid 1990s (Breivik et al. 2002; Panero et al. 2005). Thus, peaks in PCBs in the early 1960s dates are consistent with their manufacture and use in the US. Additionally, changes in congener patterns, as noted in Core 1 (see above; Fig. 6) indicate that sources have changed over the decades.

DDT was first manufactured in large amounts as a pesticide during World War II and became a popular agricultural insecticide after the war. Its use in the US peaked in 1959, and declined thereafter due to the development of resistance by its target species and environmental concerns. It was banned in 1972, although it is still manufactured there for shipment abroad. This agrees with our findings of the tDDX maxima in our cores at or above the ^{137}Cs at 1963 ± 7 years.

Chlordane appeared at significant concentrations in the cores approximately coincident with the appearance of ^{137}Cs. The onset of chlordane use appears to date from 1954 ± 6 years. Chlordane was first manufactured in 1947, and banned for certain uses in 1978, with a complete ban on use in the United States in 1988. As with DDT, it is still manufactured in the US for shipment abroad. Again, this is generally consistent with its appearance in Anacostia River sediments around the 1954 period. The environmental half-life of chlordane is similar to that of DDT (i.e., approximately 10 to 20 years or longer; Incorvia Mattina et al. 1999; Van Metre and Mahler 2005; Meijer et al. 2001), and therefore its persistence is to be expected for many years.

The group of elements including Ag, Cd, Cu, Hg, Pb and Zn all show a similar contamination history in Cores 1–5. All show increasing concentrations at depths below the ~1954 ^{137}Cs onset marker, and most had attained their highest concentrations by that point. Extrapolating down the cores, using the sedimentation rates from the ^{137}Cs horizon to the sediment surface, it would appear that concentrations of these elements began to increase in the early twentieth century, or perhaps even the late nineteenth, if sedimentation rates were lower prior to the extensive build up of the Washington, DC urban area. While concentrations appeared to increase in the same general time frame, there were differences between metals. For example, in Core 1, Hg and Pb went from very low concentrations at 325 cm to nearly maximum concentrations at 300 cm, while Zn and Cu increased from background at 300 to approximately half of their maximum concentrations, and Ag and Cd showed negligible increase between 300 and 325 cm, but increased between 300 and 250 cm (Fig. 9). Each of these metals have a myriad of uses, which have changed through time as the region has gone from agricultural, through industrial, and now largely residential land periods, and we do not have sufficient information to explain these variations. Using the onset of Cd contamination as a model, we extrapolated that Cd and other metal contamination began to increase around 1934, and peaked near 1943. Due to sediment compaction and potential changes in sedimentation rate before the ^{137}Cs peak, these age estimates should be accorded less weight than points above or closer to the ^{137}Cs horizon.

After a rapid rise pre-1954, most of these trace metals began to decrease toward the present. Pb had a unique pattern; in most core profiles, lead began to decline towards the surface, started to increase again to a second maximum, and then declined to towards the surface again (Figs. 7 and 8). This pattern likely represents the influence of leaded gasoline, phased out in the US from 1975–1986. This second, more recent Pb maximum dates to 1984 ± 5 years, which suggests that it originated with leaded gasoline use, and declined after it was banned.

Chromium and Ni showed relatively little change in concentration with depth in the cores (particularly after normalization to Al). Chromium showed a weak maximum at mid-depth, and this maximum occurred at a mean date of 1961 ± 6 years. Nickel showed a moderate increase approaching the surface, well above the ^{137}Cs horizon, which appears to date to 1974 ± 4 years. Both Ni and Cr are important components of steels (a majority of the Ni used annually in the US is in stainless steel, and chromium is largely used for chrome plating or in steel alloys). Stainless steel usage is currently increasing at a rate of 5–6% annually (INSG 2006) so slow increases in Ni and Cr in receiving water bodies due to erosion of stainless steel are not unexpected.

Three metals, As, Fe, and Mn did not show significant variations in the top (and largely muddy) portions of the cores. They did, however, show variations which corresponded to the presence of sand and gravel layers at the bottom of the cores (indicative of a more fluvial environment than is currently present in that region of the Anacostia River). In some, but not all of these coarser layers, we observed that the concentration of these metals, corrected for Al, showed local maxima. We believe that this was caused by redox transformations and vertical and/or horizontal movements of these elements within the sediments. The sediment sections enriched in these elements were recorded as brown, olive or light gray sands, suggestive of a degree of oxidation of Fe in the sediments in contrast to the black, FeS-rich sediments above (and sometimes below) them. Movements of groundwater may provide oxidants (O_2 or NO_3^-) which can oxidize reduced metals, Fe^{2+}, Mn^{2+}, and As(III) diffusing into these zones, oxidizing them to Fe^{3+} and Mn^{4+} and As(V) and causing them to precipitate out as $Fe(OH)_3$, MnO_2 and $FeAsO_4$. This creates a concentration gradient that causes more of the reduced metals to diffuse in and be subsequently sequestered in this layer. Similar reactions are known to occur at the interface between anoxic sediments and oxic waters (Riedel et al. 1987, 1989, 1997, 1999).

Comparison to previous sediment data

Surface and core sediments have been collected in the Anacostia over the past 15 years (Velinsky et al. 1994, 1997; Velinsky and Ashley 2001; Wade et al. 1994; and current study). In 1995, sediment cores up to 300 cm long were collected on the opposite side of the lower tidal river (near the Washington Navy Yard) as this study (Velinsky et al. 1997). Maximum peak concentrations of lead and tPCBs in cores from 1995 were slightly lower than those taken in 2003 for tPCBs (i.e., 1,500 ± 1,300 ng/g dw, $n = 6$ versus 2,100 ± 520 ng/g dw, $n = 5$) but similar for total Pb (i.e., 250 ± 150 μg/g dw, $n = 6$ and 260 ± 33 μg/g dw, $n = 5$).

In both coring studies, maximum concentrations of tPCBs, tDDXs and most metals (e.g., Cu, Cd, Pb, and Zn) were measured below the surface suggesting a decrease in inputs over time. However, the rate of decline of concentration in the surface is generally low, so that given the spatial variability of sediment, the coarse depth resolution of the older core data, and the potential differences in sampling depths at different sites it is not surprising that we do not see a consistent decline in the contaminants in the surface at particular sites.

Surface sediment concentrations at various locations in the tidal river from 1989 to 2003 (the current study) are presented in Fig. 10. At the Poplar Point location, concentrations were similar throughout this time period, similar to other locations except near the Navy Yard and Government Services Administration (GSA) location across the river. At this location, concentrations of Pb and tDDX increased from 1989 to 2000, while tPCBs increased to 1995 then decreased in 2000. This location is near large storm water and

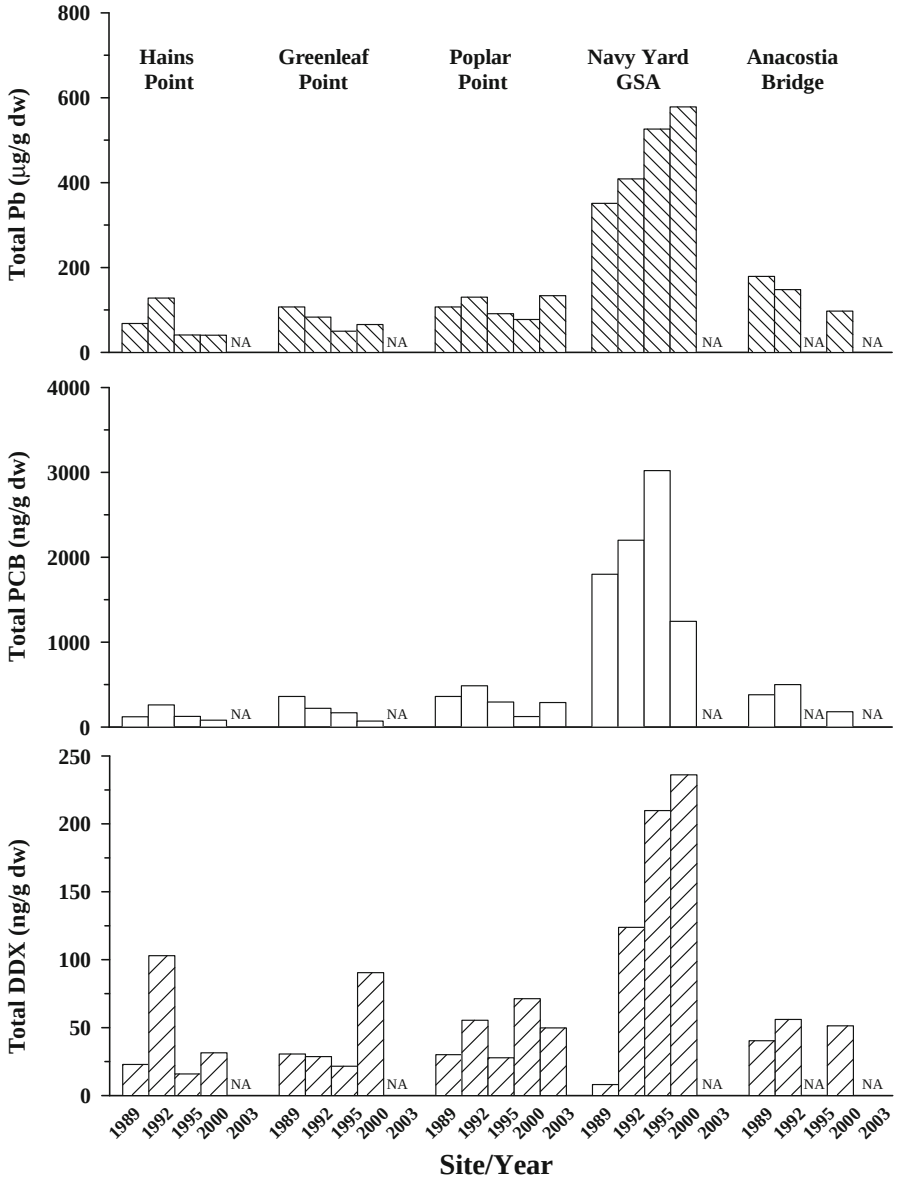

Fig. 10 Concentrations of three selected contaminants (Pb, tPCBs and tDDXs) in surface sediments from several sites from the tidal Anacostia River from 1989 to 2003

combined sewer outfalls that result in higher and more variable concentrations.

Cores have also been used to look at the history of contamination, regionally and nationally. Long et al. (2003) measured a similar suite of analytes in cores from lakes in New Jersey and New York, including three urban lakes and one rural lake. Given the number of analytes, making comprehensive comparisons between the studies is prohibitive, but many similarities are evident. They observed that many trace elements from the urban lakes showed a similar pattern to many of those in our study (e.g., Ag, Cd, Cu, Hg, Pb, and Zn); all at low concentrations deep in the cores, starting to rise sharply around the 1950s, and many of them showing a decline in the recent past (1980–present) in the urban sites. Similarly, they showed the onset of DDT and chlordane contamination in one urban lake shortly after their synthesis (the other cores did not reach that horizon) and a decline in PCB concentrations after its production in the US was halted. Not all

analytes behaved similarly between the studies, for example Zn, which in our study showed a strong pattern of rise and decline through time, while showing very little temporal change in the Long et al. study.

In another example, Van Metre and Mahler (2005) used dated cores to examine historical trends in organic contaminants in 38 rural and urban lakes. Some contaminants, including PCBs and DDXs showed downward trends since 1970, while chlordane showed both upward and downward trends in different systems. However, PAH trends were most often upward trends.

The future of contamination in the Anacostia River

The Anacostia River is one of three environmental "regions of concern" in Chesapeake Bay acknowledged by the USEPA (EPA 1994; the other two are Baltimore Harbor, MD and Elizabeth River, VA). As part of this selection process, PCBs, Hg, and PAHs (and others) were noted to be contaminants of concern. In addition, studies from the Anacostia Watershed Toxics Alliance (AWTA) indicated that there are a number of "hot spots", based on PCB and PAH levels in the sediments. These areas are located in the upstream and downstream tidal river and have multiple sources of contaminants. Recently, the Maryland Department of the Environment has issued PCBs loadings estimate (i.e., total maximum daily load or TMDL) for the non-tidal watershed and portions of the tidal waters within Maryland (MDE 2010); while the District of Columbia issued a TMDL and load estimates for the tidal waters in 2007 (US EPA 2007). In both studies, the amount of PCBs that can be introduced into the waters of the tidal Anacostia River needs to be substantially reduced. The goal is to reduce ambient water concentrations such that fish tissue from the river will be below consumption guidelines and with reduced risk to consumers. In this regard, the US EPA (2007) PCB TMDL recommends a loading reduction of over 90% (i.e., from ~30 kg PCB/year to 1.5 kg PCB/year) in order to meet water quality criteria. The District of Columbia government currently has advisories against consuming any fish caught in the Anacostia River, based on high concentrations of PCBs, chlordane and Hg (DC DOH 2006). Concentrations of several organic pollutants and several metals are above concentrations associated with adverse biological effects. What do the current findings in this study suggest for the future of contamination in the Anacostia River?

Many of the pollutants of concern in this system are decreasing in concentration in surface sediment with time. A combination of production bans/restrictions and pollution controls are important factors in this decrease. Total PCB concentrations have fallen from as much as 3000 ng g^{-1} dw in the late 1950s to early 1960s to 100–200 ng g^{-1} dw today. Chlordane has decreased from a concentration of 100 to 50 ng g^{-1} dw over the same period. While there are still "hot spots" within the river, both coring and surface sediment data indicate an overall decrease in chemical loadings. With the production and use of these compounds halted it seems inevitable that the declines in these compounds in surface sediments will continue. Trace metals, such as Ag, Cd, Cu, Hg, Pb, Zn, all show declines in concentration in recent sediment, although concentrations of most of them are all still elevated over concentrations in the deepest sediments sampled. The core and surface sediment data indicate that pollution controls over the past 40 years or more have resulted in a measurable decrease in contaminant loads and concentrations. The decrease in loadings is likely due to various bans and reduced use, and better point source controls and treatment. Reductions from contaminated waste sites/landfills and importantly combined sewer overflows and stormwater runoff will become more evident as better regulations are put in place. In addition, there is debate whether there are remedial actions that should take place (e.g., capping or dredging) that can help remove sediments with elevated concentrations versus the focus being more on source reduction and natural attenuation. As one of the main goals is to make the river fishable and swimmable (i.e., Anacostia 2032 Plan; US EPA 2007), this debate is important to resolve as there are limited resources. One important question that would be impacted by the direction of remediation is whether the apparent decrease in sediment bound contaminants

resulted in a similar decrease in contaminants in resident fish species within the Anacostia?

There have been only a limited number of fish contaminant studies within the tidal waters of the Anacostia River (see reviews in ASTDR 1998; Velinsky and Cummins 1996; Pinkney et al. 2001). Concentrations of total PCBs ranged from 1.1 to 2.5 and 0.2 to 0.6 μg g^{-1} wet wt over a 13-year period with no consistent decrease with time for channel catfish or largemouth bass, respectively (Velinsky and Cummins 1996; Pinkney et al. 2001). The fact that sediment levels of PCBs have declined by nearly a factor of 10 in the last 25 years (Fig. 5), suggests that present day inputs are still sufficient for bioaccumulation processes, from both water and sediments, to keep fish tissue elevated above specific EPA criteria so that the fish advisories are still in place. As part of the restoration of the aquatic habitat of the Anacostia River, a consistent and statistically-based fish monitoring program needs to be maintained so that sound management decisions can be made and verified with regards to source reduction policies.

Summary and conclusions

Six long (~4 to 5 m) cores were collected near Poplar Point in the tidal Anacostia River. Most of the cores reached sandy or gravelly sediments underlying more modern muddy and silty sediments, suggesting penetration to pre-industrialized times. The cores were dated using ^{137}Cs and ^{210}Pb. Sediment samples at selected intervals were also analyzed for a suite of trace elements, including Al, Ag, As, Cd, Cr, Cu, Fe, Mn, Ni, Pb, and Zn, and a suite of organic contaminants including PCBs, PAHs, DEHP, DDT and metabolites, and chlordane.

The ^{137}Cs and ^{210}Pb dating did not agree for recent sediments, with ^{210}Pb giving improbably older ages, leading to the conclusion that some of the assumptions of ^{210}Pb dating were invalid. Using the ^{137}Cs onset benchmark, recent sedimentation rates varied between about 3–7 cm $year^{-1}$ among the cores. Using the ^{137}Cs derived sedimentation rate allowed the assignment of approximate dates to common contamination events in the sediment cores. Despite the difficulty in determining precise radiometric sedimentation rates in urban environments, the importance of understanding the trajectory of contamination in such important and difficult places makes the effort worthwhile (e.g., Mason et al. 2004).

Organic compounds also showed a variety of patterns, depending on the particular compound. The apparent dates of the onset and decline in anthropogenic compounds such as PCBs, DDT, chlordane, DEHP, etc., corresponds to the dates of their introduction to mass use, within the error of the sediment dating. PAHs and PCBs showed compositional changes with depth in the cores. In deeper horizons of the cores, PAHs were composed largely of compounds derived from combustion further down the cores, but were dominated by petrogenic compounds higher up, reflecting a shift from a wood- and coal-based industry to petroleum in the early twentieth century. PCBs shifted from lighter molecular weight compounds in the newer sediments to higher molecular weight compounds corresponding to the time of peak use in total PCBs in older sediments. This more likely results from a shift in the composition of the PCBs used through time more than from degradation of the PCB in situ.

Trace elements showed a variety of patterns. Three elements, Fe, Mn, and As, showed little change throughout the sediment column, except for low values in the sandy sediment, which, when normalized to the clay structural element Al, tended to even out the variations in these metals due to grain size. In a few sandy layers, after normalization with Al, there were some layers with substantial enrichment of these elements. This appeared to be post depositional movements of these elements in response to redox zones.

Another group of metals, Ag, Cd, Cu, Hg, Pb, and Zn, showed low concentrations in the deepest sediment, a substantial increase going towards the surface to a mid-depth maximum, and a decrease again towards the surface. The depth at which the rise in concentration occurred varied somewhat between metals, but was similar among the group. The increase, presumably marking the onset of wide-scale contamination of these metals, occurred prior to the ^{137}Cs in the 1950s making exact dating difficult, but probably occurred

before or during the 1930s. The point at which each element reached a maximum and began to decline again varied somewhat from metal to metal. Concentrations of these metals at the surface now are higher than the "pristine" values in the deepest sediment, but, in most cases, considerably lower than the values in the middle of the sediment column, suggesting reduced loadings in recent times. Many of these elements also showed mild enrichment in the deep sandy zones where Fe, Mn, and As showed enrichment. Two elements, Cr and Ni, showed little trend with depth, although Ni showed a slight enrichment from the 1950s through to the surface, suggesting a continued increase in input.

In some cases (notably Hg), concentrations of the contaminant in surface sediment is beginning to approach the lower pre-industrial levels seen at the bottoms of the cores, and little more decrease can be reasonably expected. For anthropogenic contaminants and many metals, the concentrations in surface sediments appears to be declining at a slow rate as new sediment accumulates on top and mixes with older sediment. This is likely to be a long, slow ongoing process however, as the newly accumulated sediment is probably derived at least in part from contaminated soils in the watershed. Without major changes in source materials, rapid changes (for better or worse) in the future, seems unlikely.

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Appendix E
Approach for Developing Background Sediment Concentrations Using Existing Data Sets

Appendix E

Approach for Establishing Sediment Background Concentrations for the Lower Anacostia River Washington Navy Yard Operable Unit (OU) 2

April 30, 2009

Introduction

In the December 3, 2008 Joint Tier 1 and Tier 2 Partnering Meeting for Washington Navy Yard Operable Unit (OU) 2, the team agreed on the locations of reference areas for use in the ecological risk assessment (ERA). However, EPA BTAG requested that a larger data set be used to establish ambient (background) concentrations for contaminants of potential concern (COPCs) in the river sediments. Background data will be used to help identify and delineate areas that pose an unacceptable risk and have COPC concentrations that exceed background levels for the Anacostia River.

A technical planning meeting was held on March 4, 2009 to develop consensus on the approach for determining background concentrations of COPCs in sediment for comparison to results from OU2. This memorandum summarizes EPA guidance on defining background concentrations at CERCLA sites, and presents the approach for determining background concentrations of COPCs in sediment, relative to OU2, based on the outcome of the technical planning meeting.

EPA Guidance on Background

EPA CERCLA guidance addresses the importance of establishing background concentrations during the completion of the remedial investigation (RI). The term "background" refers to chemical concentrations (or locations) that are not influenced by contamination from a specific CERCLA site, and can be defined as naturally occurring or anthropogenic. "Naturally occurring" refers to substances that are present in the environment in forms and concentrations that have not been influenced or caused by human activities. "Anthropogenic" refers to natural or man-made compounds present in the environment that have been influenced by human activity (EPA, 2002a and 2002b). EPA's guidance for comparing background and chemical concentrations in soil at CERCLA sites (EPA, 2002b) states that

> "A background reference area is the area where background samples will be collected for comparison with the samples collected on the site. A background reference area should have the same physical, chemical, geological, and biological characteristics as the site being investigated, but has not been affected by activities on the site … the ideal background reference area would have the same distribution of concentrations of the chemicals of concern as those which would be expected on the site if the site had never been impacted. In most situations, this ideal reference area does not exist."

Given these considerations, the background locations for the OU2 RI should have similar characteristics to OU2, but should not be influenced by releases from OU2 or other point sources of contamination. The largest possible data set that meets these criteria should provide the most representative characterization of background conditions.

Approach for Determining Background Concentrations

The following is the consensus-based approach for developing background concentrations for COPCs in Anacostia River sediment:

1. Determine list of OU2 COPCs for which background concentrations must be determined.

   Background concentrations will be established for all COPCs that are determined to be contributing to unacceptable risk at OU2 based on the results of the BERA. Total organic carbon and grain size (percent silt and clay) will also be included in the analysis. In the event that unacceptable risks are posed by constituents that have no current background data, then the team will evaluate the necessity and approach for determining background for those constituents. It may be that the area impacted by the constituent in question is also impacted by other constituents that will drive any action.

2. Determine the area of the Anacostia River to include in the background data set:

   Multiple background data sets will be developed for consideration in the risk management process. These are:

   - Entire river (upstream of the area influenced by the Potomac River)
   - Entire river excluding AWTA Areas of Concern (AOCs) and WNY
   - Lower Anacostia River excluding AOCs and WNY

3. Identify the appropriate existing data sets to include in the background data sets. Table E-1 lists the data sets that were included in NOAA's calculation of river-wide total PAH concentrations. Several additional data sets were added to the list of possible data (1999 Navy reference samples, Navy OU2 Phase II RI reference data set [yet to be collected] , and 2003 ANS Poplar Point cores). Sample locations for each study are shown in Figures E-1 through E-7, along with the boundaries of the AWTA AOCs.

   The background data sets will include the data from the studies indicated in Table 1. Rationale for excluding historical locations from the background data set were: 1) if the data was collected from within the OU2 box or from an area that may have been impacted for OU2 –related activities and 2) within the area influenced by the Potomac River. The background data set for the entire Anacostia River will include all other sample locations. Selected sample locations will be excluded from the background data sets for the entire Anacostia River minus AOCs, and the lower Anacostia River minus AOCs.

4. Identify the samples within each data set to include.

   The list of sample locations to be included in each background data set is provided in Table E-2.

5. Identify and resolve data comparability issues:

   - Analytical parameters – consistency between data sets
   - Analytical methods (particularly for metals)
   - Depth interval represented

Questions regarding data comparability between data sets will be resolved on a case-by-case basis pending identification of the specific COPCs that will require background evaluation. This determination will be made at the conclusion of the Phase II sampling activities and the evaluation of the data in Phase 2 of the RI, (which includes the BERA, and the HHRA). Variations in surface sediment depth interval represented will be considered an uncertainty in the background evaluation. The analytical parameters available for each data set are shown in Table E-3.

6. Reach consensus on the data management approach:

   - List of individual PAHs and PCBs to include in total PAH and total PCB sums
   - Treatment of non-detects in calculation of totals and summary statistics for each COPC – include as 0, ½ the detection limit, or detection limit?
   - Approach for developing background concentrations for COPCs with little or no existing data - can we rely on the proposed Phase II RI (BERA) reference data set in this case?

   Decisions about data management will be discussed and resolved on a case-by-case basis pending identification of the specific COPCs that will require background evaluation. This determination will be made at the conclusion of Phase 2 of the RI, (which includes the BERA, and the HHRA). .

7. Develop background data sets and calculate summary statistics for each COPC

   This step will be performed after Steps 1-6 have been completed.

8. Determine approach for performing background comparisons (i.e., how we are going to use the data)?

   Data evaluation approaches for COPCs that are driving unacceptable risk may include but are not limited to the following:

   - **Graphical and statistical evaluation of background data sets and WNY data sets**
     - Calculate descriptive statistics and test for normality
     - Prepare quantile plots, box and whisker plots, etc.
     - Prepare geochemical normalization plots
     - Perform statistical tests to compare sample groups (e.g. Wilcoxon Rank Sum test, quantile test)
   - **Spatial analysis: GIS mapping of background and WNY sediment sample concentrations to identify areas that should be targeted for remedial action.**

Uncertainty Associated with the Background Evaluation

The background evaluation will rely on historical data compiled from a variety of studies. Because these studies were conducted at different times for different purposes, the sample results are not always directly comparable. Some of the differences between the data sets include:

- Different depth interval sampled to represent surface sediment
- Samples were collected in different years between 1991-2009
- Different analytical methods and laboratories were employed for different studies.

Despite these uncertainties, the background data are considered to be sufficiently representative of sediment conditions in the Anacostia River to support risk management decision-making.

References

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TABLE E-1
Summary of Data Sets for Inclusion in OU2 Background Database

Study Name	Total No. Samples	Year Sampled	Depth Interval (cm)	Include in at least one background data set? [1]	Rationale for Exclusion	
					In or Near OU2	Potomoc Influence
1995 Washington Navy Yard	7	1995	0 - 30.48	No	all locations	
1992 Bolling AFB - SW Corner Landfill	5	1992	0 - 30.48	No		all locations
1996 WA Gas - East Station Project	7	1996	0 - 15.24	Yes		
1997 DC Sediment Core Analysis	6	1995	0 - 5 0 - 20	4 locations		2 locations
1996 FWS PAH/PCB - Mason Neck	3	1997	0 - 4	3 locations		
1992 Potomac & Anacostia Sediment Study	12	1991	0 - 20	7 locations	3 locations	2 locations
1998 USACE Federal Nav Channel	4	1998	0 - 30.48	Yes		
1999 WA Navy Yard RI	29	1999	0 - 15.24	3 locations	26 locations	
1999 GSA SE Federal Center	24	1999	0 - 10	No	all locations	
2003 Active Capping Site Char Rpt	77	2003	0 - 15.24	Yes		
1990 EMAP-Chesapeake Bay	1	1990	Not reported	Yes		
2000 ANS Sediment Study	124	2000	0 - 4	Yes	7 locations	7 locations
2000 USFWS Bioavailability	4	2000	0 - 2	Yes		
2000 Ambient Tox Chesapeake Bay	6	1998	Not reported	5 locations		1 location
Additional Data:						
2009 WNY BERA Reference Site Data	6	Est. 2009	0-15	Yes [2]		
ANS Poplar Point cores	6	2003	0-15	Yes		

[1] Some sample locations will be excluded from the data sets for the entire Anacostia River minus AOCs, or for the lower Anacostia River minus AOCs (see Table 2)

[2] Contingent on data review, BERA reference station data may be excluded from the background data sets that exclude AOCs.

TABLE E-2
Summary of Sample Locations Proposed for Inclusion in OU2 Background Data Sets

	Samples to be Included in Each Data Set			Sampes to be Excluded from Data Sets	
Study Name	**"Entire River" Data Set [2]**	**"Entire River minus AOCs" Data Set**	**"Lower River minus AOCs" Data Set**	**Excluded - in or near OU2**	**Excluded - Potomac influence**
1996 WA Gas - East Station Project	96SD06	96SD06	96SD06		
	96SD01	96SD01	96SD01		
	96SD02				
	96SD03				
	96SD07				
	96SD04				
	96SD05				
1997 DC Sediment Core Analysis	ANC6	ANC6	ANC6		
	ANC-5	ANC-5	ANC-5		
	ANC-4	ANC-4	ANC-4		
	ANC-3	ANC-3	ANC-3		
					ANC-2
					ANC-1
1996 FWS PAH/PCB - Mason Neck	MA01				
	MA02	MA02			
	MA03	MA03			
1992 Potomac and Anacostia Sediment Study	KL_5				
	OAR_1	OAR_1	OAR_1		
	AR_1	AR_1	AR_1		
				OAR_2	
				AR_2	
				AR_3	
	OAR-4	OAR-4	OAR-4		
	AR_4	AR_4	AR_4		
	AR_5A	AR_5A	AR_5A		
	OAR-6	OAR-6	OAR-6		
					AR_6
					WSC_6
1998 USACE Federal Nav Channel	AN01	AN01			
	AN02	AN02			
	AN03	AN03			
	AN04	AN04			
2003 Active Capping Site Char Report	77 [1]				
1990 EMAP - Chesapeake Bay	90-088				
2000 ANS Sediment Study	AR - 1	AR - 1			
	AR - 2	AR - 2			
	AR - 3	AR - 3			
	AR - 4	AR - 4			
	AR - 5	AR - 5			
	AR - 6	AR - 6			
	AR - 7	AR - 7			
	AR - 8	AR - 8			
	AR - 9	AR - 9			
	AR - 10	AR - 10			
	AR - 11	AR - 11			
	AR - 12	AR - 12			
	AR - 13	AR - 13			
	AR - 14	AR - 14			
	AR - 15	AR - 15			
	AR - 16	AR - 16			
	AR - 17	AR - 17			
	AR - 18	AR - 18			
	AR - 19	AR - 19			
	AR - 20	AR - 20			
	AR - 21	AR - 21			
	AR - 22	AR - 22			
	AR - 23	AR - 23			
	AR - 24	AR - 24			
	AR - 25	AR - 25			
	AR - 27	AR - 27			
	AR - 28	AR - 28			
	AR - 29	AR - 29			
	AR - 30	AR - 30			
	AR - 31	AR - 31			

TABLE E-2
Summary of Sample Locations Proposed for Inclusion in OU2 Background Data Sets

	Samples to be Included in Each Data Set			Sampes to be Excluded from Data Sets	
Study Name	**"Entire River" Data Set [2]**	**"Entire River minus AOCs" Data Set**	**"Lower River minus AOCs" Data Set**	**Excluded - in or near OU2**	**Excluded - Potomac influence**
	AR - 32				
	AR - 33	AR - 33			
	AR - 34	AR - 34			
	AR - 35				
	AR - 36				
	AR - 37	AR - 37			
	AR - 38	AR - 38			
	AR - 39	AR - 39			
	AR - 40	AR - 40			
	AR - 41	AR - 41			
	AR - 42	AR - 42			
	AR - 43	AR - 43			
	AR - 44	AR - 44			
	AR - 45	AR - 45			
	AR - 46	AR - 46			
	AR - 47	AR - 47			
	AR - 48	AR - 48			
	AR - 49	AR - 49			
	AR - 50				
	AR - 51				
	AR - 52	AR - 52			
	AR - 115	AR - 115			
	AR - 53	AR - 53			
	AR - 54	AR - 54			
	AR - 55	AR - 55			
	AR - 116	AR - 116			
	AR - 56	AR - 56			
	AR - 57	AR - 57			
	AR - 58	AR - 58			
	AR - 59	AR - 59	AR - 59		
	AR - 60	AR - 60	AR - 60		
	AR - 61				
	AR - 117				
	AR - 62	AR - 62	AR - 62		
	AR - 63	AR - 63	AR - 63		
	AR - 64	AR - 64	AR - 64		
	AR - 65	AR - 65	AR - 65		
	AR - 66	AR - 66	AR - 66		
	AR - 67	AR - 67	AR - 67		
	AR - 68	AR - 68	AR - 68		
	AR - 69	AR - 69	AR - 69		
	AR - 70	AR - 70	AR - 70		
				AR - 71	
				AR - 118	
				AR - 74	
	AR - 72	AR - 72	AR - 72		
	AR - 73	AR - 73	AR - 73		
	AR - 75	AR - 75	AR - 75		
	AR - 76	AR - 76	AR - 76		
				AR - 77	
	AR - 78	AR - 78	AR - 78		
	AR - 79	AR - 79	AR - 79		
	AR - 80	AR - 80	AR - 80		
	AR - 119				
	AR - 81				
				AR - 82	
	AR - 83	AR - 83	AR - 83		
				AR - 84	
	AR - 85	AR - 85	AR - 85		
	AR - 86	AR - 86	AR - 86		
				AR - 87	
	AR - 88	AR - 88	AR - 88		
	AR - 89	AR - 89	AR - 89		
	AR - 120				
	AR - 90				
	AR - 92				
	AR - 91	AR - 91	AR - 91		

TABLE E-2
Summary of Sample Locations Proposed for Inclusion in OU2 Background Data Sets

	Samples to be Included in Each Data Set			Sampes to be Excluded from Data Sets	
Study Name	**"Entire River" Data Set [2]**	**"Entire River minus AOCs" Data Set**	**"Lower River minus AOCs" Data Set**	**Excluded - in or near OU2**	**Excluded - Potomac influence**
	AR - 93	AR - 93	AR - 93		
	AR - 94				
	AR - 95	AR - 95	AR - 95		
	AR - 96	AR - 96	AR - 96		
	AR - 97	AR - 97	AR - 97		
	AR - 98	AR - 98	AR - 98		
	AR - 121	AR - 121	AR - 121		
	AR - 99	AR - 99	AR - 99		
	AR - 100	AR - 100	AR - 100		
	AR - 101	AR - 101	AR - 101		
	AR - 102	AR - 102	AR - 102		
	AR - 103	AR - 103	AR - 103		
	AR - 104	AR - 104	AR - 104		
	AR - 105	AR - 105	AR - 105		
	AR - 106	AR - 106	AR - 106		
					AR - 107
					AR - 108
					AR - 109
					AR - 110
					AR - 111
					AR - 112
					AR - 113
2000 USFWS Bioavailability	FOF	FOF			
	WAG	WAG			
	HIR	HIR	HIR		
	TSS				
2000 Ambient Tox Chesapeake Bay	AR-1				
	AR-2				
	AR-3	AR-3	AR-3		
	AR-4				
	AR-5	AR-5	AR-5		
					AR-6
1999 WA Navy Yard RI	WBK-01			26 locations	
	WBK-02	WBK-02			
	WBK-03				
2009 WNY BERA Reference Site Data (not yet collected)	(station IDs not yet designated)				
ANS Poplar Point cores	C1	C1	C1		
	C2	C2	C2		
	C3	C3	C3		
	C4	C4	C4		
	C5	C5	C5		
	C6	C6	C6		

[1] 77 sample locations clustered in small area of river; consider averaging for background data evaluation
[2] Shading = location in AOC

TABLE E-3
Summary of Available Surface Sediment Data for Background Data Sets

Study Name	Year Sampled	Depth Interval (cm)	OU2 Sediment COPC Analyses for BERA						
			Metals	PCB Aroclors	PCB Congeners	Pesticides	PAHs	TOC	Grain Size
1996 WA Gas - East Station Project			23	-	-	-	22	X	X
1997 DC Sediment Core Analysis	1995	0 - 5 0 - 20	9	-	~100	22	~25	X	X
1996 FWS PAH/PCB - Mason Neck									
1999 WA Navy Yard RI	1999	0-15	24	7	20	-	17	X	X
1992 Potomac & Anacostia Sediment Study			7	total PCB	-	22	X	X	X
1998 USACE Federal Nav Channel			23	7	-	23	23	X	X
2003 Active Capping Site Char Rpt			13	7	209	21	16	X	
1990 EMAP-Chesapeake Bay			15	-	12	7	25	X	X
2000 ANS Sediment Study	2000	0 - 4	10	-	107	22	50	X	X
2000 USFWS Bioavailability	2000	0 - 2	-	4	~100	17	16	X	X
2000 Ambient Tox Chesapeake Bay	1998	Not reported	11	-	~100	17	16	X	X
Additional Data:									
2009 WNY BERA Reference Site Data	Est. 2009	0-15	24	7	112	21	34	X	X
ANS Poplar Point cores	2003	0-15, 0-20	11	-	100+	(see note A)	39	X	X
Site Data for Comparison to Background									
1999 WNY Nearshore Sediment RFI	1999	0-15	24	7	20 (11 smpls)	-	17	X	X
Phase I RI	2006	0-15	24	7	16 (10 smpls)	20	17	X	X
Phase II RI	Est 2009	0-15	24	7	112	21	34	X	X

Notes:
A - total DDX, total Chlordanes available (individual results not obtained)

V:\18GIS\WNY\figures\Anacostia_River_Sediment_Samples\Figure E-1 Locations of Anacostia River Sediment Samples in NOAA Database.mxd

N

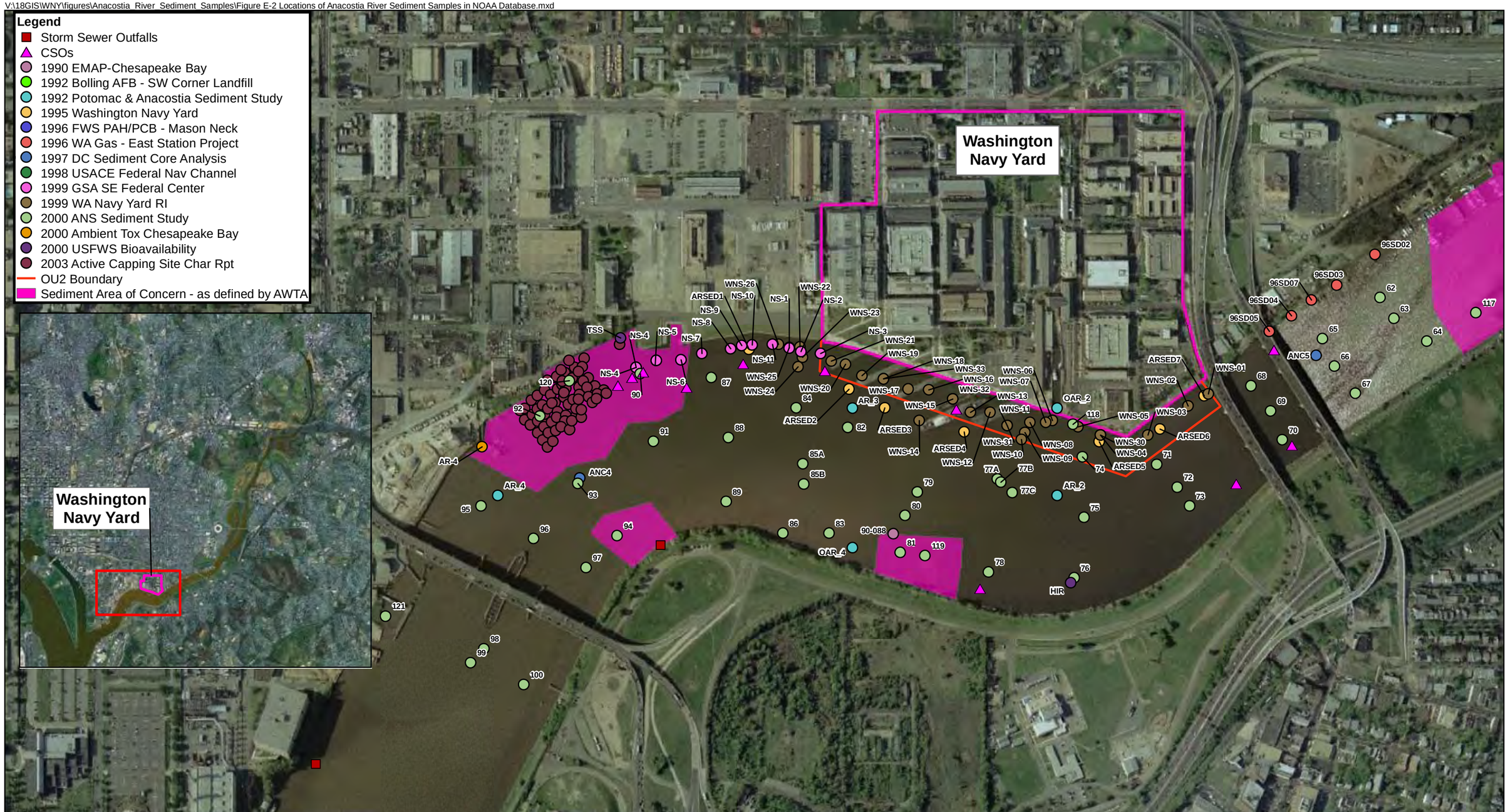
0 275 550 Feet

1 inch = 550 feet

Figure E-1
Locations of Anacostia River Sediment Samples in NOAA Database

CH2MHILL

V:\18GIS\WNY\figures\Anacostia_River_Sediment_Samples\Figure E-2 Locations of Anacostia River Sediment Samples in NOAA Database.mxd



N

0 275 550 Feet

1 inch = 550 feet

Figure E-2
Locations of Anacostia River Sediment Samples in NOAA Database

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N

0 275 550 Feet

1 inch = 550 feet

Figure E-3
Locations of Anacostia River Sediment Samples in NOAA Database

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1 inch = 550 feet

Figure E-4
Locations of Anacostia River Sediment Samples in NOAA Database

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1 inch = 550 feet

Figure E-5
Locations of Anacostia River Sediment Samples in NOAA Database

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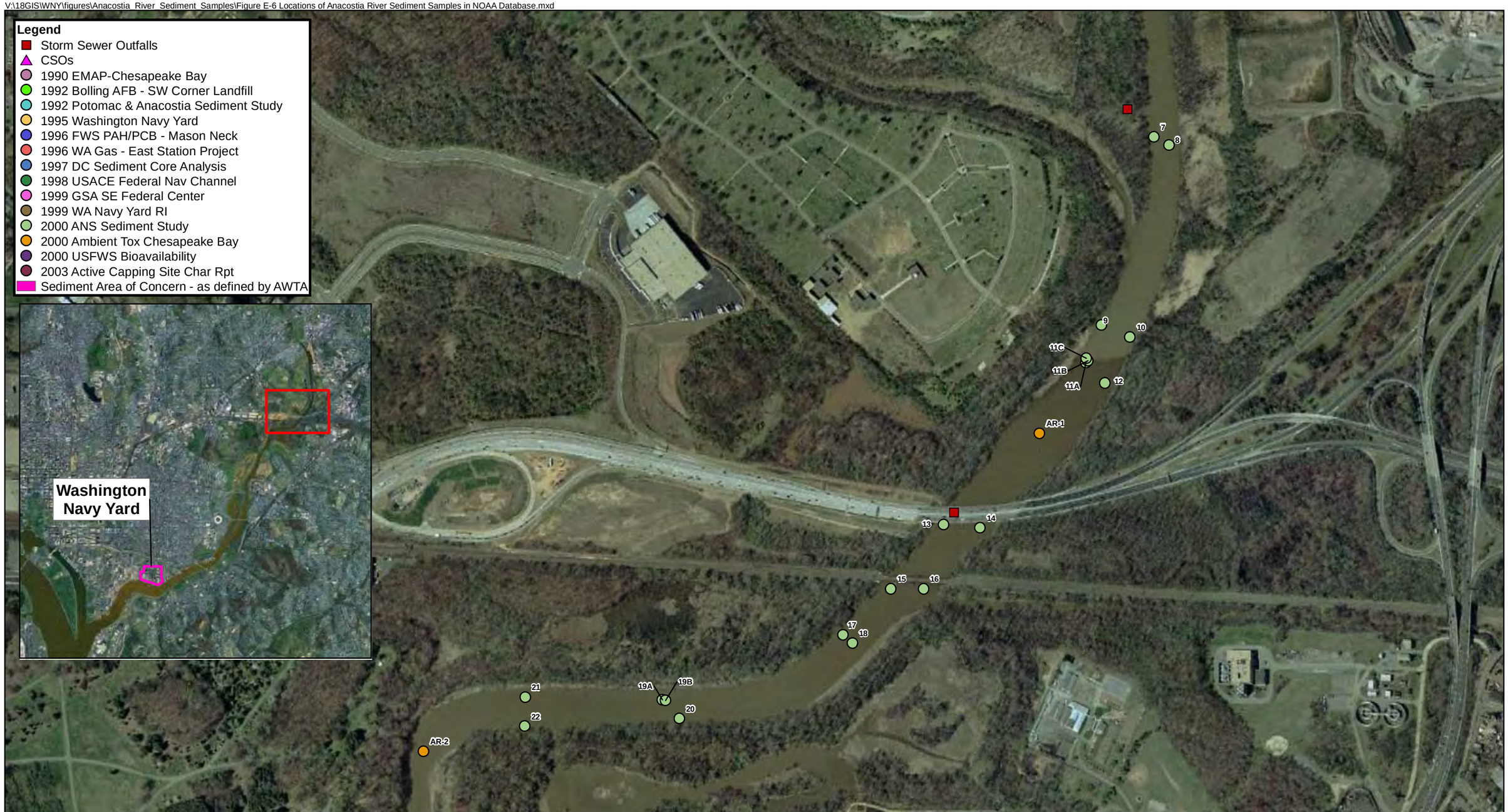

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1 inch = 550 feet

Figure E-6
Locations of Anacostia River Sediment Samples in NOAA Database

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0 350 700 Feet

1 inch = 700 feet

Figure E-7
Locations of Anacostia River Sediment Samples in NOAA Database

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TUMOR PREVALENCE AND BIOMARKERS OF EXPOSURE IN BROWN BULLHEADS (*AMEIURUS NEBULOSUS*) FROM THE TIDAL POTOMAC RIVER, USA, WATERSHED

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Abstract—Associations between contaminant exposure and liver and skin tumor prevalence were evaluated in brown bullheads (*Ameiurus nebulosus*) from the tidal Potomac River, USA, watershed. Thirty bullheads (≥ age 3) were collected from Quantico embayment, near a Superfund site that released organochlorine contaminants; Neabsco Creek, a tributary with petroleum inputs from runoff and marinas; and Anacostia River (spring and fall), an urban tributary designated as a Chesapeake Bay region of concern, that was contaminated with polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and organochlorine pesticides. Fish were collected from the Tuckahoe River, as a reference. Cytochrome P450 activity, bile PAH metabolites, and muscle organochlorine pesticide and PCB concentrations were measured in randomly selected individuals and sediment contaminants were analyzed. We found statistically significant differences in liver tumor prevalences: Anacostia (spring), 50%; Anacostia (fall), 60%; Neabsco, 17%; Quantico, 7%; and Tuckahoe, 10%. Skin tumor prevalences were significantly different: Anacostia (spring), 37%; Anacostia (fall), 10%; Neabsco, 3%; Quantico, 3%; and Tuckahoe, 0%. Tumor prevalence in Anacostia bullheads warrants concern and was similar to those at highly contaminated sites in the Great Lakes. Evidence was found of higher PAH exposure in Anacostia fish but a cause–effect linkage could not be established. Fish tumor surveys, with histopathologic examination of internal and external organs, are recommended for monitoring the status of regions of concern.

Keywords—Tumors Biomarkers Brown bullheads Polynuclear aromatic hydrocarbons

INTRODUCTION

The prevalence of tumors in wild fish has been used as an indicator of environmental quality in saltwater and freshwater ecosystems [1–7]. The strongest evidence for chemical etiology exists for polycyclic aromatic hydrocarbons (PAHs) in sediments, which have been implicated in the development of liver carcinogenesis [1–6]. A cause and effect relationship between PAHs and liver tumors or preneoplastic lesions in fish has been established by experimental studies [8,9]. Further evidence linking PAHs in sediments with liver tumors was developed by Baumann and Harshbarger [6] from surveys conducted in the 1980s and 1990s with bottom-feeding brown bullheads (*Ameiurus nebulosus*) in the Black River, Ohio, USA. They observed that liver tumor prevalence increased and decreased according to changes in sediment PAH concentrations. During the 1980s, tumor prevalence decreased after closure of a coking plant and a dramatic decline in sediment PAH concentrations. In 1992 and 1993, tumor prevalence increased in age-3 fish that had been exposed to highly contaminated sediments resuspended from remedial dredging in 1990. In 1994, age-3 fish were free of tumors, and Baumann and Harshbarger [6] theorized that this was the first-year class that would not have been present during the dredging.

The linkage between skin and oral (orocutaneous) tumors and environmental contaminants in bullheads is less established. Black et al. [10] induced papillomas in brown bullheads by repeatedly painting the skin with sediment extracts containing high PAH concentrations. Black and Baumann [11] summarized several Laurentian Great Lakes surveys with brown bullheads in which higher oral and cutaneous tumor prevalence occurred in PAH-contaminated tributaries relative to uncontaminated creeks or lakes. Poulet et al. [12] concluded that no evidence existed for viral etiology because they were unable to transmit orocutaneous tumors to healthy brown bullheads. However, Poulet et al. [13] noted the occurrence of orocutaneous tumors in 94 brown bullheads collected from 17 locations (both contaminated and uncontaminated) in New York State, USA, and stated that the distribution of lesions did not suggest a strict correlation with chemical carcinogens.

Environmental managers in the Great Lakes have used the presence of tumors (especially liver tumors) as a criterion for identifying and prioritizing contaminated areas or areas of concern. Hartig et al. [14] considered tumor prevalence in bottom-feeding fishes greater than 2% to be elevated. Baumann et al. [5] summarized liver and skin tumor data from the Great Lakes and reported that, in brown bullheads, liver tumor prevalence exceeding 9% and skin tumor prevalence exceeding 20% were nearly always observed in chemically contaminated areas.

This report describes a survey of tumor prevalence in brown bullheads from three locations in the tidal Potomac River watershed (part of the Chesapeake Bay watershed), with varying degrees and types of contaminant inputs. A reference site, in an agricultural and forested watershed on Maryland's Eastern Shore, was also sampled. The objectives were to compare the prevalence of skin and liver tumors among fish from these areas and examine the possible association between tumor prevalence and indicators of contaminant exposure.

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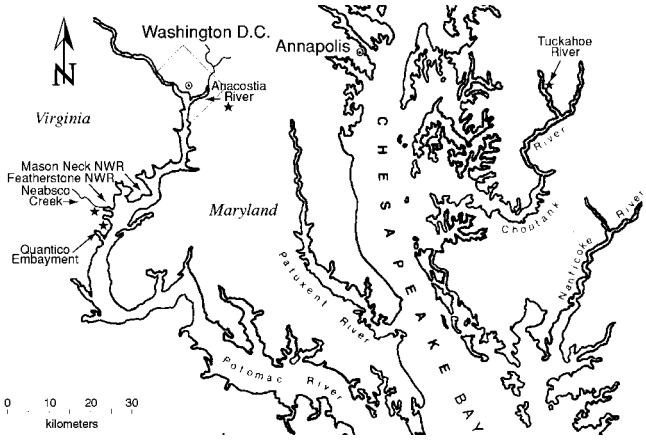

Fig. 1. Location of the sampling sites.

MATERIALS AND METHODS

Site selection and sampling

Groups of 30 brown bullheads (≥260 mm total length) were collected in 1996 from the following locations in the Potomac River watershed: Anacostia River, Neabsco Creek, and the Quantico embayment (Fig. 1). The Anacostia River (Washington, DC, USA) is one of three regions of concern identified by the U.S. Environmental Protection Agency's Chesapeake Bay Program. Sediments are contaminated with PAHs, polychlorinated biphenyls (PCBs), chlordane, and heavy metals, and a health advisory restricting fish consumption is in effect [15]. A preliminary survey of 20 brown bullheads (>280 mm total length) from the lower portion of the river revealed that 15 fish had hepatocellular carcinomas [16]. Neabsco Creek, a Potomac River tributary 35 km down river from Washington, DC, borders the Featherstone National Wildlife Refuge (VA, USA). Moderately high amounts of PAHs (8.2–25.5 ppm total PAH [17]) are present in sediments in some areas of Neabsco Creek, most likely from inputs from marinas in the tidal portion and urban runoff in the nontidal portion. Pinkney et al. [17] reported a 10% prevalence of hepatocellular carcinomas and a 33% prevalence of squamous carcinomas in brown bullheads from this site. The Quantico embayment is a crescent-shaped, 78-ha area of the Potomac River, 56 km down river from Washington, DC. The Quantico embayment borders a U.S. Environmental Protection Agency Superfund hazardous waste site, the old landfill at the Marine Corps Combat Development Command, which released PCBs and DDT compounds that accumulated in embayment sediments [18]. An additional group of 30 fish was collected from the Tuckahoe River (Fig. 1), which drains a forested and agricultural watershed on the eastern shore of the Chesapeake Bay and served as a reference area for the survey.

The Anacostia site was sampled twice, in April (ANA-S) and in October (ANA-F), to provide information on the variability in response in one location across seasons. Fish were collected by electrofishing (Anacostia) or otter trawling (Neabsco [NEAB] in September, Quantico [QUAN] in June, and Tuckahoe [TUCK] in November). A Hydrolab Surveyor 2 water quality meter (Hydrolab, Austin, TX, USA) was used to record temperature, dissolved oxygen, pH, and conductivity at each location (see [19] for water quality data).

Laboratory procedures

Fish were maintained overnight in coolers with aerated collection-site water. The next day, they were measured for total length, weighed to the nearest gram, and necropsied. Condition factor, $K = (\text{wt (g)} \times 10^5)/\text{length (mm)}^3$, was calculated. Gross lesions were noted and the liver was excised and weighed so that the hepatosomatic index (HSI = liver weight/body weight) could be determined. Livers (except a 0.5-g portion used for biochemistry) and skin areas with visible lesions were preserved in 10% buffered formalin and transported to George Washington University Medical Center (Washington, DC, USA) for histopathologic examination and tumor diagnosis. All materials from the study were maintained and the case reports were entered into the Registry of Tumors in Lower Animals. The head and caudal kidney, spleen, brain, muscle, eye, stomach, skin, and gill were preserved in zinc formol alcohol, prepared, and examined histopathologically at the Maryland Department of Natural Resources Laboratory (Oxford, MD, USA). The pectoral spines were removed, sectioned, and aged [20].

The tissues were processed according to standard histologic procedures, sectioned at 6 μm, and stained with hematoxylin and eosin [21]. At least two sets of slides were prepared from each tissue block for histopathologic examination.

Biochemical and chemical analyses were done on randomly selected fish from each group. A 0.5-g section of the liver was flash frozen in liquid nitrogen and stored at −80°C for analysis of cytochrome P450 enzyme activity with the ethoxyresorufin-*O*-deethylase (EROD) assay [22]. Induction of these enzymes in fish livers is used as an indicator of exposure to PAHs and chlorinated hydrocarbons [23]. Bile was collected in disposable syringes, placed in cryotubes in liquid nitrogen, and stored at −80°C for analysis of PAH metabolites. Because PAHs are rapidly metabolized and eliminated by fish, measurement of PAH metabolites in bile has been used as an indicator of recent (within several days) exposure to PAHs [24]. Fish were filleted and muscle tissue samples were placed in chemically cleaned glass jars and stored at −20°C for analysis of organochlorine pesticides and PCBs. Muscle tissues were used rather than whole-body residues in an attempt to reduce variability and because the interest was in obtaining an indicator of exposure rather than assessing risks to piscivorous wildlife.

Sediment sampling

A total of 12 sediment samples (three from each location) were collected (July and August 1997) using a stainless steel petite ponar grab. Samples were collected along a transect through the fish sampling area, with one sample near each shore and one in the channel area of the river. For the Quantico embayment, the samples were collected along the length of the trawling transect. Each sample consisted of two or three grabs. The top 2 to 4 cm from each grab was removed with a stainless steel spoon, homogenized in a stainless steel bowl, and placed in chemically cleaned glass jars for analysis. Samples for organic analysis were stored at −20°C and samples for total organic carbon and grain size were stored at 0 to 4°C before analysis.

Chemical analysis

Sediment PAH and bile PAH metabolite analyses were performed at the Geochemical and Environmental Research Group Laboratory at Texas A&M University (College Station,

TX, USA). Sediments were analyzed for PAH compounds by capillary gas chromatography–mass spectrometry in the selected ion mode [25]. Metabolites of benzo[*a*]pyrene (B*a*P), naphthalene, and phenanthrene were analyzed by high-performance liquid chromatography, with a fluorescence detector [26]. These data were reported as the amount of B*a*P, naphthalene, and phenanthrene equivalents in ppm wet weight. Sediments were analyzed for grain size and total organic carbon by Geochemical and Environmental Research Group methods 006 and 009. Organochlorine pesticide and PCB analyses of sediments and tissues were performed at the U.S. Fish and Wildlife Service, Patuxent Analytical Control Facility (Laurel, MD, USA) according to the methods of Cromartie et al. [27].

Biochemical analysis

The EROD activity was determined according to Melancon [22], using an amount of microsomes equivalent to 2.6 mg of liver, 0.125 mM nicotinamide adenine dinucleotide phosphate, and 1.25 μM substrate at 26°C. Assays run on different days were normalized using mallard duck reference microsomes. Protein was determined by the method of Lowry et al. [28] at 50% reduced volume and EROD activity was reported on a picomole per minute per milligram microsomal protein basis.

Data analysis

Histologic data were summarized as the prevalence of the various types of lesions among fish from each of the locations. Exposure cannot be inferred to have occurred at the location of capture unless it is known that brown bullheads tend to remain in specific locations. In tributaries of the Laurentian Great Lakes, brown bullheads tend to remain in specific creeks with minimal crossover (P. Baumann, unpublished data). A tagging study conducted in the Presque Isle Bay area of Lake Erie, which is approximately 1,500 ha, indicated that nearly all tagged brown bullheads were recaptured within the bay [29]. However, few data have been published on the movements of brown bullheads in river systems and none have been published for the Chesapeake watershed.

Sediment contaminant data were summarized in terms of total PCBs, total DDT (DDT and metabolites) compounds, total chlordane (sum of *cis*- and *trans*-nonachlor, alpha- and gamma-chlordane, and oxychlordane), and total PAHs. Concentrations of the eight PAHs identified as carcinogens or suspected carcinogens by Menzie et al. [30] (B*a*P, benz[*a*]anthracene, benzo[*b*]fluoranthene, benzo[*k*]fluoranthene, benzo[*ghi*]perylene, chrysene, dibenzo[*a,h*]anthracene, and indeno[1,2,3-*c,d*]pyrene) were summed as total carcinogenic PAHs.

Concentrations of total PCBs, total DDT compounds, and total chlordane in muscle tissues, bile PAH-metabolites, and differences in EROD activities among the groups of fish were compared using one-way analysis of variance and Tukey's multiple comparison test [31]. If parametric assumptions were not satisfied, we used the nonparametric Kruskal–Wallis test followed by Dunn's method. SigmaStat® software [32] was used for these analyses. The prevalence of tumors among the five collections of fish was compared statistically using an extension of Fisher's exact test [33]. Because the risk of liver neoplasms is known to increase significantly in older fish [34] and in females relative to males [20], both the whole collections and subsets of same-aged and same-sexed fish were compared.

Correlation analysis [31] was used to determine if associations existed between EROD activity or HSI and concentrations of PAH-metabolites in bile or organochlorine contaminants in muscle tissue. Logistic regression [33] was used to evaluate the relationship between chemical, biological, and biochemical variables and the prevalences of liver and skin tumors. The biological predictor variables included sex, age, length, weight, HSI, and *K*. The chemical predictor variables were total PCBs, DDT, and chlordane in muscle tissues. The biochemical predictor variables were P450 activity, and B*a*P, naphthalene, and phenanthrene in bile. Each predictor variable was examined separately and models were considered statistically significant if the *p* value for the Wald statistic [33] was less than 0.05. For all significant logistic regressions, odds ratios were reported, with values greater than one indicating an increased risk for the response variable for an incremental increase in the predictor variable (e.g., per year of age). Stepwise logistic regression was considered but was not feasible because of intercorrelations between predictor variables and limited sample size (because not all fish were analyzed for all of the predictor variables).

RESULTS

Biological parameters

Small but statistically significant differences were found in the length, weight, and *K*s of the fish from the five collections. The median length of the TUCK fish (266 mm) was significantly less than that of the other four collections (272–278 mm; Kruskal–Wallis test, $p < 0.001$; Table 1). The TUCK fish also weighed less and were younger than the other collections. Statistically significant differences were found in *K*, with the highest mean *K* in the QUAN fish (1.51) and the lowest in the TUCK fish (1.22; Table 1). The slightly smaller fish from the Tuckahoe were younger (ages 3 and 4) than the Anacostia (ages 3 through 7) and NEAB and QUAN fish (ages 3 through 6). Sex ratios were also variable, with mostly females collected from the fall in the Anacostia, whereas mostly males or nearly equal numbers were determined for the other collections.

The greatest HSI values were calculated for the two collections of Anacostia River fish (Table 1). Significantly greater HSI values were observed in the ANA-S fish (0.025 ± 0.001; mean ± one standard error) compared to all of the other groups of fish, including the ANA-F fish (0.023 ± 0.001; analysis of variance, $p < 0.001$). Both of the groups of Anacostia fish had significantly greater HSI values than the NEAB (0.019 ± 0.0005) and QUAN fish (0.019 ± 0.001). The HSI values were positively correlated with bile PAH metabolite concentrations: B*a*P ($r = 0.61$, $p < 0.0001$), naphthalene ($r = 0.52$, $p < 0.0001$), and phenanthrene ($r = 0.58$, $p < 0.0001$, all based on 70 observations). The HSI values were also positively correlated with muscle total chlordane concentrations ($r = 0.42$, $p = 0.003$, $n = 46$).

Fish pathology

Gross external examination revealed the presence of numerous lesions in the mouth area in some of the fish, particularly those from the ANA-S group. Lesions were generally fleshy-pink colored, oval or round, and solid in texture (Fig. 2). After histopathologic examination of the skin lesions, four ANA-S fish (13%) were diagnosed with invasive (cancerous) skin tumors, characterized as squamous carcinomas (Table 2 and Fig. 3) and seven ANA-S fish were diagnosed with noninvasive epidermal papillomas. Three ANA-F fish (10%), one NEAB fish (3%), and one QUAN fish (3%) also had nonin-

Table 1. Biological data for the five collections of brown bullheads[abc]

	ANA-S	ANA-F	NEAB	QUAN	TUCK	Statistics
Length (mm)	272 (260–302) AB	276 (262–301) A	278 (261–315) A	273 (260–311) AB	266 (261–277) B	K-W, $p < 0.001$
Weight (g)	269 (198–378) B	265 (228–360) B	295 (217–399) AB	307 (262–428) A	234 (197–270) C	K-W, $p < 0.001$
Liver weight (g)	6.78 ± 0.25 A	6.20 ± 0.22 AB	5.58 ± 0.21 BC	6.10 ± 0.24 AB	4.87 ± 0.15 C	ANOVA, $p < 0.001$
Condition factor (K)	1.28 ± 0.02 BC	1.28 ± 0.04 BC	1.36 ± 0.02 B	1.51 ± 0.02 A	1.22 ± 0.02 C	ANOVA, $p < 0.001$
Hepatosomatic index (HSI)	0.025 ± 0.001 A	0.023 ± 0.001 B	0.019 ± 0.0005 C	0.019 ± 0.001 C	0.021 ± 0.0005 BC	ANOVA, $p < 0.001$
Sex	17 M, 11 F, 2 ?	6 M, 23 F, 1 ?	13 M, 8 F, 9 ?	19 M, 11 F	14 M, 16 F	
Age	5(4–7) A	5 (3–6) A	4 (3–6) A	4 (3–6) A	3 (3–4) B	K-W, $p < 0.001$
	4+: 5; 5+: 14; 6+: 4; 7+: 2; not aged: 5	3+: 2; 4+: 7; 5+: 12; 6+: 3; not aged: 6	4+: 15; 5+: 9; 6+: 3; not aged: 3	3+: 1; 4+: 14; 5+: 10; 6+: 1; not aged: 4	3+: 14; 4+: 12; not aged: 4	

[a] Mean ± one standard error or median with minimum and maximum in parentheses, all based on $n = 30$.
[b] Groups with different letters are significantly different at $p < 0.05$ using Tukey's test (analysis of variance [ANOVA]) or Dunn's method (Kruskal–Wallis test [K-W]).
[c] ANA-S = Anacostia River, spring; ANA-F = Anacostia River, fall; NEAB = Neabsco Creek; QUAN = Quantico embayment; TUCK = Tuckahoe River; M = male; F = female; ? = sex not determined.

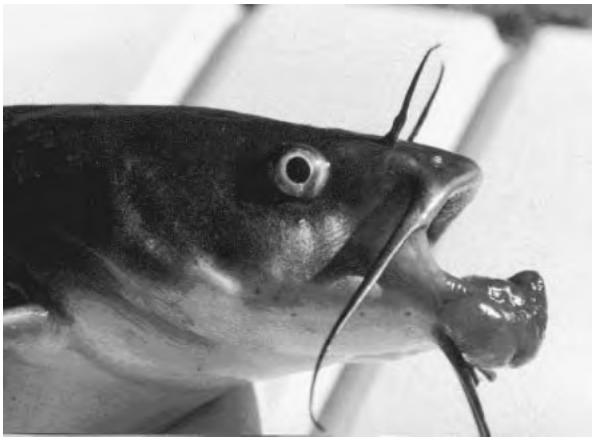

Fig. 2. Brown bullhead from the Anacostia River with 2.1 × 1.3-cm firm red lesion on lower lip and dental ridge diagnosed as a squamous carcinoma (Registry of Tumors in Lower Animals 7110).

vasive epidermal papillomas. Statistically significant differences ($p = 0.001$, based on an extension of Fisher's exact test) were found in the prevalence of skin tumors (of either diagnosis) with the highest rates in the ANA-S and ANA-F fish (37% and 10%, respectively) compared with the collections from the other sites (0–3%; Table 2 and Fig. 4a).

Gross liver lesions, characterized as whitish and pale-colored areas up to 0.3 cm in diameter, were observed in several of the Anacostia fish. After histopathologic examination of the livers of all fish, neoplastic lesions of various types were diagnosed (Table 2). Prevalence of hepatocellular carcinoma (Fig. 5) was significantly different among the collections, with the highest rates in the Anacostia fish (27%, ANA-S; 30%, ANA-F) compared to the other collections (0–7%, $p = 0.001$; Table 2 and Fig. 4b). Prevalence of invasive tumors of bile duct cell origin (cholangiocarcinoma; Fig. 6) was more evenly distributed ($p = 0.12$) between Anacostia fish (17%, ANA-S; 13%, ANA-F), NEAB fish (10%), and the other two collections (0–3%; Table 2). Other fish were diagnosed with noninvasive tumors (hepatocellular adenomas and cholangiomas) and preneoplastic lesions (foci of hepatocellular alteration). Statistically significant differences were found in the prevalence of liver tumors of any type, with the highest rate in the Anacostia fish (50%, ANA-S; 60%, ANA-F) compared to the other collections (7–17%, $p = 0.001$; Table 2 and Fig. 4).

In general, significant ($p < 0.05$; Table 2 and Fig. 4) differences were found in lesion prevalence among the groups of fish. Maximum skin and liver lesion prevalence occurred in the two collections from the Anacostia River and lesser prevalence occurred in collections from the other three sites. The rankings in lesions and the statistically significant differences were maintained when the analysis was restricted to either same-aged or same-sexed fish (Table 2).

Other lesions

The prevalences of liver parasitism and lesions in the brain, eye, gill, head and caudal kidney, heart, and spleen are summarized in Pinkney et al. [19]. No evidence was found of a relationship between these lesions and the presence or absence of tumors or preneoplastic lesions.

Fish tissue and bile contaminants

Median concentrations of total PCBs were significantly higher in the ANA-S, ANA-F, and NEAB fillets compared with

Table 2. Liver and skin tumor prevalence (number affected with percentage in parentheses) for the five collections of brown bullheads[a]

Lesion	ANA-S	ANA-F	NEAB	QUAN	TUCK	Statistics[b]
			Entire collection (n = 30)			
FHA	8 (27%)	6 (20%)	1 (3%)	0 (0%)	1 (3%)	$p = 0.001$
HA	3 (10%)	8 (27%)	1 (3%)	0 (0%)	1 (3%)	$p = 0.002$
HC	8 (27%)	9 (30%)	2 (7%)	0 (0%)	0 (0%)	$p = 0.001$
C	1 (3%)	1 (3%)	0 (0%)	2 (7%)	1 (3%)	$p = 0.72$
CC	5 (17%)	4 (13%)	3 (10%)	0 (0%)	1 (3%)	$p = 0.12$
TLC	12 (40%)	10 (33%)	4 (13%)	0 (0%)	1 (3%)	$p = 0.001$
TLB	15 (50%)	18 (60%)	5 (17%)	2 (7%)	3 (10%)	$p = 0.001$
EP	7 (23%)	3 (10%)	1 (3%)	1 (3%)	0 (0%)	$p = 0.007$
SC	4 (13%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	$p = 0.002$
TS	11 (37%)	3 (10%)	1 (3%)	1 (3%)	0 (0%)	$p = 0.001$
LF	6 (20%)	7 (23%)	24 (80%)	27 (90%)	26 (87%)	$p = 0.001$
			Age 4 fish (no. affected/total no.)			
TLB	1/5 (20%)	4/7 (57%)	2/15 (13%)	0/14 (0%)	1/12 (8%)	$p < 0.001$
LF	1/5 (20%)	2/7 (29%)	12/15 (80%)	13/14 (93%)	11/12 (92%)	$p < 0.001$
			Age 4–6 females (no. affected/total no.)			
TLB	7/8 (88%)	11/16 (69%)	3/8 (38%)	2/8 (25%)	1/7 (14%)	$p = 0.01$
LF	0/8 (0%)	3/16 (19%)	5/8 (62%)	6/8 (75%)	6/7 (86%)	$p = 0.001$

[a] ANA-S = Anacostia River, spring; ANA-F = Anacostia River, fall; NEAB = Neabsco Creek; QUAN = Quantico embayment; TUCK = Tuckahoe River; FHA = foci of hepatocellular alteration; HA = hepatocellular adenoma; HC = hepatocellular carcinoma; C = cholangioma; CC = cholangiocarcinoma; TLC = total liver or bile invasive tumors; TLB = total liver and bile duct invasive or noninvasive tumors; EP = epidermal papilloma; SC = squamous carcinoma; TS = total skin tumors; LF = lesion free (skin and liver).
[b] Extension of Fisher's exact test [33].

the TUCK fillets ($p < 0.001$; Table 3). Nearly identical median concentrations (0.30–0.34 ppm) were found in the Anacostia and NEAB fish, whereas PCBs were detected in only 1 of the 10 TUCK fish (median concentration of 0.025 ppm = one half of detection limit). The median concentration of total PCBs was 0.16 ppm in the QUAN fish. Mean total DDT concentrations were also significantly higher in the ANA-F, NEAB, and QUAN fish compared with the TUCK fish ($p < 0.001$).

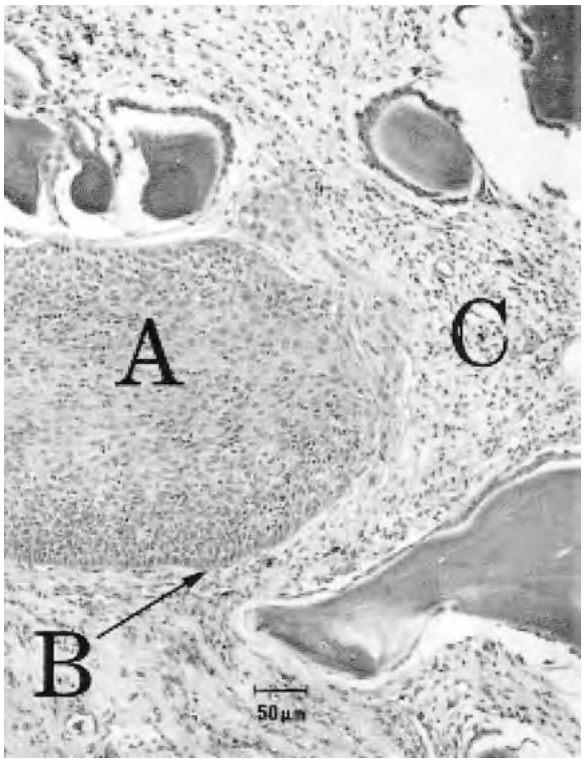

Fig. 3. Squamous carcinoma: a peg of neoplastic epithelium (A) from the lip breached the basal cell layer (B) and invaded the connective tissue (C) (Registry of Tumors in Lower Animals 6484).

Concentrations of B*a*P metabolites in bile were significantly higher in the ANA-S collection compared with those from all other collections ($p < 0.001$; Table 3). In contrast, concentrations of B*a*P were similar in the ANA-F and QUAN collections.

Cytochrome P450

The EROD activity was significantly elevated in the ANA-S fish (median: 79.4 pmol/min/mg microsomal protein) compared with the QUAN fish (median: 36.5) and TUCK fish (median: 39.0) ($p < 0.001$; Table 3). Although the highest median values were in fish from the Anacostia collections, the two individuals with the highest activities were from Neabsco Creek (405.4 and 174.1 pmol/min/mg). No significant correlations were found between EROD activity and concentrations of PAH metabolites in bile or organochlorine contaminants in muscle.

Sediment contaminants

Sediments from the four locations were similar in terms of grain size and total organic carbon content (Table 4). However, mean total PAH concentrations were significantly higher in the Anacostia sediments (26.8 ppm dry weight) compared with the three other collection sites (1.8–5.1 ppm; $p < 0.001$). Mean carcinogenic PAH concentrations were also significantly higher in the Anacostia sediments (9.0 ppm) compared to the other sites (0.5–2.2 ppm; $p < 0.001$). The differences in mean total PCB concentrations among the Anacostia (0.89 ppm), Quantico (0.31 ppm), and Neabsco (0.26 ppm) were not large enough to be statistically significant. Polychlorinated biphenyls were not detected in the Tuckahoe River sediments.

Logistic regression analysis

With hepatocellular carcinoma as the response variable, increased risks were associated with the following predictor

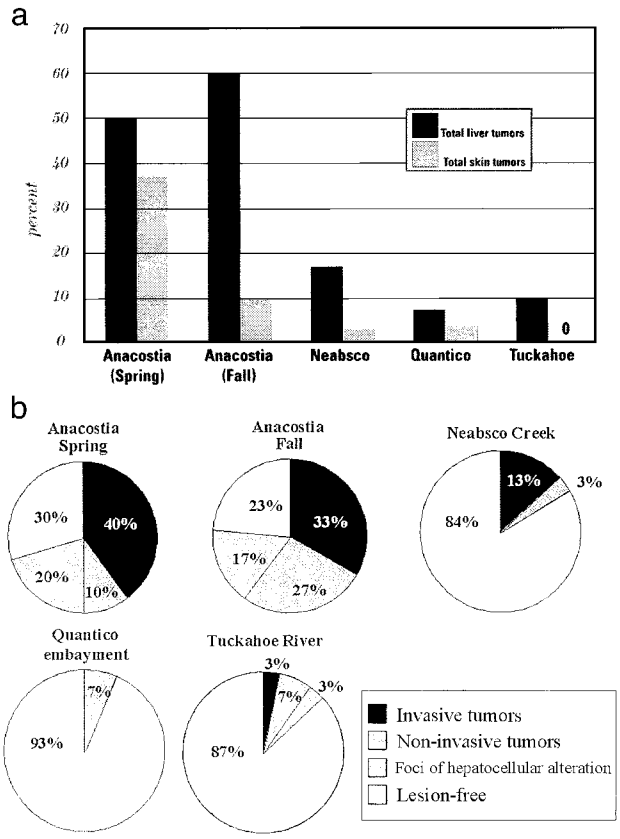

Fig. 4. (**a**) Percentages of liver and skin tumors in five collections of brown bullheads. (**b**) Percentage of brown bullheads from each collection with various types of neoplastic and preneoplastic liver lesions.

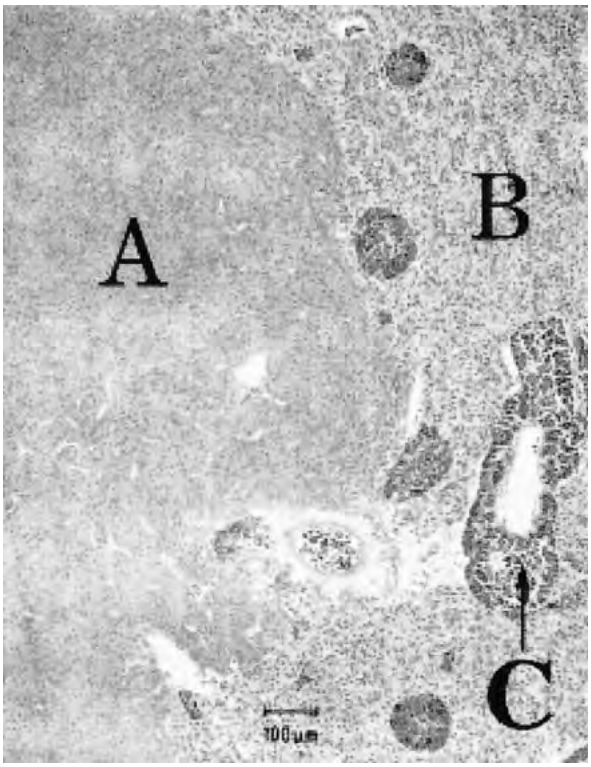

Fig. 5. Hepatocellular carcinoma. Cancerous cells (A) have expanded into normal liver tissue (B) containing exocrine pancreas (C) (Registry of Tumors in Lower Animals 6491).

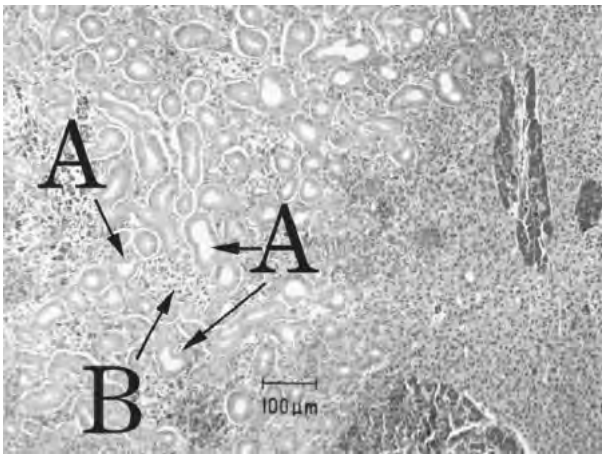

Fig. 6. Cholangiocarcinoma. Neoplastic bile ducts (A) entrapping normal liver tissue (B) (Registry of Tumors in Lower Animals 6491).

variables: sex, age, length, *K*, HSI, bile B*a*P, and bile naphthalene (Table 5). Based on the odds ratio, the strongest effects (greatest relative risks) were for sex (females had 4.514 times the odds for males) and age (3.525 times per year). An increased risk was found with increasing concentrations of bile B*a*P (1.401 times per 1.0 ppm) and naphthalene (1.063 times per 100 ppm). The logistic regression results for total liver tumors were similar to those for hepatocellular carcinoma. Increased risks for total skin tumors were associated with age (2.457 times per year), HSI (1.231 times per 0.001 units), bile B*a*P metabolites (1.846 times per 1.0 ppm), bile napthalene metabolites (1.102 times per 100 ppm), and bile phenanthrene metabolites (1.445 times per 100 ppm).

DISCUSSION

Lesion prevalence in relation to contaminant exposure

The liver tumor prevalences in the Anacostia River bullheads (50 and 60%) warrant concern, in that they greatly exceeded the 9% prevalence that Baumann et al. [5] suggested was indicative of contaminant exposure. Of the surveys conducted with brown bullheads, these liver tumor prevalences are second only to those observed in the Black River in the 1980s and early 1990s (P. Baumann, unpublished data). Liver tumor prevalence in Neabsco Creek bullheads (17%) was also above the 9% prevalence, whereas the 10% prevalence in Tuckahoe bullheads was essentially equivalent. However, a 1998 sampling of 39 bullheads from the same Tuckahoe location had no skin tumors and a 2.6% prevalence of liver tumors (U.S. Fish and Wildlife Service, unpublished data).

Increased odds for liver and skin tumors were associated with increased concentrations of several bile PAH metabolites and were not associated with concentrations of organochlorine pesticides or PCBs in muscle, or EROD activity. Of the PAH metabolites, the highest odds ratios were for B*a*P, known to be carcinogenic in mammals [30], and reported to be transformed to carcinogenically active intermediates in brown bullheads [35]. Studies conducted by the National Oceanographic and Atmospheric Administration with marine fish on the United States west coast have also reported positive statistical associations between bile PAH metabolites and neoplastic and preneoplastic liver lesions [3,26]. Based on the West Coast National Oceanographic and Atmospheric Administration studies, Horness et al. [36] used regression analysis to propose 2.8 ppm total PAHs (confidence limit of 0.011–5.5 ppm) as a

Table 3. Chemical and biochemical analyses[abc] of brown bullheads

	ANA-S	ANA-F	NEAB	QUAN	TUCK	Statistics[d]
Muscle t-PCB	0.33 (ND–0.91) A	0.30 (ND–0.61) A	0.34 (ND–0.65) A	0.16 (ND–0.67) AB	0.025 (ND–0.07) B	K-W, $p = 0.002$
Muscle t-DDT	0.084 ± 0.012 AB	0.088 ± 0.013 A	0.10 ± 0.021 A	0.10 ± 0.024 A	0.042 ± 0.002 B	ANOVA,[e] $p = 0.01$
Muscle t-chlordane	0.059 (ND–0.19) A	0.032 (ND–0.11) AB	0.025 (ND–0.050) B	0.025 (ND–0.036) AB	0.025 (all ND) B	K-W, $p < 0.001$
Bile B*a*P	4.9 ± 0.3 A	1.1 ± 0.1 B	0.47 ± 0.05 C	1.0 ± 0.1 B	0.49 ± 0.07 C	ANOVA,[e] $p < 0.001$
Bile naphthalene	2,200 (1.7–3,600) A	290 (86–560) A	61 (24–210) B	140 (59–260) AB	60 (0.3–170) B	K-W, $p < 0.001$
Bile phenanthrene	863 (480–1,164) A	100 (34–230) AB	26 (13–80) C	57 (27–88) BC	43 (13–160) BC	K-W, $p < 0.001$
EROD	79.4 (31.3–139.0) A	55.9 (23.8–109.8) AB	52.6 (4.0–405.4) AB	36.5 (10.6–107.5) B	39.0 (27.9–59.9) B	K-W, $p < 0.001$

[a] ANA-S = Anacostia River, spring; ANA-F = Anacostia River, fall; NEAB = Neabsco Creek; QUAN = Quantico embayment; TUCK = Tuckahoe River; t-PCB = total polychlorinated biphenyl; t-DDT = total DDT; t-chlordane = total chlordane; B*a*P = benzo[*a*]pyrene; EROD = ethoxyresorufin-*O*-deethylase; ND = not detected.

[b] For calculations, ND values reported as one half of the detection limit (0.025 ppm for PCBs, 0.005 ppm for DDT and chlordane); units: PCBs, DDT, chlordane, bile PAH metabolites are ppm wet weight of B*a*P, naphthalene, and phenanthrene equivalents; EROD: picomoles per minute per milligram protein.

[c] Mean ± one standard error or median with range in parentheses; muscle data, $n = 10$ per collection; bile data, $n = 14$–15 per collection; EROD: $n = 18$–20 for all except QUAN ($n = 29$).

[d] Groups with different letters are significantly different at $p < 0.05$ using Tukey's test (analysis of variance [ANOVA]) or Dunn's method (Kruskal–Wallis test [K-W]).

[e] Log-transformed data.

threshold sediment concentration above which an increased prevalence of hepatic lesions occurred in bottom-dwelling English sole (*Pleuronectes vetulus*). Although such an analysis has not been performed for brown bullheads, the average total PAH concentration in the three Anacostia River sediments near the fish collection site was 26.8 ppm, nearly 10 times the proposed threshold.

The 50% and 60% liver tumor prevalences observed in the Anacostia River collections were nearly as high as those observed in the Black River, Ohio, USA [5,6]. In this river, tumor prevalence has been linked to sediment PAH contamination from steel operations, including a coke plant. Baumann et al. [5] summarized three collections from the Black River as having total liver neoplasm prevalence of 60% (1982), 32.5% (1987), and 58% (1992). Concentrations of 12 PAHs (acenaphthene, acenapthylene, B*a*P, benz[*a*]anthracene, benzo[*b*]fluoranthene, benzo[*k*]fluoranthene, benzo[*ghi*]perylene, chrysene, fluoranthene, indeno[1,2,3-*c*,*d*]pyrene, phenanthrene, and pyrene) in Black River sediment samples were measured over various years and decreased from 1,096 ppm in 1980 to 4.27 in 1987. After remedial dredging in 1990 resuspended some of the sediments, concentrations increased to 16.6 ppm in 1992 and declined to 9.8 ppm in 1994 [6].

The PAHs in the Anacostia River are derived from both petroleum discharges and combustion of petroleum products. These chemicals enter the system via point and nonpoint sources, including National Pollution Discharge Elimination System outfalls, hazardous waste sites, combined sewer and storm sewer outfalls, and spills [15]. The mean (± standard deviation) concentration of the same 12 PAHs as in Baumann and Harshbarger [6] in the three Anacostia River sediment samples collected in the present study was 17.0 ± 1.5 ppm. The mean total PAH concentration (sum of 44 analytes including alkylated PAHs) was 26.8 ± 2.9 ppm. Other monitoring studies in the Anacostia River have reported total PAH concentrations in sediments as high as 249 ppm [37]. Thus, analysis of the present and historical data for the Anacostia River indicates that sediments are contaminated with PAHs, although no concentrations as high as those initially measured in the Black River (1,096 ppm) have been reported.

Several studies of the possible association between liver neoplasia and PAH contamination in the Chesapeake Bay region have been reported. Vogelbein et al. [2] reported a 33% prevalence of hepatocellular carcinomas in mummichogs (*Fundulus heteroclitus*) from an area of the Elizabeth River where sediments were contaminated with creosote. Total PAHs in the Elizabeth River sediments were considerably higher, 2,200 ppm, than the concentrations reported in the present study. Pinkney et al. [17] reported a 10% prevalence of hepatocellular carcinomas in Neabsco Creek where maximum PAH concentrations were 25.5 ppm in 1992. This prevalence is similar to that reported in Neabsco Creek in the present study (7% hepatocellular carcinomas, 17% total liver tumors), in which the maximum sediment concentration was 12.7 ppm.

The apparent association between tumor prevalence and PAHs in sediments and PAH metabolites in bile should not be considered proof of a cause–effect relationship. First, the bile reflects recent exposure (i.e., days), whereas the development of tumors was initiated months to years before collection. Second, fish in the Anacostia River and Neabsco Creek are exposed to both PAHs and organochlorines, in addition to other chemicals that were not measured in this study. Tumors possibly are initiated by PAHs and are promoted by exposure to

Table 4. Sediment chemistry data (ppm dry wt) based on three samples per location, mean ± one standard error or median with range in parentheses[a]

Chemical[b]	Anacostia	Neabsco	Quantico	Tuckahoe	Statistics
Total PAHs	26.8 ± 1.6 A	4.8 ± 4.0 B	5.1 ± 2.7 B	1.8 ± 1.3 B	ANOVA, $p < 0.001$
Carcinogenic PAHs[c]	9.0 ± 0.2 A	1.4 ± 1.3 B	1.2 ± 0.6 B	0.5 ± 0.4 B	ANOVA, $p < 0.001$
Total PCBs	0.89 ± 0.25 A	0.26 ± 0.10 A	0.31 ± 0.13 A	ND[d] B	ANOVA, $p < 0.02$
Total DDT	0.18 ± 0.02	0.10 ± 0.02	0.32 ± 0.15	ND[d]	ANOVA,[e] $p < 0.08$
Total chlordane	0.16 (0.13–0.18)	ND[d]	ND[d]	ND[d]	Kruskal–Wallis, $p = 0.10$
Fraction fines[f]	0.56 ± 0.09	0.62 ± 0.22	0.71 ± 0.16	0.61 ± 0.22	
% Total organic C	4.5 ± 0.6	2.9 ± 0.9	3.9 ± 1.2	3.8 ± 1.6	

[a] Groups with different capital letters are significantly different, based on Tukey's test ($p < 0.05$).
[b] PAH = polycyclic aromatic hydrocarbon; PCB = polychlorinated biphenyl.
[c] Total of benzo[*a*]pyrene, benz[*a*]anthracene, benzo[*b*]fluoranthene, benzo[*k*]fluoranthene, benzo[*ghi*]perylene, chrysene, dibenzo[*a*,*h*]anthracene, and indeno[1,2,3-*c*,*d*]pyrene.
[d] Not detected; for calculations, values reported as one half of the detection limit (0.043–0.118 ppm for PCBs, 0.052–0.142 for DDT, 0.052–0.119 for chlordane).
[e] Log_{10}-transformed data.
[f] Fraction fines = fraction silt + fraction clay.

organochlorine pesticides and PCBs [3,34]. Also, movements of the fish may confound the interpretation.

The average Anacostia skin tumor prevalence (23%) slightly exceeded the 20% rate that Baumann et al. [5] suggested as indicative of contaminant exposure. In the two Anacostia collections, liver tumor prevalences (spring, 50%; fall, 60%) were similar, whereas skin tumor prevalences were markedly different (spring, 37%; fall, 10%). Similar prevalences of liver tumors also were found in the sampling of Neabsco Creek in 1992 (10%) and 1996 (17%), whereas the skin tumor prevalences were very different (33% in 1992, 3% in 1996). These findings are consistent with literature [5] that indicates a stronger linkage between liver tumors and chemical contamination than between skin tumors and chemical contamination.

Although not observed in the present study, bullheads from the Anacostia River are frequently observed to have clubbed or missing barbels (J. Siemien, unpublished data). This lesion has been correlated with elevated sediment PAH concentrations [7]. However, the lesions we observed in organs other than the liver as well as the parasitic lesions in the livers were not related to the tumor prevalence. For example, Pinkney et al. [19] reported that the prevalence of liver parasitism was equally high (14 of 30) in ANA-S, ANA- F, and TUCK fish.

Biochemical indicators of exposure

According to S. MacDonald (Texas A&M Geochemical and Environmental Research Group, unpublished data) bile B*a*P equivalent concentrations above 1 ppm, phenanthrene equivalent concentrations above 50 ppm, and naphthalene equivalent concentrations above 500 ppm are indicative of highly polluted environments. Benzo[*a*]pyrene concentrations of approximately 0.2 to 1.0 ppm, phenanthrene concentrations of approximately 10 to 50 ppm, and naphthalene concentrations of approximately 300 to 500 ppm are indicative of moderately polluted environments. Based on the concentrations of PAH metabolites in bile, the Anacostia bullheads would be in the highly polluted environment classification. These fish had greater recent exposure to PAHs than fish collected at the other sites (Tables 3 and 4) and metabolite concentrations are consistent with those reported from PAH-contaminated sites. For

Table 5. Results of logistic regressions showing only significant ($p < 0.05$) associations

Response variable	Predictor variable[a]	Frequency of response	*p* value[b]	Odds ratio[c]
Hepatocellular carcinoma	Sex	19/138	0.0001	4.514
	Age	16/128	0.0004	3.525
	Length	19/150	0.029	1.527
	K	19/150	0.018	0.615
	HSI	19/150	0.0001	1.315
	Bile B*a*P	11/74	0.030	1.401
	Bile naphthalene	11/74	0.048	1.063
Total liver tumors	Sex	42/138	0.001	3.654
	Age	38/128	0.0002	2.652
	HSI	43/150	0.0001	1.334
	Bile B*a*P	17/74	0.034	1.349
	Bile phenanthrene	17/74	0.032	1.184
Total skin tumors	Age	13/128	0.009	2.457
	HSI	16/150	0.001	1.231
	Bile B*a*P	10/74	0.0005	1.846
	Bile naphthalene	10/74	0.003	1.102
	Bile phenanthrene	10/74	0.0003	1.445

[a] *K* = condition factor; HSI = hepatosomatic index; B*a*P = benzo[*a*]pyrene.
[b] Based on Wald statistic.
[c] Scaling of odds ratios: sex (female : male); age (per year); length (per 10 mm); K (per 0.10 units); HSI (per 0.001 units); bile B*a*P (per 1.0 ppm); bile naphthalene and phenanthrene (per 100 ppm).

example, the mean concentration of B*a*P equivalents in the ANA-S fish (4.1 ppm) was similar to values reported by Arcand-Hoy and Metcalfe [23] for Black River brown bullheads collected in 1994 (2.8 ppm) and for brown bullheads caged for 8 d in the PAH-contaminated Trenton Channel area of the Detroit River [24]. The B*a*P equivalents measured by Leadley et al. [24] in an upstream reference area (0.6 ppm) and in laboratory controls (0.3 ppm) were similar to the mean concentrations in the NEAB and TUCK fish (0.47 and 0.49 ppm, respectively).

However, bile PAH metabolite concentrations cannot serve as a simple predictor of neoplasm frequencies, for several reasons. First, this biomarker measures response to exposures that occurred over a period of days, whereas the critical period for initiating carcinogenesis probably occurred months or years before the fish were collected. Second, considerable temporal variability exists in this response. Leadley et al. [24] reported significant differences in bile PAH concentrations in caged brown bullheads over a course of 16 d.

Levels of cytochrome P450 (as measured by EROD) activity, indicative of exposure to both organochlorine and PAH contamination, were not consistent with the tumor rankings. For example, although cytochrome P450 activity was significantly elevated in the ANA-S fish relative to QUAN and TUCK fish, the activity in the ANA-F fish was similar to that in all of the other groups of fish (Table 3). Possible explanations for the lack of consistency between the cytochrome P450 activities and liver neoplasm prevalence in the two collections from the Anacostia are a seasonal effect on enzyme response; movement into or out of the collection site (i.e., collection of different populations with different exposure histories); differences between types of contaminant exposure at the time of tumor induction versus the exposure that resulted in enzyme response; and evidence that PCBs are stronger inducers of cytochrome P450 than PAHs [38].

Mean EROD activities in the Anacostia and Neabsco collections, ranging from 52.6 to 79.4 pmol/min/mg protein, were similar to those measured by Arcand-Hoy and Metcalfe [23] in brown bullheads from three contaminated sites in the Great Lakes (42.0–59.5 pmol/min/mg protein). However, because the two Great Lakes control site collections had lower mean EROD activities (both 18.9 pmol/min/mg protein) than the TUCK fish (39.0 pmol/min/mg protein), the ratio of activities between contaminated and control sites was greater in the Great Lakes study. At present, no data are available from other reference areas in the Chesapeake to indicate whether the TUCK fish should be considered to have elevated EROD activity.

Hepatosomatic index and condition factor

The highest HSI rankings occurred in the two Anacostia collections with the highest liver tumor prevalence and the logistic regression analysis identified HSI as a significant predictor variable for both liver and skin tumors. A similar result was reported in a survey of four Great Lakes sites by Baumann et al. [4]. The mean HSI value determined for the ANA-S fish (0.025) was similar to the mean HSI determined by Baumann et al. [4] for brown bullheads from both the Cuyahoga River (0.026) and Munuscong Lake (0.026), where bullheads with liver tumors were found. Baumann et al. [4] did not detect liver tumors in bullheads from the Fox River (HSI = 0.022) or Menominee River (HSI = 0.020). Higher HSI values were also reported by Arcand-Hoy and Metcalfe [23] in collections from two Great Lakes contaminated sites (0.024 and 0.030) compared to a control site (0.020). Fabacher and Baumann [39] reported HSI values of 0.047 for male and 0.057 for female bullheads from the Black River compared with values of 0.017 to 0.027 with fish from uncontaminated locations. They stated that although sex and seasonal effects on liver enlargement exist, it is still useful as an indicator of contaminant stress.

Condition factors reported in the present study ranged from 1.22 to 1.51, which encompasses the 1.30 value reported by Sinott and Ringler [40] in a highly productive eutrophic lake. The logistic regression identified K as a significant predictor variable for hepatocellular carcinoma (odds ratio of 0.615 per 0.1 unit increase = 39% decreased odds for lesion with 0.1 unit increase in K) and for being lesion-free (1.318 odds ratio per 0.1 unit increase). This suggests that the more robust fish have less risk of being diagnosed with tumors. However, the results of the logistic regression are not consistent with the comparisons of mean K for the five collections, in which the highest (Quantico, 1.51) and lowest (Tuckahoe, 1.22) mean K values were measured in fish from the two sites with the lowest tumor prevalence.

Recommendation

Tumor prevalence surveys are recommended for monitoring the status of areas of the Chesapeake Bay with contaminated sediments, including regions of concern. Additional studies should be conducted in remote areas to develop a larger database on background prevalence and to identify areas needing further investigation. The brown bullhead is recommended as an appropriate species for tumor surveys in low-salinity areas. However, further information on movement is needed to identify home range and confirm its utility as a site-specific indicator. For higher salinity areas such as the Elizabeth River, the mummichog, a species with a small home range, is recommended [2]. Such surveys should be conducted before and after sediment remediation or source control measures have been implemented. Key indicators of exposure are the analysis of PAH metabolites in bile, EROD (although this may be more responsive to PCBs than PAHs), and the determination of DNA adducts in the liver. Calculation of the HSI and observation of barbels are recommended for bullhead surveys.

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TUMOR PREVALENCE AND BIOMARKERS OF EXPOSURE AND RESPONSE IN BROWN BULLHEAD (*AMEIURUS NEBULOSUS*) FROM THE ANACOSTIA RIVER, WASHINGTON, DC AND TUCKAHOE RIVER, MARYLAND, USA

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Abstract—We evaluated liver and skin tumor prevalence and biomarkers of exposure and response in brown bullhead (*Ameiurus nebulosus*) from three locations in the Anacostia River (Washington, DC, USA), a Chesapeake Bay region of concern. The Tuckahoe River (Maryland, USA) served as a reference. Each river was sampled in fall 2000 and spring 2001. In the Anacostia, prevalence of liver tumors was 50 to 68%, and prevalence of skin tumors was 13 to 23% in large (≥260 mm, age ≥3 years) bullheads. Liver and skin tumor prevalence was 10 to 17% and 0%, respectively, in small (150–225 mm, age 1–2 years) bullheads. Tuckahoe bullhead liver tumor prevalence was 0 to 3% (large) and 0% (small); none had skin tumors. Biliary polynuclear aromatic hydrocarbon (PAH)-like fluorescent metabolites and liver DNA adduct concentrations were elevated in large and small Anacostia bullheads. Mean adduct concentrations were 16 to 28 times higher than those in Tuckahoe fish. Chromatograms revealed a diagonal radioactive zone, indicating polycyclic aromatic compound (PAC)-DNA adducts. The biomarker data and the 10 to 17% liver tumor prevalence at ages 1 to 2 suggest that these year classes are likely to have a high prevalence as they reach age 3 and older. This study provides the strongest evidence to date of the role of PAHs in tumor development in Anacostia bullheads.

Keywords—Tumors Biomarkers Brown bullheads Polynuclear aromatic hydrocarbons

INTRODUCTION

The prevalence of tumors in fish has been used as an indicator of environmental quality in saltwater and freshwater ecosystems [1–9]. In controlled laboratory exposures, many chemicals, including polynuclear aromatic hydrocarbons (PAHs), nitrosamines, and some halogenated hydrocarbons, have been shown to be carcinogenic to fish [10]. The strongest case for a chemical etiology for liver tumors observed in field-collected fish is for PAHs in sediments [4,7,9]. Field-based evidence linking PAHs in sediments with liver tumors was developed by Baumann and Harshbarger [1] from surveys in the Black River (Ohio, USA) conducted in the 1980s and 1990s with bottom-feeding brown bullhead (*Ameiurus nebulosus*). They observed that liver tumor prevalence increased and decreased according to changes in sediment PAH concentrations. A cause and effect relationship between PAHs and liver tumors or pre-neoplastic lesions has also been established through laboratory studies [11,12].

Skin tumors in brown bullhead have been induced by repeatedly painting the skin with sediment extracts containing high PAH concentrations [13]. Grizzle et al. [14] observed an increased prevalence of papillomas in black bullhead (*Ameiurus melas*) exposed to chlorinated wastewater effluent, and prevalence decreased when chlorination was decreased. In a summary of studies conducted in the Laurentian Great Lakes (North America), Baumann et al. [4] reported that higher oral and cutaneous tumor prevalence occurred in PAH-contaminated tributaries compared with reference sites. Poulet et al. [15], however, noted the occurrence of orocutaneous tumors in 94 brown bullheads collected from 17 locations (both contaminated and uncontaminated) in New York State (USA). They found that the distribution of lesions did not suggest a strict correlation with chemical carcinogens. Spitsbergen and Wolfe [16] stated that, in addition to PAHs, nitrosamines might contribute to both skin and liver tumor development in brown bullhead. Bunton [17] concluded that, although skin tumors in brown bullhead are associated with bottom-dwelling and feeding and contact with contaminated sediments, other factors could also be involved.

Biomarkers are physiological, biochemical, or histological changes used as indicators of chemical exposure, chemical effects, or both. Because fish rapidly metabolize PAHs [18], researchers have used biomarkers rather than tissue concentrations as indicators of exposure and response. The presence of PAH-like metabolites in bile indicates recent exposure on the order of days [19]. The presence of a diagonal radioactive zone (DRZ) on chromatographs of liver DNA results from polycyclic aromatic compounds (PACs), PAHs, and nitro-PAH compounds, forming adducts with DNA. These adducts can be an early stage in carcinogenesis [20].

The Anacostia River (Fig. 1), a tidal freshwater system, is one of three regions of concern identified by the U.S. Environmental Protection Agency's Chesapeake Bay Program. Sediments are contaminated with PAHs, polychlorinated biphenyls (PCBs), and chlordane, and a health advisory encourages restriction in fish consumption [21]. In a 1996 survey of brown bullheads from the Anacostia River, Pinkney et al. [7] reported

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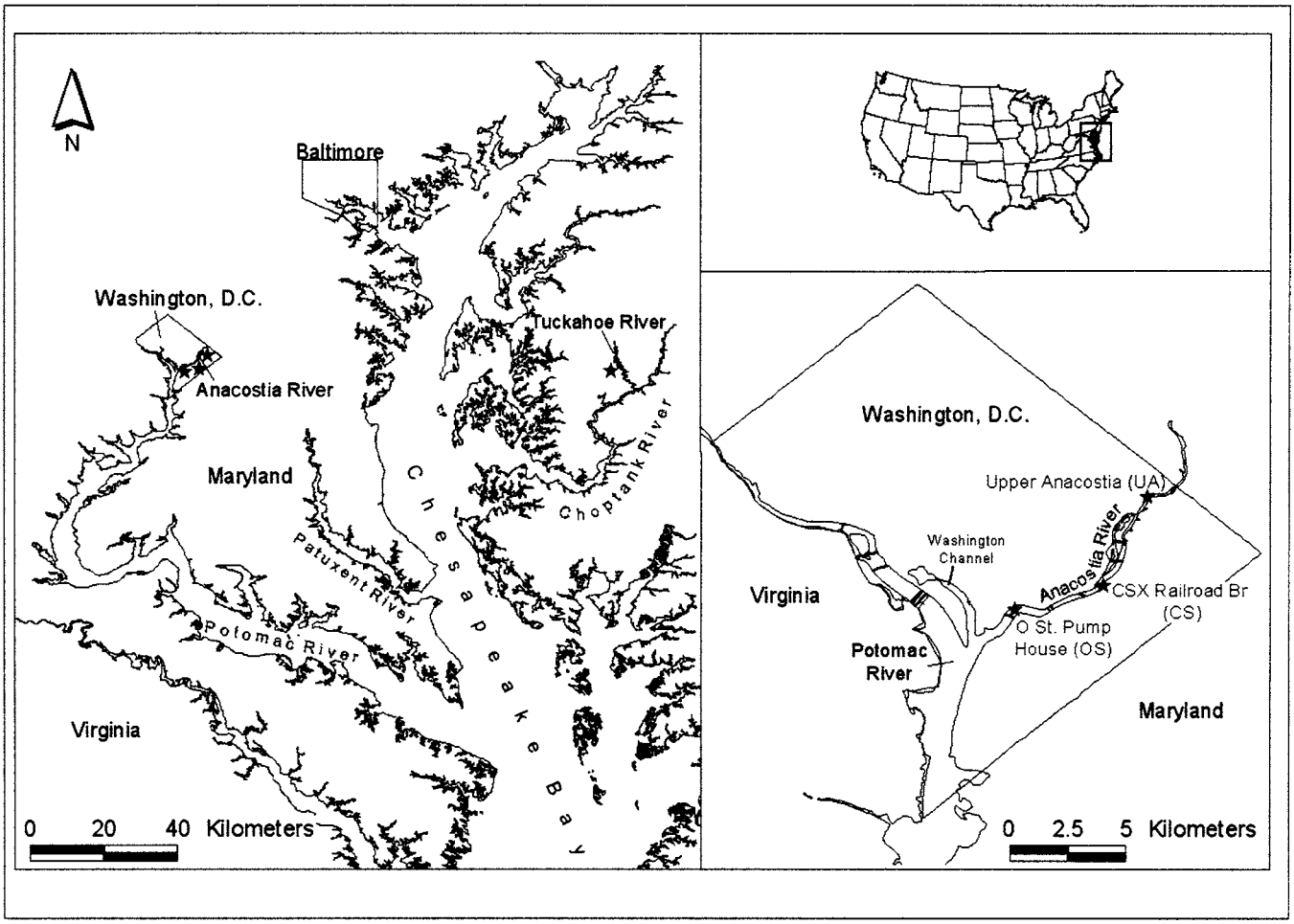

Fig. 1. Brown bullhead collection sites in the Anacostia River (Washington, DC) and Tuckahoe River (Maryland).

that the prevalence of liver tumors averaged 55% and that of orocutaneous tumors averaged 23%.

Environmental managers in the Great Lakes have used the prevalence of tumors as a criterion for identifying and prioritizing contaminated sites (areas of concern). Baumann et al. [4] reported that liver tumor prevalence exceeding about 9% and skin tumor prevalence exceeding about 20% were nearly always observed in brown bullhead in chemically contaminated areas. Baumann [22] suggested criteria of about 5% liver tumors and 12% skin tumors for distinguishing highly contaminated areas of concern from less contaminated areas of recovery.

Here, we report a survey of tumor prevalence in brown bullhead from three locations in the Anacostia River (Fig. 1). A reference site, the Tuckahoe River, in an agricultural and forested watershed on the Eastern Shore of Maryland was also sampled. The objectives were to determine the prevalence of skin and liver tumors; compare lesions and biomarkers in two age classes (because the risk of liver neoplasms is known to increase with age [6]); and examine statistical associations between tumor prevalence, biomarkers, and tissue contaminants. An expanded version of this paper is available in report form [23].

MATERIALS AND METHODS

Site selection and sampling

Brown bullheads were collected from tidal freshwater areas of the Anacostia and Tuckahoe Rivers in the fall of 2000 and the spring of 2001. From the Anacostia, two groups of 30 large (total lengths ≥260 mm) and small (150–225 mm) bullheads were collected in the fall of 2000 near the mouth of Kenilworth Marsh (38.9137°N, 76.9538°W; Fig. 1). These fish were designated as upper Anacostia large–fall (UAL-F) and upper Anacostia small–fall (UAS-F). At this location, many bullheads congregate in a 3- to 5-meter-deep bend in the river. About 1 km downstream is a petroleum-contaminated tributary (Hickey Run, District of Columbia, USA). About 1 km upstream, another tributary, Lower Beaverdam Creek (Maryland, USA), has several automobile junkyards along its lower reach. In spring 2001, an additional 30 large (upper Anacostia large–spring, UAL-S) and 30 small (upper Anacostia small–spring, UAS-S) bullheads were collected from this site. Also in spring 2001, bullheads were collected near the CSX Railroad Bridge (38.8792°N, 76.9722°W), with most fish obtained within 10 m of the Northeast Boundary Combined Sewer Outfall (CSO). These fish were designated as CSX large–spring (CSL-S, n = 30) and CSX small–spring (CSL-S, n = 29). Twenty-five large bullheads also were collected in spring near the O Street CSO (OSL-S; 38.8727°N, 77.0029°W). Fish were collected by trawling, electroshocking, deploying eel pots, or angling.

Large and small bullheads were collected from the tidal freshwater area of the Tuckahoe River (38.8674°N, 75.9352°W; Fig. 1) on the Eastern Shore of Maryland, which has served as a reference site for previous surveys [7,24]. The fall 2000 collections of fish were designated as Tuckahoe large–fall (TKL-F, n = 30) and Tuckahoe small–fall (TKS-F, n = 30),

and large fish also were collected in the spring (TKL-S, n = 18). Otter trawling was used to collect the Tuckahoe fish, which school in a bend in the river at depths of 3 to 6 m.

Laboratory procedures

Fish were maintained for 1 to 2 d in coolers with aerated water from the collection site. They were measured for total length (mm), weighed to the nearest gram, euthanized by severing the spinal cord, and necropsied. Condition factor, K = (weight [g] $\times$ 10^5)/length (mm^3), was calculated. Grossly visible lesions were noted, and the liver was excised and weighed so that the hepatosomatic index (HSI = liver weight/body weight) could be determined. Livers (except a 0.5-g portion used for biochemistry) and skin areas with visible lesions were preserved in 10% buffered formalin and transported to George Washington University Medical Center (Washington, DC) for histopathological examination and tumor diagnosis. The tissues were processed according to standard histological procedures, sectioned at 6 μm, and stained with hematoxylin and eosin [25]. Four tissue blocks were sectioned from each liver and two from each skin lesion, and at least two sets of slides were prepared from each block. Materials were maintained and case reports entered into the Registry of Tumors in Lower Animals.

Brown bullheads were aged using pectoral spines on the basis of methods described in Baumann et al. [2]. Spines were cleaned of excess tissue, decalcified with 5% aqueous nitric acid, rinsed in distilled water, and stored in 50% isopropyl alcohol. A 6- to 10-mm portion of the spine, anterior of the basal groove, was used for sectioning after mounting in a paraffin medium with the use of a microtome. The sections were mounted on slides and aged with confirmation by an independent scientist.

Biochemical and chemical analyses were done on 4 to 10 randomly selected fish from each group. A 0.4- to 0.5-g section of the liver was flash frozen in liquid nitrogen and stored at −80°C for analysis of DNA adducts. The livers were shipped to the Northwest Fisheries Science Center, National Oceanographic and Atmospheric Administration (NOAA, Seattle, WA, USA) on dry ice. Hepatic DNA was isolated according to Reddy and Randerath [26]. The ^{32}P-postlabeling assay was conducted according to Reichert et al. [27] using salmon sperm DNA as a method blank. Briefly, DNA was enzymatically hydrolyzed to deoxyribonucleoside 3′-monophosphates by micrococcal endonuclease and spleen phosphodiesterase. Aliquots of hydrolyzed DNA were treated with nuclease P1 [28], which selectively hydrolyzes normal 3′-mononucleotides to nucleosides, thereby enriching the mixture in adducted 3′-monophosphates. Samples enriched in DNA adducts were postlabeled using [γ-^{32}P]adenosine triphosphate. The ^{32}P-labeled adducts were chromatographed on polyethyleneimine-cellulose thin-layer chromatography sheets prepared in the laboratory [27]. Solvent systems used in the multidirectional chromatography were D1 to 1.0 M sodium phosphate, pH 6.0; D2 is omitted; D3 to 7.25 M urea and 5.0 M lithium formate, pH 3.5; and D4 to 7.25 M urea, 1.5 M lithium chloride and 0.5 M Tris, pH 8.0. Total nucleotides were determined by postlabeling an aliquot of DNA hydrolysate followed by one-dimensional thin-layer chromatography of 5′-labeled nucleotides using 0.24 M ammonium sulfate in 8 mM sodium phosphate, pH 7.4, as a solvent and quantitation of the deoxythymidine-3′,5′-bisphosphate spot. The ^{32}P-labeled DNA adducts and DNA bases on the chromatograms were located and quantified with storage phosphor imaging technology [29]. Images were interpreted for the presence of a DRZ indicative of PAC-DNA adducts.

Bile was collected in disposable syringes, placed in cryotubes in liquid nitrogen, stored at −80°C, and shipped on dry ice to the NOAA laboratory. Fluorescent metabolites of benzo[*a*]pyrene and phenanthrene were analyzed by high-performance liquid chromatography with a fluorescence detector, according to the method of Krahn et al. [18]. These data were reported as the concentrations of benzo[*a*]pyrene- and phenanthrene-like fluorescent metabolite equivalents in bile (μl/L basis).

Fish were filleted using pesticide-grade acetone-cleaned utensils, and the samples were stored at −20°C in chemically cleaned glass bottles. (The tissue contaminants were only analyzed in large fish because of cost considerations.) The samples were homogenized and freeze dried, and the moisture and lipid content were determined. The freeze-dried tissues were analyzed for organochlorine pesticides and PCB congeners by the U.S. Environmental Protection Agency Region III, Environmental Services Division Laboratory (Fort Meade, MD, USA). The pesticides were analyzed by capillary column gas chromatography–electron capture detector. The PCB congeners were analyzed by gas chromatography–electron capture detector (Hewlett Packard, Avondale, PA, USA). Results for 80 peaks, representing either single PCB congeners or two to three coeluting congeners were provided. Nominal quantitation limits ranged from 0.0025 to 0.025 μg/g for the pesticides and 0.036 to 10.0 ng/g for the PCB congeners. Method descriptions with citations and quality assurance procedures are provided in Pinkney et al. [23].

Data analysis

Histopathological data were summarized as the prevalence of the various types of lesions among the collections of bullheads. The Anacostia and Tuckahoe Rivers are more than 100 km apart, and on separate shores of the Chesapeake Bay (Maryland and Virginia, USA), so that crossover of fish between the two rivers is highly unlikely. Within the Anacostia, we suspect that there is minimal exchange of fish between sites. Sakaris et al. [30] estimated the linear home range of bullheads in the tidal Anacostia to range from 0.5 to 2.1 km. Our three collection sites were approximately 1.5, 5.3, and 9.6 km from the river mouth (Fig. 1).

Because the risk of liver neoplasms is known to increase with age [2,6], we performed separate comparisons of lesion prevalence for the two size classes. First, we ran an extension of Fisher's exact test comparing prevalence among all large or all small collections [31]. Then, we used Fisher's exact test for pairwise comparisons between collections with a false discovery rate of 0.05 [32].

Biological parameters (length, weight, liver weight, K, age, and HSI) were compared between the collection sites, keeping the size classes separate. Either one-way analysis of variance (ANOVA) or, if parametric assumptions were not satisfied even after log transformation, Kruskal–Wallis tests were performed [33]. For the biliary PAH metabolites and DNA adducts, which reflect exposure and response, there was no a priori rationale for keeping the size classes or seasons separate. Thus, Student's *t* tests, one-way ANOVAs, or Mann–Whitney or Kruskal–Wallis tests were used to determine whether multiple collections at the same site could be combined. If there were no significant differences ($p > 0.05$), the collections were pooled and com-

parisons were made between sites. Tukey's multiple comparison test (ANOVA) or Dunn's method (Kruskal–Wallis) were used to identify statistical significance between collections or pooled groups of collections with a p value of 0.05.

Logistic regression [31] was used to evaluate the relationship between biological, biochemical, and chemical variables and the prevalence of liver and skin tumors. Regressions were performed separately for the large and small fish across all sites. The biological predictor variables were sex, age, length, weight, HSI, and K. Biochemical predictor variables were concentrations of benzo[*a*]pyrene- and phenanthrene-like fluorescent metabolite equivalents and DNA adducts. Chemical predictor variables were fillet concentrations of total PCBs, *p,p′*-1,1-dichloro-2,2-bis(*p*-chlorophenyl) ethylene (DDE), and gamma-chlordane. Each predictor variable was examined separately and models were considered statistically significant if $p \leq 0.05$, determined by exact methods [34]. For all significant regressions, odds ratios were reported, with values greater than one indicating an increased risk for the response variable for an incremental increase in the predictor variable (e.g., per year of age).

Fisher's exact test [31] was used to test for associations between the presence of a visible lesion (either altered barbels or lip lesions later confirmed histologically to be skin tumors) and the subsequent detection of a histological liver lesion (either tumors or foci of hepatocellular alteration). A one-sided test was used, which examined no effect versus a positive association. Only the large fish were used because there were too few lesions in the small fish for this analysis.

RESULTS

Biological parameters

Among the six collections of large bullheads, length, weight, liver weight, HSI, K, and age showed statistically significant differences (Table 1). For example, the TKL-S collection (median 263 mm) was significantly smaller than TKL-F (274 mm) and one of the Anacostia collections (UAL-S, 273 mm; Kruskal–Wallis, $p = 0.006$; Dunn's method, $p < 0.05$). The ages of large bullheads also showed significant differences. The TKL-F collection had a median age of 3 years, significantly less than that of the TKL-S collection (4 years) and several Anacostia collections (median ages of 4 or 5 years; Kruskal–Wallis, $p < 0.001$). Sex ratios, however, were similar among all the collections of large fish (Anacostia and Tuckahoe), with all at least 80% males. Significant differences in these same six biological parameters were seen in the four collections of small bullheads (Table 2). In most cases, the statistically significant differences were between the different Anacostia collections; the Tuckahoe collection usually had intermediate values. In contrast to the larger fish, the small fish were nearly evenly split between males and females, with similar ratios in the Anacostia and Tuckahoe fish.

Pathology

Gross examination revealed that many large Anacostia fish had shortened, clubbed (stubbed), or missing barbels (Fig. 2). The prevalence of abnormalities (any of these observations) on one or more barbels ranged from 23 to 56% in the large Anacostia fish compared with 0 to 17% in the large Tuckahoe fish ($p < 0.00001$, Fisher's exact test; Table 3). In the collections of small fish, the prevalence of abnormal barbels was 0 to 27% in the Anacostia and 0% in the Tuckahoe ($p = 0.0004$; Table 4).

Table 1. Biological data for the six collections of large (≥260 mm) brown bullheads[a]

	UAL-F[b] (n = 30)	UAL-S[b] (n = 30)	CSL-S[b] (n = 30)	OSL-S[b] (n = 25)	TKL-F[b] (n = 30)	TKL-S[b] (n = 18)	Statistics[c]
Length (mm)	272 (262–285) AB	273 (260–304) A	270 (262–305) AB	265 (260–306) AB	274 (261–298) A	263 (260–282) B	K-W $p = 0.006$
Wt (g)	245 ± 5 A	269 ± 8 A	269 ± 8 A	254 ± 6 A	252 ± 5 A	244 ± 5 A	ANOVA $p = 0.025$[d]
Liver wt (g)	6.04 (4.58–8.23) AB	5.98 (2.70–7.80) AB	6.30 (3.95–8.30) A	5.37 (3.25–6.51) AB	5.12 (3.86–7.02) BC	3.77 (2.50–5.43) D	K-W $p < 0.001$
K[b] (units)	1.20 (1.10–1.41) C	1.29 (1.00–1.42) BC	1.32 (1.05–1.49) A	1.31 (1.01–1.48) AB	1.23 (1.04–1.43) BC	1.29 (1.6–1.43) ABC	K-W $p < 0.001$
HSI[b] (units)	0.025 ± 0.0006 A	0.022 ± 0.0007 BCD	0.024 ± 0.0008 AB	0.021 ± 0.0008 D	0.021 ± 0.0004 CD	0.015 ± 0.0008 E	ANOVA $p < 0.001$[d]
Sex	26m, 3f, 1?[b]	24 m, 6f[b]	25m, 5f[b]	20m, 5f[b]	24m, 5f, 1?[b]	16m, 2f[b]	
Age (years)	4 (2–5) BC	t 5 (4–6) A	4 (3–7) B	4 (4–6) A	3 (2–5) C	4 (3–5) AB	K-W $p < 0.001$

[a] Mean ± 1 SE or median with range in parentheses.
[b] UAL-F = upper Anacostia large–fall 2000; UAL-S = upper Anacostia large–spring 2001; CSL-S = CSX Railroad bridge large–spring 2001; OSL-S = O Street large–spring 2001; TKL-F = Tuckahoe large–fall 2000; TKL-S = Tuckahoe large–spring 2001; K = condition factor; HSI = hepatosomatic index; m = male, f = female, ? = sex not determined.
[c] Groups with different capital letters are significantly different at $p < 0.05$ using Tukey's test following ANOVA or Dunn's method following Kruskal–Wallis (K-W) test; p values for ANOVA and K-W are shown in this column.
[d] Log-transformed data used in ANOVA; untransformed means and SE reported.

Table 2. Biological data for the four collections of small (150–225 mm) brown bullheads[a]

	UAS-F[b] (n = 30)	UAS-S[b] (n = 30)	CSL-S[b] (n = 29)	TKS-F[b] (n = 30)	Statistics[c]
Length (mm)	188 (153–209) B	200 (161–222) AB	204 (185–223) A	194 (169–225) AB	K-W $p < 0.001$
Wt (g)	70 (37–95) B	80 (44–120) B	100 (70–180) A	81 (52–134) AB	K-W $p < 0.001$
Liver wt (g)	1.86 ± 0.10 B	1.90 ± 0.11 AB	2.27 ± 0.08 A	2.25 ± 0.10 A	ANOVA $p = 0.003$
K[b] (units)	1.08 (0.93–1.26) BC	1.07 (0.92–1.28) C	1.18 (0.94–2.25) A	1.12 (1.00–1.58) AB	K-W $p = 0.002$
HSI[b] (units)	0.027 ± 0.0007 A	0.023 ± 0.0006 BC	0.023 ± 0.0008 C	0.026 ± 0.0006 AB	ANOVA $p < 0.001$
Sex	11m, 15f, 4?[b]	15m, 15f[b]	17m, 12f[b]	13m, 17f[b]	
Age (years)	1 (1–2) B	2 (1–3) A	2 (2–3) A	1 (1–2) B	K-W; $p < 0.001$

[a] Mean ± 1 SE or median with range in parentheses.
[b] UAS-F = upper Anacostia small–fall 2000; UAS-S = upper Anacostia small–spring 2001; CSS-S = CSX Railroad bridge small–spring 2001; TKS-F = Tuckahoe small–fall 2000; K = condition factor; HSI = hepatosomatic index; m = male, f = female, ? = sex not determined.
[c] Groups with different capital letters are significantly different at $p < 0.05$ using Tukey's test following ANOVA or Dunn's method following Kruskal–Wallis (K-W) test; p values for ANOVA and K-W are shown in this column.

Pink, oval or round, solid (in texture) lesions were seen in the mouth area in some of the Anacostia bullheads. After histopathological examination of these lesions, three UAL-F fish, two UAL-S fish, and four CSL-S fish were diagnosed with invasive (cancerous) skin tumors, characterized as squamous carcinomas (Table 3). In addition, two UAL-F, two UAL-S, five CSL-S, four OSL-S, and one UAS-S fish had lesions similar in gross appearance that were characterized histopathologically as noninvasive epidermal papillomas. No Tuckahoe fish had skin tumors of either type. Skin tumor prevalence ranged from 13 to 23% in the large Anacostia bullheads versus 0% in the large Tuckahoe fish ($p = 0.02$; Table 3). In the small fish, the prevalence was 0 to 3% in the Anacostia and 0% in the Tuckahoe ($p = 1.0$; Table 4).

No grossly visible liver lesions were found in any of the bullheads. On the basis of histopathological examination of all livers, significantly higher prevalence of preneoplastic (foci of hepatocellular alteration) and neoplastic liver lesions were diagnosed in the Anacostia versus Tuckahoe bullheads, and prevalence was greater in large versus small fish (Tables 3 and 4). The prevalence of liver tumors (either invasive or noninvasive) was 50 to 68% in the large Anacostia fish compared with 0 to 3% in the large Tuckahoe fish ($p < 0.0001$) and 10 to 17% in the small Anacostia fish versus 0% in the small Tuckahoe fish ($p = 0.11$). In both size classes, bile duct tumors (cholangiomas and cholangiocarcinomas) were much less common than liver cell tumors (hepatocellular adenomas or hepatocellular carcinomas). Of the large Anacostia fish, 70 to 73% had livers with either preneoplastic or neoplastic lesions compared with 0% (TKL-S) and 23% (TKL-F; $p < 0.00001$; Table 3). Between 10 and 20% of the small Anacostia fish had pre-neoplastic or neoplastic liver lesions compared with 3% of the small Tuckahoe fish ($p = 0.23$; Table 4).

Only one case of a seasonal difference in lesion prevalence was found in Anacostia bullheads. The upper Anacostia large bullheads from the fall (UAL-F) had a much higher prevalence of hepatocellular adenomas (47%) compared with the spring collection (UAL-S, 13%; Fisher's exact test, $p = 0.01$). Two cases of seasonal differences were found in the Tuckahoe bullheads. The prevalence of liver lesions (either pre-neoplastic or neoplastic) was 23% in the fall collection of large fish (TKL-F) versus 0% in the spring (TKL-S; $p = 0.036$). The prevalence of abnormal barbels was 0% in the TKL-F collection and 17% in the TKL-S collection ($p = 0.047$).

Fig. 2. Brown bullhead from the Anacostia River (Washington, DC) with missing (A) and severely shortened (B) barbels.

Biomarkers of exposure and response

Median benzo[*a*]pyrene-like fluorescent metabolites in the bile of Anacostia bullheads ranged from 2.3 μl/L in bullheads from the upper Anacostia in the fall (UAL-F) to 7.8 μl/L for those collected near the O Street pump house outfall in the spring (OSL-S, Fig. 3a). For the Anacostia, all small and large fish collected from the same location during the same season could be pooled (Mann–Whitney tests, $p < 0.05$). However, benzo[*a*]pyrene-like fluorescent metabolite concentrations in the upper Anacostia spring (median 7.3 μl/L) versus fall (median 2.3 μl/L) collections were significantly different. Most of the Anacostia groupings of bullheads had significantly higher benzo[*a*]pyrene-like fluorescent metabolites than the Tuckahoe bullheads, which had median concentrations of 0.21 μl/L (small) and 0.44 μl/L (large; $p < 0.001$, Kruskal–Wallis test; Fig. 3a). Mean concentrations of phenanthrene-like fluorescent metabolites in Anacostia bullheads ranged from 523 μl/L (upper Anacostia location) to 725 μl/L (O Street pump house), significantly greater than small and large Tuckahoe bullheads with 26.4 μl/L and 69.5 μl/L, respectively (ANOVA, $p < 0.001$; Fig. 3b).

The mean concentrations of DNA adducts were 16 to 28 times higher in the Anacostia bullheads, 690 to 1,146 nmol/

Table 3. Liver and skin tumor prevalence and prevalence of shortened, clubbed, or missing barbels (number affected with percentage in parentheses) for the six collections of large (≥260 mm) brown bullheads

Lesion[a]	UAL-F[a] (n = 30)	UAL-S[a] (n = 30)	CSL-S[a] (n = 30)	OSL-S[a] (n = 25)	TKL-F[a] (n = 30)	TKL-S[a] (n = 18)	p value[b]
FHA	17 (57) A	16 (53) A	18 (60) A	14 (56) A	6 (20) B	0 (0) B	0.00001
HA	14 (47) A	4 (13) B	9 (30) A	8 (32) A	0 (0) B	0 (0) B	0.00001
HC	10 (33) A	10 (33) A	17 (57) A	12 (48) A	0 (0) B	0 (0) B	0.00001
C	2 (7)	4 (13)	1 (3)	3 (12)	1 (3)	0 (0)	0.42
CC	3 (10)	4 (13)	1 (3)	2 (8)	0 (0)	0 (0)	0.19
TLC	11 (37) A	12 (40) A	17 (57) A	13 (52) A	0 (0) B	0 (0) B	0.00001
TLT	17 (57) A	15 (50) A	18 (60) A	17 (68) A	1 (3) B	0 (0) B	0.00001
TLL	22 (73) A	21 (70) A	22 (73) A	18 (72) A	7 (23) B	0 (0) B	0.00001
EP	2 (7)	2 (7)	5 (17)	4 (16)	0 (0)	0 (0)	0.07
SC	3 (10)	2 (7)	4 (13)	0 (0)	0 (0)	0 (0)	0.10
TST	5 (17) AB	4 (13) ABC	7 (23) A	4 (16) AB	0 (0) C	0 (0) BC	0.023
SB	16 (53) A	14 (47) AB	7 (23) B	14 (56) A	0 (0) C	3 (17) B	0.00001

[a] UAL-F = upper Anacostia large–fall; UAL-S = upper Anacostia large–spring; CSL-S = CSX Railroad Bridge large–spring; OSL-S = O Street pump house large–spring; TKL-F = Tuckahoe large–fall; TKL-S = Tuckahoe large–spring; FHA = foci of hepatocellular alteration; HA = hepatocellular adenoma; HC = hepatocellular carcinoma; C = cholangioma; CC = cholangiocarcinoma; TLC = total liver or bile invasive tumors; TLT = total liver and/or bile duct invasive or noninvasive tumors; TLL = total liver lesions (neoplastic or preneoplastic); EP = epidermal papilloma; SC = squamous carcinoma; TST = total skin tumors; SB = shortened, clubbed, or missing barbels.

[b] Extension of Fisher's exact test (Stokes et al. [31]). Groups with different capital letters are significantly different at $p < 0.05$ on the basis of pairwise Fisher's tests with a false discover rate of 0.05 (Benjamini and Hochberg [32]).

mol, compared with the Tuckahoe bullheads (42.1 nmol/mol ANOVA, $p < 0.001$; Fig. 3c). Concentrations of DNA adducts were not statistically different in large and small or spring and fall fish from the same locations; therefore, multiple collections from the same site were pooled. In the chromatograms of the Anacostia fish, the DRZ was pronounced, indicative of PAC-DNA adducts (Fig. 4). In the Tuckahoe fish, in addition to a much less dense DRZ, a second zone of adducts was also evident, which was not attributable to a specific class of compounds. Thus, the mean (±1 SD) concentration of total DNA adducts in the TKL-F fish (20 ± 5 nmol/mol) was nearly twice the average concentration of adducts in the DRZ (12 ± 3 nmol/mol). This second zone also was observed in the Anacostia fish but was very faint and at the limits of quantitation.

Table 4. Liver and skin tumor prevalence and prevalence of shortened, clubbed, or missing barbels (number affected with percentage in parentheses) for the four collections of small (150–225 mm) brown bullheads

Lesion[a]	UAS-F[a] (n = 30)	UAS-S[a] (n = 30)	CSL-S[a] (n = 29)	TKS-F[a] (n = 30)	p value[b]
FHA	4 (13)	0 (0)	3 (10)	1 (3)	0.12
HA	4 (13) A	0 (0) A	0 (0) A	0 (0) A	0.013
HC	3 (10)	3 (10)	4 (14)	0 (0)	0.18
C	1 (3)	0 (0)	0 (0)	0 (0)	1.0
CC	0 (0)	0 (0)	0 (0)	0 (0)	—
TLC	3 (10)	3 (10)	4 (14)	0 (0)	0.18
TLT	5 (17)	3 (10)	4 (14)	0 (0)	0.11
TLL	6 (20)	3 (10)	4 (14)	1 (3)	0.23
EP	0 (0)	1 (3)	0 (0)	0 (0)	1.0
SC	0 (0)	0 (0)	0 (0)	0 (0)	—
TST	0 (0)	1 (3)	0 (0)	0 (0)	1.0
SB	8 (27) A	3 (10) AB	0 (0) B	0 (0) B	0.0004

[a] UAS-F = upper Anacostia small–fall; UAS-S = upper Anacostia small–spring; CSL-S = CSX Railroad Bridge small–spring; TKS-F = Tuckahoe small–fall. See Table 3 for lesion acronyms.

[b] Extension of Fisher's exact test (Stokes et al. [31]). Groups with different capital letters are significantly different at $p < 0.05$ on the basis of pairwise Fisher's tests with a false discover rate of 0.05 (Benjamini and Hochberg [32]).

Tissue contaminants

On the basis of Mann–Whitney rank sum tests, it was possible to pool the data from the two collections from the upper Anacostia site and from the two collections from the Tuckahoe. Median total PCB concentrations in the Anacostia fillets ranged from 0.198 μg/g for the upper Anacostia collections (UAL-S + UAL-F) to 0.467 μg/g for the CSL-S collection. All of the median concentrations in the Anacostia locations were significantly greater than the median (0.0143 μg/g) from the Tuckahoe (Kruskal–Wallis test, $p < 0.001$). Median concentrations of gamma-chlordane were significantly higher in several Anacostia groupings (CSL-S, 0.0131 μg/g; UAL-F + UAL-S, 0.00887 μg/g) compared with the collections from the Tuckahoe (TKL-F + TKL-S, not detected [<0.000475 μg/g]). Median *p,p′*-DDE concentrations were significantly higher in the CSL-S (0.0515 μg/g) and OSL-S (0.0363 μg/g) collections compared with the Tuckahoe (TKL-F + TKL-S, 0.00654 μg/g; Kruskal–Wallis test, $p < 0.001$). Data tables are provided in Pinkney et al. [23].

Statistical analyses

For the large fish, with total liver tumors (TLT, either invasive or noninvasive) as the response variable, the logistic regression analysis indicated increased risks associated with the predictor variables length, age, sex, HSI, bile benzo[*a*]pyrene, bile phenanthrene, tissue total PCBs, and tissue *p,p′*-DDE (Table 5). On the basis of odds ratios, the strongest effects (greatest relative risks) for TLT were for sex (females had 3.953 times the odds for males). This was reflected in the liver tumor prevalence of 95% (18 of 19) for females and 50% (48 of 95) for males. Bile PAH metabolites, tissue PCBs, and tissue *p,p′*-DDE were significant predictor variables for TLT, with odds ratios ranging from 1.193 to 1.327. With total skin tumors (TST, either invasive or noninvasive) as the response variable, only HSI was identified as a significant risk factor (1.812 times per 0.005 units). An increased risk of TLT with increased length (1.826 times per 10 mm) and weight (1.245 times per 10 grams) was seen among the small fish.

On the basis of Fisher's exact tests, associations between

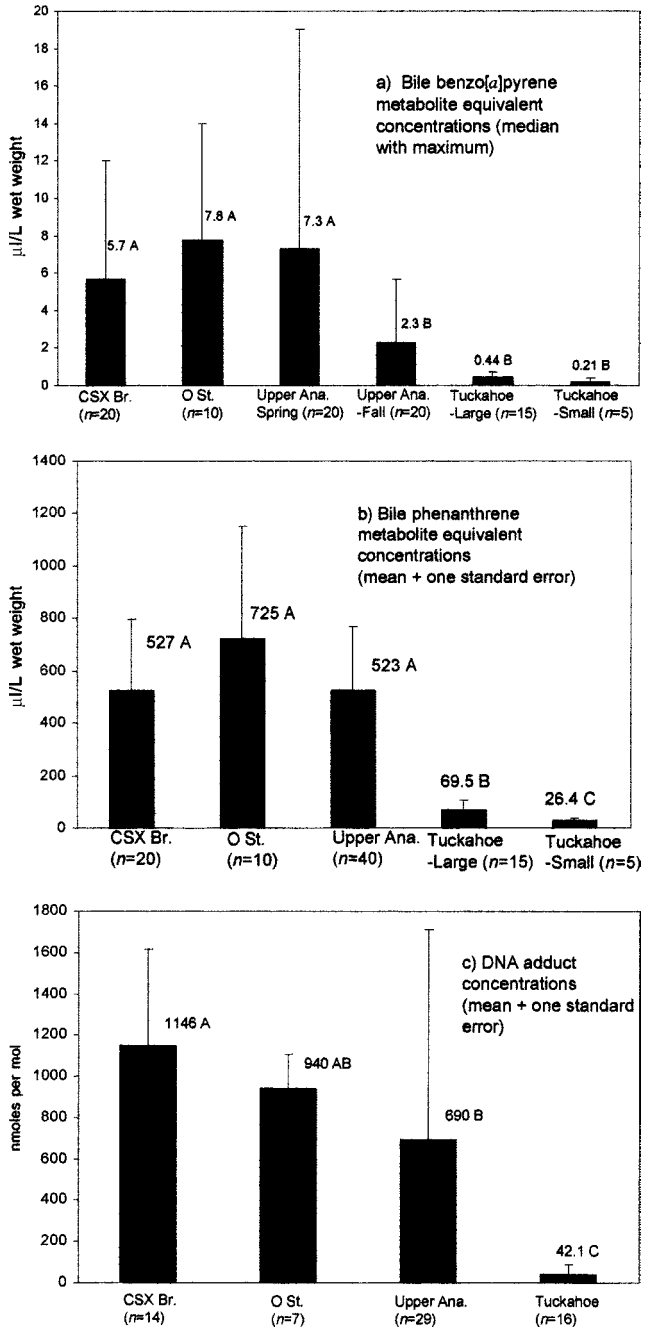

Fig. 3. Comparison of (**a**) benzo[*a*]pyrene and (**b**) phenanthrene metabolite equivalent concentrations in bullheads from different locations. (**c**) Comparison of DNA adduct concentrations in bullheads from different locations. Different collections (large and small, spring and fall) from the same location were pooled if there were no statistical differences between them ($p > 0.05$ Kruskal–Wallis [**a**] or ANOVA [**b** and **c**]). Different capital letters indicate statistically significant ($p < 0.05$) differences: (**a**) Kruskal–Wallis and Dunn's method, (**b, c**) ANOVA and Tukey's test. Refer to Figure 1 for locations.

the detection of shortened, clubbed, or missing barbels (SB) and the subsequent histological diagnosis of total liver lesions (TLL, either tumors or foci of hepatocellular alteration) or TLT were significant (TLL, $p = 0.0001$; TLT, $p = 0.001$). Associations between skin tumors (TST, either invasive or noninvasive) and TLL or TLT also were significant (TLL, $p = 0.003$; TLT, $p = 0.006$). The association between these visible lesions (SB or TST) and either type of histological liver lesion (foci of hepatocellular alteration or TLT) was also significant ($p = 0.00002$). Analysis of whether there is a stronger association between those fish with two visible lesions (both SB and TST) and a histological liver lesion (foci of hepatocellular alteration or TLT) was of borderline significance ($p = 0.064$). All nine bullheads that had both altered barbels and skin tumors had at least one histological liver lesion.

DISCUSSION

Tumor prevalence, DNA adducts, and contaminant exposure

The 50 to 68% liver tumor prevalence in the ≥260 mm Anacostia River brown bullheads is essentially equivalent to the highest reported prevalence observed in the Laurentian Great Lakes (i.e., the Black River [Ohio] in the 1980s and early 1990s [60% in 1982 and 58% in 1992]) [1,4]. The 50 to 68% prevalence greatly exceeded the 5% criterion suggested by Baumann [22] to distinguish between highly contaminated and less contaminated areas. Liver tumor prevalence was similar in the 1996 and 2000/2001 surveys. The average prevalence of all large Anacostia bullheads (58%, 67 of 115) was nearly identical to the 55% (33 of 50) prevalence reported by Pinkney et al. [7] for similar-sized bullheads collected in 1996 near the CSX Bridge. The 0 to 3% liver tumor prevalence we reported for the large Tuckahoe River fish was less than the 10% (3 of 30) reported from the same location in 1996 [7] and similar to the 3% (1 of 39) reported in 1998 [24].

The 17% (20 of 115) average skin tumor prevalence in all the large Anacostia bullheads (combined across locations and seasons) was not statistically different from the average 23% (14 of 60) Pinkney et al. [7] determined from two 1996 collections at the CSX Bridge ($p = 0.42$, Fisher's exact test). Coincidentally, the skin tumor prevalence in the large bullheads collected in 2001 from the CSX site was also 23% (7 of 30). Thus, Anacostia skin tumor prevalence in both 1996 and 2000/2001 was above the 12% criterion suggested by Baumann [22].

The higher prevalence of tumors in the large versus small Anacostia fish is consistent with studies indicating an increased tumor risk in older fish [2,6]. The greater prevalence of liver tumors in female bullheads was reported previously by Pinkney et al. [7] in the Anacostia and by Baumann et al. [2] in Lake Erie tributaries.

On the basis of the logistic regression, biliary benzo[*a*]pyrene- and phenanthrene-like fluorescent metabolites were significant risk factors for liver tumors (either invasive or noninvasive). The odds ratios of 1.252 times per 1 μl/L and 1.250 times per 100 μl/L, respectively, were similar to those reported by Pinkney et al. [7] (1.349 and 1.1284 times). These authors also identified these metabolites as significant risk factors for skin tumors (1.846 times for benzo[*a*]pyrene and 1.445 times for phenanthrene).

The ranges of concentrations of benzo[*a*]pyrene-like metabolites in the Anacostia (2.1–8.4 μl/L) and Tuckahoe (0.25–0.34 μl/L) bullheads were similar to the concentrations measured in the 1996 survey (Anacostia, 1.1 and 4.9 μl/L; Tuckahoe, 0.49 μl/L) [7]. Other bullhead studies in PAH-contaminated areas have reported mean biliary benzo[*a*]pyrene concentrations of 2.8 μl/L (Black River, Ohio, USA [35]) and 3.5 μl/L (Detroit River, USA [36]). Lower concentrations, similar to those in the Tuckahoe, were reported for bullheads from a reference area (0.6 μl/L) and laboratory controls (0.3 μl/L) [36]. Biliary PAH metabolite concentrations, however, are not

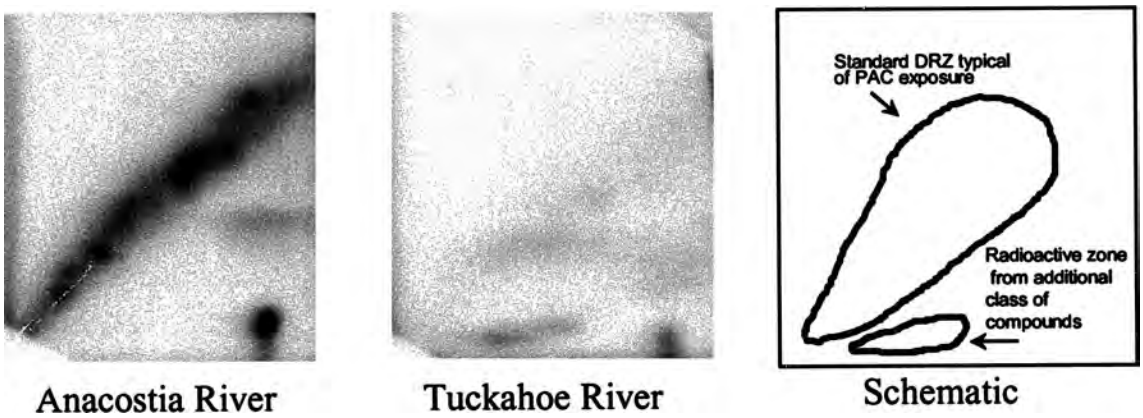

Fig. 4. Representative chromatograms of DNA adducts in livers of brown bullhead from the Anacostia River (Washington, DC) and Tuckahoe River (Maryland) with schematic. DRZ (diagonal radioactive zone); PAC (polycyclic aromatic compound).

simple predictors of neoplasm frequency. These concentrations indicate exposure over a period of days, whereas carcinogenesis was initiated months to years before collection. Variability in metabolite concentrations within a collection of bullheads can arise as a result of feeding status and fish movement [36].

The appearance of a DRZ in chromatograms of Anacostia bullhead livers has been observed previously in collections of fish from areas with PAH-contaminated sediments and has been reproduced in laboratory exposures with PAHs [20]. The concentration of DNA adducts, while 16 to 28 times higher on average in the Anacostia versus Tuckahoe bullheads, was not statistically associated with increased odds for tumors in the logistic regression analysis. Once again, it is important to recognize that the critical period for initiation of the tumors in the age ≥3 bullheads probably occurred several years before the fish were collected. Chemical (e.g., exposure to tumor promoters) and biochemical factors (e.g., the ability of individuals to repair DNA damage) also determine whether exposure to carcinogenic PAHs will result in tumors.

The overall median DNA adduct concentration in the Anacostia bullheads (678 nmol/mol) was approximately 7 to 10 times higher than that reported (using similar methods) in bullheads from contaminated areas in Great Lakes tributaries. Eufemia et al. [37] reported median DNA adduct concentrations of 64 and 94 nmol/mol in two collections of the PAH-contaminated Buffalo River (New York). These concentrations were significantly higher than the 4.5 and 20 nmol/mol they detected in the reference site (Black Creek, ON, Canada) fish. Dunn et al. [38] reported mean (±SE) DNA adduct concentrations of 70.1 ± 6.3 nmol adducts/mol in bullheads from the PAH-contaminated Buffalo River (n = 21) and 52 and 56 nmol/mol in two fish from the Detroit River. The mean DNA adduct concentration was 14.7 ± 9.2 nmol/mol in fish captured from a nonindustrialized landlocked pond and raised in an aquarium. The Tuckahoe bullheads had mean DNA adduct concentrations of 20.4 to 33.2 nmol/mol, only slightly higher than those reported by Eufemia et al. [37] and Dunn et al. [38] from reference sites.

Horness et al. [5] applied regression analysis to a database of west coast (USA) tumor surveys. They proposed 2.8 μg/g total PAHs as a threshold sediment concentration for an increased prevalence of hepatic lesions in bottom-dwelling English sole (*Pleuronectes vetulus*). Although a similar statistical analysis has not been performed for brown bullheads, the average total PAH concentration in 15 to 31 Anacostia sediments collected in fall 2000 within 1 km of the fish collection sites was 15.2 to 30.9 μg/g [39], about 5 to 10 times higher than the 2.8 μg/g threshold. In other Anacostia River locations, sediment total PAH concentrations were as high as 97.9 μg/g [39]. Sediment total PAH concentrations near the fish collection sites were about two orders of magnitude higher in the Anacostia than the Tuckahoe (0.19 μg/g, collected in 1998 by Pinkney et al. [24]).

Other chemicals, including PCBs, DDT, and chlordane, are widespread in the Anacostia River [21]; recent sediment concentrations of organochlorine pesticides, PCBs, PAHs, and metals are provided by Velinsky and Ashley [39]. Moore and Myers [6] noted that DDT and PCBs have been shown in laboratory studies to modulate tumor formation; DDT enhanced tumor yield, whereas, depending on the timing, PCBs either enhanced or inhibited tumor formation. In the current study, in contrast with Pinkney et al. [7], an increased risk for total liver tumors was associated with tissue concentrations of total PCBs and *p,p*-DDE. Odds ratios were 1.327 times per 0.1 μg/g PCBs and 1.193 times per 0.05 μg/g *p,p′*-DDE. These ratios were similar to that for bile benzo[*a*]pyrene (1.252 times per 1 μg/g) or phenanthrene (1.250 times per 100 μg/g). It is uncertain whether these chemicals are truly involved in tumor formation or are simply co-occurring with the biliary PAH metabolites. Nitrosamines are an additional class of chemicals that warrant investigation in the Anacostia because these carcinogens can be formed in waters with high sewage content [40]. The CSOs release raw sewage into the Anacostia during and after moderate to heavy rains; two of the three collection areas (CSX and O Street) were near CSOs.

Abnormal barbels

The greater prevalence of abnormal barbels in the larger (and older) Anacostia bullheads (23–56%) versus smaller (younger) bullheads (10–27%) is consistent with Smith et al. [8]. They reported that these lesions became prevalent in bullheads close to 300 mm in total length. Within the older Anacostia bullheads, prevalence of abnormal barbels was nearly identical in age 4 (21 of 44 = 48%) and age 5 (19 of 37 = 51%) animals, with too few for age 6 to 7 fish (n = 10) for a reliable comparison.

Smith et al. [8] stated that the presence of abnormal barbels was correlated with the presence of elevated PAHs in sediments. They reported an abnormal barbel prevalence of approximately 45 and 70% in fish from the contaminated Black

Table 5. Results of logistic regressions for foci of hepatocellular alteration, total liver tumors, total skin tumors, and abnormal barbels showing only significant ($p \leq 0.05$) associations[a]

Response variable	Predictor variable	Frequency of response	p value[b]	Odds ratio[c]
Large bullheads				
Foci of hepatocellular alteration	Length	71/163	0.0022	1.670
	Weight	70/162	0.0032	1.147
	Sex	70/161	0.0175	2.924
	Hepatosomatic index	70/162	<0.0001	2.604
Total liver tumors	Length	68/163	0.0506	1.377
	Age	65/160	0.0147	1.547
	Sex	67/161	0.0023	3.953
	Hepatosomatic index	67/162	<0.0001	2.735
	Bile benzo[*a*]pyrene	21/55	0.0027	1.252
	Bile phenanthrene	21/55	0.0081	1.250
	Tissue total PCB	19/46	0.0169	1.327
	Tissue *p,p′*-DDE	17/43	0.0057	1.193
Total skin tumors	Hepatosomatic index	20/162	0.0287	1.812
Small bullheads				
Total liver tumors	Length	12/119	0.0075	1.826
	Weight	12/119	0.0507	1.245
Abnormal barbels	Age	11/119	0.0206	0.165

[a] See Pinkney et al. [23] for results of logistic regressions for specific types of tumors.
[b] p value determined with exact methods [34].
[c] Scaling of odds ratios: Length, per 10 mm; Weight, per 10 g; Sex, female:male; Age, per year; Hepatosomatic index, per 0.005 units; K, per 0.05 units; bile benzo[*a*]pyrene, per 1 μl/L bile phenanthrene, per 100 μg/g; tissue polychlorinated biphenyl (PCB), per 0.1 μg/g; tissue *p,p′*-dichlorodiphenyldichloroethylene, per 0.05 μg/g.

and Cuyahoga Rivers, respectively, compared with about 5% from the cleaner Huron River (Ohio). Steyermark et al. [41] reported a nearly 40% prevalence of abnormal barbels in brown bullheads from the industrialized Schuylkill River (Philadelphia, PA, USA) versus about 5% in a New Jersey (USA) pond not affected by industry.

CONCLUSION

Besides finding extremely high liver tumor prevalence in Anacostia bullhead, this study is unique in its detailed examination of two age/size classes and the relationship between tumors and biomarkers in different-aged fish. Young and older bullheads had equally high concentrations of biliary PAH-like fluorescent metabolites and PAC-DNA adducts. The biomarker data and the 10 to 17% liver tumor prevalence at ages 1 to 2 suggest that these year classes are likely to have a high prevalence as they reach age ≥3. The finding of highly elevated PAC-DNA adduct concentrations in the DRZ, high concentrations of PAH-like metabolites in bile, and high sediment PAH concentrations provides the strongest evidence to date for the role of PAH exposure in the development of tumors in Anacostia bullheads. It does not, however, exclude the possibility of other chemicals functioning as tumor initiators or promoters or weakening immune responses. The results confirm the utility of using brown bullheads for assessing fish exposure and response to contaminants in the Anacostia River. As the river is remediated, tumor surveys can serve as a useful tool for monitoring the recovery of the ecosystem.

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Identification of PCB, PAH and Chlordane Source Areas in the Anacostia River Watershed

Final Report to the DC Water Resources Research Center
University of the District of Columbia
Washington, DC 20008

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ABSTRACT

In 2004 this Anacostia River biomonitoring project used a two-week Asiatic clam (*Corbicula fluminea*) translocation bioaccumulation protocol to find the clean upstream reaches of the most highly contaminated first-order tributaries. These tributaries were identified from earlier studies as Lower Beaverdam Creek (PCBs), NorthEast Branch (total PAHs and chlordane) and Watts Branch (total PAHs and chlordane). At the Lower Beaverdam Creek Landover Metro site the clams accumulated high PCBs and Aroclors, but at the Corporate Drive site those contaminants dropped to reference control levels upstream of the Landover Metro, Ardwick-Ardmore Industrial Park and the New Carrolton Metro. Landover Metro clams had Aroclors 1242 and 1254. At the NorthEast Branch Odell Road site the clams had high total PAHs which dropped by 50% at the Virginia Manor Road site upstream, above the Beltsville Industrial Center. The NorthEast Branch Riverdale East subtributary site had clams with high chlordane not found at six other upstream subtributaries. Clams at the Watts Branch Upper site had total PAHs not significently lower than at other Watts Branch sites. It was concluded that high levels of bioavailable PCBs, Aroclor and PAHs in Anacostia watershed tributaries may be associated with industrial parks in Prince George's County. High bioavailable chlordane was not associated with other contaminants or an identifiable industrial park. Clams at the Fort Foote control site had a significently greater pesticide (endosulfan I) accumulation than other sites and may have detected an endosulfan I spill in the Potomac River in May 2004. The high endosulfan was lost over the two week translocation period at Anacostia watershed sites.

INTRODUCTION

The heavily contaminated tidal freshwater 10 km Anacostia River estuary stems from the Potomac estuary and is the major water body within the District of Columbia. The poor quality of the Anacostia River estuary has been known for years (Freudberg et al.1989, Cummins et al. 1991) and the Anacostia River is considered one of the three most contaminated locations in the Chesapeake Bay. The Anacostia River runs along the lower third of the District and essentially separates Federal buildings and upscale housing from the poorer and mostly minority communities to the south and west. There is a high incidence of cancer and other diseases in this minority community, where there is also subsistence fishing in the Anacostia in spite of a fishing advisory. Anacostia River estuary catfish have tumors related to high polycyclic hydrocarbon (PAH) levels in sediment (Pinkney e.a. 2000), and dangerous tissue levels of polychlorinated biphenyls (PCBs) and chlordane which can be associated with cancer . Fish that yearly migrate into the Anacostia estuary have also been found contaminated (Velinsky and Cummins 1994).

Reference: Phelps, HL. 2005. Identification of PCB, PAH and Chlordane Source Areas in the Anacostia River Watershed. DC Water Resources Research Center Report. 9p.

The Anacostia River estuary has very poor benthic life and shows water and sediment toxicity to clam larvae (Phelps 1985, Phelps 1993, Phelps 1995). Most studies of Anacostia River contaminants have focussed on water and sediments of the estuary portion (Velinsky et al. 1992, Wade et al 1994, Velinsky et al. 1994, Velinsky and Ashley 2001, AWTA 2002). However, chemical contaminants are increasingly recognized as coming from Anacostia tributaries, with many in Maryland (Warner et al.1997, Phelps 2004, Washington Post 2004). UDC's WRRC-sponsored clam biomonitoring studies have developed a rapid two-week protocol using Asiatic clams (*Corbicula fluminea*) translocated from the healthy Potomac to sites in the Anacostia River watershed where they accumulate bioavailable contaminants. These common, non-endangered clams have a high filtration rate, can accumulate toxic contaminants from the water and have been used elsewhere for freshwater biomonitoring (Dougherty and Cherry 1988, Crawford and Luoma 1993, DeKock and Kramer 1994, Colombo et al 1995). Clam translocation and bioaccumulation has identified one of Anacostia's five first order tributaries as a source of bioavailable PCBs, two as sources of chlordane, and four as sources of PAHs. This kind of information is essential for DC's Mayor to bring to the attention of counties surrounding the District for successful remediation efforts to achieve the objectives of a fishable and swimmable DC Anacostia River.

The most serious contaminants of the Anacostia from the standpoint of human health are the pesticide chlordane and PCBs which are above FDA action levels in Anacostia fish (Velinsky and Cummins 1994). PCBs are known to be toxic and come from a variety of sources (Ahlborg et al. 1994, Safe 1994). Chlordane is a termite pesticide harmful to humans and has been banned for over 20 years. But chlordane is slow to biodegrade and its accumulation in fish tissues is one basis for the 1994 Anacostia fishing advisory. Recent studies found Anacostia clams placed at the lower NorthEast Branch and Watts Branch tributaries accumulated chlordane (Phelps 2000, 2002).

The primary objective of the 2004 study was to use clam biomonitoring to find the uncontaminated upstream portions of the major Anacostia tributaries contributing the target toxic contaminants of polychlorinated biphenyls (PCB), polycyclic hydrocarbons (PAH), and chlordane (Phelps 2004). PCBs and chlordane in fish tissues are responsible for the Anacostia fishing advisory (Velinsky and Cummins 1994). High levels of PAHs in sediment are identified with sediment toxicity and tumors in fish (Pinkney et al 2000). PAHs are not bioaccumulated by fish so clam biomonitoring is essential in locating PAH sources. The second objective was to continue the involvement and training of UDC undergraduate students in research on DC's Anacostia River.

METHODOLOGY

Asiatic clams (*Corbicula fluminea*) were collected from May through September at the healthy nearby Potomac River estuary control site of Fort Foote (MD). Clams collected by along-shore sieving were selected from the same cohort, 20 - 30 mm, and kept cool and dry before 15-20 were placed in mesh shellfish cages at the tributary sites within 24 hours (Table 1). As clams can accumulate a maximum of contaminants within one to two weeks (Phelps 2004) they were collected after two weeks exposure. The 15 - 30 clams were washed, depurated for 24 hours in three changes of spring water at room temperature and briefly frozen to open shells and extract tissues. The combined frozen tissues were sent to the certified Severn-Trent Laboratory (STL), Burlington, VT for chemical analyses. The STL EPA Priority Pollutant tissue analysis included 21 pesticides, 28 polychlorinated biphenyl (PCB) congenors, 6 Aroclors, 18 polycyclic hydrocarbons (PAHs), and 7 metals of interest (As, Cu, Cd, Cr, Fe, and Zn), with percent lipid included. Electronic results were available within five weeks. The STL analytical variability has been determined as SD = 0.175 (mean)- 1.12 (n = 9) (Phelps 2002). Statistical comparison between sites was by t test and the 95% confidence limits of the mean were calculated as 2.05 SD = 0.36 (mean). Because clam tissues were pooled for analysis the analytical error was most significant.

The sites chosen for biomonitoring were located on Anacostia watershed first and second order streams where previously translocated clams had accumulalted high PCBs (Lower Beaverdam Creek), chlordane (NorthEast Branch), and PAHs (NorthEast Branch) (Phelps 2003, Phelps 2004). Not all tissue contaminants were examined at each site.

RESULTS

The GPS site locations and clam translocation dates are in Table 1, listed in order of date. The Riverdale East site clams had to be replaced four times due to pilfering. Translocated clam survival was 97 - 100%. Figure 1 shows the Anacostia River watershed.

Table 1. Clam site locations listed by translocation date.

Date placed	Date collected	Site (Code)	GPS Northing	GPS Westing
5/13	5/13	Fort Foote, MD (FF5/04)	38^{0}46’458”	077^{0}01’752”
5/13	5/27	Watts Branch Upper, DC (WBU)	38^{0}58’357”	076^{0}54’619”
	5/27	Landover Metro Yard, MD (LMT)	38^{0}55’932”	076^{0}53’355”
	5/27	Riverdale West Branch, MD (RVW)	38^{0}57’582”	076^{0}55’557”
6/1	6/15	NorthEast Branch 04, MD (NEB04)	38^{0}57’621”	078^{0}55’583”
	6/15	Odell Road, MD (ODR)	38^{0}58’375”	076^{0}55’509”
	6/15	Virginia Manor Road, MD (VMR)	39^{0}03’522”	076^{0}53’909”
7/20	8/10	Corporate Drive, MD (CRD)	38^{0}56’318”	076^{0}51’646”
8/28	9/9	Riverdale East Branch, MD (RVE)	38^{0}57’644”	076^{0}55’572”

Contaminants detected in clam tissues were summarized by the total accumulation of each type (tmetals, tPAHs, tPCBs tAroclors and tpesticides), with alpha and beta chlordane additionally summed as tChlr (Table 2). FF control was the average of Fort Foote clams with eight previous Fort Foote samples from 1999 to 2003 (Phelps 2004).

Table 2. Clam tissue contaminant concentration totals (ug/Kg) at sites by tributary.

Site	tMetalx.001	tPAH	tPCB	tArocl.	tPest.	tChlr.
FF Control (average)	77	376	93	140	72	
Potomac						
Fort Foote	116	60	76	116	169*	38
Lower Beaverdam Creek						
Landover Metro	24	---	366*	630*	97	50
Corporate Drive	70	267	105	120	93	83*
NorthEast Branch						
NorthEast Branch	69	923*	86	149	74	40
Riverdale West Branch	21		142	62	62	27
Riverdale East Branch		---	---	---	246*	144*
Odell Road		2196*	---	188	---	---
Virginia Manor Rd	66	996*	72	149	31	19
DC						
Watts Branch Low	23	1088*	---	120	55	30

* significantly (95%) greater than FF control

Figure 1. The Anacostia River watershed with some monitoring sites labelled (Phelps 2004).

The clam tissue PAH and pesticide totals data of the NorthEast Branch tributary were compiled with additional data from earlier studies (Phelps 2004) (Fig. 1, Fig. 2). Statistical similarity was found in 62% of repeated site test results (Phelps 2003).

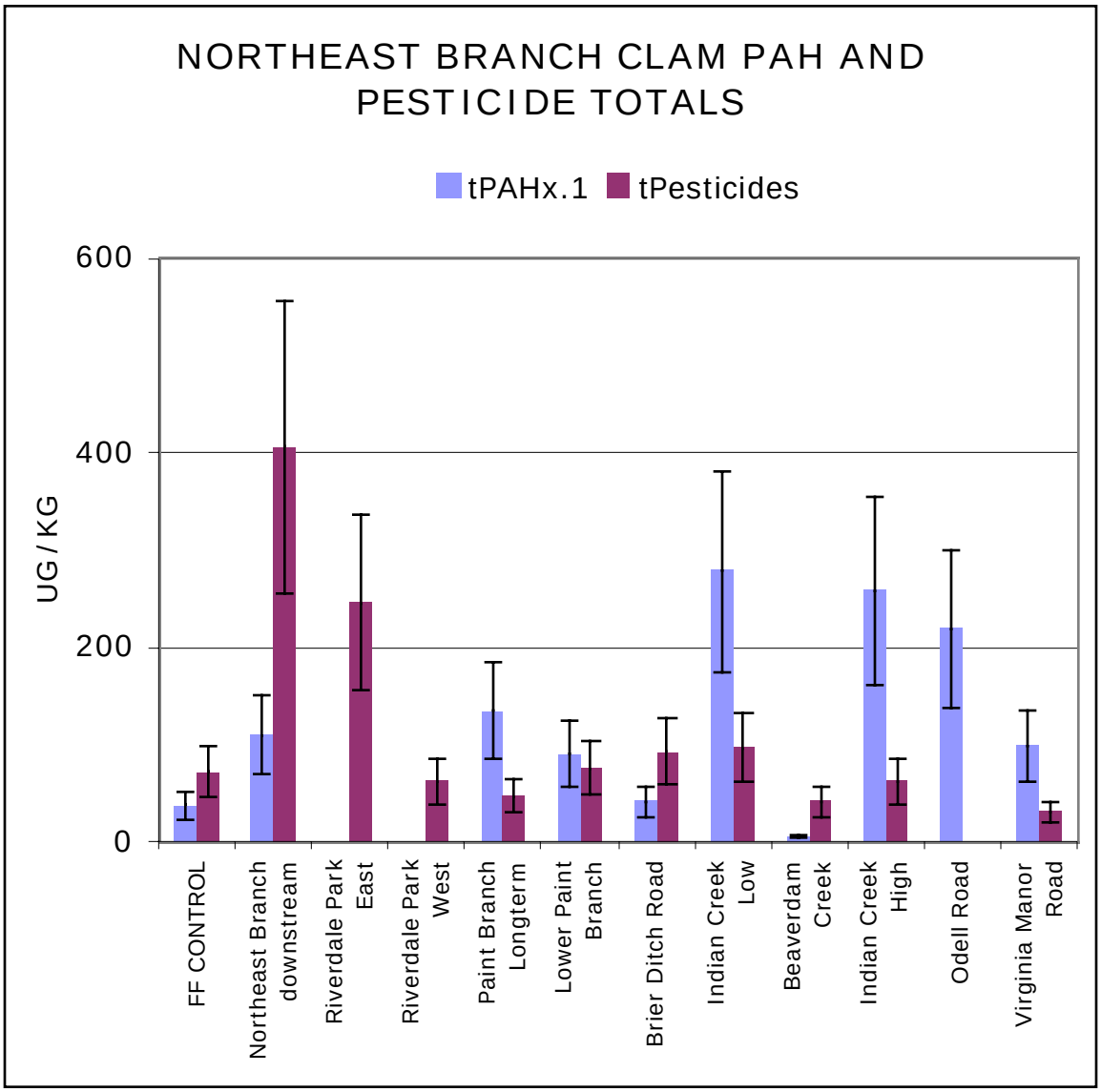

Figure 2. NorthEast Branch clam tissue concentrations of total polycyclic hydrocarbons (tPAH) and total pesticides (tPest) at the downstream site just above the head of tide and at stream sites proceeding upstream (Phelps 2004). Second order stream sites are: Riverdale Park East, Riverdale Park West, Paint Branch Longterm, Lower Paint Branch, Brier Ditch Road and Beaverdam Creek. Error bars show 95% analytical variation confidence limits. All sites were in Maryland.

The data on Lower Beaverdam Creek tributary total PCBs was compiled with data from earler study sites (Phelps 2004) to

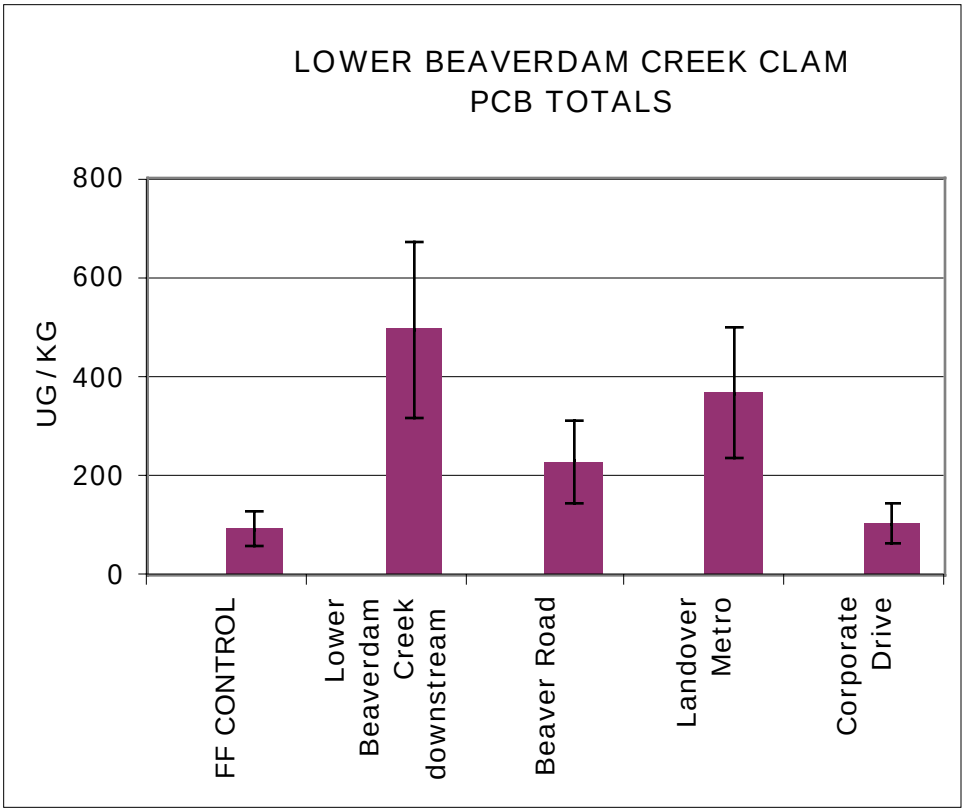

Figure 3. Lower Beaverdam Creek clam concentrations of total polychlorinated biphenyls (tPCB) at the downstream site just above head of tide and proceeding going right to upstream sites. Error bars show 95% analytical variation confidence limits. All but the downstream site were located in Maryland.

Contaminant types were considered separately.

METALS: No clam tissue metal concentrations were significantly greater than the FF control (Table 2). Total metals at Fort Foote were higher than the FFcontrol due to iron, but not significantly greater than average. Toxicity from metals is not considered a problem in the Anacostia.

PAHs: At all sites the clam tissue total PAH concentrations were significantly increased over the FF control, except at Corporate Drive on Lower Beaverdam Creek (Table 2, Fig 2). High PAHs had been found in 20 of 24 previously studies on Anacostia watershed sites (Phelps 2004). Control level PAHs had earlier been found only in clams at the downstream site of the NorthWest Branch (MD) tributary, at the Beaverdam Creek (MD) and Brier Ditch Creek (MD) second order stream sites of the NorthEast Branch tributary, and the Beaver Road (MD) first order site on the Lower Beaverdam Creek tributary (Phelps 2004). In the combined NorthEast Branch data (Figure

3) the highest clam PAHs were at the first-order stream sites of Lower Indian Creek and Upper Indian Creek below Beltsville Industrial Park, and Odell Road below Konterra Industrial area. Though clams at the upstream Virginia Manor stream had 50% of Odell Road clam PAHs they still was not at control site levels. More upstream sites need to be found, and monitored.

PCBs: Total PCBs in clam tissue significantly exceeded control at all Lower Beaverdam Creek sites up to and including the Landover Metro Station site (Table 2, Fig. 3). The present study found low control-level total PCBs in clams placed at the Corporate Drive site which is just above the combined Landover Metro Station/ Ardwick-Ardmore Industrial Center/ New Carrolton/Amtrak Metro area of Lower Beaverdam Creek. The Corporate Drive site probably represents the highest uncontaminated reach of Lower Beaverdam Creek.

AROCLORS: Total clam Aroclor accumulation in this study significantly exceeded control only at the Landover Metro Station site on Lower Beaverdam Creek. The Aroclors accumulated were Aroclor 1242 (220 ug/kg) and Aroclor 1254 (110 ug/kg).

PESTICIDES: Total pesticides in clam tissues significantly exceeded the FFcontrol at Fort Foote (discussed below) and at Riverdale East Branch, a small second order stream near the mouth of the NorthEast Branch (Table 2, Fig. 2). Data from previous studies found clams at six other first and second-order streams of the NorthEast Branch did not have significantly increased total pesticides (Phelps 2004, Fig. 2). The small Riverdale East Branch appeared to be a major pesticide source although it is from no identified industrial park area.

TOTAL CHLORDANE: The sum of alpha and beta chlordane in this study was significently greater than Fort Foote clams only at the Riverdale East Branch site. This is interesting because chlordane which is responsible for the fishing advisory has been associated only with clams at the NorthEast Branch and Watts Branch (Phelps 2003). However, followup studies have not confirmed high chlordane in Watts Branch clams (Phelps 2004).

In considering the consequences of these findings it is helpful to recall that although Lower Beaverdam Creek is only 12% of Anacostia watershed input it has the highest concentration of industrial parks in Prince George's County (Warner et al 1997). The present study has identified a PCB source area in the upper reach containing the Landover Metro Station, Ardwick-Ardmore Industrial Center and New Carrolton/Amtrak Station. Future investigations of watershed sources of PCBs to the Anacostia River should start in this section of Lower Beaverdam Creek.

The NorthEast Branch contributes about 45% of Anacostia watershed input with some of the highest clam total pesticides and PAHs of the five major Anacostia tributaries, and 88% of total pesticide being chlordane (Warner et al 1997, Phelps 2003). The present study suggests the highest PAH concentrations in clams are below industrial parks in the Northeast Branch. High chlordane accumulation in clams was associated with one second order stream: Riverdale East Branch.

Fort Foote on the tidal freshwater Potomac River estuary five km below Washington, DC has been the source of *Corbicula* clams for the Anacostia biomonitoring studies. It is considered a reference area because this part of the Potomac is a major Chesapeake Bay restoration success with the return of submerged aquatic vegitation, a healthy clam population, and development as a bass-fishing area (Phelps 1994, Orth et al 1996). At least part of the success has been attributed to the water-clearing action of the large Asiatic clam population, which does not survive in the contaminated Anacostia River (Cohen et al 1984, Phelps 1985, Phelps 1993). In the present study the Fort Foote clams had abnormally high total pesticides, of which 65% (110 ug/kg) was

endosulfan I. Endosulfan, a toxic pesticide used in crops and other plants, is normally not found in Fort Foote clams (Phelps, unpublished data). The EPA standard for endosulfan in freshwater is 100 ug/kg and the Fort Foote clams may have detected an endosulfan spill in the Potomac in May. It is interesting to note that those same clams following two-week deployment in the Anacostia watershed had no detectable Endosulfan I. Such unusual clam bioaccumulations, like the 2002 finding of high napthalene in lower Watts Branch clams (Phelps 2003), show that rapid *Corbicula* biomonitoring may be able to detect contaminant spills as well as longer-term pollution similar to the International Mussel Watch (Sericano 2000). More studies need to be made and followed up.

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Using the Sediment Quality Triad to characterize baseline conditions in the Anacostia River, Washington, DC, USA

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Abstract The Sediment Quality Triad (SQT) consists of complementary measures of sediment chemistry, benthic community structure, and sediment toxicity. We applied the SQT at 20 stations in the tidal portion of the Anacostia River from Bladensburg, MD to Washington, DC to establish a baseline of conditions to evaluate the effects of management actions. Sediment toxicity was assessed using 10-day survival and growth tests with the freshwater amphipod, *Hyalella azteca* and the midge, *Chironomus dilutus*. Triplicate grabs were taken at each station for benthic community analysis and the Benthic Index of Biotic Integrity (B-IBI) was used to interpret the data. Only one station, #92, exhibited toxicity related to sediment contamination. Sediments from this station significantly inhibited growth of both test species, had the highest concentrations of contaminants, and had a degraded benthic community, indicated by a B-IBI of less than 3. Additional sediment from this station was tested and sediment toxicity identification evaluation (TIE) procedures tentatively characterized organic compounds as the cause of toxicity. Overall, forty percent of the stations were classified as degraded by the B-IBI. However, qualitative and quantitative comparisons with sediment quality benchmarks indicated no clear relationship between benthic community health and contaminant concentrations. This study provides a baseline for assessing the effectiveness of management actions in the Anacostia River.

Keywords Anacostia River · Sediment Quality Triad · Benthic community · Toxicity identification evaluation

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Introduction

The Anacostia River, one of three Regions of Concern identified by the US Environmental Protection Agency (USEPA) Chesapeake Bay Program, is a tidal freshwater tributary that flows through suburban Maryland and Washington, DC to the Potomac River (Fig. 1). The river has been the site of moderate oil spills, receives significant input of metals and organic contaminants from urban nonpoint sources, and is known as one of the most contaminated rivers in the United States (SRC 2000). Sediments are enriched with a complex mixture of metals and organic compounds, including polynuclear aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs). A fish consumption advisory is in place for all DC waters due to elevated concentrations of PCBs and other chemical contaminants (DC Department of Health 2006). Exposure to sediment PAHs was associated with the high prevalence (50–68%) of liver tumors in brown bullheads, *Ameiurus nebulosus*, in the tidal Anacostia (Pinkney et al. 2001, 2004). Studies conducted in the late 1980s and early 1990s indicated that degradation of the benthic community in some areas was likely due to chemical contaminants (Phelps 1990; Schlekat et al. 1994).

One effort to improve the water quality of the River is the Anacostia Watershed Toxics Alliance (AWTA), a multi-agency public/private partnership formed in 1999. AWTA's goal is to investigate toxic chemical impacts on the Anacostia River and develop plans to reduce those impacts. The AWTA adopted a three-phased approach. Phase I was a compilation and summarization of existing data and identification of data gaps. Phase II studies addressed the data gaps and developed a framework for source control and sediment remediation. Phase III will be the design and implementation of projects to reduce toxic chemical loadings, remediate polluted sediments, and involve the community in pollution prevention.

The present study, conducted as part of phase II, was intended to help fill data gaps related to the paucity of synoptically collected sediment exposure and effects data and to establish a baseline of conditions to measure future improve-

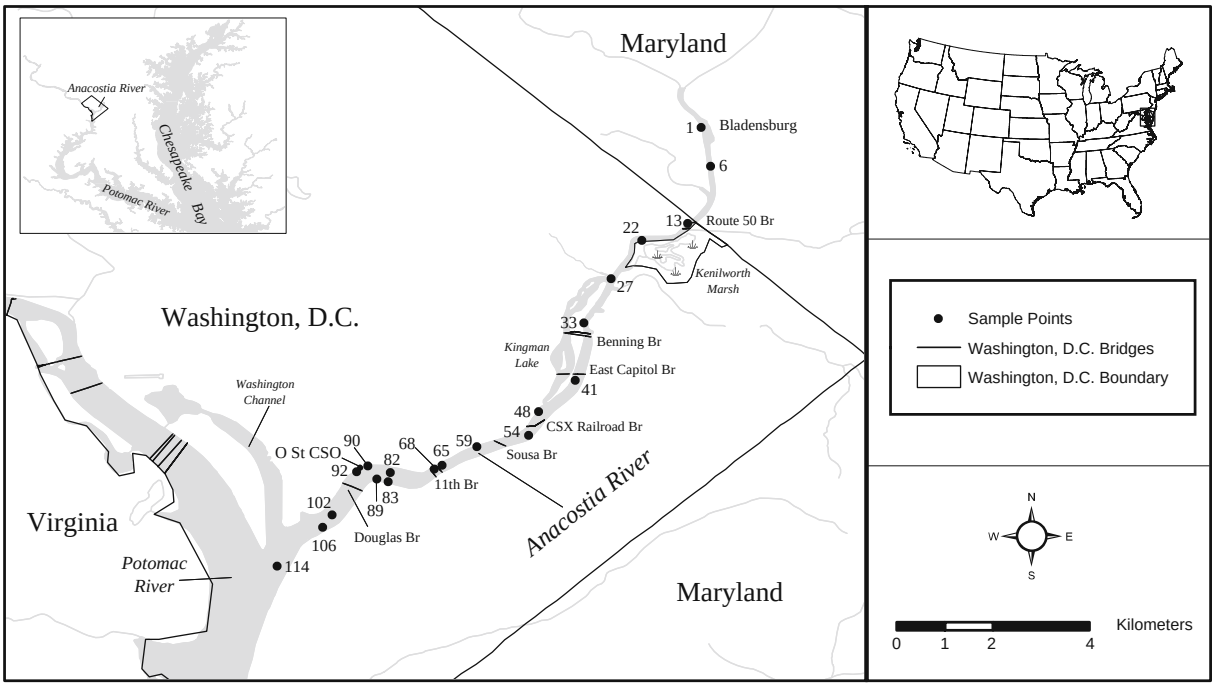

Fig. 1 Location of the 20 Sediment Quality Triad stations in the Anacostia River from Bladensburg, MD to Washington, DC

ments in habitat quality. To this end, we conducted the Sediment Quality Triad (SQT) to characterize toxic conditions in the tidal portion of the Anacostia River. This weight of evidence approach, consisting of complementary measures of sediment chemistry, benthic community structure and sediment toxicity, has been successfully applied in freshwater, estuarine and marine systems (e.g., Long and Chapman 1985; Schlekat et al. 1994; McGee et al. 1999). The combination of potential cause (chemistry) and effect (biology) measurements makes the SQT a powerful tool to determine the extent and magnitude of pollution-induced degradation. Complementary to the SQT work, sediments at any stations that exhibited significant toxicity in the initial tests were re-sampled and subjected to sediment toxicity identification evaluation (TIE) procedures (USEPA 2007).

Methods

Sampling

On September 18–21, 2000, we collected surface sediments from 20 sampling stations in the Anacostia River (Fig. 1). These were a subset of 114 Anacostia River stations sampled for chemical analysis by Velinsky and Ashley (2001), with whom we coordinated. The 20 stations were distributed throughout the tidal river from Bladensburg, MD to the confluence of the Anacostia with the Potomac River, and were intended to include a range of contaminant concentrations.

Sampling protocols followed those of USEPA/US Army Corps of Engineers (USACE) (1995) and Velinsky and Ashley (2001) In brief, sampling stations were located with a hand-held Global Positioning System (GPS) unit and latitude and longitude were recorded on site. Sediments were collected with two stainless steel 0.023 m^2 petite Ponar grab samplers. The top 3 to 4 cm of several grabs were removed with a stainless steel spoon, placed into a pre-cleaned stainless steel bowl, homogenized with a stainless steel spoon until uniform in color and texture, and transferred into several pre-cleaned containers for chemistry (~500 ml total) and toxicity testing (~3.8 liters). Samples for chemistry were stored on ice and later frozen until analysis. Sediments for toxicity testing were kept on ice and subsequently refrigerated until the start of the tests (batch 1: September 29, 2000, batch 2: October 13, 2000).

Between stations, the sampler, bowl, and mixing utensils were visually checked for cross-contamination (i.e., visible sediments or sheen) and rinsed with site water. At each station, near bottom water quality parameters (temperature, DO, salinity, and pH) and depth were measured.

Sediment physico-chemical characterization

Sediments were analyzed for grain size, total organic carbon content, trace metals (aluminum, cadmium, chromium, copper, iron, mercury, nickel, lead, silver, and zinc), 81 PCB congeners or groups of congeners, select organochlorine pesticides, and PAHs (including alkylated compounds). Details of these analyses including methods and quality assurance and quality control measures are given in Velinsky and Ashley (2001).

Sediment toxicity tests

Sediment toxicity was assessed by the University of Maryland Wye Research and Education Center (WREC, Queenstown, MD) using the USEPA (2000) 10 d survival and growth tests with the freshwater amphipod, *Hyalella azteca* and the midge, *Chironomus dilutus* (former name *C. tentans*). Test organisms were obtained from commercial suppliers. Tests consisted of a static renewal exposure with mortality and growth (weight) as endpoints. Unchlorinated well water was used as the overlying water after adjustment to 2,500 μmhos with 5 μm filtered and UV sterilized estuarine water from the Wye River, Maryland. The overlying test water has the general characteristics of pH 7.5, dissolved oxygen 6.5 mg l^{-1}, hardness of 232 mg l^{-1} as $CaCO_3$, and alkalinity of 102 mg l^{-1} $CaCO_3$. After 10 days, test organisms were sieved using a 500 μm mesh screen and survivors enumerated. Dry weight was determined by pooling all living organisms from a replicate and drying them at 82°C to a constant weight. For amphipods, this was the growth endpoint. For midges, the dried samples were

ashed at 550°C for 2 h to determine ash-free dry weight (AFDW). For logistical reasons, two separate batches of tests were conducted, both started within three weeks of sample collection. Sediment from a freshwater pond in Elk Neck State Park (North East, MD, USA) was used as the control sediment. Samples were sieved through a 500 μm stainless steel sieve before testing to remove indigenous organisms. Samples from stations #1 and #41 were too coarse for the mesh and were tested without sieving.

Reference toxicant tests

Reference toxicity tests (96 h water-only) to evaluate the sensitivity of test organisms were performed using sodium chloride for midges and potassium chloride for amphipods. The median lethal concentration (LC50) was determined by the trimmed Spearman–Karber method (USEPA 2000).

Sediment toxicity identification evaluation

One Anacostia River station (station 92; Fig. 1) was re-sampled in order to conduct a TIE after significant adverse effects on both amphipod and chironomid growth occurred in the 10-day test. Due to the large quantities of sediment (16 to 20 l) needed, it was not feasible to collect and archive sediments for the TIE during the SQT sampling. Instead, we used GPS coordinates and visual landmarks to return to the station on March 13, 2001 and collected sediments using the same procedures as the initial sampling. Samples were transferred into large high-density polyethylene containers, kept on ice, refrigerated, and shipped on ice to the USEPA laboratory (Duluth, MN, USA) for the TIE.

Screening of station #92 sediment (in March 2001) involved performing initial 10 d toxicity tests with *H. azteca* and *C. dilutus* by USEPA, Duluth. The procedures for conducting these tests were similar to those described above with some modifications. Test beakers contained 30 ml of sediment in 100-ml tall form beakers and test organisms were from USEPA—Duluth in-house cultures. Lake Superior water was used as the overlying water. It has the general characteristics of pH 7.8, dissolved oxygen 7.8 mg l^{-1},hardness of 45 to 48 mg l^{-1} as $CaCO_3$, and alkalinityof 40 to 43 mg l^{-1} $CaCO_3$. The control sediment was from West Bearskin (WBS) Lake, MN (Norberg-King et al. 2006). After 10 d, surviving organisms were recovered and weighed. All living organisms from a replicate were pooled and dried for at least 4 h at 90°C and for *C. dilutus*, AFDW was determined after ashing at 500°C. During initial toxicity tests, significant effects on growth were observed with station #92 for both species, while survival was unaffected. The whole sediment TIE consists of a baseline toxicity test and the manipulation tests for sediment samples that exhibited toxicity when tested at Duluth. The toxic sample (#92) was amended for the phase I characterization of the sediment TIE. The suite of sediment manipulations in phase I include those targeted at three types of toxicants commonly found in sediments: ammonia, cationic metals, and organic chemicals (USEPA 2007) with multiple manipulations targeted at the same group of toxicants. Because metal toxicity in sediments is considered to be associated with metals in interstitial water, TIE methods are aimed at reducing the concentration of freely dissolved metal in the test matrix. For cationic metals, at least one of three treatments was used: acid volatile sulfide (AVS), zero-valent magnesium (Mg^0), and cation resin (SIR-300, high purity, ResinTech Inc., Cherry Hill, NJ, USA) (USEPA 2007). For organic toxicity, two resins—Ambersorb® (Rohm and Haas, Spring House, PA, USA) and coconut charcoal (Aquatic Eco-Systems, Apopka, FL, USA)—were used. For toxicity due to ammonia, the addition of a zeolite resin, i.e., a ground clinoptilolite slurry (56% sand, 23% silt, 21% clay size fractions from Aquatic Eco-Systems, Apopka, FL, USA) was used. Zeolite is not a selective adsorbant for only ammonia and metals and it is possible that organics may be removed from the aqueous solution by zeolite additions; however, zeolites have a greater affinity for ammonium than for metals (Besser et al. 1998). Subsamples of station #92 and WBS control sediments were treated by adding the resin or treatment manipulation directly to the sediment and stirring until well mixed. After each amendment, aliquots were stored at 4°C for at least 2 to

4 days before retesting. So that the results of the TIE manipulation tests could be compared with each other and across sample dates, survival and weight data were combined to calculate biomass (average weight per original organism).

Benthic community analyses

Because of time limitations on the sampling days, we were unable to synoptically collect benthic macroinvertebrate community samples. These were collected the following week using a GPS unit and landmarks recorded at the time of the initial collection to relocate the stations. Three petite Ponar grabs were taken at each station and contents of each were sieved through a 500 μm mesh screen. Material retained on the screen was rinsed into a plastic container, relaxed with MS-222 (3-aminobenzoic acid ethyl ester) and preserved with 70% ethanol containing rose bengal. Near bottom water quality parameters (dissolved oxygen, temperature, salinity, and pH) and depth were measured at each station.

Benthos were sorted and identified to the lowest practical taxon at a University of Minnesota, Department of Entomology laboratory (St. Paul, MN). Approximately 16% of the samples were reviewed for unacceptable error in sorting (defined as ≥6% additional specimens found). Non-oligochaetes were identified with a dissecting microscope at ×7.5 to ×90. Oligochaetes were sorted initially into groups and recognizable specimens (those that were sufficiently intact) were identified and counted. Immature specimens were counted separately. The remaining whole mature specimens and large fragments of specimens were randomly subsampled and at least 10% were identified. Specimens were gently cleared in lactic acid then mounted under cover slips for examination under higher magnification using an Olympus compound microscope and standard taxonomic references.

Data analysis

Statistical procedures for the toxicity tests followed the USEPA (2000) protocol. Survival data were arcsine square root transformed and tested for homoscedasticity and normality with the Levene's and the Kolmogorov–Smirnov tests, respectively. In all cases, arcsine transformed survival data failed to meet the normality assumption. Differences between Anacostia River stations and the control were therefore evaluated with the Kruskal–Wallis test ($\alpha = 0.05$). Growth endpoints satisfied the assumptions for parametric statistics and were analyzed via ANOVA followed by pairwise contrasts between test sediments and the control using Fisher's least significant difference (LSD; Sokal and Rohlf 1981).

The following benthic community parameters were calculated for each station: taxa richness (i.e., number of species), total abundance, proportion of oligochaetes, and the Benthic Index of Biotic Integrity (B-IBI). The B-IBI is a multiple metric index developed to identify the degree to which the benthic assemblage meets the USEPA Chesapeake Bay Program's Benthic Community Restoration Goals (Weisberg et al. 1997). B-IBI scores range from 1 to 5. Stations with scores of greater than or equal to 3 are considered to meet the restoration goals, scores of 2.7 to 2.9 are "marginally degraded", 2.1 to 2.6 are "degraded", and 2 or less are "severely degraded" (Llanso 2002). The tidal freshwater index is composed of several benthic community parameters including total abundance, percent abundance of pollution-indicative taxa, percent abundance of deposit feeders, and a tolerance score based on values assigned by Lenat (1993; Table 1). For each station, the B-IBI was calculated for each replicate and results were averaged (Llanso 2002). Cluster analysis was performed on the number of individuals per taxa in the three grabs for each station. The Bray–Curtis similarity coefficient and an unweighted mean linkage scheme were used (Clifford and Stephenson 1975).

Associations between biological and chemical data were evaluated by examining the relationship between sediment quality guidelines and biological endpoints (i.e., sediment toxicity and indices of benthic community health). We compared sediment chemical data with the freshwater probable effect concentrations (PECs), defined as those concentrations above which adverse effects are expected to occur more often than not (MacDonald et al. 2000). To address potential biological effects associated with multiple

Table 1 Metrics and threshold values used to calculate the Benthic Index of Biotic Integrity for tidal freshwater habitats (Llanso 2002)

	Scoring criteria		
	5	3	1
Abundance(#/m^2)	$\geq 1,050 - 4,000$	800–1,050 or ≥4,000–5,500	< 800 or ≥5,500
Abundance of pollution indicative taxa (%)	≤ 39	39–87	> 87
Abundance of deep-deposit feeders (%)	≤ 70	70–95	> 95
Tolerance score	≤ 8	8–9.35	> 9.35

contaminants, we calculated the mean PEC quotient according to Ingersoll et al. (2001). The mean metals PEC quotient was based on data for seven metals (cadmium, chromium, copper, lead, mercury, nickel, and zinc). Separate PEC quotients were calculated for total PCBs (t-PCBs), and total PAHs (t-PAHs). An overall mean PEC quotient was determined by averaging the metals, PCB, and PAH quotients. Linear regression (Sokal and Rohlf 1981) was used to test the significance of relationships between biological endpoints (B-IBI and taxa richness) vs. mean PEC quotient, toxicity endpoints vs. mean PEC quotient, toxicity endpoints vs. B-IBI, and toxicity endpoints vs. grain size (fraction fine sediment).

Results

Water quality and depth

Sampling depth ranged from <1.0 m at stations #1, #27 and #33 to 7.5 m at station #102. Percent saturation of dissolved oxygen was above 50% for all stations except #106 (35.7%). Water quality data and station depths are in McGee and Pinkney (2002).

Sediment toxicity tests

All water quality measurements taken during the toxicity tests were within acceptable ranges (McGee and Pinkney 2002). Performance criteria for survival in *H. azteca* and *C. dilutus* controls were met for both sets of tests (Table 2). The mean control survival in the two amphipod tests was 99% and 95%, while the mean survival in the midge tests was 74% and 86%. Each test met the test acceptability criteria (TAC; Table 2). TAC for the growth endpoints were also met, with amphipods exhibiting detectable growth during the 10-d exposures and midge AFDW averaging greater than 0.48 mg per individual (Table 2).

There were no significant differences between survival of midges or amphipods in any test sediment and the respective control sediment (Kruskal–Wallis test, $p > 0.05$; Table 2). Data from some replicates were eliminated from the statistical analyses due to a severe fungal infection. Beakers with surfaces completely covered by a fungal blanket were eliminated because experience has shown that test organism survival and growth, relative to other replicates of the same treatments, are severely reduced (D. J. Fisher, WREC, personal communication). Two replicates of station #13 and one replicate each of stations #33 and #48 were eliminated in the amphipod test. One replicate each in the control (batch 1), stations #82, and #92 were eliminated in the midge test.

There was a significant reduction in both amphipod and midge growth in station #92 sediment compared to growth in the control sediment (ANOVA, LSD, $p < 0.05$; Table 2). Midge growth was also reduced in station #1 sediment. Sediments from this station were too coarse to be sieved and we observed that midges remained on the surface, unable to construct tubes or burrow.

Reference toxicant tests

The potassium chloride reference toxicity test for *H. azteca* resulted in a LC50 of 510 mg l^{-1}. This value falls within the acceptable range for KCl reference toxicity tests for this species (253 to 641 mg l^{-1}). The *C. dilutus* reference toxicity test with sodium chloride resulted in a LC50 of

Table 2 Results of 10 day sediment toxicity tests with the amphipod, *Hyalella azteca*, and the midge, *Chironomus dilutus*

Station ID	Mean % (SD) amphipod survival	Mean (SD) amphipod dry weight (mg)	Mean % (SD) midge survival	Mean (SD) midge ash free dry weight (mg)
Batch 1				
Control (1)	99 (4)	0.172 (0.0145)	74 (19)	1.330 (0.2127)
#65	96 (5)	0.193 (0.0173)	74 (7)	1.270 (0.2488)
#68	99 (4)	0.169 (0.0116)	82 (10)	1.229 (0.1271)
#82	99 (4)	0.166 (0.0108)	80 (17)	1.222 (0.1155)
#83	99 (4)	0.183 (0.0127)	89 (11)	1.159 (0.1298)
#89	99 (4)	0.174 (0.0138)	64 (16)	1.413 (0.1763)
#90	99 (4)	0.175 (0.0264)	70 (27)	1.454 (0.2594)
#92	94 (7)	0.149 (0.0157)[a]	76 (21)	1.044 (0.1572)[a]
#102	100 (0)	0.171 (0.0172)	69 (16)	1.436 (0.2037)
#106	98 (5)	0.185 (0.0215)	80 (18)	1.21 (0.141)
#114	100 (0)	0.194 (0.0229)	76 (24)	1.342 (0.2041)
Batch 2				
Control (2)	95 (5)	0.273 (0.0287)	86 (7)	1.138 (0.0767)
#1	99 (4)	0.329 (0.0337)	91 (8)	0.879 (0.0972)[a]
#6	99 (4)	0.311 (0.0206)	91 (8)	1.304 (0.1154)
#13	95 (5)	0.309 (0.0487)	84 (11)	1.320 (0.2125)
#22	100 (0)	0.316 (0.0213)	92 (9)	1.126 (0.1020)
#27	95 (11)	0.313 (0.0315)	86 (12)	1.343 (0.1003)
#33	97 (5)	0.300 (0.0259)	90 (11)	1.191 (0.1135)
#41	100 (0)	0.315 (0.0206)	82 (10)	1.372 (0.1236)
#48	99 (4)	0.314 (0.0575)	90 (9)	1.242 (0.0923)
#54	99 (4)	0.339 (0.0205)	86 (13)	1.413 (0.2474)
#59	95 (5)	0.309 (0.0265)	88 (10)	1.312 (0.1173)

[a]Significantly less than the corresponding control, $p < 0.05$
Due to the number of samples being tested, tests were conducted on September 29, 2000–October 9, 2000 (batch 1) and October 15, 2000–October 24, 2000 (batch 2)

7.26 g l^{-1}. This value falls within the acceptable range for sodium chloride reference toxicity tests for this species (5.50 to 9.02 g l^{-1}).

Benthic community analysis

No samples failed the 6% criterion for sorting error. A total of 32 taxa were identified from the 20 stations in the Anacostia River (see McGee and Pinkney (2002) for a listing of all taxa and counts). All stations were dominated by oligochaetes, which ranged from 42% of the organisms at station #1 to 92% at station #54 (Table 3). Other taxonomic groups included midges, molluscs, crustaceans, leeches and other insects. Taxa richness ranged from 5 at station #92 to 17 at station #33. Abundance ranged from 1,088 m^{-2} at station #13 to 6,902 m^{-2} at station #54. Results of the B-IBI indicated that 8 of 20 stations (40%) were classified as degraded (B-IBI < 3). Degraded stations included #33, #41, #54, #59, #68, #83, #92 and #102 (Table 3). Results of the cluster analysis indicated that stations classified as degraded or severely degraded (B-IBI < 2.6) formed a distinct group (Fig. 2). There was no discrimination, however, between the stations that were marginally degraded (B-IBI of 2.7 to 2.9) and those that met restoration goals (B-IBI > 3.0).

Relationships between chemical, toxicological, and benthic community endpoints

In general, the minimum and maximum contaminant concentrations for the 20 SQT stations were similar or equal to those in the 114 River stations analyzed by Velinsky and Ashley (2001; Tables 4 and 5). The highest concentrations of cadmium, chromium, mercury, lead, zinc, t-PCBs, and total chlordane (t-chlordane) were detected at SQT stations. Exceedances of sediment quality PECs ranged from 0 at stations #1 and #48 to 9 at #92 (Table 6). Most of the PEC exceedances

Table 3 Benthic Index of Biotic Integrity data for the Anacostia River Triad stations

Station #	1	6	13	22	27	33	41	48	54	59	65	68	82	83	89	90	92	102	106	114
Abundance per m^2	1,552	3,031	1,088	2,900	2,059	6,337	3,727	2,915	6,902	4,423	2,668	4,539	3,016	3,132	3,408	2,132	2,219	3,219	2,059	2,451
Taxa richness	7	15	8	13	7	17	11	7	10	12	12	10	8	9	14	9	5	10	8	11
% oligo-chaeta	42	69	79	84	82	76	82	77	92	88	87	91	82	91	85	77	88	82	75	91
B-IBI	4.0	3.2	3.2	3.0	3.2	2.3	2.8	3.5	*1.7*	*2.3*	3.2	2.2	3.2	2.7	3.0	3.2	*2.8*	*2.8*	3.7	3.0

Italicized B-IBI values indicate stations that are classified as "degraded" or "severely degraded"
Data represent a composite of three grab samples

were for nickel (12 stations) and t-chlordane (17 stations; Tables 4 and 5). Contaminant concentrations (as indicated by mean PEC quotients) increased moving down river, peaked at stations #90 and #92, and decreased near the confluence with the Potomac (Table 6, Fig. 1).

Linear regressions of mean PEC quotient vs. benthic endpoints (B-IBI, taxa richness) were not statistically significant. Nor were there significant regressions between any toxicity endpoints and the B-IBI. There was a significant (negative) relationship between increasing mean PEC quotient and arc sin square root transformed survival of *C. dilutus* ($p = 0.043$) but the regression only accounted for 21% of the variability (R-squared = 0.21). Growth of *H. azteca* was significantly and negatively related with mean PEC quotient ($p < 0.001$, R-squared = 0.51). Amphipod growth was significantly related to grain size. Regression of the average weight as a percent of the control weight decreased significantly with increasing fraction fines ($p = 0.02$, R-squared = 0.22). This did not result from an association between grain size and mean PEC as that regression was not significant ($p = 0.62$).

Sediment toxicity identification evaluation

During initial toxicity tests (March), there was no effect on survival. A significant reduction in *H. azteca* growth (mean dry weight) and *C. dilutus* growth (mean AFDW) was observed in the unaltered Anacostia sediment (station #92) compared to the WBS control (t-test; $p < 0.05$). After converting to biomass (and percent of control), *H. azteca* and *C. dilutus* exposed to Station #92 sediment showed a decrease in organism performance of 50% and 59% of control performance, respectively. Because toxicity to both species was observed, a phase I TIE with both species was conducted with the sample (April) but only growth endpoints were significantly different from the WBS control (based on t-tests). When tested on this date, the baseline toxicity test showed that station #92 sediment was toxic to *C. dilutus* (66% of concurrently conducted control performance, Table 7). The toxicity was reduced by the addition of the Ambersorb® resin, as indicated by the

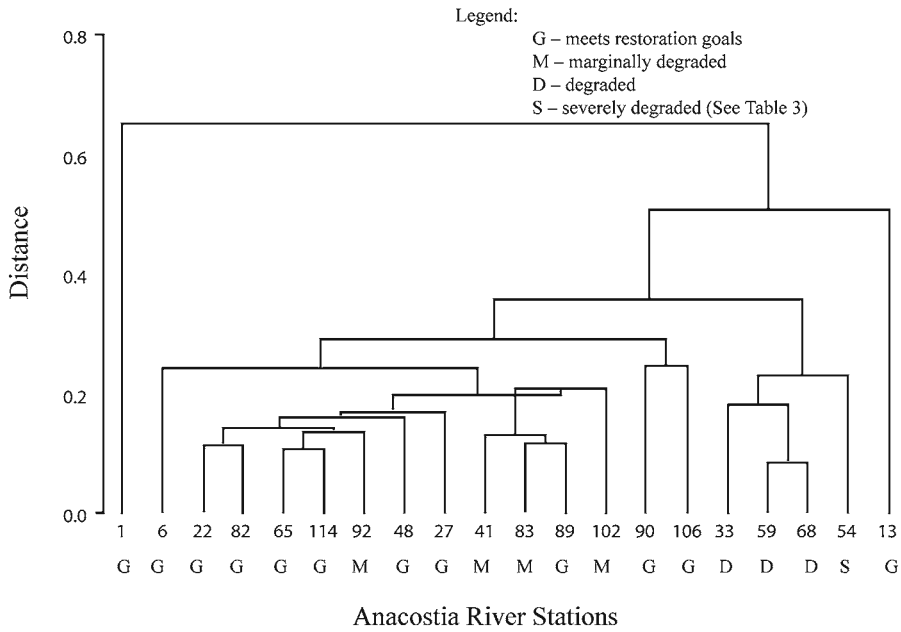

Fig. 2 Results of cluster analysis using the Bray–Curtis distance measure on benthic macroinvertebrate community data

value of 102% for biomass expressed as a percentage of the control, and was the only treatment significantly different from blank treatments. The toxicity of the sample did not appear to be substantially reduced by any other treatment while the addition of the cation exchange resin substantially increased toxicity, which suggests that the resins themselves were causing adverse effects. The interstitial water (IW) was measured for cadmium, copper, lead, zinc, and ammonia. Those concentrations and the SEM-AVS results (all less than zero) indicate that the cationic metals were not present in toxic amounts (Table 8). The measured ammonia concentrations in the overlying water and IW were also below toxic levels. The phase I characterization results with *C. dilutus* are consistent with toxicity primarily attributable to organic chemicals.

For *H. azteca* April TIE tests, in contrast to the initial test, a significant reduction in survival occurred (61% survival) relative to control (WBS) sediment (t-test; $p < 0.05$). Treatments with Ambersorb® resin and zeolite resins showed improved survival to levels similar to that of the control (Table 7). While the AVS and Mg blank treatments reduced survival when added to WBS, these same treatments in the Anacostia sediment did not increase toxicity. Based on biomass expressed as a percent of the control, toxicity to the amphipods was completely removed by treatment with Ambersorb® and the cation exchange resin (Table 7). These results suggest that, unlike the *C. dilutus* test, the *H. azteca* test did not differentiate between metals, ammonia, and organics as sources of toxicity.

Additional tests with *C. dilutus* were conducted in June to further evaluate the effectiveness of several of the TIE treatments with more replicates (Table 9). In this test, the toxicity of station #92 sediment to *C. dilutus* was less than the previous two tests (i.e., organism biomass was 76% of the control compared to 59% of the control for the initial test) and the TIE additions did not reduce toxicity during this round of testing. As was observed during the previous round of testing, increased toxicity was observed with the cation exchange resin amendment, again indicating blank toxicity. When station #92 sediment was tested again with *C. dilutus* in July and December 2001, these sediments did not exhibit any growth or survival effects.

Discussion

This study is the most comprehensive application of the Sediment Quality Triad in the tidal Anacostia River to date. Based on the B-IBI, 40%

Table 4 Sediment metals concentrations and percent fines (<0.063 mm) at Triad stations within the Anacostia River, Washington, DC

Station	% fines	Cd	Cr	Cu	Hg	Ni	Pb	Zn
#1	2.60	0.18	7.65	5.10	ND	ND	4.19	17.0
#6	42.3	0.92	62.4	38.0	0.01	41.9	55.5	291.9
#13	61.5	1.12	81.1	48.5	0.16	45.3	58.3	233.3
#22	72.9	1.43	79.9	53.8	0.18	41.1	72.7	235.5
#27	23.8	0.75	36.9	27.5	0.09	21.2	43.2	186.1
#33	64.6	1.67	81.7	65.2	0.23	*51.8*	88.1	281.7
#41	16.0	1.23	55.0	43.2	0.08	35.9	34.2	231.2
#48	58.8	0.92	55.8	57.8	0.57	33.0	89.3	204.0
#54	44.1	1.34	69.4	53.5	0.15	41.3	94.3	240.8
#59	85.2	1.66	85.4	75.1	0.23	*50.5*	80.4	278.4
#65	95.5	1.83	92.1	86.1	0.31	*54.2*	96.0	324.3
#68	95.3	1.89	94.95	90.5	0.34	*56.1*	102.4	330.1
#82	99.6	2.13	100.3	102.3	0.36	*60.1*	98.5	338.4
#83	97.6	1.88	97.4	91.9	0.34	*56.9*	96.9	319.9
#89	98.8	2.20	122.2	112.0	0.35	*78.3*	117.9	400.5
#90	43.6	2.91	85.6	*198.3*	*2.81*	*83.2*	*454.3*	*742.8*
#92	59.5	3.27	*157.2*	*212.5*	*1.32*	*94.0*	*586.5*	*750.0*
#102	99.9	1.96	*122.7*	107.4	0.31	*81.9*	101.5	359.7
#106	99.6	1.54	110.8	86.3	0.28	*77.0*	77.0	317.5
#114	71.3	1.05	75.4	57.2	0.18	*50.5*	42.3	210.0
PEC		4.98	111	149	1.06	48.6	128	459
SQT range[a]	2.60–99.9	0.18–3.27	7.65–157.2	5.10–212.5	ND–2.81	ND–94.0	4.19–586.5	17.0–750.0
Anacostia range[b]	2.60–99.9	0.18–3.27	7.65–157.5	5.10–312.5	ND–2.81	ND–386.8	0.96–586.5	17.0–750.0

Italicized values exceed their respective probable effect concentration (PEC). Concentrations are in μg g-1 dry weight
ND not detected
[a]SQT range: range of concentrations in 20 Anacostia River SQT stations
[b]Anacostia range: range of concentrations in 114 Anacostia River stations analyzed by Velinsky and Ashley (2001)

of the stations (8 of 20) fell below the breakpoint (score of 3) between degraded and non-degraded conditions. Of those eight stations, half were classified as "marginally degraded" and the other half were "degraded" or "severely degraded". The "degraded" and "severely degraded" stations were grouped together by the cluster analysis (Fig. 2), suggesting similarities in benthic macroinvertebrate species composition.

Results of regression analyses between benthic community parameters and the mean PEC quotient did not indicate significant relationships; although, other studies have found this approach to be a useful way to summarize chemical data and establish relationships among chemical and biological endpoints (Long et al. 1998; Hyland et al. 1999; McGee et al. 1999; MacDonald et al. 2000). In the development and evaluation of the PECs, MacDonald et al. (2000) reported that 92% of the sediment samples in their datasets with mean PEC quotients greater than 1.0 were toxic to one or more species of aquatic organisms. Long et al. (1998) reported a similar relationship in their evaluation of marine and estuarine sediment guidelines and datasets. Mean PEC quotients at only two stations in the present study, #90 and #92, were greater than 1.0. In an evaluation of a freshwater database of 1,657 samples with toxicity and chemistry data, Ingersoll et al. (2001) reported a 50% incidence of toxicity at a mean PEC quotient of 3.5 in 10-day midge tests and 3.4 in 10-d amphipod tests, when survival or growth were reported as an endpoint. Our results— #90, nontoxic with a mean PEC of 1.59, #92 toxic with a mean PEC of 2.26—are consistent with Ingersoll et al. (2001).

Although the water quality data at the time of sediment collection did not indicate low dissolved oxygen, Galli et al. (2001) reported frequent low dissolved oxygen concentrations in an analysis of

Table 5 Concentrations of selected organic compounds from Triad stations within the Anacostia River, Washington, DC

Station	Total PCBs	Total DDT	Total chlordane	Lindane	Dieldrin	Total PAHs
#1	2.3	1.09	3.39	< 0.12	0.23	1,005
#6	97.0	26.0	*31.5*	0.56	1.37	19,226
#13	113.0	41.2	*45.5*	1.32	2.63	*30,006*
#22	130.2	37.9	*46.8*	1.18	1.26	16,201
#27	87.7	26.0	*18.7*	0.47	1.65	*34,898*
#33	125.2	NVR	NVR	NVR	NVR	10,294
#41	82.9	65.3	*55.4*	0.65	1.92	15,396
#48	57.7	38.5	16.5	0.40	2.55	15,649
#54	119.8	54.6	*58.2*	1.43	3.76	*26,931*
#59	162.7	30.2	*51.9*	1.09	1.64	22,029
#65	156.2	32.2	*49.8*	1.19	2.64	20,758
#68	152.1	28.8	*47.3*	1.22	1.81	*29,159*
#82	144.1	46.2	*57.6*	1.77	2.35	*28,508*
#83	NVR	70.0	*44.8*	2.10	2.60	21,050
#89	183.4	116.8	*57.3*	2.55	0.89	*30,618*
#90	361.3	108.0	*110.4*	1.57	3.78	*56,928*
#92	*1,629*	152.9	*169.9*	4.83	7.95	*57,907*
#102	163.3	129.9	*46.6*	0.86	1.65	15,494
#106	NVR	40.4	*21.9*	0.85	1.12	9,445
#114	123.7	40.6	*18.1*	0.62	1.15	7,174
PEC	676	572	17.6	4.99	61.8	22,800
SQT range[a]	2.3–1,629	1.1–152.9	3.4–169.9	ND–4.83	0.23–7.95	1,005–57,907
Anacostia range[b]	2.3–1,629	ND–155.1	ND–169.9	ND–5.81	ND–8.86	1,005–90,449

Italicized values exceed their respective Probable Effect Concentration (PEC). Concentrations are in ng g^{-1} dry weight

NVR no value reported, *ND* not detected

[a]SQT range: range of concentrations in 20 Anacostia River Sediment Quality Triad stations

[b]Anacostia range: range of concentrations in 114 Anacostia River stations analyzed by Velinsky and Ashley (2001)

the District of Columbia Department of Health's water quality data (1988–2000), which could have affected the benthic communities. They reported that dissolved oxygen concentrations were less than 5.0 mg l^{-1} 75% of the time and less than 2.0 mg l^{-1} 5% to 6% of the time. The low dissolved oxygen was attributed to nutrient and organic matter loadings from stormwater runoff, combined sewer overflows, leaking sewer lines, and natural processes that contribute biological oxygen demand (MWCOG 1998). Station #92, near the O-street combined sewer outfall, had the most obvious indication of contaminant-related impact. This sample had the highest contaminant concentrations, significantly inhibited growth of both toxicity test species, and a degraded benthic community (i.e., B-IBI < 3).

The results of the phase I TIE characterization tests of station #92 were consistent with organic toxicity. However, because toxicity was declining over time, phase II identification was not possible. Declining toxicity presents a challenge to researchers performing TIEs and USEPA (2007) describes the need for a 30 to 40% reduction for TIEs to identify toxicity, consistently. When the toxicity of station #92 declined such that biomass was 76% of the control performance, treatments that typically remove the organic contaminants (coconut charcoal and Ambersorb 1500) did not reduce toxicity. USEPA (2007) postulated that, in some cases, toxicity due to organics may be caused by the presence of a non-aqueous phase (i.e., an oil), that may not be affected by these treatments. USEPA's Duluth, MN laboratory is currently investigating this issue (Norberg-King, USEPA, personal communication).

Small-scale spatial variability may be a factor in differences in the repeat sampling for the TIE and between the chemical/toxicological vs. benthic sampling. Velinsky and Ashley (2001) sampled 6 of the 114 stations (none of the 20 reported here) in duplicate (n = 3) and triplicate

Table 6 Mean Probable Effects Concentration (PEC) quotients, number of PEC exceedances and Benthic Index of Biotic Integrity (B-IBI) values for the Anacostia River stations

Station	Mean PEC quotient	Number of PEC exceedances	B-IBI
#1	0.03	0	4.0
#6	0.47	1	3.2
#13	0.65	2	3.2
#22	0.47	1	3.0
#27	0.65	2	3.2
#33	0.41	1	*2.3*
#41	0.39	1	*2.8*
#48	0.42	0	3.5
#54	0.62	2	*1.7*
#59	0.60	2	*2.3*
#65	0.60	2	3.2
#68	0.73	3	*2.2*
#82	0.73	3	3.2
#83	0.81	2	*2.7*
#89	0.83	3	3.0
#90	1.59	7	3.2
#92	2.26	9	*2.8*
#102	0.58	3	*2.8*
#106	0.57	2	3.7
#114	0.32	2	3.0

B-IBI values less than 3 are italicized, indicating an impaired benthic community

($n = 3$) within a 5-m area and performed separate analyses on each replicate. Based on an average of all analytes, relative standard deviations (triplicates) and relative percent differences (duplicates) at these stations ranged from 6.5% to 40%. The larger within-station differences may be related to both more heterogeneous grain size and organic carbon distributions at some stations (D. Velinsky, Academy of Natural Sciences, personal communication).

At Station #92, concentrations of t-PCBs, t-PAHs, and t-chlordane were the highest of all the SQT stations. These results corroborate those of Schlekat et al. (1994), who postulated that organic contaminants were responsible for sediment toxicity observed at stations in the lower river. Sediments from station #1 also had significant deleterious effects on midge growth; however, the effect was attributed to grain size (coarse sediments) rather than contaminants. This hypothesis is supported by the results of benthic community and sediment chemical analyses. Station #1 had the highest calculated B-IBI value and the lowest mean PEC quotient.

Earlier toxicological studies in the Anacostia documented a greater extent of sediment toxicity than observed in the present study. Phelps (1990) reported a high degree of toxicity to the larvae of the clam, *Corbicula fluminea*, in the lower portion of the river near our stations #83, #89, #90 and #92. Schlekat et al. (1994) conducted the SQT at 15 stations (samples collected in 1992) throughout the tidal fresh portion of the Potomac and Anacostia Rivers in Washington, DC. They observed significant reductions in survival of *H. azteca* exposed for 28 days to three of five sediments collected in the Anacostia River. Mean survival ranged from 35% to 78%, with the highest mortality observed at a station near our station #-92. Similarly, Fisher et al. (2001) evaluated sediment toxicity at six locations in the tidal Anacostia River using 10 and 28 day exposures with the estuarine amphipod, *Leptocheirus plumulosus*. Sediments from all stations significantly affected survival in 10 and 28 day exposures. Lastly, a sediment toxicity study was sponsored by the USACE to evaluate the suitability of dredged material from the Anacostia for use in wetland creation projects (EA 1999). They reported no significant effects on survival in 10 d exposures with *H. azteca*; however, the composite samples from the lower river did have adverse effects on amphipod growth. It is uncertain whether decreasing toxicity from the early 1990s to 2000 is due to differences in test methods, species sensitivity, spatial, and temporal variability in toxicity or an actual improvement in sediment quality. The application of the standardized USEPA sediment toxicity test methods used in this study for future assessments would minimize some of these confounding variables.

As part of the Schlekat et al. (1994) SQT study, surface sediments were collected in 1992 near seven of the current stations, #48, 59, 68, 83, 92, 102, and 114, and analyzed for a similar suite of contaminants (Velinsky et al. 1994; Wade et al. 1974). Although sampling methods (i.e., petite ponar) were similar, several factors may make affect comparisons of concentrations. First, the sampling sites were not exactly the same and importantly, river dynamics (i.e., discharge) over time can shift sediment (i.e., organic

Table 7 Results of TIE characterization with Anacostia River Station #92 sediment (initiated: April 27, 2001)

Sample description	Survival and growth					
	Chironomus dilutus			*Hyalella azteca*		
	Mean survival (%)	Mean ash free dry wt (mg)/initial # of midges	Biomass as a percentage of control[a]	Mean survival (%)	Mean weight (mg)/initial # amphipods	Biomass as a percentage of control[a]
WBS (control)	95	1.00	–	85	0.066	–
WBS and AVS (20 μmol/g) addition (blank)	93	1.12	111	30	0.025	38
WBS and coconut charcoal addition (15% medium; blank)	95	0.87	82	73	0.043	65
WBS and Mg addition (114 μmol/g; blank)	93	1.11	111	58	0.047	71
Station #92 sediment	88	0.66	66	61	0.041	62
Station #92 and 30% sand (blank)	85	0.74	74	73	0.037	56
Station #92 and AVS addition (20 μmol/g)	88	0.81	81	70	0.054	82
Station #92 and coconut charcoal addition (15% medium)	93	0.69	69	60	0.027	41
Station #92 and Mg addition (114 umol/g Mg)	93	0.75	75	73	0.054	82
Station #92 and Ambersorb 1500 addition (4%)	98	1.03	103	85	0.067	102
Station #92 and cation exchange addition (30%)[b]	30	0.34	34	73	0.067	102
Station #92 and zeolite addition	93	0.79	79	88	0.055	83

[a]Values are presented as percent of the WBS control

[b]Treatment with cation exchange resin decreased survival of *C. dilutus*

Table 8 Interstitial water metals and ammonia data and sediment simultaneously extracted metals (SEM) minus acid volatile solids (AVS) analyses

Analyte	Interstitial water conc. (μg l^{-1})	LC50: *H. azteca* (pH 6–6.5)[a]	SEM (μmol g^{-1})	SEM-AVS[b](μmol g^{-1})
Cadmium	0.03	228	0.0185	< 0
Copper	3.68	17	0.3269	< 0
Lead	1.26	< 90	2.0546	< 0
Zinc	13.5	1,200	9.4412	< 0
Ammonia	9.48 (1.5)[c]	20		
pH	6.57			

Sample collected March 13, 2001 from Anacostia River station #92

[a]Data from USEPA (2007)

[b]AVS concentration: 37.66 μmol/g

[c]Overlying water concentration in parentheses

carbon and grain size) and associated contaminants. In addition, organic contaminant extraction and quantification methods were slightly different, whereas metals methods were similar. Lastly, various programs within the District of Columbia and State of Maryland could have modified (i.e., reduced) the load of contaminants into the river over the 8 year period. Despite these caveats, it is useful to evaluate these data with respect to changes in chemical concentrations over time.

Two attributes of the sediments that can control the distribution of chemical contaminants are sediment organic carbon and grain size. For grain size, there was, on average, a 60% (34 to 71%) lower amount of fine grain sediment (<63 μm) in the 2000 vs. 1992 samples, while sediment organic carbon content was similar with an average increase of 15% (<1 to 76%). Total PCBs concentrations decreased between 1992 and 2000 by an average of 74% at all stations except the downstream location (#114) in which there was a 75% increase. Similarly, there was a decrease in concentration between 1992 and 2000 for total DDT compounds and t-chlordane (43% and

Table 9 Results of the follow-up TIE testing (June 2001) of station #92 using the midge, *Chironomus dilutus* with the treatments that were effective in the April 2001 testing

Sample description	*Chironomus dilutus* survival and growth		
	Mean survival (%)	Mean ash free dry wt (mg)/surviving midges	Biomass as a percentage of control
WBS control	90	1.04	–
WBS and AVS addition (20 μmol/g)	95	0.90	87
WBS and cation exchange (SIR 300) addition (30%)	98	0.96	92
WBS and coconut charcoal addition (15% medium)	90	0.91	88
WBS and Ambersorb 1500 addition (4%)	97	1.20	115
Station #92 sediment	92	0.79	76
Station #92 and AVS addition (20 μmol/g)	90	0.79	76
Station #92 and cation exchange addition (SIR 300; 30%)	18	0.20	19
Station #92 and coconut charcoal addition (15% medium)	92	0.73	70
Station #92 and Ambersorb 1500 addition (4%)	96	0.81	78

40%, respectively) in the upper river and an increase at the two lower stations. Total PAHs concentrations increased at all stations between 1992 and 2000 by an average of 84%. Organic contaminant concentrations normalized to organic carbon exhibited a similar trend as bulk concentrations with a general decrease for t-PCBs, total DDT, and t-chlordane and an increase in t-PAHs.

At the upstream stations (#48, 59, 68, and 82), concentrations of most metals were lower in 2000 than in 1992 with a tendency for slightly higher concentrations at the downstream locations in 2000 compared with 1992. On average, concentrations of cadmium (8%), copper (14%), and mercury (31%) were higher in 2000 relative to 1992 whereas concentrations of chromium (−18%), lead (−21%) and zinc (−8%) decreased. Since grain size is a controlling influence in trace metal distributions and there was a large difference between the two sampling periods, data were normalized to the amount of fine grain sediment. For stations #59, 68, 102 and 114, normalized trace metal concentrations were higher in 2000 than in 1992 by a factor of two for all metals. Spatially, the higher metal concentrations (both bulk and normalized) as well as organic contaminants were evident at the lower stations (#90, 102, and 114) compared to the upper stations.

Our benthic community results were comparable to surveys conducted by Schlekat et al. (1994), suggesting little overall improvement in the last decade. Taxa richness in both studies was lowest at or near station #92 and ranged as high as 17 in upstream stations. Abundances were also similar, ranging from approximately 1,000 to 6,000 organisms per m^2. The benthos was dominated by pollution-tolerant oligochaetes, which comprised 80% to 90% of the benthic macroinvertebrates at the majority of the stations.

The B-IBI is designed to evaluate trends in benthic community health over time and space (Weisberg et al. 1997). Unfortunately, the B-IBI cannot be applied retrospectively to the Schlekat et al. (1994) data because the level of taxonomic detail was insufficient. Hall et al. (1999) applied an earlier version of the tidal freshwater B-IBI to benthic community data from six stations in the River. They classified all four stations below the Sousa Bridge as "severely degraded" while those upstream, in the vicinity of stations #22 and #13, were not impaired. Application of the revised B-IBI to their data resulted in similar classifications (B. McGee, unpublished data). We recommend that future bioassessments in the Anacostia River be consistent in the level of taxonomic detail and sample collection (e.g., season, gear type), to facilitate comparisons.

In summary, integration of the three components of the SQT indicates that only one of twenty sampled locations had a high probability of benthic degradation due to sediment-associated contaminants. Additional sediment from this station (#92) was tested and sediment toxicity identification evaluation (TIE) procedures tentatively characterized organic compounds as the cause of toxicity. Overall, forty percent of the stations were classified as degraded by the B-IBI. However, qualitative and quantitative comparisons with sediment quality benchmarks indicated no clear relationship between benthic community health and contaminant concentrations. This study provides a baseline to evaluate future actions intended to improve water and sediment quality in the Anacostia River.

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BIOAVAILABILITY OF POLYCYCLIC AROMATIC HYDROCARBONS IN FIELD-CONTAMINATED ANACOSTIA RIVER (WASHINGTON, DC) SEDIMENT

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Abstract—Sediment–water partitioning behavior and bioavailability of five polycyclic aromatic hydrocarbons (PAHs; phenanthrene, pyrene, chrysene, benzo[*k*]fluoranthene, and benzo[*a*]pyrene) were measured in field-contaminated sediment collected from moderately polluted regions of the Anacostia River (Washington, DC, USA). Much of the sediment PAH burden was resistant to desorption: Effective partition coefficients were 2- to 10-fold greater than expected from literature values, and more than 80% of PAHs remained sorbed after treatment of the sediment with a nonionic polymeric adsorbent (Amberlite XAD-2) for 20 h. Bioaccumulation, elimination, and assimilation of each PAH in the deposit-feeding tubificid oligochaete *Ilyodrilus templetoni* were measured and compared with the equivalent measurements from laboratory-inoculated sediment. *Ilyodrilus templetoni* effectively accessed the desorption-resistant fraction of these organic contaminants, as exhibited by high single-gut passage assimilation efficiencies (ASEs) of the five PAHs (60% < ASE < 90%). However, steady-state accumulations of PAHs by *I. templetoni* were very low and consistent with low pore-water concentrations. The present results suggest that steady-state accumulation of PAHs is controlled by pore-water concentrations and is not necessarily related to route of uptake or assimilation efficiencies.

Keywords—Bioavailability Biota–sediment accumulation factor Desorption resistant Oligochaete worm

INTRODUCTION

Sediments serve as the ultimate sink for many hydrophobic organic contaminants (HOCs), such as polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls. Sediments also represent biologically important environmental habitats. Information regarding the availability of the sediment-associated HOCs to sediment-dwelling organisms, such as deposit-feeding invertebrates, is crucial for understanding contaminant transfer into both these organisms and consumers higher up the food chain. Bioaccumulation measurements often are used to determine the bioavailability of sediment-associated contaminants and trophic transfer potential of contaminants in aquatic environments [1]. Bioaccumulation or net uptake of a HOC often is indicated by the biota–sediment accumulation factor (BSAF), which is defined as the ratio of lipid-normalized tissue concentration over the organic carbon–normalized sediment concentration [2]:

$$\mathrm{BSAF} = \frac{C_t/f_{\mathrm{lipid}}}{C_s/f_{\mathrm{OC}}} \tag{1}$$

where C_s is the sediment concentration of HOCs (μg/g dry wt), C_t is the tissue concentration of HOCs (μg/g dry wt), f_{OC} is the fraction of total organic carbon content of the sediment (weight fraction, %), and f_{lipid} is the fraction of the tissue lipid content (weight fraction, %). This definition is based on the equilibrium partitioning theory [3, 4], which assumes that the HOCs distribute between sediment organic carbon, pore water, and lipids of biota and that, at equilibrium, partitioning among these three phases is reproducible.

The equilibrium partitioning theory predicts that BSAF will be close to unity if an organic contaminant partitions similarly between the lipid of an organism and the organic carbon fraction of the sediment. Biota–sediment accumulation factors of approximately one have been demonstrated by Ankley et al. [5] for both laboratory and field populations of benthic oligochaetes exposed to a wide variety of polychlorinated biphenyls and by Ingersoll et al. [6] as well as Gewurtz et al. [7] for PAHs. However, significant deviations from unity also have been observed as a result of chemical transformation, biomagnification, or differential partitioning potential between lipids and sediment organic carbon [8–10]. In addition, BSAFs of significantly less than one have been observed for sediments in which the fast-desorbing fraction significantly decreased as a result of contaminant sequestration or removal of the fast-desorbing fraction by adsorbents [11–13].

Our previous studies concerning the bioavailability of phenanthrene and benzo[*a*]pyrene in laboratory-inoculated sediment demonstrated that observed reductions in BSAF were approximately proportional to increases in the sediment–water partition coefficient (i.e., proportional to decreases in the pore-water concentration) associated with the desorption-resistant fraction. Sediment pore-water concentration, controlled by physicochemical desorption processes, determined the equilibrium tissue concentration of the tested contaminants independent of the route of uptake and assimilation efficiency [14, 15]. This suggests that physicochemical measurements (i.e., pore-water concentration or observed sediment–water partition coefficient) will effectively predict bioavailability. Because use of the pore-water paradigm to define bioavailability has been limited to laboratory-inoculated sediments in the previous work [14,15], testing of this model in field-contaminated sediments is desired. Few studies have been conducted to determine the relationship between pore-water concentrations and uptake in field-contaminated sediments as a result of complications associated with sequestration, mass-transport limita-

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Table 1. Sediment-water partition coefficients (K_{OC}) in field-collected and laboratory inoculated sediments[a]

	PHE	PYR	CHR	B*k*F	B*a*P
Sediment concentration (μg/g dry wt)	1.67 (0.17)	4.64 (0.90)	1.54 (0.37)	0.74 (0.06)	1.57 (0.17)
Field-collected log K_{OC}					
Without correction for DOC	4.74 (0.06)	5.38 (0.03)	5.85 (0.07)	6.48 (0.20)	6.51 (0.03)
With correction for DOC	4.76 (0.06)	5.43 (0.03)	6.05 (0.07)	6.74 (0.20)	6.79 (0.03)
Laboratory-inoculated log K_{OC}					
Rapidly desorbing	4.32 (0.03)				6.21 (0.06)
Desorption resistant	4.82 (0.06)				6.26 (0.06)
Expected log K_{OC}	4.36	4.97	5.65	5.79	5.83

[a] Values in parentheses represent the standard deviation. B*a*P = benzo[*a*]pyrene; B*k*F = benzo[*k*]fluoranthene; CHR = chrysene; DOC = dissolved organic carbon; PAH = phenanthrene; PYR = pyrene.

tions, strong binding to soot, and variability in the polarity of organic matter [16]. Although other researchers have proposed pore-water concentration as a good predictor of bioaccumulation [4,17,18], to our knowledge simultaneous observations of physicochemical availability by experiments regarding desorption as well as biological uptake rate and extent have not been conducted with field-contaminated sediments.

The primary objectives of the present study were to determine if pore-water concentrations in field-contaminated sediments define the extent of accumulation in a deposit-feeding invertebrate and to determine if bioaccumulation is independent of the contaminant rate of uptake and single-gut passage assimilation efficiency.

MATERIALS AND METHODS

Sediment selection and PAH quantification

Sediment employed in the present study was collected during the year 2002 from the Anacostia River, which flows from Maryland (USA) to Washington, DC, and the Potomac River. Major contaminants in the sediment include PAHs, polychlorinated biphenyls, and metals. Here, we focus on the bioavailability of PAHs. Total PAHs in the collected sediment averaged approximately 30 μg/g, and total organic carbon content averaged 4.32% ± 0.16% (mean ± standard deviation). The sediment was passed through a 2-mm sieve to remove debris and large particles and then homogenized for the experiments.

An ultrasonic extraction method based on standard U.S. Environmental Protection Agency Method 3550 [19] was used to extract PAHs from sediment (and, later, from worm tissue). The extract was analyzed by a Hewlett-Packard 1100 series high-performance liquid chromatograph with ultraviolet-diode array (Hewlett-Packard, Palo Alto, CA, USA) and fluorescence detectors. The procedure includes grinding sediment or tissue with sodium sulfate, followed by addition of a solvent (sediment was extracted with hexane and acetone [1:1, v/v], and tissue was extracted with dichloromethane) and then sonication for 25 min. For samples of worm tissue, the extracts were cleaned with a silica gel column based on U.S. Environmental Protection Agency Method 3630C [20]. Ultimately, the solvent was exchanged with acetonitrile before analysis with high-performance liquid chromatography.

Five of the 16 PAHs in the sediment samples—phenanthrene, pyrene, chrysene, benzo[*k*]fluoranthene, and benzo[*a*]pyrene—were identified with high confidence for the present study. These five PAHs exhibit a wide range of hydrophobicity ($4.5 < \log K_{OW} < 6.5$). Table 1 lists the measured concentrations of the five selected PAHs in Anacostia River sediment.

Desorption measurement

Physicochemical availability of PAHs was assessed by measurement of the sediment–water partition coefficient and by evaluation of the fraction that would rapidly desorb after treatment with a nonionic polymeric adsorbent, Amberlite XAD-2 (divinylbenzene-styrene copolymer; Supelco, Bellefonte, PA, USA). Pore-water concentration of the tested sediment, as indicated by sediment–water partition coefficients, were measured using standard procedures of the American Society for Testing and Materials [21], as we have employed previously [14,15] but with minor modifications. For each sample, 2.5 g of sediment and 140 ml of electrolyte solution (0.01 M NaCl, 0.01 M $CaCl_2 \cdot 2H_2O$, and 0.01 M NaN_3 in deionized water) was used to achieve recommended solid to water ratios in the desorption vials. The sediment slurry was tumbled for 20 d to allow partitioning to reach apparent equilibrium and then centrifuged at 700 *g* for 20 min to separate water from the sediment. Although the water to solid ratio of these measurements is much higher than the water to solid ratio in the sediments, pore-water concentrations were expected to be effectively identical at equilibrium because of the small mass fraction of PAHs in the water (typically <1% for all PAHs of interest except phenanthrene, which was expected to be <5%). In situ measurement of the pore-water concentration using diffusion samplers (peepers) also were considered, but heterogeneity suggests that it would not necessarily better represent pore-water concentrations of the collected, homogenized sediment.

Eighty milliliters of the derived pore water was extracted with 4 ml of dichloromethane, and another 10 ml of the water were measured for dissolved organic carbon (DOC) content in the water using a TOC-5000A total organic carbon analyzer (Shimadzu, Columbia, MD, USA). An additional water sample was directly injected into a high-performance liquid chromatograph, but concentrations were too low for detection for most PAHs of interest. Both truly dissolved and DOC-associated HOCs likely are extracted by dichloromethane. Therefore, extraction by dichloromethane overestimates the free or true pore-water concentration, and the water concentration derived by solvent extraction was corrected for DOC using the following equation:

$$C_w = \frac{C_{wm}}{1 + C_{DOC} K_{DOC}} \quad (2)$$

where C_{wm} is the dissolved water concentration (mg/L), C_w is the free or truly dissolved water concentration (mg/L), C_{DOC} is the DOC content in water, and K_{DOC} is the DOC–water partition coefficient of HOCs. Large uncertainties exist in the determinations of K_{DOC} because of the limitations in measuring the freely dissolved water concentration. For the present study, the correlation of Burkhard [22] between K_{DOC} and K_{OW} based on PAH data from different DOC sources and different analytical methods was employed:

$$\log K_{OC} = \log K_{OW} - 0.58 \quad (3)$$

The equilibrated sediment concentration (C_s, μg/g) was calculated based on mass balance. The observed partition coefficient (K_{OC}^{obs}) was calculated according to a linear partitioning model [23]:

$$K_{OC}^{obs} = \frac{K_p}{f_{OC}} = \frac{C_s}{C_w f_{OC}} \quad (4)$$

where K_p is the sediment–water partition coefficient of the HOC (L/kg). Although the correction for partitioning to DOC is subject to large error, the maximum influence on K_{OC}^{obs} was 0.28 log units (for the most hydrophobic compound, benzo[*a*]pyrene).

The fast-desorbing fraction of PAHs was evaluated by short exposure (20 h) to a nonionic polymeric adsorbent, Amberlite XAD-2. Because of its strong affinity for aromatic compounds, Amberlite XAD-2 has been used in cleaning up water samples with trace PAHs [24] and in assisting desorption of PAHs from field-contaminated sediment [25]. The Amberlite XAD-2 was purchased from Supelco and has a particle size of 20 to 60 mesh and a surface area of 300 m^2/g. Wet sediment (100–200 g; moisture content, ~45%) was mixed thoroughly with 10% (dry-wt ratio) XAD-2 and stored for 20 h, which was demonstrated by Chai [26] to be appropriate for characterizing the fast-desorbing fraction of contaminant from sediment based on the shape of the desorption kinetics by XAD-2. At the end of exposure, sediment and XAD-2 were separated, and chemical concentrations in sediment and XAD-2 resin were determined using the method described above. The fast-desorbing fraction was defined as the fraction of contaminant in sediment removed by XAD-2.

Bioavailability studies

The freshwater deposit-feeding tubificid oligochaete *Ilyodrilus templetoni* (Southern) was used in the present bioavailability studies, as in our previous studies with laboratory-inoculated sediments. Sexually mature *I. templetoni* had an average wet weight of 3.2 mg and a dry weight to wet weight ratio of approximately 0.17 to 1 on initial collection from the culture.

Bioaccumulation as well as assimilation efficiency and elimination rate were measured in a manner employed previously [14,15]. Bioaccumulation (*I. templetoni* tissue concentration) of PAHs from Anacostia River sediment was measured at 5, 10, 15, 20, and 26 d to estimate the kinetics of uptake and the time to reach steady state. Each chamber was considered as a replicate measure of bioaccumulation, and four replicates were used in each exposure period. Lipid-normalized tissue concentrations at different exposures were analyzed by one-way analysis of variance. Differences were considered to be statistically significant at $p < 0.05$.

Assimilation efficiency was measured using the pulse-chase feeding technique [27] and was based on direct measurement of the contaminant concentration ingested after 40 min (time for one gut passage or less) exposure to field-collected Anacostia River sediment and the concentration remaining in tissue after complete egestion (depuration in clean sediment for 4 h), which is the contaminant assimilated into the tissue. Assimilation efficiency was calculated as the ratio of the contaminant assimilated over the total contaminant ingested. In the elimination rate measurement, after exposing worms to Anacostia River sediment for 14 d to achieve sufficient body burden of PAHs, worms were then exposed to sediment without PAHs and allowed to eliminate assimilated contaminants. The clean sediment used during the elimination period was a lower-organic-carbon sediment (1.2% organic carbon) from Bayou Manchac (LA, USA). The lower organic carbon content and other factors may cause the elimination rate in this sediment to be different than would have occurred in the Anacostia River sediment, but direct measurement of elimination rates in the contaminated Anacostia River sediment was not possible. The quantity and rate of elimination was determined by collection and analysis of whole-worm tissues at 0, 6, 12, 24, 48, and 72 h. Tissue-concentration data were fit to a first-order decay model (Eqn. 5) , from which the elimination rate constant (k_e) was determined:

$$C(t) = C(0) \cdot e^{(-k_e t)} \quad (5)$$

where t represents time (h).

RESULTS AND DISCUSSION

Comparison of equilibrium partitioning in field-contaminated sediment with laboratory-inoculated sediment and calculated values

Measured K_{OC} values of PAHs in field-contaminated sediment are shown in Table 1, along with the previously measured K_{OC} values in laboratory-inoculated sediments [14,15] and K_{OC} values predicted from K_{OW} [23] (Eqn. 6). Table 1 also includes estimated partition coefficients with and without a correction for association with DOC:

$$\log K_{OC} = \log K_{OW} - 0.218 \quad (6)$$

The measured partition coefficients for all five PAHs in the Anacostia River sediment were significantly higher (2- to 10-fold) than expected by the predictive relationship (Eqn. 6) of Karickhoff et al. [23]. The fast-desorbing fraction as measured by XAD-2 desorption was effectively 0 to 22%, illustrating large amounts of contaminants remaining on the sediment and in a desorption-resistant fraction. Chai [26] showed that 29% of the organic matter in the Anacostia River sediment remained after 24-h combustion at 375°C. This nonvolatile organic carbon measured in this manner has been used as an indicator of condensed-phase carbon exhibiting greater sorption capacity and slow desorption kinetics. The effective partition coefficient of benzo[*a*]pyrene in the Anacostia River sediment was almost one order of magnitude higher than the literature partition coefficient and those measured in short-term, laboratory-inoculated sediment by Lu et al. [15].

Uptake, assimilation, and elimination

Figure 1 shows the uptake of phenanthrene, pyrene, chrysene, benzo[*k*]fluoranthene, and benzo[*a*]pyrene by *I. templetoni* from Anacostia River sediment during the 26-d exposure in 50-ml test tubes. Tissue concentrations of all compounds except phenanthrene were essentially constant after 5 d of exposure. The analysis of variance showed no significant

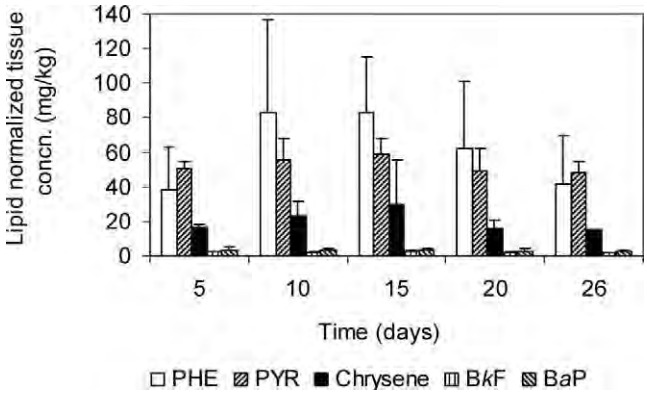

Fig. 1. Uptake of phenanthrene (PHE), pyrene (PYR), chrysene (CHR), benzo[*k*]fluoranthene (B*k*F), and benzo[*a*]pyrene (B*a*P) by *Ilyodrilus templetoni* in field-collected Anacostia River (Washington, DC) sediment. Error bars represent one standard deviation from the mean.

changes over time in lipid-normalized accumulation for any of the selected PAHs (all $p > 0.05$), suggesting that a steady-state tissue concentration was achieved within 5 d. Although similar rapid achievement of steady-state conditions was observed with phenanthrene in laboratory-inoculated sediment [14], benzo[*a*]pyrene kinetics in laboratory-inoculated sediment was much slower [15].

Single-gut passage assimilation efficiencies of PAHs in this field sediment were very high, ranging from 63 to 88% across compounds (Table 2). Assimilation efficiencies of phenanthrene and benzo[*a*]pyrene were approximately equal for field-collected and laboratory-inoculated sediments (Table 2). The high assimilation efficiencies indicate that even contaminants exhibiting desorption resistance were effectively accessed by this deposit feeder.

Although assimilation efficiencies for contaminants from field-collected and laboratory-inoculated sediments were similar, elimination rates (after depuration) from field-collected sediment were significantly higher (by approximately an order of magnitude). The higher elimination rates may have been caused by the organism response to the different sediments (Bayou Manchac) in which elimination was measured. Because the microbial community presumably was acclimated and self-selected for the Anacostia River sediments, PAH degradation was much faster than in the laboratory-inoculated sediment experiments. High microbial activity and PAH degradation rates were shown in the Anacostia River sediment compared to Bayou Manchac sediment (M. Nabatilan, Louisiana State University, Baton Rouge, LA, USA; unpublished data).

Bioaccumulation and applicability of pore-water paradigm

The BSAFs in the 50-ml test tubes were calculated at each exposure period in which tissue concentrations were measured. The BSAFs calculated from the measured lipid-normalized concentration for all five PAHs are listed in Table 3. These BSAFs were compared with those derived from experiments conducted previously with laboratory-inoculated sediments [14,15,28]. With the exception of that for phenanthrene, measured BSAFs were significantly lower ($p < 0.001$) in field-contaminated Anacostia River sediment than in laboratory-inoculated sediments. As indicated above, steady state also was rapidly achieved compared with that in laboratory-inoculated sediments and may be the result of the comparatively low normalized accumulation in Anacostia River sediment, whereas assimilation efficiencies between the two sediments were equivalent. Similar results were observed by Van holf [29] when comparing the time to reach steady state for ''aged'' sediment with that for freshly inoculated sediment. Phenanthrene exhibited anomalously high BSAFs and a high variability that was not observed in the other PAHs. As the least hydrophobic and most volatile of the compounds evaluated, phenanthrene was the least subject to desorption-resistant phenomena and the most subject to both biotic and abiotic fate processes, potentially complicating analysis and evaluation of results.

Low BSAFs (i.e., <1) of the more hydrophobic compounds are consistent with the high desorption-resistant fraction of the contaminants, as indicated by the high effective partition coefficients or low pore-water concentrations measured in the sediment. Our previous studies regarding laboratory-inoculated sediment showed that reductions in BSAF were approximately proportional to increases in sediment–water partition coefficients as the desorption-resistant fraction increased [14, 15]. As pore-water concentrations of PAHs decreased because of increases in sediment–water partitioning, the corresponding steady-state tissue concentration also decreased, regardless of the route of exposure (either absorption from pore water or ingestion of sediment [30]). This behavior can be expressed by the model that Lu et al. [14] defined:

$$\mathrm{BSAF}^{\mathrm{res}} = \frac{K_{\mathrm{OC}}^{\mathrm{lab}}}{K_{\mathrm{OC}}^{\mathrm{res}}}\mathrm{BSAF}^{\mathrm{lab}} \tag{7}$$

where $\mathrm{BSAF}^{\mathrm{res}}$ is the effective BSAF as a result of exposure to sediments containing the desorption-resistant fraction of contamination, $\mathrm{BSAF}^{\mathrm{lab}}$ is the BSAF if the contaminants were purely in the labile fraction, $K_{\mathrm{OC}}^{\mathrm{res}}$ is the organic carbon–normalized sediment–water partition coefficient of the desorption-resistant fraction, and $K_{\mathrm{OC}}^{\mathrm{lab}}$ is the organic carbon–normalized sediment–water partition coefficient of the labile fraction. The

Table 2. Assimilation efficiencies (ASE) and elimination rates (k_e) by *Ilyodrilus templetoni*[a]

Sediments	PHE	PYR	CHR	B*k*F	B*a*P
Field collected					
ASE (%)	62.6 (7.0)	77.3 (12.2)	81.5 (13.4)	75.2 (3.9)	88.1 (17.2)
k_e (/h)	0.22	0.058	0.040	0.047	0.064
Laboratory inoculated					
ASE (%)	50.0				80.4
k_e (/h)	0.042				0.0066

[a] Values in parentheses represent the standard deviation. See Table 1 for definitions of abbreviations.

Table 3. Biota-sediment accumulation factors (BSAFs) of polycyclic aromatic hydrocarbons in Anacostia River (Washington, DC, USA) sediment[a]

	PHE	PYR	CHR	B*k*F	B*a*P
Measured BSAFs[b]	1.55 (1.04)	0.49 (0.09)	0.48 (0.11)	0.11 (0.04)	0.09 (0.03)
Predicted BSAFs[c]	0.40 (0.35–0.46)	0.34 (0.32–0.37)	0.40 (0.34–0.47)	0.11 (0.07–0.18)	0.11 (0.10–0.12)

[a] See Table 1 for definitions of abbreviations.
[b] Values in parentheses represent the standard deviation.
[c] Values in parentheses represent predicted values based on one standard deviation from the average of observed sediment-water partition coefficients.

K_{OC}^{lab} was predicted from K_{OW} (e.g., that defined by Eqn. 6), whereas the K_{OC}^{res} was measured directly. Using this model and assuming that $BSAF^{lab}$ equals unity, the BSAFs of PAHs in field-contaminated Anacostia River sediment were predicted and compared with the experimentally measured BSAFs, as shown in Table 3. The predicted BSAFs (excluding the highly variable phenanthrene data) exhibited a high correlation with the measured BSAFs (r^2 = 0.90), and the predicted BSAFs typically are less than one standard deviation from the measured values, which implies that the effective partition coefficient or pore-water concentration is a good predictor for the BSAF of PAHs in the field-collected Anacostia River sediment. A comparison of measured BSAFs and predictions of $BSAF^{res}$ based on $BSAF^{lab}$ equals unity, measured pore-water concentration data from previous studies in the literature [14,15,28,31], and those measured herein are plotted in Figure 2. This further supports the conclusion of Lu et al. [14,15] that pore-water concentrations ultimately control the bioaccumulation of PAHs (as a model of HOCs) in the deposit-feeding organisms. Steady-state BSAF proved to be unrelated to assimilation efficiency, suggesting that extraction by digestive fluids [32, 33] will not predict bioaccumulation under these conditions. This conclusion was reached previously with laboratory-inoculated sediment [14, 15, 17], but the present results provide further support with field-contaminated sediment.

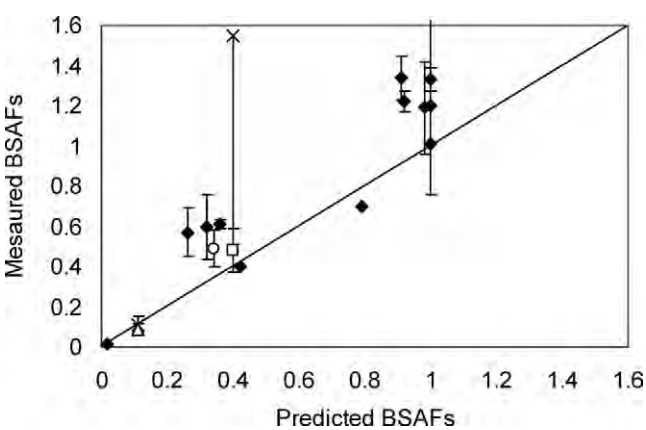

Fig. 2. Experimentally measured biota–sediment accumulation factors (BSAFs) versus BSAFs predicted from the measured effective partition coefficient (Eqn. 7) assuming that $BSAF^{lab}$ (the BSAF if the contaminants were purely in the labile fraction) equals unity. Error bars represent one standard deviation from the mean (data from Millward et al. [28] were calculated values without replicates). ♦ = laboratory-inoculated sediments from previous studies in the literature [14, 15, 28, 31], and open symbols represent field-contaminated sediment from the present study (× = phenanthrene; ○ = pyrene; □ = chrysene; * = benzo[*k*]fluoranthene; △ = benzo[*a*]pyrene).

CONCLUSION

Field-collected Anacostia River sediment exhibited a lower pore-water concentration of PAHs, as reflected by a higher sediment–water partition coefficient and correspondingly lower BSAFs compared to laboratory-inoculated sediment; however, the assimilation efficiencies of these sediments were very close. The present results further support the conclusion that physicochemical measurements of pore-water concentration can be used to predict the bioavailability and bioaccumulation potential of sediment-associated PAHs, which had been demonstrated previously by laboratory-inoculated sediment [14,15,17]. Sediment-quality criteria often are defined on the basis of equilibrium partitioning from the solid phase [34]. The present data suggest that a more effective means of defining exposure and risk from PAH-contaminated sediments is from measured pore-water concentrations. Measured pore-water concentrations reflect the fate processes of contaminants in pore water and any dynamic desorption limitations associated with the desorption-resistant fraction of contaminants while still indicating directly the steady-state uptake in the deposit-feeding organisms in these studies.

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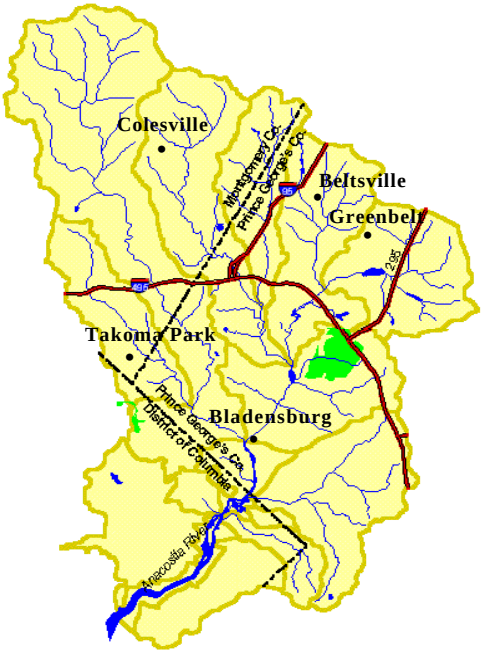
Interpretive Summary of Existing Data Relevant to Potential Contaminants of Concern within the Anacostia River Watershed



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ACRONYMS FOR ANACOSTIA FILES

ARBC	Anacostia River business coalition
AWCAC	Anacostia Watershed Citizens Advisory Committee
AWRC	Anacostia Watershed Restoration Committee
CBFO	Chesapeake Bay Field Office
COG	Metropolitan Washington Council of Governments
CSO	Combined Sewer Overflow
CWA	Clean Water Act
DNT	Maryland Department of Natural Resources
DCRA	Department of Consumer Regulatory Affairs
GDC	Government of the District of Columbia
ICPRB	Interstate Commission on the Potomac River Basin
MDE	Maryland Department of the Environment
MWCOG	Metropolitan Washington Council of Governments
NCP	National Capital Parks
NPS	National Parks Service
NPDES	National Pollutant Discharge Elimination System
USACE	United States Army Corps of Engineers
USCOE	United States Army Corps of Engineers
U.S. EPA-CBP	United States Environmental Protection Agency and Chesapeake Bay Program
USFWS	U.S. Fish and Wildlife Service

PREFACE

This report was prepared by Syracuse Research Corporation (SRC) under a contract from GEO-CENTERS, Inc (GC-3381-99-002) for the Anacostia Watershed Toxics Alliance. The report was developed in collaboration with the National Oceanic and Atmospheric Administration (NOAA) and O'Brien and Gere Engineers, Inc. Contributions made by NOAA, with assistance from EVS Environmental Consultants, included assembling all of the environmental monitoring data into the Anacostia River Watershed Database and Mapping Project, the development of Chapter 7, which describes the ecological screening-level risk assessment, and related contributions to Chapters 8 and 9. Contributions made by O'Brien and Gere Engineers included the evaluation of information on river hydrodynamics and sediment transport, and development of Chapters 3 and 4. Important contributions were also made by U.S. EPA Region 3, which provided access to many of the background reports and documents that were reviewed, and by the Anacostia Watershed Toxics Alliance, whose members provided comments and suggestions on an earlier draft of the report (March 2000).

Executive Summary

As part of first phase of activities directed to meeting the objectives of the Anacostia Watershed Toxics Alliance, an assessment of chemical hazards and preliminary characterization of the associated risks to both humans and ecological receptors was initiated. The *Interpretive Summary* report provides a synopsis of the results of these Phase I risk characterization efforts. The goal of Phase I was to summarize, within a generally accepted data quality evaluation framework, information about the historical and current conditions and concerns related to the environmental quality of the Anacostia Watershed. Currently available information was relied upon to form the basis of the following:

1.a preliminary conceptual site model of the tidal Anacostia River and associated chemical hazards;

2.screening-level human health and ecological risk assessments to identify chemicals of potential concern (COPCs) in the tidal Anacostia River; and,

3.identification of data gaps relevant to developing a more complete risk characterization of the tidal Anacostia and to evaluating potential remediation alternatives.

The Phase I assessment began with collecting and organizing the existing information about watershed usage, sources of contamination, processes for contaminant deposition and transport, potential exposure pathways and receptors. The information used in the assessment was that made available by the Alliance and other sources prior to January, 2000. This included data in the Anacostia River Watershed Database and Mapping Project developed by NOAA plus water quality data. The report contains a brief review of the nature of physical, biological, and chemical stressors to the environmental integrity of the system based on these existing data plus other reports. Other important environmental issues were considered beyond the scope of this effort.

Understanding hydrodynamic processes and characteristics of the Anacostia River and its watershed is the one of the first steps in identifying contaminant fate and transport. Hydrodynamics and water quality of a river are influenced by the characteristics of the river itself, as well as the surrounding watershed. A generalized conceptual model of these dynamics was developed. In general though, data for chemical loadings, concentrations in various media, plus transformation and transport processes have been collected over several decades and throughout the Anacostia River, thus and comprise a patchwork understanding of contamination in the tidal Anacostia. Data have not been collected and analyzed in a coordinated manner in order to develop a comprehensive understanding of chemical contamination sufficient for quantifying current exposures or for predicting future exposures or future contamination conditions under various remediation scenarios.

Regardless of the limitations of the existing information, there is sufficient data, often biased to the vicinity of suspected sources of contamination, to allow for screening estimations of risk due to exposure to toxic compounds. A screening of human health risk potential was conducted using standard techniques and assumptions about maximal exposure to contaminated media, including consumption of contaminated fish. The human health risk screening identified several chemicals of potential concern (COPCs) is sediment, surface water, or fish which exceed acceptable benchmarks. Levels in sediment and fish tissue for several pesticides, polychlorinated biphenyls (PCBs), polycylic aromatic hydrocarbons (PAHs), lead, mercury, arsenic, and cadmium were confirmed as COPCs. Due to data limitations, it is uncertain how representative these estimates may be of broader conditions. However, these results do suggest that at least isolated circumstances occur in which there may be potential risk to human health.

A screening of potential risk to ecological organisms was also conducted using highly conservative assumptions (ones which tend to over-estimate risk) and existing data. Risk factors were estimated for a number of ecological communities whose members may be potential receptors of, or exposed to, contaminated media. These include aquatic birds, aquatic mammals (for example raccoons), fish, and benthic invertebrates (those which live on or in the river bottom) which are key elements of the food chain necessary for supporting these other organisms. Some of these invertebrates may also be targets for recreational fishing as well. To examine the risk to benthic invertebrates, sediment contamination was compared to benchmarks of known toxicity. Limited toxicity tests were also examined for confirmation of the predicted toxic impacts. Risk to fish were estimated by comparing water concentrations of COPCs to EPA Ambient Water Quality for the Protection of Aquatic Life; by comparing fish tissue residues of COPCs to toxicity benchmarks; and by comparing sediment levels of PAHs to those associated with adverse impacts to fish. Food chain models were employed to estimate the dose of COPCs to birds and mammals. These doses were then compared with benchmark values.

Results of the ecological screening indicate with a high probability that sediment concentrations of chromium, lead, mercury, nickel, zinc, PAHs, PCBs, and several pesticides are sufficiently elevated to be toxic to benthic invertebrates, and, that sediment PAH levels are high enough to be injurious to fish. Fish residues of PCBs appear to be high enough to impair reproductive success. Using overly-conservative approaches, the risk to aquatic birds or mammals does not appears to be as significant as that to other receptors. Given the large uncertainty associated with these conservative estimates, firm conclusions regarding the actual risk posed to the organisms are not possible.

Although there are gaps in understanding, and large uncertainties about some potential risk estimates, this systematic investigation of existing knowledge confirms the probability of unacceptably high impacts due to toxic contamination, distinguishes contaminants which are primary risk drivers (beyond those already suspected), and identifies the principal parameters which must be addressed to support decisions to restore the river.

The goal of the risk assessment process is to achieve a sufficiently detailed understanding so that 1) current ecological and human health risks can be reliably estimated; and 2) reductions in risk when assessing different remediation strategies, can be predicted with sufficient confidence to support risk management decisions. The first goal requires both detailed data on the contamination pattern of various media and on the resource use of those media in order to define exposure, plus knowledge of the potential threat or toxicity of compounds receptors are exposed to. The latter goal requires the development, validation, and calibration of hydrodynamic and ~~a~~ sediment transport models that will accurately simulate the physical and chemical processes that contribute to transport of COPCs in the river and associated environmental media. Such models need to be developed to the point where they can support estimation of contaminant mass fluxes. This will in turn require a reasonably complete understanding of transport mechanisms for affected media, and accurate estimates of contaminant loadings.

In general, data concerning chemical loadings from sources, chemical concentrations in various media, chemical transformation, and chemical transport processes have been collected over the course of decades and over a wide geographic range. As such, these data comprise a patchwork of chemical contamination in the tidal Anacostia. Data have not been collected and analyzed in a coordinated manner in order to develop a comprehensive understanding of chemical contamination.

Several gaps and limitations in the existing database limit the ability of the data to support a baseline risk assessment. (This limitation has no effect on the screening assessment, which is based primarily on maximum concentrations detected.). The major data gaps related to exposure information used in the Anacostia River human health risk screening assessment can be classified into three categories: 1) inadequate geographic

coverage of sampling in the tidal Anacostia; 2) inadequate numbers of samples; and 3) lack of data for a chemical class in a specific media. The absence of this information may render estimates of exposure concentrations for potential receptors highly uncertain and potentially highly biased towards those geographic areas that have been more extensively sampled. The same limitations will make it extremely difficult to model chemical loadings to the tidal river.

Spatial and temporal patterns of human uses of the river, including fishing, boating, waterskiing, wading, swimming, picnicking (etc.) within the tidal Anacostia river have not been sufficiently characterized to ensure that all potential human receptors are considered in risk estimates, or to estimate values for exposure factors for potential exposure scenarios. Likewise, the extent, duration, exact locations, and timing of habitat usage by aquatic ecological receptors are not understood fully enough to allow refinement of exposure estimates for these species.

Additionally, the hydrodynamics in the river and the dynamics of sediment transport are not understood sufficiently to enable predictions of contaminant concentration profiles over the length of the river, or to identify future high impact areas and estimate associated concentrations. This limitation is particularly relevant to extreme (high and low) flow conditions; disturbances that might be imposed on the river as part of remediation or other modifications to the river (e.g., dredging); and to interactions with the Potomac River.

These are the general categories of gaps in knowledge that should be addressed to ensure that effective, efficient remedial decisions can be made. Future efforts should be directed at addressing these data gaps.

1. INTRODUCTION

The Anacostia Watershed Toxics Alliance (AWTA) was created to foster a public-private partnership in establishing a watershed-wide focus on the assessment and management of toxic chemicals in the Anacostia River. The mission of the AWTA is as follows:

> *To work in good faith as partners to evaluate the presence, sources, and impacts of toxic contaminants on the Anacostia River with all stakeholders, both public and private, and other interested parties, and to evaluate and take actions to enhance the restoration of the watershed to its beneficial use to the community and ecosystem as a whole.*

To achieve this mission, the AWTA has adopted the following objectives: 1) Identify and quantitatively assess risks to human health and the environment from toxic contaminants in the Anacostia River. 2) Reduce risks from toxic contaminants to levels that are safe for humans and aquatic life. 3) Build effective partnerships among AWTA members, encourage public input and promote effective restoration of the Anacostia watershed.

As part of activities directed at the above objectives, an assessment of chemical hazards and characterization of related risks to humans and ecological receptors was initiated. This report summarizes the results of Phase I of the risk characterization. The objective of Phase I was to summarize, within a generally accepted data quality evaluation framework, information about the historical and current conditions and concerns related to the environmental quality of the Anacostia Watershed. The currently available information was to form the basis of the following: 1) a preliminary conceptual site model of the tidal Anacostia River and associated chemical hazards; 2) screening-level human health and ecological risk assessments to identify chemicals of potential concern (COPCs) in the tidal Anacostia River; and 3) identification of data gaps relevant to developing a more complete risk characterization of the tidal Anacostia and evaluating potential remediation alternatives, should they be needed. Phase I was to be followed with Phase II data collection efforts to fill data gaps identified in Phase I.

The data quality evaluation framework used in this project is that described in the Risk Assessment Guidelines for Superfund (RAGS), Volume 1, Part A, Chapter 5: Data Evaluation (U.S. EPA, 1989; 1997), as modified by the U.S. EPA Region III Technical Guidance Manual, Selecting Exposure Routes and Contaminants of Concern by Risk-based Screening (U.S. EPA, 1993a), and the Interim Final Guidance on Data Quality Objectives Process for Superfund (U.S. EPA, 1993b). Components of the process used in the screening assessment, and how it would link to Phase II, or subsequent remedial investigation and baseline ecological and human health risk assessments are depicted in Figure 1-1.

The Phase I assessment began with collecting and organizing the existing information about watershed usage, sources of contamination, processes for contaminant deposition and transport, potential exposure pathways and receptors. The information used in the assessment was that made available by the AWTA and other sources prior to January, 2000. This included data in the Anacostia River Watershed Database

and Mapping Project developed by the National Oceanic and Atmospheric Administration (NOAA, 2000) and water quality data that was provided by NOAA in spreadsheet format on January 3, 2000; the latter is from a study by Velinsky et al. (1999). Subsequent to completing a preliminary draft of the Phase I report in March, 2000, additional data, information and reports were identified by the ATWTA that would have been of value for consideration in Phase I. However, in order to accommodate the logistical demands of completing Phase 1 in a timely manner, this additional information could not be included in all aspects of the Phase I assessment. This information will be considered in evaluating the data gaps identified in Phase I and in subsequent reassessments that may occur as part of Phase II activities.

This report is organized into ten chapters and three appendices. Chapter 2 summarizes information on the natural history and environmental management of the Anacostia Watershed. Chapters 3 and 4 summarize information on hydrodynamics and sediment transport in the tidal Anacostia. Chapter 5 describes the data that was used in screening level assessments. The results of the human health and ecological screening assessments are provided in Chapters 6 and 7, respectively. Chapters 8 presents the major conclusions of the assessment, data gaps relevant to fully characterizing human health and ecological risks, including those related to completing a conceptual site model and the development of hydrodynamic and sediment transport models. Recommendations for future data collection and assessment activities are presented in Chapter 9. Supporting data tables, hazard identification summaries for COPCs, and RAGS Section D tables are provided in the appendices.

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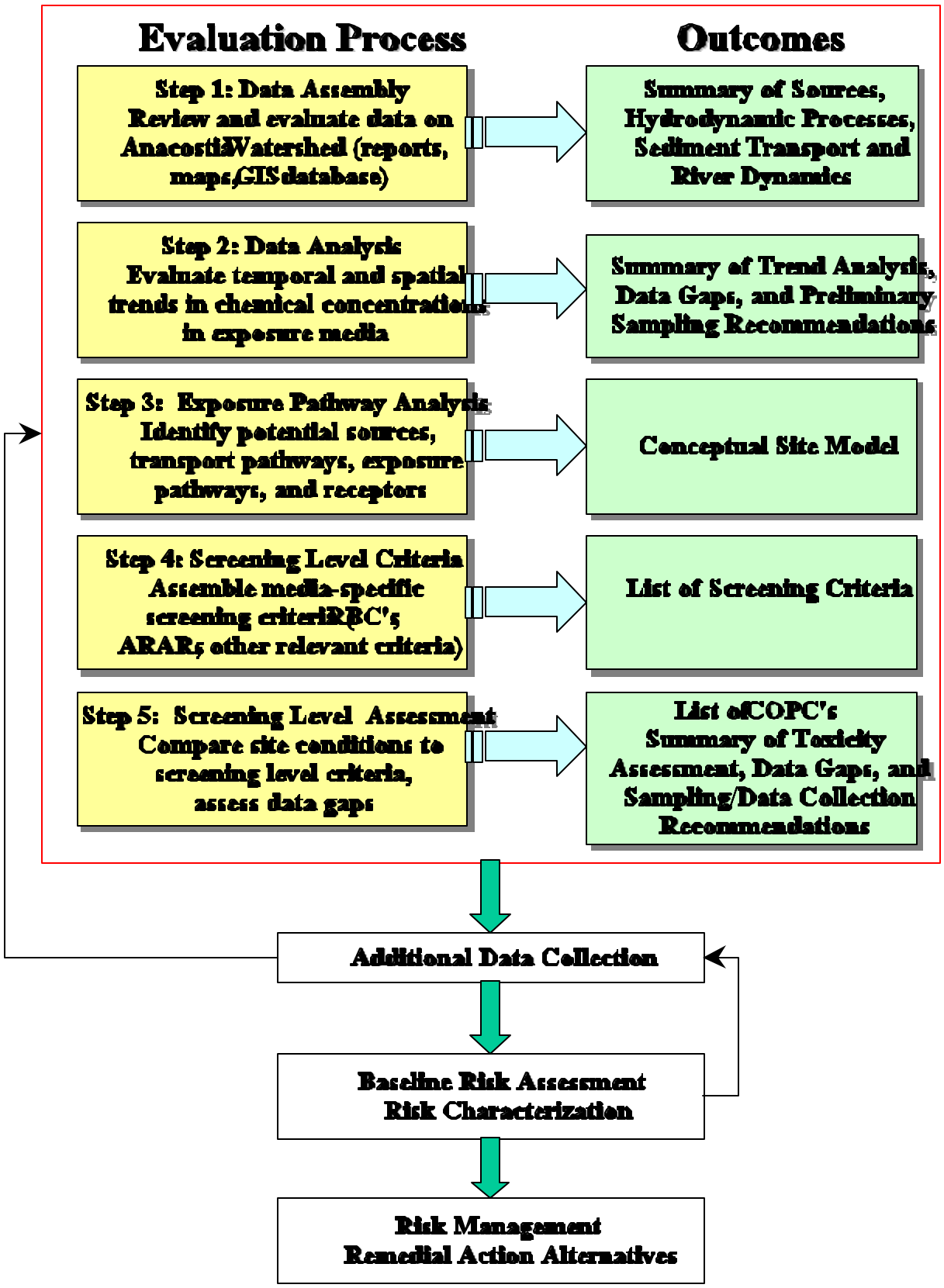
Figure 1-1. Overview of Process and Outcomes of Screening Level Assessment.



2. BACKGROUND ON THE ANACOSTIA WATERSHED

2.1 NATURAL HISTORY AND HISTORICAL CHANGES IN HUMAN USES OF THE ANACOSTIA RIVER WATERSHED

2.1.1 PHYSIOGRAPHY

The Anacostia River watershed drains approximately 403 km^2 of land area (Scatena, 1986). It is comprised of the Piedmont Plateau and Atlantic Coastal Plain physiographic provinces, divided at the Fall Line, which is an area of steep descent in the watershed streams from the plateau to the plain (U.S. EPA-CBP, 1992). The Northwest Branch of the Anacostia River drains a 127 km^2 area of ridge and ravine topography carved into the Piedmont crystalline metamorphic rock of the plateau, and the Northeast Branch drains a 190 km^2 area of primarily relatively flat coastal plain sediments comprised of alternating layers of sand, silt, and clay (Scatena, 1986). The channel of the tidal Anacostia River occupies a narrow strip between Pleistocene terraces (Scatena, 1986).

2.1.2 CLIMATE AND HYDROLOGY

The Anacostia River watershed is a sub-watershed within the Potomac River Drainage Basin, which in turn empties into the Chesapeake Bay (U.S. EPA-CBP, 1992). The climate of the region is characterized by hot summer and mild winter temperatures, and precipitation is evenly distributed throughout the year, averaging approximately 106 cm/year in the center of the watershed (Scatena, 1986). Most of the rainfall in the summer is provided by intense, convective thunderstorm events (Metropolitan Washington Council of Governments [MWCOG], 1986).

The mean yearly discharge of the Anacostia River is 3.9 m^3/sec, and records as of 1986 indicated a minimum discharge of 0.05 m^3/sec and a maximum of 900 m^3/sec (Scatena, 1986). The high volume to influx ratio in the tidal Anacostia River results in a flow rate that is frequently described as *sluggish*. One estimate of the residence time of water in the tidal Anacostia River was 35 days (Scatena, 1986), and another report estimated residence times of between 20 and 40 days under average rainfall conditions, and 100 days or more during periods of low rainfall (MWCOG, 1986).

The waters of the Anacostia River originate in northern Prince Georges and Montgomery counties in Maryland, and flow freely through numerous tributaries to the confluence of the Northeast and Northwest Branches, where the freshwater, tidal Anacostia River is formed (U.S. EPA, 1999a). Several other smaller tributaries empty directly into the tidal Anacostia along its length (U.S. EPA, 1999a). Sand bars and shoals near the mouths of tidal Anacostia tributaries provide evidence of upstream erosion (MWCOG, 1986).

The current channel of the tidal Anacostia River, as well as the Kingman Lake and Kenilworth Marsh embayments, are almost entirely man-made (Scatena, 1986). Efforts during the period 1902 to 1960 to

implement flood control projects, construct sea walls on both sides of the tidal Anacostia River, and fill in wetlands ultimately contributed to ecological degradation by eliminating extensive areas of wetland, aquatic habitat, and bottomland hardwood forest (U.S. EPA, 1999a). Natural wetlands and riverside forests can act as an effective ecological buffer, erosion control, and filtration systems between populated areas and a major water body.

The tidal Anacostia River is both free-flowing and tidally influenced. During storms, the waterway behaves like a river with unidirectional, down-gradient flow, whereas, between storm events, the Anacostia behaves more like a tidal lake with 3-foot tidal fluctuations (Scatena, 1986). Coffin et al. (1998, 1999) attributed thermal stratification observed during June 1997 through February 1998 in the center of the lower Anacostia River (between the Washington Naval Yard and the Pennsylvania Avenue Bridge) to tidal circulation, which may periodically move cooler Potomac River water into the lower surface water stratum of the lower Anacostia River.

2.1.3 LAND USE/HUMAN USE

At the time of European colonization of the Atlantic coast during the early 1600s, the area surrounding the confluence of the Potomac and Anacostia Rivers was forested and used by the native Nacotchtank Indians for subsistence hunting and as a regional trading center (U.S. EPA, 1999a). The Anacostia waterway itself reportedly contained abundant populations of numerous species of fish, including the sturgeon, American and hickory chad, white and yellow perch, red-breasted sunfish, striped bass, catfish, and herring and was utilized extensively for subsistence fishing by the native people and early settlers (U.S. EPA, 1999a).

As the area was more heavily settled by European immigrants, the Anacostia River became an early shipping and trade region and was navigable throughout the length of the 8.4-mile tidal portion of the river up to the historic port city of Bladensburg, MD, near the confluence of the Northeast and Northwest Branches (U.S. EPA, 1999a, Warner et al., 1997).

Widespread deforestation for tobacco farming in colonial times and later commercial crop farming during the late 1700s and early 1800s contributed to massive surface soil erosion and heavy inputs of sediments to the tidal river, so that by the mid 1800s, ships could no longer navigate the upper tidal river to the port at Bladensburg (Kumble, 1990; U.S. EPA, 1999a), and extensive mud flats formed along the shoreline (Kumble, 1990). More recently, surface mining excavations and urban/suburban development continued to contribute to deforestation, resulting in estimated sediment loads to the tidal Anacostia River of 134,420 tons/year in 1963 and 137,000 tons/year in 1981 (Scatena, 1986). Surface mining operations and abandoned sand and gravel mines comprise approximately only 2% of the land area in the Maryland portion of the Anacostia watershed (U.S. EPA-CBP, 1992), but they are suspected of contributing significantly to the current total annual loading of sediment to the tidal Anacostia River (MWCOG, 1986; Warner et al., 1997).

Based on an analysis of aerial photographs taken in 1990, only 7.1% of the entire watershed remained in agriculture, 1.6% was sand and gravel mines, 43.3% was residential, and a significant fraction of the watershed was in forest (24.6%), parkland (7.1%), or wetland (2.8%); the remaining 16.7% of land area was accounted for as *institutional*, *commercial*, *industrial*, or *federal* use categories (Warner et al., 1997). Most of the agricultural area lies within the USDA Beltsville Agricultural Research Center within the Northeast Branch drainage area, and most of the forest area is confined to the headwaters of the tributary streams (Scatena, 1986).

2.1.4 URBANIZATION

The land area comprising the Anacostia River watershed falls within the local jurisdictions of Prince Georges and Montgomery Counties of the state of Maryland and the District of Columbia, and most of the tidal Anacostia River falls within the boundaries of the District of Columbia (U.S. EPA-CBP, 1992).

Over the period 1980 to 1990, the populations of Prince Georges and Montgomery Counties increased 9.7 and 30.7%, respectively, and the number of housing units has increased by 14.2 and 36.8%, respectively (U.S. EPA-CBP, 1992). More than 800,000 people currently live in the Anacostia River watershed, with the highest density of residents near the tidal Anacostia (U.S. EPA, 1999a). As in other highly populated urban river areas, continuous potential sources of pollution include human and industrial waste, trash, and petroleum-based chemical runoff from intensive vehicular traffic. These challenges are particularly difficult in some urban areas along the tidal Anacostia River. For example, antiquated combined sewer systems designed for human populations and land use conditions of nearly a century ago are overtaxed and frequently overflow during storms, emptying untreated sewage directly into the river (U.S. EPA-CBP, 1992).

The land area within the tidal portion of the Anacostia River watershed is almost entirely developed, with scattered woodlands in parks (U.S. EPA-CBP, 1992). Suburban residential settlement and commercial development has also continued in the upper watershed, contributing to deforestation and streambank erosion. Development throughout the watershed has resulted in a high proportion of the land area in impervious surfaces (e.g., pavement in roads and parking lots, sidewalks, and residential/ commercial/ industrial structures), which adversely impacts stream hydrology, water quality, and ecology (U.S. EPA-CBP, 1992). Much of the impervious surface is drained by collecting water from large surface areas (water that otherwise would have soaked into the ground, recharging the groundwater) into narrow outflow channels, which increases downstream flow velocity and leads to erosion, especially during storm events. Hydrographs obtained from USGS gauging stations in 1988–1989 indicate that flow is extremely responsive to even small rainfall events, which appears to be a direct result of increased impervious surfaces from urbanization (Kumble, 1990).

2.2 AN OVERVIEW OF THE ENVIRONMENTAL ISSUES IN THE ANACOSTIA RIVER WATERSHED AND PROGRAMS DEVELOPED TO STUDY OR MANAGE THE WATERSHED

2.2.1 RATINGS OF OVERALL ENVIRONMENTAL QUALITY IN THE ANACOSTIA RIVER

The environmental quality of the Anacostia River has consistently been rated poorly relative to other water bodies in evaluations by several different organizations. The unanimously poor ratings of the Anacostia River and most of its watershed have been based on both ecological and human health issues.

The District of Columbia prepared a draft unified watershed assessment report in 1998 concerning the waters of the District, which included part of the Anacostia watershed (MWCOG, 1998). The assessment included a Nonpoint Source Management Program Watershed Priority List, which rated the Anacostia River and some of its tributaries, specifically Watts Branch, Hickey Run, and Kingman Lake, as *high priority* water bodies (using a ranking system of high, medium, and low priority). These high priority water bodies were considered to be most in need of restoration and were also considered for review for possible accelerated restoration.

The 1998 Maryland Clean Water Action Plan Technical Workgroup's *Report on Unified Watershed Assessment, Watershed Prioritization and Plans for Restoration Action Strategies* identified Category 1 priority watersheds in Maryland that do not meet general water quality or other natural resource goals, and which have been recommended for restoration action within the next two years. The Anacostia River watershed was identified as a priority restoration watershed based on a low non-tidal benthic *Index of Biotic Integrity*, high percent impervious surface, high population density, and high soil erodability (Clean Water Action Plan Technical Work Group, 1998).

The U.S. EPA has identified the Anacostia River as one of the most contaminated rivers in the Chesapeake Bay watershed (AWRC, 1999); it is one of only three sites recognized by the U.S. EPA's Chesapeake Bay Program as posing a significant risk to aquatic life due to sediment contamination, and has been designated a *Region of Concern* based, in part, on the issuance of a fish consumption advisory for elevated levels of PCBs and chlordane in fish (Government of the District of Columbia [GDC], 1996; MWCOG, 1998).

The Anacostia River is widely regarded to be among the 10 most polluted urban rivers in the United States (GDC, 1994, 1996, 1998), and the American Rivers conservation organization identified the Anacostia River as the fourth most polluted river in the United States as of 1993 (MWCOG, 1998) and the seventh most polluted river in 1997. During 1993–1994, a White House Ecosystem Management Task Force completed a case study of the Anacostia River, one of only seven in the nation, and recommended a substantial and coordinated federal role in restoring the watershed (U.S. EPA, 1999).

2.2.2 MAJOR ENVIRONMENTAL QUALITY ISSUES IN THE ANACOSTIA RIVER WATERSHED

Numerous reports have identified major environmental pollution issues in the Anacostia River watershed (e.g., Kumble, 1990; McCabe, 1997; MWCOG, 1986, 1991, 1998; U.S. EPA-CBP, 1992). A brief review of the nature of physical, biological, and chemical stressors to the environmental integrity of the system based on these and other reports, is provided here. Other important environmental issues have also been identified concerning the Anacostia watershed, including drinking water, land use, public education, community involvement, resource use, funding for environmental programs, and environmental justice; these are not addressed in this review.

2.2.2.1 PHYSICAL AND BIOLOGICAL STRESSORS

Major physical stressors include a persistently high particulate loading to the tidal Anacostia River, particularly during storm events, leading to high turbidity and high rates of sedimentation, both of which seriously impact the viability of submerged biotic communities and potentially contribute to the transport of biological and chemical agents within the watershed. The suspended particulates are reported to originate from storm-related erosion and non-point surface runoff in the upper tributaries and from non-point source runoff (both direct inflow and via stormwater catchments) from impervious surfaces in the tidal Anacostia. The absence of adequately vegetated upland and wetland buffer areas in some areas of the watershed also contributes to the problem of particulate loadings from non-point surface runoff.

Biological stressors in the Anacostia River include fecal coliform (and possibly other pathogens) originating from the repeated and significant influx of untreated sewage to the tidal Anacostia River from outdated combined sewer overflows (CSOs) during storm events. Due in part to the persistent presence of significant levels of fecal coliform bacteria, the tidal Anacostia River is not currently classified as a Class A (primary contact) waterbody under the Clean Water Act system of classification, although it is

slated for future Class A designation, presumably pending successful restoration (GDC, 1994, 1996, 1998). High nutrient loadings to the Anacostia from non-point surface runoff and CSOs also potentially contribute to biological stress by promoting eutrophication, which may lead to dissolved oxygen depletion sufficient to impact water column and benthic biota.

2.2.2.2 CHEMICAL STRESSORS

Numerous reports concur that major pollution issues concerning the Anacostia River watershed include non-point source loadings, combined sewer overflows, high rates of erosion and downstream sedimentation, high nutrient loadings, and chemical contamination of sediments and fish. While each type of stressor may contribute significantly to overall environmental degradation, this screening level risk assessment is concerned primarily with the potential for adverse health effects in human and ecological receptors from exposures to chemicals in the Anacostia River.

Many studies have identified the presence of chemical contaminants in sediment, surface water, or fish (e.g., Banta and Horowitz, 1992; Banta, 1993; Block, 1990 Clark and Crutchley, 1995; Clark and Gower, 1995; Coffin et al., 1998; Coffin et al., 1999; GDC, 1998; Groundwater and Environmental Services, 1998; Gruessner et al., 1997; Harshberger et al., 1997; Haywood and Focazio, 1990; Herson-Jones et al., 1994; Hydro-Terra, Inc., 1989, 1997; Loos, 1999; LTI, 1990; McCabe, 1997; MWCOG, 1986; Montaser, 1997; Phelps, 1985, no date; Phelps and Clark, 1988; Pinkney et al., 1993; Pinkney, 1999; Shepp and Cole, 1993; Shepp and Parikh, 1995; Stribling et al., 1999; U.S. EPA-CBP, 1992; USFWS, 1990, 1994; Velinsky et al., 1992, 1994, 1999; Velinsky and Cummins, 1994, 1996; Wade et al., 1994).

Due to PCB and chlordane concentrations in fish above the FDA action levels of 2.0 and 0.3 ppm, respectively, a fish consumption advisory was first issued in 1989 for the District of Columbia's portion of the Anacostia River (GDC, 1994). The advisory was re-issued in 1994 to discourage consumption of any bottom dwelling fish, specifically catfish, eel, and carp, to recommend strict limits on weekly adult consumption rates of predatory game fish such as largemouth bass, and to identify pregnant women and children as groups particularly at risk from consuming Anacostia River fish (MWCOG, 1998). Using a risk assessment approach, ATSDR (1998) concluded that concentrations of contaminants, particularly PCBs, in fish collected for analysis in 1991 from the Anacostia and Potomac Rivers could pose a public health hazard for sport fishermen.

In spite of the fish advisories, consumption of contaminated fish is potentially a significant route of human exposure to chemicals in the tidal Anacostia river. As an indication of fishing use of District of Columbia waters, including the Anacostia River, the number of fishing licenses sold in the District more than doubled during the years 1988–1997 (GDC, 1998). Two surveys of anglers conducted in the early 1990s indicated that fish caught in the tidal Anacostia River, including species specified in fish advisories, were regularly consumed as a source of food by a substantial proportion of shoreline anglers (McCabe, 1997).

The control of hazardous chemical loadings has been regarded as one of the primary issues of concern in the Anacostia River in recent comprehensive reviews of pollution issues in the Anacostia watershed (ICPRB, 1996; McCabe, 1997).

A comprehensive study of chemical contaminant sources throughout the Anacostia watershed prepared by the District of Columbia identified nonpoint sources as the primary concern, although the study acknowledged that no information concerning groundwater or direct aerial deposition contributions, illicit

dumping or discharge, or CERCLA/Superfund sites was used in the evaluation (Warner et al., 1997). With respect to chemical contaminants in the Anacostia watershed, the source report addressed loadings of petroleum hydrocarbons, lead, and zinc, in particular. Hickey Run was reported to have a history of episodic petroleum hydrocarbon inputs. A plan to trace the specific point sources in Hickey Run is being implemented by MWCOG (Warner et al., 1997). Eighty-five percent of the annual loadings of lead were from CSOs in the tidal Anacostia, while zinc loadings were predominantly from nonpoint sources (Warner et al., 1997). The loadings of arsenic, chromium, and copper and chlordane were also attributed to nonpoint sources, although the study reported that no data concerning CSO loadings were available for these metals. *No other specific chemicals were evaluated in the Warner et al. (1997) source study*. The Interstate Commission on the Potomac River Basin (ICPRB) identified surface runoff, storm and combined sewer discharges, and direct atmospheric deposition as potential sources of hazardous substances detected in sediment sampled in the tidal Anacostia River (Gruessner et al., 1997). Particulates that were aerially deposited on impervious surfaces throughout the watershed are likely to contribute substantially to total chemical loading to the tidal river surface waters via stormwater runoff (ICPRB, 1996; Warner et al., 1997). The relative contribution of direct aerial deposition to total loadings of chemicals to the surface waters of the tidal Anacostia is uncertain (Warner et al., 1997), however, direct deposition estimates based on data collected in the Elms region of the Chesapeake Bay Atmospheric Deposition Study (the nearest region to the District of Columbia) suggest that direct deposition of iron and zinc may be significant (ICPRB, 1996); direct deposition of PCBs, arsenic, cadmium, chromium, copper, nickel, lead, and selenium were also estimated, but were not as high as for iron and zinc.

The total number of other known and unknown potential point sources of chemical contamination to the Anacostia River may be large, as the following official accounting of known facilities and sites illustrates. The Anacostia River Toxics Management Action Plan reported that, as of 1996, approximately 50 sites in the Anacostia River watershed had been or were being investigated under CERCLA (many of which required no further action or were delisted for brownfield development at that time), while the USDA Beltsville Agricultural Research Center was identified as an NPL site under CERCLA (ICPRB, 1996). Within the District of Columbia, there were 939 RCRIS sites and 6 Toxic Release Inventory facilities reported under EPCRA. None of the 32 CERCLIS sites in the District were on the NPL list, but the U.S. EPA had recently proposed that the Washington Navy Yard be added to the list (McCabe, 1997). McDonald et al. (1994) and McDonald (1998) identified the names, locations, and substances of concern for CERCLIS sites in the District, including those in the Anacostia watershed, as well as the locations of permitted air pollution dischargers, permitted water pollution dischargers, major generators of hazardous waste, and leaking underground storage tanks.

The Warner et al. (1997) study concluded that permitted discharges constitute the majority of known point source discharges to the surface waters of Anacostia River tributaries (and identified the locations of facilities holding active NPDES permits). The study indicated that the permitted discharges were estimated to contribute less than 1% of the total loadings of arsenic, chromium, copper, lead, zinc, and chlordane to the watershed as a whole, relative to nonpoint sources and CSOs. Since not all NPDES permits require reporting loadings of these chemicals, the reported loading estimates were likely to somewhat underestimate the actual combined loadings from all NPDES permit-holders. In general, this study was not sufficiently focused on chemical loadings to identify primary chemical sources. The review considered total loading of all types of pollution, evaluated for only a limited number of individual chemicals, and considered loadings from only three types of sources: nonpoint stormwater runoff, CSOs, and permitted industrial and municipal discharges.

2.2.3 ORGANIZATIONS, PROGRAMS, AND ACTIONS RELATED TO ENVIRONMENTAL MANAGEMENT OF THE ANACOSTIA RIVER WATERSHED

A variety of organizations and governmental environmental offices have contributed to restoring the Anacostia River watershed. As of 1995, hundreds of engineering, ecological restoration, education and outreach projects had been completed in the Anacostia watershed during the previous decade, at a total cost of approximately $130 million (MWCOG, 1995). Other initiatives have been implemented since 1995. The following section provides thumbnail sketches, in alphabetical order, of organizations, programs, and specific actions related to environmental management of Anacostia watershed pollution. These sketches were drawn from information in the documents made available for the screening level risk assessment; this section is not intended to be an exhaustive synthesis of the history of environmental management in the Anacostia River watershed.

Anacostia River Toxics Alliance

The Anacostia River Toxics Alliance, a partnership of a number of public and private members, was formed to address problems related to hazardous chemicals in the Anacostia watershed (AWRC, 1999).

Anacostia Watershed Restoration Committee (AWRC)

The Anacostia Watershed Restoration Strategy Agreement was signed in 1984 by the state of Maryland and the District of Columbia (MWCOG, 1986), and was expanded to form the Anacostia Watershed Restoration Committee in 1987, including Prince Georges and Montgomery Counties, as well as the US Army Corps of Engineers , the MWCOG (administrator of the agreement) and the Interstate Commission on the Potomac River Basin (ICPRB) (ICPRB, fall 1994, 1996). The four jurisdictions adopted a Six-Point Action Plan in 1991, the first goal of which was to reduce chemical contaminant loads and improve water quality in the tidal Anacostia (ICPRB, fall 1994; MWCOG, 1991).

A Memorandum of Understanding was signed in 1996 between the Anacostia Watershed Restoration Committee (AWRC) and U.S. EPA Region III to formally underscore that the two parties will jointly cooperate and coordinate in efforts to restore the Anacostia watershed (AWRC, 1996; U.S. EPA, 1996).

In 1996, the AWRC established the Anacostia Watershed Citizens Advisory Committee (AWCAC) to provide a conduit for input from local residents into the watershed restoration effort (AWRC, 1998). In 1997, the AWCAC co-hosted a watershed-wide cleanup event involving over 800 volunteers and planned to hold town meetings across the watershed in 1998 to gain a better understanding of citizen concerns.

The 1998 Anacostia Watershed Restoration Progress and Conditions Report (1990–1997) was issued by the AWRC to provide an update on the progress made toward attaining each of the six restoration goals, including an assessment of the state of knowledge and actions concerning toxics in the Anacostia (MWCOG, 1998).

Government of the District of Columbia (GDC)

A Kingman Lake water quality model using the U.S. EPA Water Quality Analysis Program (version 5.0; WASP5) was developed as a planning level tool for the District of Columbia Environmental Regulation Administration to address Kingman Lake water quality (particularly algal growth and dissolved oxygen) and to evaluate the impacts of alternative proposed restoration methods (Badruzzaman and Nemura, 1993).

In response to a directive from the Executive Council of the U.S. EPA's Chesapeake Bay Program to develop a regional action plan to address toxic chemical issues in the Anacostia River, the District of Columbia organized two stakeholder meetings in 1995 which focused on scoping the vision, and prioritizing goals and objectives for a Toxics Management Action Plan for the Anacostia River (GDC, 1995).

In a 1995 news release, PEPCO announced an agreement with the District of Columbia concerning participation in Anacostia River restoration, specifically, constructing wetlands, enhancing the Anacostia fishery, shore cleanups, planting trees, and education (PEPCO, 1995).

The Anacostia River Toxics Management Action Plan was prepared by the Interstate Commission on the Potomac River Basin (ICPRB) and released by the District of Columbia in 1996 as part of the District's commitment to the U.S. EPA's Chesapeake Bay Program (ICPRB, 1996). The plan summarized the findings of studies as of 1996 that had evaluated contaminant levels in surface water, sediment, and biota, and addressed five major areas of management to reduce the impact of chemical contaminants on human and ecological health: 1) coordination and funding; 2) public awareness; 3) research and monitoring; 4) source control; and 5) sediment remediation. The initial scope of the plan was confined to the District portion of the Anacostia, however, provisions were made for extending the plan into the upper Anacostia watershed in Maryland if ongoing monitoring of the Anacostia tributaries so indicated.

The District of Columbia has repeatedly recommended that efforts to restore the watershed should be undertaken at the watershed level (GDC, 1994, 1998). The District indicated that control of chemical contaminant inputs from upstream sources in Maryland must be implemented in order for the action plan to be a success (GDC, 1998).

A *Special Tributary Strategy for Federal Lands in the District of Columbia* is a cooperative effort by Federal facilities within the District of Columbia to control stormwater runoff and reduce nutrient loadings to District waterbodies, including the Anacostia River (GDC, 1998).

Stream bank restoration of Watts Branch was planned to reduce direct sediment and pollutant runoff from impervious surfaces; a "continuous" monitoring program and a USGS gauging station have also been installed for Watts Branch (GDC, 1998).

The District of Columbia provided specific recommendations for point source and non-point source water pollution control programs (GDC, 1998). One recommendation was to "establish a mechanism to reduce human health and environmental risks from groundwater impacted by past activities" (GDC, 1998).

Interstate Commission on the Potomac River Basin (ICPRB)

The Interstate Commission on the Potomac River Basin (ICPRB) initiated *The Potomac River Watershed Visions Project*, which encompasses a large geographic area, including the Anacostia River watershed, and which was designed, in part, to complement the nutrient reduction strategy for the Potomac River basin developed as part of the U.S. EPA Chesapeake Bay Program (Cummins, 1994).

Metropolitan Washington Council of Governments (MWCOG)

MWCOG is an independent, non-profit regional organization comprised of representatives from 17 local governments in the Washington, DC area, as well as members from the Maryland and Virginia legislatures and the U.S. Senate and House of Representatives.

In a 1995 report, a six-part Anacostia Special Study was described that had the goal of developing a Comprehensive Restoration Plan for the Anacostia watershed (MWCOG, 1995). Projects contributing to the Comprehensive Restoration Plan that were related to chemical assessment included an Existing Source Assessment, Long-Term Monitoring Plan, and Water Quality Report.

Maryland-National Capital Park and Planning Commission (M-NCPPC)
As of 1992, watershed development was reported to have progressed for 28 years according to a plan developed by the M-NCPPC to direct growth of commercial, industrial, and heavy residential land uses to transportation corridors, and maintain low intensity use areas (such as parks, recreation centers, reserved open spaces, and low density residential housing) as buffer zones between the heavy use areas. In addition, parklands were maintained to buffer streams in the watershed from heavily urbanized, high-intensity use areas (U.S. EPA-CBP, 1992).

United States Army Corps of Engineers (USACE)
Since 1961, the Anacostia River has been periodically dredged by the USACE, and dredged materials have been used to build Children's Island, the National Arboretum, the Kenilworth Aquatic Gardens, and riverside parkland (GDC, 1994). Dredging from the Conrail Bridge to the Bladensburg Marina was implemented in 1992, and dredged materials from this effort were used to restore Kenilworth Marsh tidal emergent wetlands. It has been hypothesized that dredging may have diluted the concentration of contaminants in the surface sediment by introducing significant quantities of *cleaner* sediments from dredge depths of up to six feet (GDC, 1994).

Kenilworth Marsh restoration was linked to a nearby dredging operation in the Anacostia River by the USACE and was completed in 1993, doubling the size of the original planned restoration area (AWRC, 1998). Collaborative efforts were planned between the District of Columbia and the USACE to develop further wetlands in the Kingman Lake area and riparian wetlands on the Anacostia (GDC, 1994, 1998).

In accordance with the 1994 Agreement of Federal Agencies on Ecosystem Management in the Chesapeake Bay, the USACE developed a Biennial Federal Work Plan for the Anacostia River Watershed in 1996 that identified federal agencies with facilities in the watershed, outlined the roles that the agencies were currently taking toward achieving the goals of the AWRC six-point action plan for the watershed, and suggested further assistance that they could provide (USACE, 1996).

United States Environmental Protection Agency - Region III
An *Inventory of EPA Region III Activities/Initiatives in Support of Anacostia Improvement Goals* was compiled in 1994 that included several activities regarding chemical issues in the watershed, including site inspections of potential sources of chemical contamination in the watershed (U.S. EPA [Initiatives], 1997).

The U.S. EPA Region III Anacostia Ecosystem Initiative was initiated in 1994 to work toward attaining the following six objectives: target existing U.S. EPA programs in the watershed; control combined sewer overflows and stormwater; public education and outreach; build federal sector support for watershed restoration; reduce environmental and human health risks; and support community-based environmental justice initiatives (U.S. EPA, 1998).

A 1998 update report on the U.S. EPA Region III Anacostia Ecosystem Initiative indicated that the U.S. EPA had required removal of the sediment from sewers in the Southeast Federal Center as part of a NPDES permit issued to the General Services Administration because of high levels of PCBs and heavy

metals found in the sewers by the U.S. EPA (U.S. EPA, 1998). The report also indicated that the U.S. EPA proposed that the Washington Navy Yard become an NPL site, and that the Navy had been ordered to begin cleanup of contaminated soil, surface water, and groundwater at the Naval Surface Warfare Center on Paint Branch in the Anacostia watershed.

2.2.4 PROGRAMS AND STUDIES INITIATED TO GATHER DATA CONCERNING CHEMICAL STRESSORS IN THE ANACOSTIA WATERSHED.

A comprehensive review of studies conducted to measure chemical contamination levels in various tidal Anacostia media is provided in the problem assessment section of *The Anacostia River Toxics Management Action Plan* (ICPRB, 1996). Some of these studies were available for the screening level risk assessment. The following are brief summaries of studies and sampling programs described in reports that were available for the screening level risk assessment and that have contributed to the overall information base concerning chemical contamination levels and toxic effects to biota in the Anacostia watershed. The studies are organized alphabetically by the organization or program that either sponsored or conducted the study.

East Station Project.
Biota, Soil, and Groundwater. Habitat quality and benthic community structure were evaluated at six sampling locations in 1988 in the lower Anacostia in the vicinity of the 12th Street Bridge and the Navy Yard as a part of the East Station Contamination Study (Hydro-Terra, Inc., 1989); the study concluded that the area was significantly impacted. An attachment to the Hydro-Terra, Inc. (1989) report indicated that PAHs and PCBs were detected in the surface soil between the 12th Street perimeter fence and a retaining wall below, identified elevated sediment PAH concentrations related to a groundwater contamination plume in the fill behind the seawall that was being monitored by on-shore shallow wells, and identified low concentrations of benzene, toluene, ethylbenzene and xylenes in the water collected from the 12th Street sewer, but concluded that the sewer contamination probably did not significantly impact Anacostia River water quality.

Surface Water and Sediment. Hydro-Terra, Inc. (1997) reported analytical data, but no interpretation, of a 1996 surface water and sediment sampling effort just north of the 12th Street Bridge on the west shore of the Anacostia River. Data from this study are included in the database used for the screening level human health risk assessment; see Section 5 - *Existing Data Summary/Compilation*.

Government of the District of Columbia (GDC)
Surface Water and Biota. The District of Columbia's Water Management Division of the Department of Consumer and Regulatory Affairs, Environmental Regulation Administration, has prepared a series of reports to the U.S. EPA and the U.S. Congress concerning water quality information for the District of Columbia's surface and ground waters as required under Section 305(b) of the federal Clean Water Act (GDC, 1994, 1996, 1998).

In 1997, an existing fixed station water monitoring program (for evaluating physical/chemical water quality parameters, heavy metals, and pathogen analysis) was revised to include 12 Anacostia River stations, 3 stations in Watts Branch, 2 stations in Kingman Lake, and 1 station in Kenilworth Marsh (GDC, 1998). In addition, the District developed a tributary monitoring program in 1995 for monitoring smaller tributaries for periodic standard water quality parameters and biological/habitat assessments. In 1997, the tributary monitoring program was implemented to periodically gather data concerning stream hydrology, morphological conditions, and types of organisms living in the streams.

The Steuart Petroleum Company, in cooperation with the District of Columbia and the National Park Service, developed a monitoring study to evaluate the residual effects of an oil release that occurred in 1992 into the Anacostia River (Pinkney et al., 1993). Based on compositional analysis, they concluded that the spilled fuel oil was not a significant source of total petroleum hydrocarbons and/or PAHs that were detected in surface water, sediment, and fish nearby in the Anacostia River (Pinkney et al., 1993).

Groundwater. Approximately 325 sites have been identified in the District of Columbia as having confirmed groundwater contamination (GDC, 1998); the proportion that lie within the Anacostia watershed and the identity of the chemical contaminants were not reported. Sources and sites of groundwater contamination in District of Columbia waters were under investigation as of 1994, and were to be compiled into the *District of Columbia's Sources of Potential Ground Water Contamination Inventory* (GDC, 1994).

The District of Columbia conducted a study of contaminant levels in groundwater samples collected during a single sampling event in July, 1996, from one monitoring well in each of the two Kenilworth Landfills on opposite banks of the Anacostia (Montaser, 1997). One of the landfills was capped with soil and is now the Kenilworth Park. The report indicated that low levels of cadmium, copper, iron, lead, and zinc were detected in one or both wells, and that no pesticides, PCBs, or mercury were detected in the sampled groundwater.

Biota. A series of studies was supported by the District of Columbia and the National Park Service to investigate benthic macroinvertebrates in the Anacostia River. In 1984 survey, no live macrobenthic animals of any type were found upriver of the Pennsylvania Avenue bridge in the tidal Anacostia (Phelps, 1985). A related study reported reduced gonadal mass and severely impeded spawning in clams introduced to the lower Anacostia in an *in situ* bioassay conducted in 1986 (Phelps, no date), but a study on the toxic effects of Kenilworth Marsh sediments to clams was inconclusive (Phelps and Clark, 1988).

In the early 1990s, the District of Columbia's Water Hygiene Branch developed a program to monitor the health of District streams using rapid bioassessment of habitat quality and biological water quality, including 11 sites within the Anacostia River watershed (Banta and Horowitz, 1992; Banta, 1993).

Interstate Commission on the Potomac River Basin (ICPRB)

Surface Water. A 1990 report from the ICPRB presented data from two sampling locations in the Anacostia River in a 1986–1987 water quality survey of standard physical/chemical water quality parameters and several heavy metals (Haywood and Focazio, 1990); the report did not provide an interpretation of the results.

A year-long surface water monitoring project was undertaken during 1995–1996 by the ICPRB to evaluate chemical loadings from the Northeast and Northwest Branches to the tidal Anacostia River (Gruessner et al., 1997). Surface water samples and concurrent flow data were collected throughout the year under both storm and non-storm conditions. Various metals, PCBs, PAHs, and organochlorine pesticides were detected in the particulate phase of the samples, and the report concluded that the large amount of suspended matter transported into the tidal Anacostia from both branches may constitute a significant transport mechanism for these chemical contaminants from upstream sources to the tidal Anacostia.

Sediment and Biota. In an October 1989 study performed for the ICPRB, Limno-Tech, Inc. (LTI, 1990) sampled surface sediments (top six inches) throughout the District of Columbia area of the Potomac River Basin, including throughout the tidal Anacostia, Kingman Lake, Watts Branch, and Hickey Run. Samples were analyzed for U.S. EPA's list of priority pollutants and detections for over 60 chemicals on the list were reported. The highest contaminant levels and the greatest numbers of detected priority pollutants were found between the Benning Road Bridge and the South Capital Street Bridge of the Anacostia River. Contaminant concentrations were compared to U.S. EPA Great Lakes Sediment Guidelines, and the greatest frequencies of exceedance in the tidal Anacostia River were reported to be in the organochlorine pesticide/PCB and metals classes of chemicals (LTI, 1990).

During the 1990s, the ICPRB, in cooperation with the District of Columbia and other interested governmental offices and private organizations, conducted a series of studies and prepared several reports concerning chemical contaminants in fish and sediments in District waters, including the tidal Anacostia River.

In June, 1991, sediments were sampled throughout the major District of Columbia waterways, including six stations in the lower Anacostia River south of the Pennsylvania Avenue Bridge, and five stations throughout Kingman Lake, and then analyzed for levels of PAHs, PCBs, pesticides, and metals (Velinsky et al., 1992). Some of the sampling stations were situated in the river proximal to sewer outfalls, and sediment samples were also taken at the outfalls and further up inside the sewers themselves to ascertain whether sewers were sources of river sediment contamination. Lead, cadmium, mercury, PAHs, PCBs, and total DDT were detected in several places, such as near the Washington Navy Yard. Sediment toxicity tests in amphipods and macroinvertebrate community analysis also indicated a severe degree of biological impairment in the lower Anacostia River. The study concluded that sewers were a major source of chemical contamination in the Anacostia River, and that the lower Anacostia River was the area of greatest concern within the waters of the District of Columbia. The study also provided a history of other earlier sampling efforts to evaluate the nature and extent of chemical contamination in several media in District of Columbia waters. Data from the Velinsky et al. (1992) study are included in the database used for the screening level human health risk assessment; see Section 5 - *Existing Data Summary/Compilation*.

In a re-analysis of the Velinsky et al. (1992) data, Wade et al. (1994) and Velinsky et al. (1994) concluded that decreasing concentration gradients between sewer, outfall, and river sediment samples, particularly near the Washington Navy Yard, suggest that urban runoff may be a major non-point source of metals, hydrocarbon (e.g., PAHs), PCB, and DDT contamination to Anacostia River sediments. They also reported that for certain contaminants, like PAHs, the outfall sediment concentrations indicate diffuse distributions, while for other contaminants such as PCBs, the distributions suggest that specific outfalls may be major contributors (Wade et al., 1994).

A 1994 study conducted by the District of Columbia and reported by the ICPRB evaluated 129 U.S. EPA priority pollutants as well as separate analyses for PCBs and PAHs in tissues of fish collected from 1989 to 1992 throughout the major District of Columbia waterways, including 18 samples collected in the tidal Anacostia river below the New York Avenue bridge (Cummins and Velinsky, 1993; Velinsky and Cummins, 1994). Metals detected most often in the edible portions of the fish were arsenic, selenium, and mercury, while total PCBs, organochlorine pesticides, and certain PAHs were found in highest concentrations in the American eel and channel catfish. A potential for an excess cancer risk greater than 10^{-4} to 10^{-3} from consumption of total PCBs or chlordane in fish was estimated. FDA action levels

for total PCBs and chlordane were exceeded in 4 and 1 fish samples, respectively, that were collected from District waters.

A follow-up 1996 study by the District of Columbia and ICPRB evaluated 129 U.S. EPA priority pollutants as in addition to PCBs and PAHs in tissues of fish collected throughout the major District of Columbia waterways, including from the upper tidal Anacostia River (New York Avenue Bridge to the CSX railroad bridge near the south end of Kingman Lake) in 1994, from Kenilworth Marsh in 1993, and from the lower tidal Anacostia River (the CSX railroad bridge near the south end of Kingman Lake to the confluence with the Potomac River) in 1993 (Velinsky and Cummins, 1996). Samples were composited apparently by sampling location, sampling event, and species. Detectable levels of many chemicals were in the edible portions of the sampled fish, with the highest levels of metals found in predatory fish such as the sunfish and largemouth bass. The highest levels of bioaccumulative organics (such as PCBs, PAHs, and chlordane) were found in the channel catfish and common carp from the lower Anacostia. The study concluded that levels of certain contaminants in fish may pose a health risk to people who consume the fish. Data from the Cummins and Velinsky (1993) and Velinsky and Cummins (1994, 1996) studies are included in the database used for the screening level human health risk assessment; see Section 5 - *Existing Data Summary/Compilation*. Velinsky and Cummins, (1994, 1996) regarded the data from both studies as inadequate for detecting geographic or temporal trends in contaminant levels in fish.

Metropolitan Washington Council of Governments (MWCOG)

Surface Water and Biota. A Coordinated Anacostia Monitoring Program (CAMP) was organized in 1984 between the District of Columbia, the state of Maryland, Prince Georges County, and Montgomery County and other interested governmental offices to provide for bimonthly, same-day surface water sampling at a network of 46 sites throughout the Anacostia watershed, most of which are in the tidal Anacostia River (U.S. EPA-CBP, 1992). The District of Columbia maintained 9 other water quality stations as of 1992, in addition to those monitoring stations maintained for CAMP. The MWCOG coordinates sampling activities, compiles data from the CAMP into computerized databases, and develops annual reports on water quality condition in the watershed (U.S. EPA-CBP, 1992).

In 1986, the water quality data from sampling locations throughout the Anacostia River watershed were compiled from records of sampling events from the early 1980s provided by Montgomery County, Prince Georges County, District of Columbia, and the state of Maryland (MWCOG, 1986). In addition to standard general water quality parameters and assessments of biological resources, data concerning concentrations of metals and pesticides in surface water and in fish were summarized. Some information regarding dredging events by the USACE was also provided.

A 1994 Anacostia Watershed Water Quality Report on conditions in the watershed during 1987–1990 was produced by the MWCOG as part of the broader Comprehensive Restoration Plan and provided standard water quality and biological assessment data in the tidal river, tidal tributaries, and upper tributaries (Herson-Jones et al., 1994). The investigators divided the tidal Anacostia into segments based on physiography and locations of tributary and CSO inputs to the system. In a spatial re-analysis of Velinsky et al. (1992) sediment contamination data of the tidal Anacostia below Kingman Lake, Herson-Jones et al. (1994) found a peak in concentrations of cadmium, mercury, lead, zinc, DDT, and PCBs, immediately downstream of the Navy Yard . The report identified the Navy Yard, the Bureau of Engraving and Printing, the old Lionel freight yard and the U.S. Botanical Gardens as potential sources of the down river contamination; whereas, the spatial profile for chlordane was attributed to a possible source within or upstream of Kingman Lake.

In recognition of repeated oil releases to Hickey Run, the MWCOG initiated a comprehensive pollution abatement study in 1993, which included a detailed map of storm drains in the catchment area and plan to develop a hydrocarbon spill storm drain tracing system to identify the locations of petroleum sources (Shepp and Cole, 1993; Shepp and Parikh, 1995). The report indicated that previous investigations had identified METRO, AMTRAK and the Greyhound Bus Company as likely contributors based on oil fingerprinting but that there were also a large number of smaller potential contributors (GDC, 1998; Shepp and Parikh, 1995).

PEPCO

Surface Water. In an experiment conducted from 1995–1997 during a PEPCO construction project, concentrations of certain contaminants, including chlordane and some metals, appeared to be elevated in the water column during and after dredging operations compared to pre-dredging levels, but dredging did not appear to affect concentrations of PCBs, chlordane, or metals (the only analytes tested) in the sediment (Loos, 1999). Data from the Loos (1999) study are included in the database used for the screening level human health risk assessment; see Section 5 - *Existing Data Summary/Compilation*.

Prince Georges County

Surface Water and Biota. A comprehensive biological assessment was conducted in the spring of 1999 in streams and watersheds of Prince Georges County, MD, including those in the Anacostia River watershed, as the initial event in a 5-year periodical assessment plan (Stribling et al., 1999). The assessment rated 11 of the 12 randomly selected sites in the Anacostia River watershed as poor or very poor regarding the capacity to support aquatic life, and all three targeted sites in Lower Beaverdam Creek were rated as very poor (using ratings of good, fair, poor, and very poor).

United States Army Corps of Engineers (USACE)

Sediment. The USACE, Baltimore District, sponsored a study of physical and chemical analyses of sediment collected at 3 depths (0–1, 1–5, and 5–9 feet) from four sampling locations in the Anacostia River in the river reach that parallels Kingman Lake (Groundwater and Environmental Services, 1998). The study identified numerous semivolatiles, pesticides/PCBs, and metals in sediments that were characterized as dark gray-brown silt with some fine-grained sand and little clay.

United States Environmental Protection Agency

Surface Water. In 1997, the U.S. EPA conducted a comprehensive *Environmental Characterization of the District of Columbia* that reviewed and summarized existing information from both human health and ecological perspectives (McCabe, 1997). The report characterizes sources of pollution to air and surface water. Data gaps in the current knowledge concerning human health issues related to exposures to toxic chemicals were identified by the U.S. EPA, and included the need for a regional perspective on the dynamics of pollutant migration from surrounding counties and the District, and the need for data on human activity patterns including fishing, swimming, and wading.

U.S. EPA Region III funded a study of the effects of stormwater runoff on the water quality of the Anacostia River, which concluded that the non-tidal watershed contributes significant loadings of chemical contaminants to the upper tidal Anacostia waters within 24 hours of significant rainfalls, while urban runoff is the primary source of contaminants in the lower tidal Anacostia River (Velinsky et al., 1999). Data from the Velinsky et al. (1999) study are included in the database used for the screening level human health risk assessment; see Section 5 - *Existing Data Summary/Compilation*.

Sediment. In 1995, as part of the overall U.S. EPA Region III Anacostia River Initiative, the Annapolis Operations Section of Region III performed a special sampling investigation of contaminant levels in residue/sediment within the major storm sewer systems that drain the Washington Navy Yard (Clark and Crutchley, 1995). Heavy metals (particularly zinc, lead, copper, nickel, chromium, and mercury) and PCBs were detected in solid residues collected from storm sewers that drain the Washington Navy Yard, and heavy metals were detected in one adjacent District of Columbia municipal storm sewer. The report concluded that it was not possible to tell whether contaminants were deposited from ongoing contaminant releases or from historical releases, and advised that the Navy Yard should vacuum out the solids currently in the sewers and monitor new deposits for contaminants to see whether release is on-going. The report indicated that specific Navy Yard buildings were identified that are good candidates for further PCB source investigation.

Clark and Gower (1995) compared the findings of Clark and Crutchley (1995), who sampled deposits within sewers that drain the WNY, to those of Velinsky et al. (1992), who sampled sediments in the riverbed in the lowermost 4-mile reach of the tidal Anacostia River. A sample that had a PCB concentration of 227 ppm was obtained from one of the Navy Yard's storm sewers. However, neither the Navy Yard nor the adjacent Southeast Federal Center reported any PCB transformers or other electrical equipment containing PCBs. Several Anacostia River bottom sediment samples showed PCB concentrations greater than the U.S. EPA Sediment Quality Guideline for PCBs; the furthest upstream exceedance occurred at the Pennsylvania Avenue Bridge. Based on a comparison of sediment contaminant levels to the respective U.S. EPA sediment quality guidelines, Clark and Gower (1995) concluded that the contaminants of greatest concern in the lower Anacostia are lead, nickel, silver, zinc, and PCBs, with exceedances ranging from 2 to 5 times the guideline. They also concluded that it was unclear whether PCB contamination was from past releases or from continued stormwater runoff.

United States Fish and Wildlife Service (USFWS)

Sediment and Biota. Surveys conducted in 1992 and 1996 found that liver and integumentary tumors were prevalent in brown bullhead populations of the Anacostia River in 55% and 23% of fish sampled, respectively (Harshberger et al., 1997; Pinkney, 1999). The Pinkney (1999) report noted that the prevalence of these tumors in Anacostia River fish was comparable to those observed at sites in the Great Lakes region; a follow-up analysis was underway to examine possible associations between tumor prevalence and chemical contamination. An earlier study in 1987 surveyed contaminant concentrations and incidence of lesions in channel catfish and largemouth bass in District of Columbia waters, including the tidal Anacostia River; the highest concentrations of chlordane and DDT were obtained in the lower Anacostia, and the incidence of total gross lesions and non-parasitic lesions was statistically significantly greater at two sampling sites in the Anacostia compared to a reference site located at Fletcher's Boat House on the Potomac River, upstream of the Anacostia River confluence (Block, 1990). Data from the Block (1990) study are included in the database used for the screening level human health risk assessment; see Section 5 - *Existing Data Summary/Compilation*.

Results from a 96-hour pore water bioassay and a 10-day sediment bioassay indicated that sediment sampled in August of 1993 from Kingman Lake and from the Anacostia River near Kingman Lake was not acutely toxic to the amphipod *Hyalella azteca* (USFWS, 1994, 1997).

Dredged Anacostia River sediment that was used to restore Kenilworth Marsh was sampled shortly after placement at the marsh in 1993, and both sediment solids and sediment pore water were evaluated for contaminant concentrations; analytical data were provided in a 1997 data report (USFWS, 1997). A 1998 report prepared by the U.S. Fish and Wildlife Service found elevated levels of chromium, copper, lead,

nickel, total PCBs, total DDT, and total chlordane in sediments, killifish, and/or cattails in Kenilworth Marsh compared to a regional reference location and to national averages, and indicated that the observed levels were associated with adverse effects in fish-eating wildlife (Murphy et al., 1998). The report attributed the contamination to the use of dredged Anacostia River sediments that were used restore the marsh, and recommended that future use of dredge sediments from the Anacostia for wetland restoration should be evaluated on a case-by-case basis (Murphy et al., 1998). Data from both the USFWS (1997) and Murphy et al. (1998) studies are included in the database used for the screening level human health risk assessment; see Section 5 - *Existing Data Summary/Compilation*.

United States Navy

Surface Water and Sediment. A Navy Research Program entitled *Contaminant Distribution and Fate in Anacostia River Sediment* was funded by the Environmental Regulatory Coordinator of the Washington Naval Base and performed by the Naval Research Laboratory. A particulate transport survey that evaluated sediment transport mechanisms within the tidal Anacostia River (Coffin et al., 1998) and an extension study concerning the fate and transport of PAHs and metals in the tidal Anacostia (Coffin et al., 1999) were funded under this program.

Coffin et al. (1998, 1999) attributed thermal stratification observed during June 1997 through February 1998 in the center of the lower Anacostia River (between the Washington Naval Yard and the Pennsylvania Avenue Bridge) to tidal circulation, which may periodically move cooler Potomac River water into the lower surface water stratum of the lower Anacostia River. Stratification was observed to be greatest during flooding tides at these locations. However, no thermal stratification was seen either at the mouth of the Anacostia River or upstream of the Pennsylvania Avenue Bridge. The hypothesis that tidal circulation may resuspend and transport Potomac River sediments that are proximal to the Anacostia River mouth into the lower Anacostia River has not been studied. However, Coffin et al. (1999) hypothesized that temperature stratification in the lower Anacostia River may indicate tidal upflow of colder Potomac River water, which may increase upriver transport of TSS. Coffin et al. (1999) observed that flow direction at the Pennsylvania Avenue Bridge and in front of the Washington Navy Yard was dependent on the tidal cycle, based on four 3-day measurement events during the period between June 1997 and June 1998.

Coffin et al. (1999) observed both geographical and seasonal variation occurred in TSS in the Anacostia River during the period June 1997 through May 1998. TSS in the tidal Anacostia River increased with distance from the confluence of the Potomac River at sampling locations up to the Bladensburg Marina, and TSS concentrations were most consistently low in November and consistently high in February, while TSS in May and June showed relatively high variability. Coffin et al. (1999) suggested that relatively low TSS concentrations at the Washington Navy Yard may be due to greater sedimentation occurring at that location, due to lower current velocities. They hypothesized that the upper tidal region of the Anacostia was a source of TSS-associated PAHs to the lower Anacostia, based on observations of higher TSS levels in the upper tidal Anacostia than in lower reaches.

Coffin et al. (1999) hypothesized that reduced current velocity in front of the Washington Navy Yard may indicate that enhanced sediment deposition could occur at that point, based on the observation that mean current velocity at the Pennsylvania Avenue Bridge, as measured using Acoustic Doppler Current Profiles (ADCP), was consistently greater at several measurement depths than in front of the Navy Yard. Measurements using a hand-held velocity meter (calibrated to the ADCP readings) also indicated statistically significantly reduced mean current velocities in the Anacostia River in front of the Washington Navy Yard over the period June 1997 through February 1998, compared to readings obtained at the

confluence with the Potomac River, at the Pennsylvania Avenue Bridge, and at the Benning Road Bridge (Coffin et al., 1999). Sediment deposition measured by sediment traps at the Washington Navy Yard was reportedly similar to values from the upper tidal Anacostia, although supporting data were not provided (Coffin et al., 1999).

Coffin et al. (1999) also hypothesized that temperature stratification observed in the lower Anacostia River from June 1997 through February 1998 may indicate tidal upflow of colder Potomac River water, which may in turn affect TSS deposition in certain (unspecified) areas.

PAH concentration in solids obtained in sediment traps near the Washington Navy Yard was greater than or equivalent to concentrations either at the confluence with the Potomac River, or PAH concentrations measured in deposited solids at locations upstream of the Navy Yard (Coffin et al., 1999).

Coffin et al. (1999) recommended dye tracer studies to analyze tidal excursions in various segments of the river, Beryllium tracer studies to determine sedimentation rates over the short term, microbial degradation studies of PAHs, immunological toxicity assays of PAHs in the river, and stable carbon isotope analyses to fingerprint PAH sources throughout the tidal and nontidal Anacostia River.

2.2.5 ITEMIZED SUMMARY OF INFORMATION ON POTENTIAL SOURCES OF CHEMICAL STRESSORS IN THE ANACOSTIA WATERSHED AND DATA GAPS RELEVANT TO PREDICTING RISK FROM CHEMICAL EXPOSURES IN THE TIDAL ANACOSTIA RIVER

Potential Sources. Identifying point sources of chemical contamination and the nature and magnitude of chemical releases from those sources is informative for estimating current and potential future human exposures, and is necessary for remediation planning if unacceptable risks are associated with the predicted exposures. However, the identity of a point source from the perspective of exposure modeling may differ from the corresponding point source considered for remediation. For instance, a specific stormwater sewer or CSO outfall, or tributary confluence, may constitute a point source of chemical contaminants to the tidal Anacostia (e.g., Velinsky et al., 1992, 1994; Wade et al., 1994), when considered from the perspective of modeling contaminant transport within the tidal river proper. Whereas, identifying the specific location of the ultimate source of the PCBs within the sewer or tributary's drainage area would be important from the perspective of remediation. Information concerning sources of chemical contamination that was collected from documents available for the screening risk assessment is presented below.

- Current point sources of ongoing chemical release to the tidal river may include pockets of contamination in groundwater, soil, or other below-ground sources such as underground storage tanks or landfill material, that may have been deposited by past activities. Certain documents that were available for the screening risk assessment identify some of the potential sources of groundwater contamination (GDC, 1994, 1996, 1998).

- Approximately 325 sites have been identified in the District of Columbia as having confirmed groundwater contamination (GDC, 1998); the proportion that lie within the Anacostia watershed was not reported. Sources and sites of groundwater contamination in District of Columbia waters were under investigation as of 1994, and were to be compiled into the *District of Columbia's Sources of Potential Ground Water Contamination Inventory* (GDC, 1994). Some work has been initiated to study groundwater dynamics in the District of Columbia (GDC, 1994). A comprehensive District of Columbia *Groundwater Resource Assessment Study* was prepared in 1994, but was not available

for the screening risk assessment. Available information indicates that groundwater generally flows toward the surface water bodies in the Anacostia watershed, except in the lower reaches of the tidal Anacostia, where tidal action causes an interchange of groundwater and surface water in both directions (GDC, 1994). The adequacy of the reported data for constructing a groundwater-surface water hydrodynamic model of the tidal Anacostia could not be evaluated since the studies themselves were not available for the screening risk assessment.

- McCabe (1997) identified 7 facilities in the District that had active permits, as of 1997, to discharge wastewater directly into the surface waters of the tidal Anacostia. Chemicals permitted for discharge at these facilities included oil and grease, chromium, zinc, copper, lead, cadmium, silver, and mercury. The identity and locations of facilities with NPDES permits throughout the Anacostia watershed are provided in Warner et al. (1997).

- The total number of other known and unknown potential point sources of chemical contamination to the Anacostia River may be large, as the following official accounting of known facilities and sites illustrates. The Anacostia River Toxics Management Action Plan reported that, as of 1996, approximately 50 sites in the Anacostia River watershed had been or were being investigated under CERCLA (many of which required no further action or were delisted for brownfield development at that time), while the USDA Beltsville Agricultural Research Center was identified as an NPL site under CERCLA (ICPRB, 1996). Within the District of Columbia, there were 939 RCRIS sites and 6 Toxic Release Inventory facilities reported under EPCRA. None of the 32 CERCLIS sites in the District were on the NPL list, but the U.S. EPA had recently proposed that the Washington Navy Yard be added to the list (McCabe, 1997). McDonald et al. (1994) and McDonald (1998) identified the names, locations, and substances of concern for CERCLIS sites in the District, including those in the Anacostia watershed, as well as the locations of permitted air pollution dischargers, permitted water pollution dischargers, major generators of hazardous waste, and leaking underground storage tanks.

- Annual loadings of selected metals, PAHs, pesticides, and PCBs (both particulate and dissolved) from the Northeast and Northwest Branches to the tidal Anacostia river were estimated using mean measured concentrations (measured during both storm and non-storm conditions) and mean annual flow rates from USGS stations (Gruessner et al., 1997).

- A comprehensive study of chemical contaminant sources throughout the Anacostia watershed prepared by the District of Columbia identified nonpoint sources as the primary concern, although the study acknowledged that no information concerning groundwater contributions was used in the evaluation (Warner et al., 1997). With respect to chemical contaminants in the Anacostia watershed, the source report addressed loadings of petroleum hydrocarbons, lead, and zinc, in particular. Hickey Run was reported to have a history of episodic petroleum hydrocarbon inputs. A plan to trace the specific point sources in Hickey Run is being implemented by MWCOG (Warner et al., 1997). Eighty-five percent of the annual loadings of lead were reported to be from CSOs in the tidal Anacostia, while zinc loadings were predominantly from nonpoint sources (Warner et al., 1997). The loadings of arsenic, chromium, and copper were also attributed to nonpoint sources, although the study reported that no data concerning CSO loadings were available for these metals; no other chemicals were evaluated in the source study (Warner et al., 1997). Warner et al. (1997) concluded that permitted discharges constitute the majority of known point source discharges to the surface waters of Anacostia River tributaries (and identified the locations of facilities holding active NPDES permits),

but that the permitted discharges were estimated to contribute less than 1% of the total loadings to the watershed as a whole, relative to nonpoint sources and CSOs

- The Interstate Commission on the Potomac River Basin (ICPRB) identified surface runoff, storm and combined sewer discharges, and direct atmospheric deposition as potential sources of hazardous substances detected in sediment sampled in the tidal Anacostia River (Gruessner et al., 1997).

- Velinsky et al. (1992) concluded that sewers were a major source of chemical contamination in the Anacostia River, and that the lower Anacostia River was the area of greatest concern within the waters of the District of Columbia. The study also provided a history of other earlier sampling efforts to evaluate the nature and extent of chemical contamination in several media in District of Columbia waters. Several documents identify locations of stormwater sewer outfalls and CSOs in the lower tidal Anacostia River (Clark and Crutchley, 1995; Clark and Gower, 1995; Velinsky et al., 1992, 1994; Wade et al., 1994).

- In a spatial re-analysis of Velinsky et al. (1992) sediment contamination data of the tidal Anacostia below Kingman Lake, Herson-Jones et al. (1994) found a peak in concentrations of cadmium, mercury, lead, zinc, DDT, and PCBs, immediately downstream of the Navy Yard . The report identified the Navy Yard, the Bureau of Engraving and Printing, the old Lionel freight yard and the U.S. Botanical Gardens as potential sources of the down river contamination; whereas, the spatial profile for chlordane was attributed to a possible source within or upstream of Kingman Lake.

- Repeated oil releases have occurred to Hickey Run, according to the MWCOG, which initiated a comprehensive pollution abatement study in 1993. The study included a detailed map of storm drains in the catchment area and plan to develop a hydrocarbon spill storm drain tracing system to identify the locations of petroleum sources (Shepp and Cole, 1993; Shepp and Parikh, 1995). The report indicated that previous investigations had identified METRO, AMTRAK and the Greyhound Bus Company as likely contributors based on oil fingerprinting but that there were also a large number of smaller potential contributors (GDC, 1998; Shepp and Parikh, 1995).

Data Gaps. In general, data concerning chemical loadings from sources, chemical concentrations in various media, chemical transformation, and chemical transport processes have been collected over the course of several decades and throughout the Anacostia River watershed, and as such comprise a spatio-temporal patchwork picture of chemical contamination in the tidal Anacostia. In addition, analytical methods and target analytes differed between studies. However, the tidal Anacostia is a complex, dynamic system. Data have not been collected and analyzed in a coordinated manner in order to develop a comprehensive understanding of chemical contamination sufficient for quantifying current human exposures to various media, or for predicting future human exposures or future contamination conditions under various remediation scenarios. Some specific data gaps are discussed in Section 8.

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3. HYDRODYNAMIC PROCESSES/CHARACTERISTICS OF THE RIVER AND WATERSHED

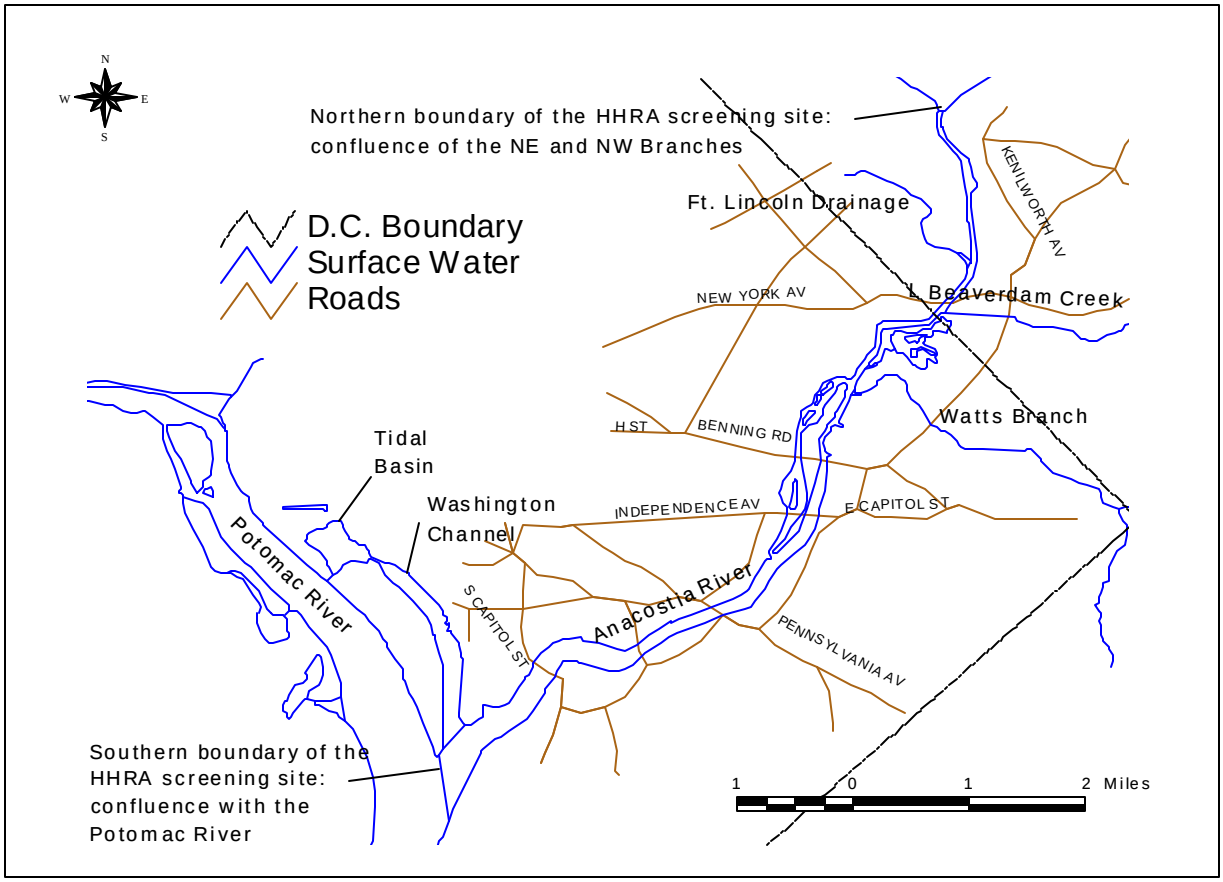
Understanding hydrodynamic processes and characteristics of the Anacostia River and its watershed is the one of the first steps in identifying contaminant fate and transport information and general water quality. Hydrodynamics and water quality of a river are influenced by the characteristics of the river itself, as well as characteristics of the surrounding watershed. Processes include the effects of tides and the incursion of water from the Potomac River, river flow and velocity, inflows from tributaries, CSOs, NYPDES outfalls, and others, and storm responses (Section 3.1). General water quality characteristics and dynamics of the river can indicate impacts of land uses in the watershed (Section 3.2). In addition, water quality characteristics such as pH and dissolved oxygen can participate in metal cycling and the transport of organic compounds in aquatic systems (Allen, 1995; Schwarzenbach et al., 1993; Stumm and Morgan, 1981). An understanding of the watershed can be used to identify sources of loading observed in tributaries. In each of the subsections below, the data are reviewed in the context of a conceptual model of the river.

3.1 HYDRODYNAMIC CHARACTERISTICS OF THE RIVER

The tidal reach of the Anacostia River (the tidal Anacostia River) is bounded by the Northeast and Northwest Branches upstream, and the confluence with the Potomac River, 8.4 miles downstream (see Figure 3-1). Hydrodynamic characteristics of the river are an important component of a constituent transport model. Development of a hydrodynamic submodel requires understanding flow sources in the watershed. Investigations have been performed to support development of a hydrodynamic model, as discussed throughout this section. Flow, TSS and constituent data provide information for evaluation of mass transport.

The Anacostia River is freshwater with an average diurnal tidal amplitude of 3 feet (Warner et al., 1997). Tidal transport of sediment, including particulate bound contaminants in the Anacostia River would be expected to have cyclical directional fluctuations corresponding to the tide movement. On a broad scale, tides affect sediment dispersion in rivers. However, on a short time scale, tides can also affect advective transport of constituents[1] (Chapra, 1997). Deposition would be expected to occur under high, slack tide periods when water velocities are minimal and water column particulate loading is maximum. Slack tide periods occur during the period between flow and ebb tides. Resuspension or scouring may occur during ebb tides when water movement out from the river occurs due to the outward flow of the tide combined with the flow of the river. The tidal influence complicates interpretation of sediment movement and depositional patterns.

[1]Constituents refer to chemicals that occur in the environment originating from natural or anthropogenic sources.



The tidal Anacostia River has been characterized as analogous to a tidal lake that occasionally receives enough discharge to respond like a river (Scatena, 1986). It has been estimated that approximately 85% of the sediment that enters remains in the tidal river (Scatena, 1986). The average residence time of water inFigure 3-1. Site Map for the Tidal Anacostia River and the Human Health Risk Screening Assessment. For the purpose of the human health screening assessment, the site was geographically defined as the tidal Anacostia River extending from the juncture of the Northwest and Northeast Branches to the Potomac River, including Kenilworth Marsh and Kingman Lake, and excluding the Washington Channel and Tidal Basin the lower Anacostia River, south of Blandensburg, is approximately 35 days (Nemura and Pontikakis-Coyne, 1991, cited in Gruessner et al., 1997). The generally slow movement of water in the river is an important hydrodynamic characteristic in the transport of solids and potential contaminants.

Current velocities and flow are hydrologic properties used to assess mass loading and transport of solids or contaminants in a river. Current velocity (distance/time) is an important physical property that affects the potential for particulate matter settling, resuspension, or scouring. The product of current velocity and the cross-sectional area of the river at a location are used to calculate flow (volume/time). If concurrently collected flow and constituent concentration data are available, mass transport estimates (mass/time) may be calculated as their product. Mass loading may be calculated as the difference in mass transport between two sections of a river. In a river, current velocities, flow, and constituent loading and transport are dynamic. Therefore, changes in current velocity result in changes in transport potential.

Constituent mass loading in a river may be highly variable. Therefore, the accuracy of mass transport estimates is dependent on the representativeness of sampling data.

In the Anacostia River, the average current velocity decreases in the region of the river from Pennsylvania Avenue Bridge to the vicinity of the 11th Street Bridge (Table 3-1). The decrease in current velocity has been proposed as a potential mechanism for increased settling of suspended matter in this area, relative to upstream higher velocity locations (Coffin et al. 1999).

Table 3-1. Average River Current Velocities for Select Sections of the tidal Anacostia River

Sampling location	Avg Velocity (ft/s)	Number of Measurements
Benning Road Bridge	0.72 +/- 0.66	89
Pennsylvania Avenue Bridge	0.43 +/- 0.26	71
The vicinity of the 11th Street Bridge	0.26 +/- 0.16	113
Confluence with Potomac River	0.69 +/- 0.62	115

Note: The current velocity data were collected at 0.5m depth intervals at each station throughout the water column.

Source: Coffin et al., 1999

At the Benning Road Bridge (upstream) and the confluence with the Potomac River (downstream) sampling stations, higher variability in current velocities were observed relative to the other stations. The differences were attributed to tidal effects on a narrow channel, and confluence with the Potomac River, respectively (Coffin et al., 1999). During a slack tide, current velocity rates measured at mid-river stations ranged from 0 to 0.3 ft/sec. As noted above, increased settling may occur during slack tides.

The main flow (the thalweg) occurs in the deepest portions of a river (Rutherford, 1994). Traveling from upstream to downstream, the main flow of the Anacostia River is located in the approximate center of the river at Benning Road Bridge and meanders toward the west portion of the channel in the vicinity of the Pennsylvania Avenue Bridge. Further downstream, in the vicinity of the 11th Street Bridge, the main flow meanders toward the southeast shore and then back toward the center of the channel at the confluence of the Anacostia River with the Potomac River (Coffin et al., 1998). Areas outside the main flow tend to have lower current velocities facilitating settling of suspended solids.

Approximate mean annual flows for the tidal Anacostia River are summarized in Table 3-2.

Table 3-2. Approximate Mean Annual Flows for the Anacostia River

Year	Flow (cfs)	Range	Data source
Oct 90-Sep 92	120	50 (Aug 91) - 260 (Mar 91)	DC 1994[1]
1993	180	50 - 530 cfs (1993–1997)	Kelly 1998[1]
1994	175		Kelly 1998
1995	125		Kelly 1998
1996	250		Kelly 1998
1997	140		Kelly 1998

[1] Anacostia River flows obtained as the sum of flows at the Northeast and Northwest Branches as measured by the United States Geological Survey (USGS). Flow values were adjusted by a factor of 1.02 to account for ungaged drainage area (DC, 1994; Kelly, 1998).

Cfs, cubic foot per second

Flow data from bordering water bodies also provides information on the hydrodynamics of the Anacostia River. Upstream of the tidal Anacostia River, at United States Geological Survey (USGS) gages located in the Northeast and Northwest Branches, long-term mean daily flows indicated that the tributaries contributed approximately 64% (85 cfs) and 36% (48 cfs) of the total flow to the tidal Anacostia River at Bladensburg, respectively (James et al., 1995 cited in Gruessner et al., 1997). Estimates of flow from the upper portions of the river upstream of the gaging stations include watershed contributions, tributaries, CSOs, NPDES outfalls and other sources within those areas.

Downstream, annual mean flow rates in the Potomac River at Chain Bridge for 1991 and 1992 were 1,200 cfs and 800 cfs, respectively (DC, 1994). Flow variation in the Potomac River may influence tidal affects in the Anacostia River, as discussed above. Over that time period, flow ranged from approximately 100 cfs (Sep, Oct 91) to 3,500 cfs (Jan 91) (DC, 1994). Information on flow dynamics of Kingman Lake and the Kenilworth Marsh located in the tidal reach of the Anacostia River were not identified in the documents reviewed. However, it was noted that both the lake and the marsh were almost entirely constructed (Scatena, 1986). Current velocities would be expected to be lower in the lake and in the marsh compared to the main stem of the river, which may result in a higher deposition and burial rates (mass/time). However, the flow characteristics of the lake and marsh need to be understood to evaluate this possibility.

Storm and flood events result in periods of sediment loading, resuspension, and deposition in river systems (Huber, 1993; Rutherford, 1994). The initial pulse of water that occurs during a storm event will often carry accumulated materials from the watershed into the river at higher concentrations than found during other periods of the storm event (Huber, 1993). This first flush phenomenon can make an important contribution to the transport of sediments and sediment-laden contaminants. Therefore, storm and flood event characterization should include evaluation of constituent concentrations as the river flow rises during a storm (the rising limb of a hydrograph). As river flows peak, flood plains may be impacted by

inundation with water. As the flows subside, particulate matter may be deposited as flow velocities decrease, allowing settling to occur.

Limited storm sampling has been performed in the Anacostia River system. Storm samples that have been collected consisted of sampling before and after the storm events (Gruessner et al., 1997; Velinsky et al., 1999). Therefore, first flush of the storms was not sampled. As a result, available storm sampling data for the Anacostia River provide a qualitative rather than quantitative assessment of the impacts of storm events on water quality.

A notable storm event occurred in the Washington, DC area on May 6, 1989. The storm event produced the highest flows recorded since 1979. As a result of the storm, daily discharges from the tidal Anacostia River of approximately 5,800 cfs were reported (MWCG-DEP, 1990). The elevated flows that occurred during the May 1989 storm likely resulted in elevated sediment transport at that time (Huber, 1993; Rutherford, 1994).

In addition to rain storm events, snowfall events and subsequent snow melt may also elevate flows and increase sediment transport in the river. In the Anacostia River watershed snowmelt may not be a concern. Although, in northern climates, this type of event can be a significant factor in the hydrodynamics of a river. Information was not identified that would confirm or allay concerns of the potential impact of snow events on the Anacostia River.

3.2 GENERAL WATER QUALITY CHARACTERISTICS

General water quality of a river is assessed by several parameters. Total suspended solids (TSS) is one of the most important parameters that is used along with flow data to measure solids loading to the river (Section 3.2.1). Solids are often a carrier for contaminant transport of hydrophobic organic compounds and metals that associate with or are adsorbed to particulate matter. Dissolved organic carbon (DOC) and particulate organic carbon (POC) are useful for evaluating adsorption potential of the solids, as well as the aquatic productivity of the river (Section 3.2.2). Conventional water quality parameters consisting of pH, conductivity, dissolved oxygen, and turbidity are also used to evaluate the water quality of the river (Section 3.2.3). Water temperature profiles can be useful to refine estimates of transport (Section 3.2.4). Nutrient data provide a characterization of general water quality (Section 3.2.5). Organic compound and metals data are also summarized (Section 3.2.6).

3.2.1 TOTAL SUSPENDED SOLIDS

Total suspended solids (TSS) in the water column are a key component of evaluations of sediment and constituent transport in rivers (Manhattan College, 1994). Transport and deposition of solids is dynamically related to flow and watershed characteristics. Results of TSS sampling indicated that average concentrations ranged from 19 to 39 mg/L along the length of the tidal Anacostia River (Table 3-3). Typical ranges for TSS in rivers in streams are 10–110 mg/L (McCutcheon et al., 1993). The highest TSS concentrations were consistently measured in upper reaches of the tidal Anacostia River from the Pennsylvania Avenue Bridge to the Blandensburg Marina. Lower concentrations were observed in the vicinity of the 11th Street Bridge (Coffin et al., 1999). The relative spatial distribution of TSS is consistent with expected scouring and loading from upstream sections of the river with higher current velocities, and settling and deposition in lower reaches that also have lower current velocities (Table 3-1). Seasonal variations in TSS concentrations have also been observed in the Anacostia River ranging from 2.1 to 69.0 mg/L (Table 3-3) (Coffin et al., 1999).

Table 3-3. Average Total Suspended Solids Concentration

Month/Year	Concentration (mg/L)	Number of Observations
June 1997	19.4 +/- 6.8	38
September 1997	20.0 +/- 12.2	49
February 1998	38.8 +/- 5.6	12
May 1998	25.0 +/- 9.6	20

Source: Coffin et al., 1999

Non-point sources of TSS consist of in-stream erosion (bank erosion and substrate scour), runoff of solids deposited on paved areas, and construction activities which account for 95% of the TSS loading to the Anacostia and its tributaries (Warner et al., 1997). TSS loading in the Anacostia River is estimated at 48,200 tons (96 million pounds) per year, averaging approximately 0.43 tons per acre per year (Warner et. al., 1997). Generally, the largest subwatersheds contributed the largest TSS loading and most developed areas contributed the highest average TSS loadings. During storm events it was estimated that approximately 95% of the TSS in the Anacostia watershed resulted from stormwater runoff, the remaining 5% was associated with Combined Sewer Overflow (CSO) discharges (Warner et al., 1997)

General spatial trends of water column concentrations of TSS in the river indicated that TSS increased in the vicinity of Kenilworth Marsh and the CSX railroad bridge and then declined downstream (Velinsky et al., 1999). In addition, occasional increases in TSS concentration were observed at the mouth of the Anacostia River. Following storm events, increases in water column TSS concentrations generally occurred in the river (Velinsky et al., 1999). The effects of tides on the dynamics of TSS concentrations in the Anacostia River was not evaluated in the reports reviewed. Water column data did not include references to tide levels observed during sampling.

3.2.2 DISSOLVED ORGANIC CARBON AND PARTICULATE ORGANIC CARBON

Organic carbon in aquatic environments may play an important role in the transport of organic compounds in the water column. Many organic compounds are nonpolar and do not readily interact with water. However, naturally occurring organic carbon from plants and organisms in the water column may provide a more favorable interactive media for the transport of organic compounds (Schwarzenbach et al., 1993)

Similar to observations of spatial trends of TSS (Section 3.2.1), water column concentrations of POC increased in the vicinity of Kenilworth Marsh and the Conrail railroad bridge and declined downstream. Generally, increases occurred in water column POC concentrations following storm events at downstream locations, although this trend was not observed consistently at stations located upstream of the Anacostia Bridges (Station 3; Velinsky et al. 1999).

3.2.3 CONVENTIONAL WATER QUALITY PARAMETERS

Water quality characteristics such as pH and dissolved oxygen can participate in metal cycling and the transport of organic compounds in aquatic systems (Allen, 1995; Schwarzenbach et al., 1993; Stumm and Morgan, 1981).

3.2.4 THERMAL STRATIFICATION

Thermal stratification may occur in water bodies due to the density difference of waters with different temperatures. Thermal stratification is common in water bodies with slow water movement, particularly in lakes. It may also occur in slow moving rivers. Stratification decreases circulation of water depths in a river or lake thereby impacting water movement and fine particulate transport. The overall effect of thermal stratification is to reduce the rate of vertical mixing and in some cases this reduction can be substantial (Rutherford, 1994).

Thermal stratification was observed in the Anacostia River at sampling stations at the Pennsylvania Avenue Bridge and in the vicinity of the 11th Street Bridge. The maximum gradient was located in the vicinity of the 11th Street Bridge with a change of 1.3 degrees Celsius that was observed through a 2 m depth (Coffin et al., 1998). During an ebb tide, the thermal stratification was less pronounced. Seasonal differences indicated that stratification decreased in winter months (Coffin et al., 1999).

The thermal stratification data collected to date has qualitatively identified stratification in the lower reach of the tidal Anacostia River during certain time periods. The effect of thermal stratification on constituent transport has not been completely identified. However, the presence of thermal stratification is indicative of the tidal influence of the Potomac River in lower reaches of the river.

3.2.5 WATER COLUMN PARTICULATE MATTER

Particle size analysis

Particle size analysis provides a description of the materials contained in the water column thereby providing evidence of flow dynamics. Data collected in June 1997 indicated that the amounts of small particle size (0.2 to 1.0 µm) materials in the water column in the vicinity of Benning Road Bridge and the vicinity of the 11th Street Bridge were approximately 60% lower than in areas at the mouth of the river. This suggests that settling of fine materials occurs in this region of the river. For all sections sampled in the river, the predominant particle size was in the range of 3.0 to 5.0 µm (Coffin et al. 1998). The particle size distribution analysis was performed by acoustic signal analysis. Horizontal layer scattering was observed at all sites, supporting the observations of stratification due to thermal and density differences that occur in the water column (Coffin et al. 1998).

Seston

Seston consists of minute living organisms and particles of nonliving organic matter which float in the water and contribute to turbidity. Therefore, seston analyses provide a measurement of the organic carbon content of river sediment. Concentrations of seston measured across the river were skewed toward the west shore at stations located at the Benning Road and Sousa Bridges. In the vicinity of the vicinity of the 11th Street Bridge, concentrations were consistent across the river. Further downstream, at the confluence with the Potomac River, concentrations were skewed toward the east shore (Coffin et

al. 1998). Overall, spatially traveling down the river, seston concentrations decreased (Coffin et al. 1998). The decreases in seston concentrations observed were likely related to decreases in current velocities that resulted in increased settling of suspended materials as the water traveled downstream from a region of relatively high current velocity to a region of lower current velocity. However, TSS monitoring was not included in the study to evaluate this possible relationship.

3.3 DATA GAPS RELATED TO MODELING RIVER HYDRODYNAMICS

The hydrodynamics in the river are not understood sufficiently to enable predictions of contaminant concentration profiles over the length of the river, or to identify future high impact areas and estimate associated concentrations. This limitation is particularly relevant to extreme (high and low) flow conditions and disturbances that might be imposed on the river as part of remediation or other modifications to the river (e.g., dredging). Some specific data gaps include the following:

- Water flows and channel volumes have not been determined over a sufficient geographic and temporal scale to support the development of a hydrodynamic model of both the "average" long-term behavior of the river and the behavior of the river during extreme events (e.g., storms, drought).

- Flows and first-flush and peak fluvial chemical loadings from tributaries to the tidal Anacostia during storm events have not been quantified in available documents.

- The exchange of surface water and sediment between the Potomac and Anacostia Rivers during tidal flux has not been quantified.

- The exchange of ground water and surface water within the tidal Anacostia River has not been quantified.

- A model calibration data set has not been collected. This would include sediment and water column concentrations of representative chemicals at various locations in the river, including predicted high impact areas, at various times, including during and after extreme events (e.g. storms).

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4. SEDIMENT TRANSPORT DYNAMICS

Sediment transport dynamics of the tidal Anacostia River are described herein. Key issues in developing a sediment transport model are bed-mapping, *in situ* resuspension potential, and bed elevation monitoring (Manhattan College, 1994). Water column TSS concentrations which were discussed previously (Section 3.2.1), are an additional key component to the sediment transport model (Manhattan College, 1994). Sediment bed-mapping and bed elevation monitoring provide a description of depositional areas in the river and the accumulation of sediment over time (Section 4.1). The dynamics of sediment transport has been impacted by dredging in the river (Section 4.2). An understanding of the physical characteristics of the sediment in the river provides a basis for evaluating *in situ* resuspension potential (Section 4.3). A conceptual model describing the pathways of constituent influx and migration through the tidal Anacostia River has been developed incorporating existing data for the river (Section 6). For each of the subsections below, data are reviewed in the context of this conceptual model.

4.1 DEPOSITIONAL AREAS

Sediment deposition occurs in low velocity regions of the river. As discussed previously, deposition is dynamic due to fluctuations in flow (Section 2.1).

The volume of contaminated sediment and burial rates of the sediment were investigated in the Anacostia River. Sediment depths of up to 3 meters extending across most of the lower tidal Anacostia River were reported. Several studies have been conducted to evaluate sediment depositional rates:

- Analysis of burial rates using lead-210 dating techniques indicated a sediment accumulation rate in the Washington Channel of approximately 0.9 cm/yr for the period of 1878–1978 (Brush et al. 1982, cited in Velinsky 1997).

- Recent sedimentation rates varied between 0.9 to 1.6 cm/yr. From 1972–1985, the sedimentation rate for the Anacostia River was estimated as approximately 3.1 cm/yr (Velinsky et al., 1997).

- The rate of sediment deposition in the mid-channel was estimated as 4.2 cm/yr for the period 1958 to 1980 (Scatena, 1986). The estimate was based on 12 cross-section surveys conducted at a location in the tidal Anacostia River. That estimate agreed with an estimate based on the mass balance of TSS in the tidal embayment. The total amount of sediment deposited evenly over the entire tidal area was estimated to be 3.2 $g/cm^2/yr$ (Scatena, 1986). This was estimated to be equivalent to a sedimentation rate of 3.8 cm/yr (wet) and 1.9 cm/yr (dry) (Scatena, 1986). A range of sedimentation rates from 1.4 to 8.0 cm/yr was estimated to account for annual variabilities (Scatena, 1986).

- Sediment (measured as seston in sediment traps) deposition rates were also estimated for June 26, 1997. From that study, the highest sedimentation rates were observed in the upper river at Benning Road Bridge, 1150 mg/d. Lower values were observed in the vicinity of the 11th Street Bridge with

an average of 170 mg/d. A rapid change in sedimentation was observed over the short distance between the Pennsylvania Avenue Bridge and the vicinity of the 11th Street Bridge. The observed differences were attributed to tidal mixing, current flow rates and the effect of river morphology (Coffin et al., 1998). The tide status was not reported in the report.

In summary, most estimates of sediment deposition rates in the Anacostia River were between 0.5 and 4.2 cm/yr. Differences in reported sedimentation rates may be due to techniques employed, or spatial or annual differences.

Sediment mass balances indicated that approximately 85% of sediment that enters the lower river is trapped and buried (Scatena, 1986). However, using lower estimates of sediment deposition rates obtained by others (Coffin et al., 1998; Velinsky et al., 1997) could reduce this retention rate to less than 50%. It was also estimated that 30–40% of the total annual amount of sediment deposited occurred during distinct hydrologic events rather than continuous sedimentation (Scatena, 1986).

High resolution seismic-reflection profiling was conducted to evaluate bathymetry of the river bed. Eight sediment cores were also collected (Velinsky et al., 1997). The high resolution profiles were not available for review.

Grain size analysis is used for estimating deposition. If grain size analysis is used to estimate the concentrations of chemical constituents in the Tidal Anacostia River, it will not provide information that is sufficient to identify separate sources of the chemical constituents. Some of the confounders that preclude the use of grain size analysis to identify specific sources include variability in the intensity of chemical releases over time and variability in the initial time and duration over which releases occur. In addition, NAPL sources will not be successfully characterized using grain size analysis alone.

4.2 DREDGING

The Anacostia River has been dredged for various purposes. Channel improvement projects in the Anacostia River started in the 1880s with the removal of polluted sediments from the Anacostia River and Washington Channel area. In the late 1950s, the river was structurally modified to its present configuration upstream to Blandensburg, Maryland (Scatena, 1986). Past dredging of the center of the river resulted in depths outside of the channel generally ranging from 0.5 to 5 m (Velinsky et al., 1992). River dredging alters the hydrodynamics of the river, generally increasing flow in the center of the channel and reducing flow outside of the channel. Changes in sediment transport would likely result from the hydrologic impacts.

More recently, dredging has been performed at Blandensburg Marina. A study conducted to evaluate the potential impacts of dredging at the Blandensburg Marina concluded that dredging of the marina did not impact surface water quality of the upper tidal Anacostia River during dredging (Velinsky et al., 1994a).

4.3 SEDIMENT CHARACTERISTICS

Sediment has two primary origins. It may originate from the drainage basin (allochthonous) or from photosynthetic processes (autochthonous). These sediment types can often be distinguished by organic carbon content, density, and particle size. The autochthonous solids are generally higher in organic carbon content and more reactive than allocthonous sediment. They are less dense with high water content and tend to be smaller in size (Chapra, 1997). Therefore, the two types of sediment also tend to have different transport dynamics. Sediment characterization of depositional areas requires investigation of

river bed surface sediment and subsurface sediment to obtain a profile of materials that have been deposited over time.

Grain size distribution

Grain size distribution analyses of sediment in the river identified predominantly clay and silt (<63 µm). In contrast, sewer samples had a greater range in grain size than those collected in the river. The size differences were attributed to physical sorting of particles in the sewers due to relatively high current velocities associated with storm runoff in sewers (Velinsky et al., 1992).

Total Organic Carbon

Analysis of total organic carbon (TOC) content of sediment supports interpretation of sediment source and affinity of the sediment for binding chemicals, as well as the aquatic productivity of the river. In the Anacostia River, TOC concentrations range from 2.5 to 6.4% of the sediment on a dry weight basis and it averages 4.0 +/- 0.9%. The highest concentrations of TOC measured in the river sediment were at Kingman Lake and in the tidal basin (Velinsky et al., 1994b). These areas represent areas of greater aquatic productivity, compared to other portions of the tidal Anacostia river. They are also areas that would be expected to have relatively lower current velocities and higher sediment deposition rates compared to other sections of the river.

Outfalls along the Anacostia River contained concentrations of TOC ranging from 0.7% to 11% indicating a wide range of point source contributions of TOC and physical sorting of particles (Velinsky et al., 1994b). In contrast, TOC concentrations in sewers were lower, averaging approximately 1.0±0.9% TOC. The lower concentrations of TOC in sewers were attributed to the larger grain size of the sand encountered compared to outfall samples (Velinsky et al., 1994b). The distinction between outfall and sewer samples was not clear from review of the report.

4.4 DATA GAPS RELATED TO MODELING SEDIMENT TRANSPORT

The dynamics of sediment transport in the river are not understood sufficiently to enable predictions of contaminant concentration profiles over the length of the river, or to identify future high impact areas and estimate associated concentrations. This limitation is particularly relevant to extreme (high and low) flow conditions and disturbances that might be imposed on the river as part of remediation or other modifications to the river (e.g., dredging). Some specific data gaps include the following:

- Water flows and channel volumes have not been determined over a sufficient geographic and temporal scale to support the development of a hydrodynamic model of both the "average" long-term behavior of the river and the behavior of the river during extreme events (e.g., storms, drought).

- The exchange of surface water and sediment between the Potomac and Anacostia Rivers during tidal flux has not been quantified.

- Depositional patterns of sediments transported into the tidal Anacostia from tributaries, including the Northeast and Northwest branches, during and between storm events have not been characterized.

- Conditions under which deposited sediments are resuspended and transported, and the relative importance of this mechanism for transport of chemical contaminants, have not been characterized.

- Particulate deposition on the floodplain and tributaries, particularly within Kennilworth Marsh and Kingman Lake, during large flow events such as storm events or during spring snowmelt have not yet been channelized has not been addressed relative to human exposures to chemical contaminants.

- The frequency and extent of dredging deep tidal river sediments have not been characterized in available documents; deep dredging may promote the resuspension of formerly buried contaminated sediment.

- Partitioning of COPCs between sediment and surface water needs to be better charactorized.

- A model calibration data set has not been collected. This would include sediment and water column concentrations of representative chemicals at various locations in the river, including predicted high impact areas, at various times, including during and after extreme events (e.g. storms).

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5. EXISTING DATA SUMMARY/COMPILATION

5.1 CONSTRUCTION OF DATABASE FOR HUMAN HEALTH RISK SCREENING ASSESSMENT

A database was created using Microsoft Access to facilitate the human health risk screening assessment (HHRA screening database). The database included information contained in the Anacostia River Watershed Database and Mapping Project (NOAA, 2000) and water quality data that was provided by NOAA in spreadsheet format on January 3, 2000; the latter is from a study by Velinsky et al. (1999).

The above information was imported into MSAccess as a series of six tables that are shown in the first column of Table 5-1, labeled "All Data". The database contains a total of 28,095 records; 27,449 of which are the results of analyses of fish tissue, sediment and water samples. The remaining 646 records are contained in tables (XCLCAS and XSTN) that describe chemical identity and sample locations (Table 5-1). Each of the 27,449 analytical data records contain the results for the analysis of a given sample and analyte. For example, if a surficial sediment sample was tested for the concentration of 15 chemicals, the database contains 15 records for that sample in the database.

For the purpose of the human health screening assessment, the site was geographically defined as the tidal Anacostia River extending from the confluence of the Northwest and Northeast Branches to the Potomac River, including Kenilworth Marsh and Kingman Lake and excluding the Washington Channel and Tidal Basin (Figure 5-1). The Tidal Basin and Washington Channel are expected to be impacted predominantly by Potomac River flow, rather than Anacostia River flow. Samples that were collected from outside of the site boundary were not included in the screening HHRA assessment. Subsurface sediment data were not used in the assessment because they may not be representative of surficial sediment, considered to be the more important exposure medium. The samples collected from within storm sewers, to the extent they could be identified, were also not included. This includes station identification names with the prefixes *'OAR'* and *'SAR'* as described in Velinsky et al. (1992). The analytical results for fish bile (Pinkney, 1999) were excluded, as this data could not be screened against the Risk Based Concentrations (RBCs) or Applicable or Relevant and Appropriate Requirements (ARARs). Table 5-1 shows the number of records in each table used in the screening database. The locations of all surficial sediment samples included in the HHRA screening database are shown in Figures 5-2 through 5-6. Surface water and fish sampling locations are presented in Figures 5-12 and 5-13, respectively.

Two other significant issues regarding the HHRA screening database were the identification of non-detects and missing data. The data included in the HHRA screening database represent a compilation of analytical results generated by 14 different efforts. Table 5-2 provides a list of the studies that contributed data to the screening database. The NOAA (2000) database includes a table that contains the quality codes assigned to the data by the various authors (see Table 5-2 for list of citations). Data with quality codes starting with "U" were considered non-detects in the HHRA screening database.

The one exception to this is the surface water data in which two-part quality codes were assigned to the combined particulate/dissolved organic data. The first part of the quality codes refers to the code assigned by Velinsky et al. (1999) to the dissolved fraction, the second part of the code refers to the code assigned to the particulate fraction.

Surface water results that were not reported by Velinsky et al. (1999) due to matrix interference were considered as *missing data* in the surface water data table; the concentration field in the database for these records is blank and a quality code of *I* was assigned. Blanks were entered in the concentration field of the surface water data table when samples were not collected from a particular station during a sampling event. Missing data were not included in counts of samples.

5.2 SUMMARY OF THE HUMAN HEALTH RISK SCREENING ASSESSMENT DATABASE

The database includes the analytical results on a total of 356 chemicals, 141 of which are polychlorinated biphenyls (PCBs) congeners, and the following 9 physical parameters: per cent lipid in fish tissue; percent clay, silt, sand, gravel, fines and solids in sediment; and percent moisture in fish and sediment. The list of analytes varied from study to study, and sometimes between the sampling events within a given study. The total number of analytes for each media was as follows: sediment, 297 (108 PCB congeners); fish tissue, 224 (94 PCB congeners); surface water, 21.

Descriptive statistics for chemicals in each medium are provided in Tables A5-1 through A5-3. In interpreting the summary statistics, the following limitations of the data need to be taken into account: 1) Although NOAA compiled the available information on detection limits and incorporated this information in NOAA (2000), the information in NOAA (2000) is insufficient to allow for consistent treatment of non-detects in the database. When calculating the mean and standard deviation for each chemical, non-detects were set equal to the value provided in the concentration field of the respective data tables. This value was assumed to represent the reported detection limit, however, confirmation of this against the original data was not attempted due to the size of the database. Negative concentrations were sometimes assigned to non-detects in the NOAA (2000) data tables when the detection limit was unknown. Records with negative concentrations were not included in the calculated sample means or standard deviations shown in Tables A5-1 through A5-3, however, the number of samples includes the records assigned negative values for concentration. 2) Statistics will be tend to be biased due to non-random sampling of the site. 3) Bias can also be expected from the nonuniform geographic distribution of sampling.

Table 5-3 shows the number of samples and the detection frequencies by chemical classes. The chemical classes shown in Table 5-3 generally correspond to the classes defined in the NOAA (2000) database with the exception of the PCB data, pesticide data, and *totals* or sums of various components of analyte classes or mixtures. The NOAA (2000) database combined the pesticide and PCB data in class *(PEST-PCB)*. The PCB congener data was given its own class name. For the purpose of the human health risk screening assessment, the pesticide data was separated from the PCB data and assigned to a new chemical class (*PEST*). A chemical class called *PCB* was created for *total PCBs*. The class *total PCBs* for the sediment and fish data represents the sum of Aroclors or congeners, depending upon the study. *Total PCBs* for the water data represent the sum of the concentrations of 77 PCB congeners (Velinsky et al., 1999). Database records that represent the summation of other analytes (e.g., total PAHs, total BTEX) were not assigned to a chemical class to avoid duplicating counts of analytes from the same sample, and not included in the frequency of detection and summary statistics calculations..

5.2.1 SUMMARY OF SEDIMENT DATA

Table 5-2 lists the eight sources of information on chemicals in sediment that are included in the screening database. Information in Velinsky et al. (1992) was obtained from grab samples collected on June 18-19, 1991, from 6 locations in the tidal Anacostia River between the Pennsylvania Avenue Bridge and the Potomac River. One location was just downstream of Kingman Lake, and 5 locations were within Kingman Lake. Samples were collected from the 0–20 cm depth interval. Data supplied by Loos (1999) was derived from 4 grab samples collected near the PEPCO Benning Generating Station on October 4, 1995 and March 25, 1997 samples were collected from the top 3 cm of sediment. USFWS (1997) supplied data on composite samples collected on July 19 and August 4, 1993 from 9 locations (one composite per location) within Kenilworth Marsh. The depth from which the samples were collected is not provided in the NOAA 2000 databases or in the report (USFWS, 1997). Murphy et al. (1998) supplied data from two grab samples collected from Kenilworth Marsh in August 1996. Samples were collected from the 0–10 cm depth interval.

The other four studies that contributed data on sediment quality were not available for review at the time this report was developed. The following description of these studies is based on the information contained in the database. Baker Environmental (ND) provided data from seven locations on the northern bank of the lower Anacostia, between 11th and South Capitol Streets. The data is from samples that were collected on June 16, 1995. Baker Environmental (ND) provided data from six locations on the southeast bank of the lower Anacostia, near the confluence with the Potomac, that were sampled on July 29 and September 7, 1992. In study IDs #01 and 02, samples were collected form the 0–30.48 cm (0–12") depth interval. Data from seven locations on the northwest bank of the lower Anacostia, between 11th Street and Pennsylvania were provided by ChemWorld Environmental (1997). These samples were obtained collected on June 11, 1996 at a depth of 0–15.24 cm (0–6"). Strobel et al. (1995) provided data from one sample collected on August 26, 1990 from Kenilworth Marsh. The sampling depth is not provided in the NOAA 2000 databases (the study was not available for review).

Figures 5-2 through 5-6 illustrate the geographic distribution of sediment samples in the following 5 chemical classes: pesticides, PAHs, PCBs, acid/base/neutral extractables, and metals. Each figure shows sediment sample locations and the number of samples at each location for a given chemical class.

The geographic coverage of the sediment data, with the exception of the PCB data, tends to be similar between chemical classes, while the number of samples varies between chemical classes and varies widely between sample locations within chemical classes. The information on Aroclors is limited to the following three areas: Kenilworth Marsh; an area downstream from the 11th St Bridge; and an area near the junction with the Potomac River. Information for *total PCBs* is more evenly distributed within the site area than information concerning Aroclors (not shown in Figure 5-6), however, in most cases, only one sample was collected from each location.

The difference in the number of sediment samples collected for each chemical class, to some extent, reflects the number of analytes included in that class, which makes comparisons of the number of samples in classes difficult to interpret. However, based on patterns exhibited in Figures 5-2 through 5-6, it is clear that the majority of the information on the concentration of chemicals in the Anacostia sediments was obtained from the following three areas: the area of the river downstream from the Pennsylvania Avenue Bridge; from Kingman Lake; and from Kenilworth Marsh. In contrast, the database contains much less information on the concentration of chemicals in sediment of the tidal Anacostia River channel, upstream from the Pennsylvania Avenue Bridge.

Figures 5-7 through 5-11 show the distribution of detection frequencies for each of the chemical classes defined in Section 5 (ABNs, dioxins, furans, PAHs, PCBs, pesticides and metals). Note that the apparent patterns in detection frequencies may be due (at least in part) to differences in sampling and analytical methods that were used by the different studies that contributed information to the database. The list of analyses that were performed on each sample also varied from study to study which could also account for some of the variation in detection frequencies illustrated in Figures 5-7 through 5-11. However, when reviewed together with Figures 5-2 through 5-6, major data gaps in the current database become apparent. The figures also may be used to tentatively identify candidate locations for collecting additional data; which is discussed further in Section 9 - *Recommendations For Future Action*.

Figure 5-7 shows the location and detection frequency for sediment sampling stations where pesticides concentration were measured. Note the detection frequency at neighboring sampling stations tend to be similar although some variation is evident, particularly for the sampling stations located on the north bank of the Anacostia, near the 11th St Bridge. There also appears to be a difference between the sampling stations located south of the South Capitol St Bridge; the stations on the northwest bank of the river appear to have higher detection frequencies than those on the southeast bank of the river. This pattern is observed for other chemical classes as well (Figures 5-8 through 5-11). However, the detection rates shown may reflect characteristics of the river hydrodynamics as well as variation in the sampling and analytical methods that were employed by the various studies that contributed data to the database. Another potential confounding influence in the detection frequencies is the variation in the list of analytes included within each chemical class by the different studies.

Figure 5-8 shows the location and detection frequency for sediment sampling stations where polynuclear aromatic hydrocarbons (PAHs) concentration were measured The detection frequency at neighboring sample stations tend to be similar, except for the area in the vicinity of the 11th Street Bridge where the detection frequencies are highly variable, which is similar to the pattern observed for pesticides (Figure 5-7). The high variability of measured concentration of PAHs in the vicinity of the 11th Street Bridge suggests that additional samples should be collected from this area.

Figure 5-9 shows the location and detection frequency for sediment sample stations where PCB Aroclor concentrations were measured. The detection frequency for samples collected from Kenilworth Marsh is higher than the detection frequency for samples collected from the lower Anacostia. Although there are a limited number of samples from Kenilworth Marsh that were analyzed for PCB Aroclors (Figure 5-4), the pattern of detections suggests that additional samples should be collected from the upper Anacostia, as well as the lower Anacostia, to better characterize the concentrations of PCB Aroclors in the tidal Anacostia sediment.

Figure 5-10 shows the location and detection frequency for acid/base/neutral extractable chemicals (ABNs) in sediment. The spatial distribution of detection frequency is similar to those observed for pesticides, PAHs, and Aroclors. Note the high detection frequencies in the upper Anacostia and Kenilworth Marsh coincide with areas where the database contains limited information (Figure 5-5).

Figure 5-11 shows the location and detection frequency for metals in sediment. Once again, the spatial distribution of detection frequency for metals is similar to those observed for the other chemical classes. In general, the detection frequencies are high throughout the tidal Anacostia. The detection frequency for the river channel between the Pennsylvania Avenue Bridge and Watts Branch is consistently high. The database contains limited data for metals concentration is this area however (Figure 5-6), indicating a potential location where additional sampling should be considered.

5.2.2 SUMMARY OF WATER DATA

The following summary is based on data that is included in NOAA 2000; this data was derived from Velinsky et al. (1999).

As shown in Figure 5-12, there is one sampling station located between Watts Branch and the confluence of the Northeast and Northwest Branches. Six of the eight stations are located between the 11th Street Bridge and the Potomac River.

The water data were collected from 11 stations before and after 5 rainfall events between February 25th and November 12th of 1998. Data from three of the stations, one each in the Northeast and Northwest Branches and one in the Potomac River, are not included in the database because the stations are located outside of the tidal Anacostia River site boundaries (Figure 5-1). Samples were collected from approximately 0.5 meters below the surface of the river except for one sample that was collected on February 25th from the bottom of the river at Station 6_14; the latter was analyzed for metals only.

The locations of the water sample stations included in the database are shown in Figure 5-12. The detection frequencies for each of the chemical classes at each of the sample stations is provided in Table 5-4. Data on water quality were obtained from a study performed by Velinsky et al. (1999) that investigated the effects of stormwater runoff on the concentrations of selected inorganic and organic contaminants in the tidal Anacostia River. The values shown in Table 5-4 include the data on total recoverable *metals* and the total *organics*. The number of samples and number of detects shown in Table 5-4 do not include the analyses for acid soluble or dissolved metals, nor do they include the dissolved and particulate analyses that were performed for the organic contaminants. Results of fractional analyses, while potentially useful for fate and transport evaluations, are not included here to avoid redundancy in data summaries.

The only analyte included in the acid/base/neutral-extractables (ABN) category is hexachlorobenzene. The metals class is comprised of arsenic, cadmium, chromium, copper, nickel, lead, zinc and mercury; the concentration of mercury was measured for the first sampling event only. The pesticide class consists of heptachlor, aldrin, trans-nonachlor, p,p'-DDE and p,p'-DDT. The PCB class represents the sum of 77 congeners.

5.2.3 SUMMARY OF FISH TISSUE DATA

Figure 5-13 shows the locations of the fish tissue samples included in the database. The detection frequencies for each chemical class and sample station are provided in Table 5-5. Data on the concentrations of contaminants in fish tissue were obtained from 5 studies (Table 5-2).

Approximately 95% of the records in the database for fish tissue were obtained from Cummins and Velinsky (1993) and Velinsky and Cummins (1996). Information reported in these two studies is based on analyses of composite fish fillets collected in 1989-1992 and 1993-1995, respectively, from the tidal Anacostia River. The data from Cummins and Velinsky (1993) are based on the analyses of 38 composite samples that were collected from two general areas, rather than specific locations, of the river. The two areas were described as the *upper Anacostia* and *lower Anacostia*, and are shown as stations 3 and 4, respectively, in Figure 5-13. The fish species analyzed were brown bullhead, common carp, largemouth bass, bluegill, American eel, channel catfish and pumpkinseed.

The data from Velinsky and Cummins (1996) is derived from the analyses of 20 composite fish fillet samples. The samples were also collected from two general areas of the tidal Anacostia River, the *upper Anacostia* and *lower Anacostia*, shown as stations LA and UA, respectively, in Figure 5-13. In addition, one sample (KM) was obtained from Kenilworth Marsh. The fish species analyzed were channel catfish, common carp, sunfish, brown bullhead and largemouth Bass.

The data from (Block, 1990; see the note in the ref section) were obtained from samples of *whole fish*, fillets and *carcass* collected at two locations: one near the Washington Ship Yard (LA) and one at Benning Road Bridge (BRA). Samples were collected on August 10 and 11, 1987. Two Largemouth Bass and two white catfish were collected at each site. One of each species of fish at each site was divided into a fillet and carcass sample; the remaining fish were used for the *whole fish* analyses.

The data from an additional study (Study ID #08; Table 5-2) are based on the analysis of two fillet samples, one of carp and one of striped bass, collected near the confluence of the Northeast and Northwest Branches (identified as location ANA82 in Figure 5-13) on September 25, 1995. Descriptions of the dataset that were available for the screening risk assessment did not indicate whether the fillets were composites or from single fish. Data from study ID #A1 are based on the analysis of three samples of whole fish, all white suckers, collected at approximately the same location used in Study ID #08 (although the station ID is different: 16330). It is unknown if the samples were composites or from single fish.

The amount of information on chemical concentrations in fish tissue varies widely between chemical classes and sample locations. There appears to be differences in the detection rates for PAHs and pesticides between sample stations 3/BRA and 4/LA, which indicates sample location may be important for the fish tissue data, at least for these two classes of chemicals. Based on the total number of observations by chemical class, the database contains more information on the concentration of contaminants in fish tissue samples collected between Watts Branch and the confluence with the Potomac River and less information for the area upstream of Watts Branch..

5.3 OUTSTANDING ISSUES AND RECOMMENDATIONS RELATED TO DATA SUMMARY AND COMPILATION

Several gaps and limitations in the existing database limit the usefulness of the data to support a baseline human health risk assessment.

Large sections of the river, including some important inflows and drainages, are not represented. The absence of this information may render estimates of exposure concentrations for potential receptors highly uncertain and potentially highly biased towards those geographic areas that have been more extensively sampled and to those times at which the samples were collected. The same limitations will make it extremely difficult to model chemical loadings to the tidal river.

Specific issues are outlined below.

1. One of the most challenging issues confronting use of the existing data in a human health risk assessment is the lack of adequate information on detection and sample quantitation limits for the various analyses captured in the database. This limitation has no effect on the human health screening assessment, which is based entirely on maximum concentrations detected; however, it may

severely compromise the estimation of statistical parameters such as the mean concentrations and associated confidence limits which may be used in a baseline risk assessment.

2. Information on contaminant concentrations in sediment derive largely from samples collected near or downstream from the Pennsylvania Avenue Bridge. There are no sediment samples for sections of the river channel upstream of Hickey Run and relatively few sediment samples between Benning Road Bridge and the Pennsylvania Avenue Bridge, none of which were analyzed for Aroclors. Examples of specific gaps in the sampling coverage include the following:

    - no samples for pesticides, metals or PCBs in the main channel of the river upstream from Watts Branch (Figures 5-2, 5-4, and 5-6)
    - only one sampling station for PAHs upstream of Pennsylvania Avenue Bridge (Figure 5-3)

3. There is only one water column sampling location upstream of the Independence Avenue Bridge within the tidal Anacostia River and no stations upstream from Lower Beaverdam Creek (Figure 5-12) There is no information on the concentration of dioxins, furans or PAHs in the water column.

4. Existing data were collected at various times and do not represent a random sample of the river either spatially or temporally. The data do not support a robust temporal or spatial trend analysis. Extrapolations of parameter estimates (e.g., mean exposure concentrations) over time, including extrapolations to present or future conditions will be highly uncertain.

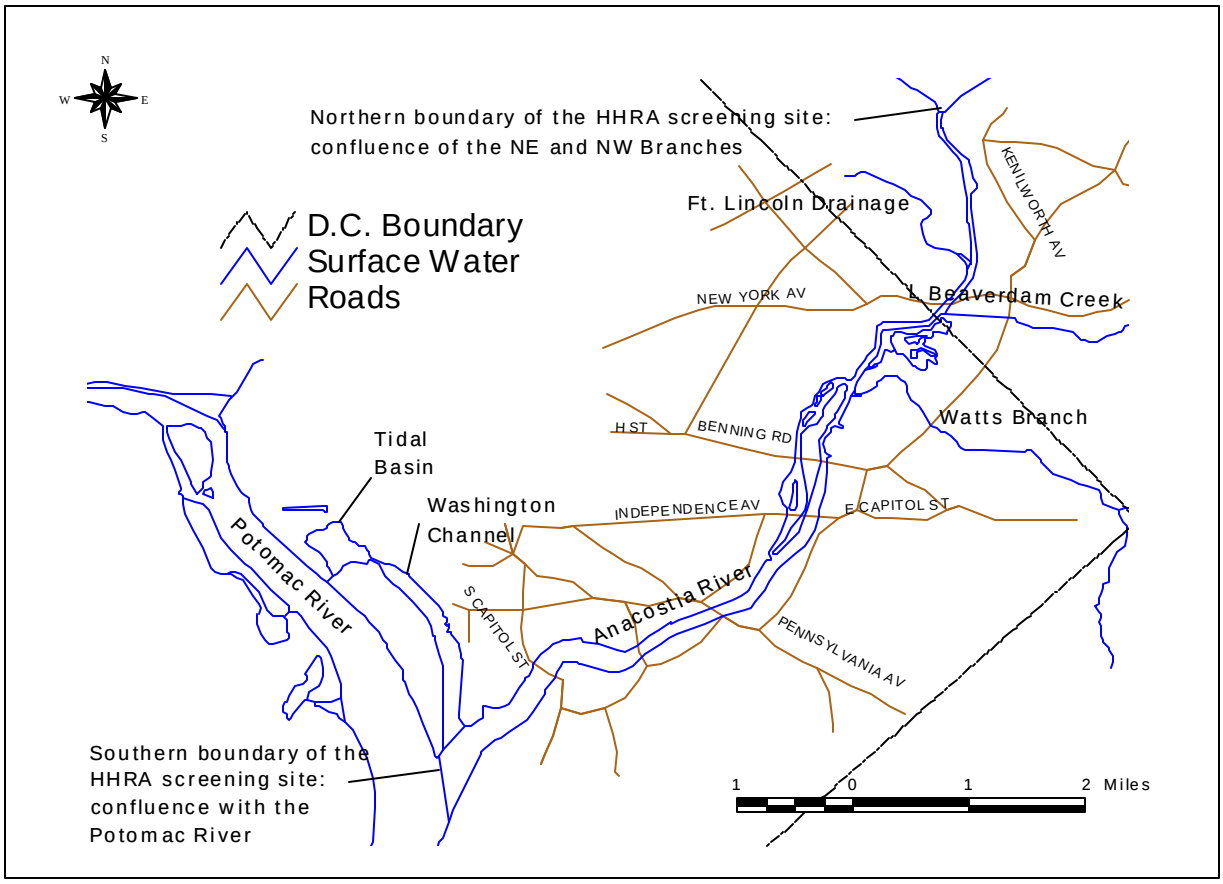

Figure 5-1. Site Map for Human Health Risk Screening Assessment. For the purpose of the human health screening assessment, the site was geographically defined as the tidal Anacostia River extending from the juncture of the Northwest and Northeast Branches to the Potomac River, including Kenilworth Marsh and Kingman Lake, and excluding the Washington Channel and Tidal Basin

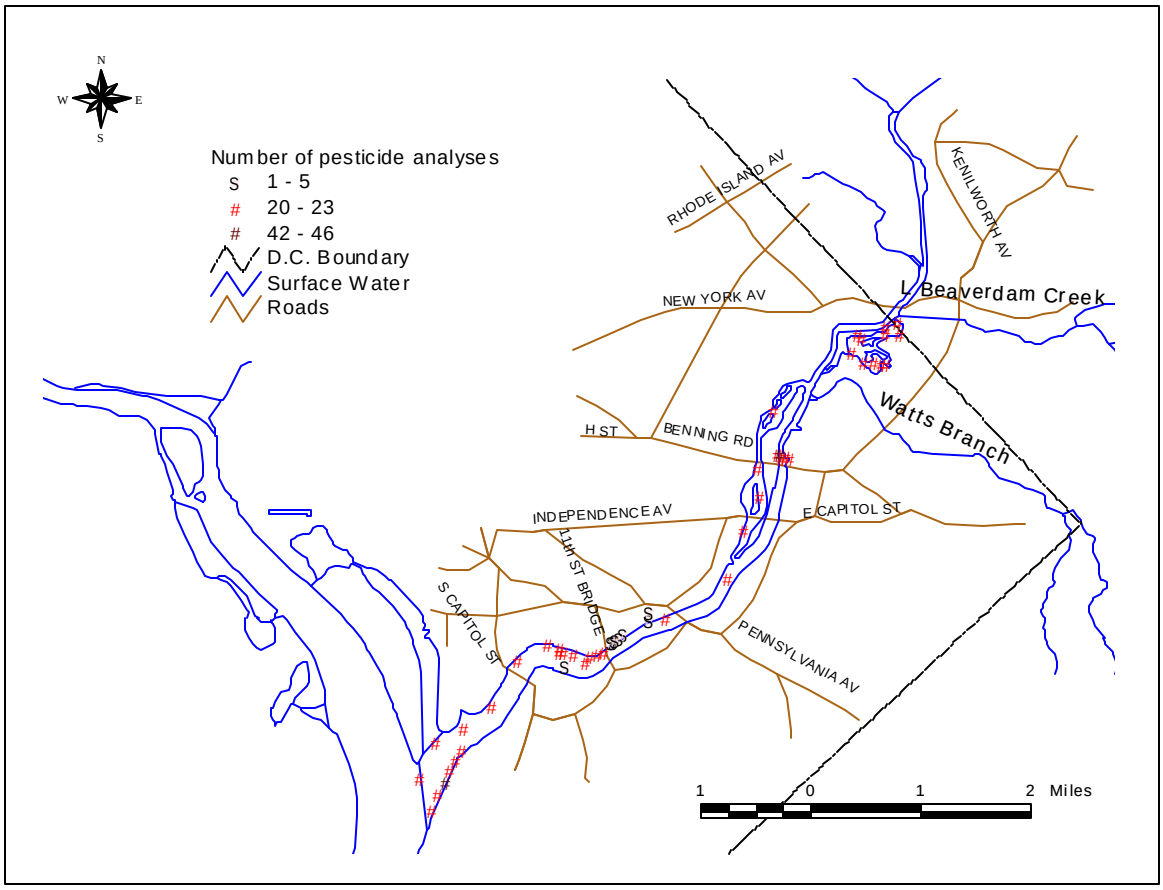

Figure 5-2. Number of Analyses for Pesticides at Sediment Sampling Stations. The figure shows a lack of samples for the tidal Anacostia River channel, upstream of Watts Branch. The large gaps in the sample number ranges shown in the legend reflect the data profile. For example, there were no sampling stations with a total number of pesticide analyses between 6 and 19.

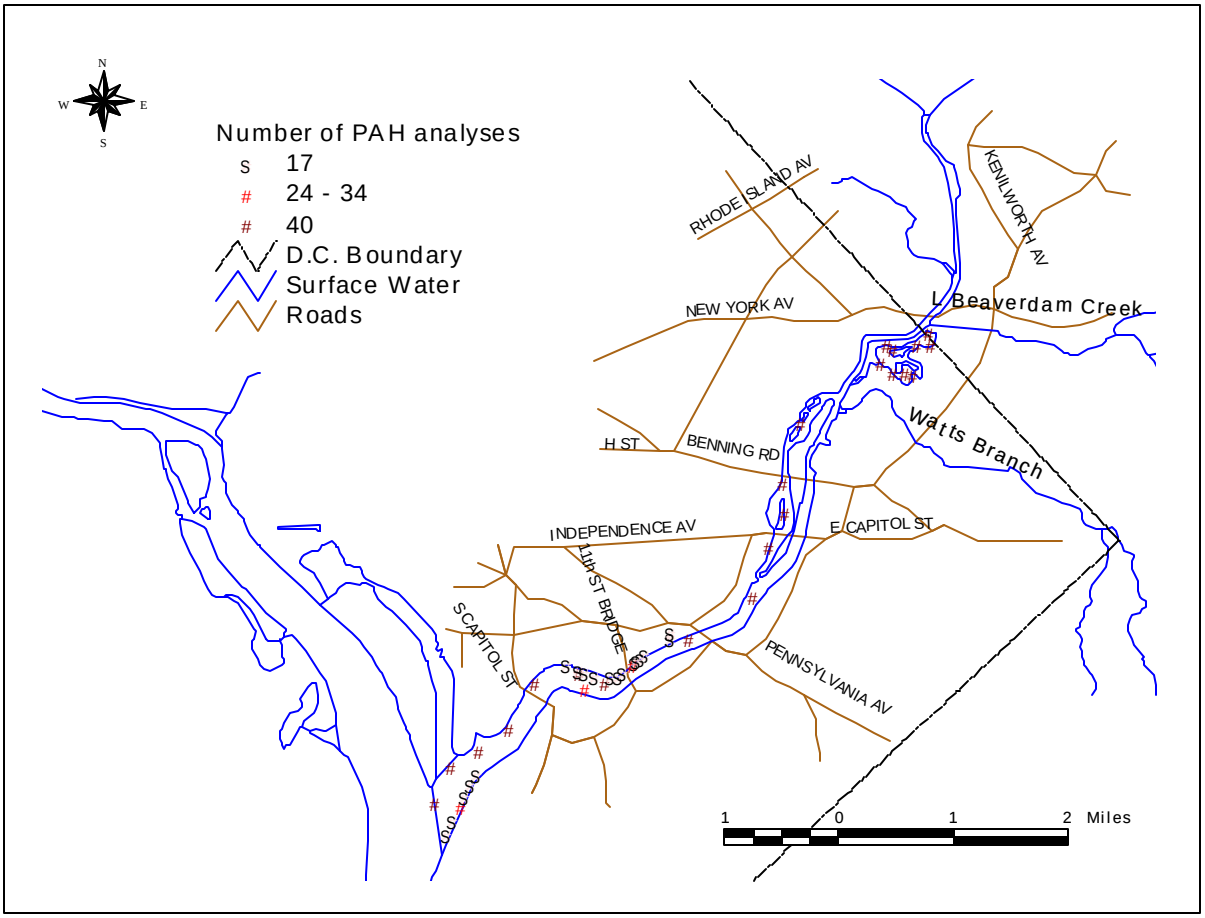

Figure 5-3. Number of Analyses for PAHs at each Sediment Sampling Station. Note that there is only one sampling station in the Anacostia River channel upstream of Pennsylvania Avenue Bridge.

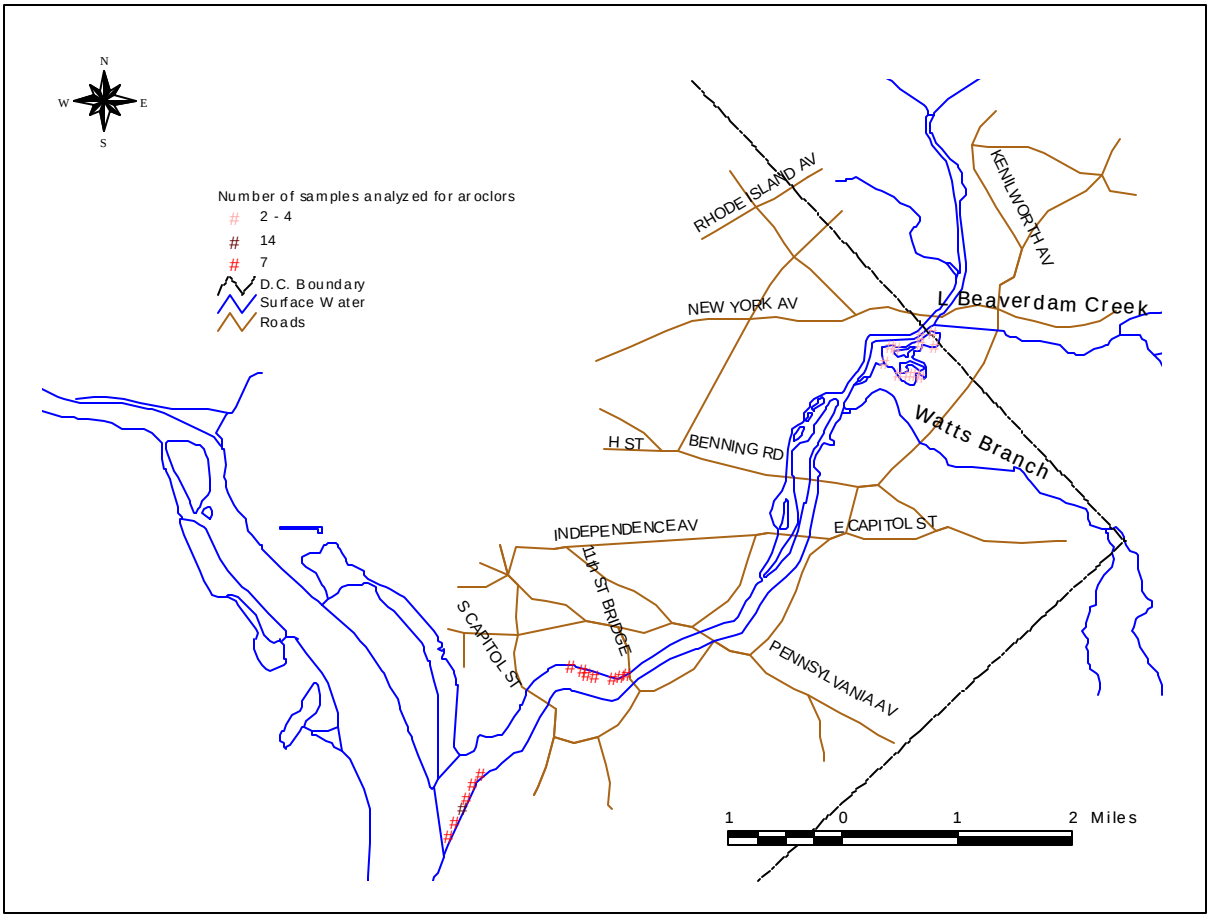

Figure 5-4. Number of Analyses for PCB Aroclors at each Sediment Sampling Station. Sediment samples collected from three areas were analyzed for aroclors: Kenilworth Marsh, near the navy shipyard and near the confluence with the Potomac.

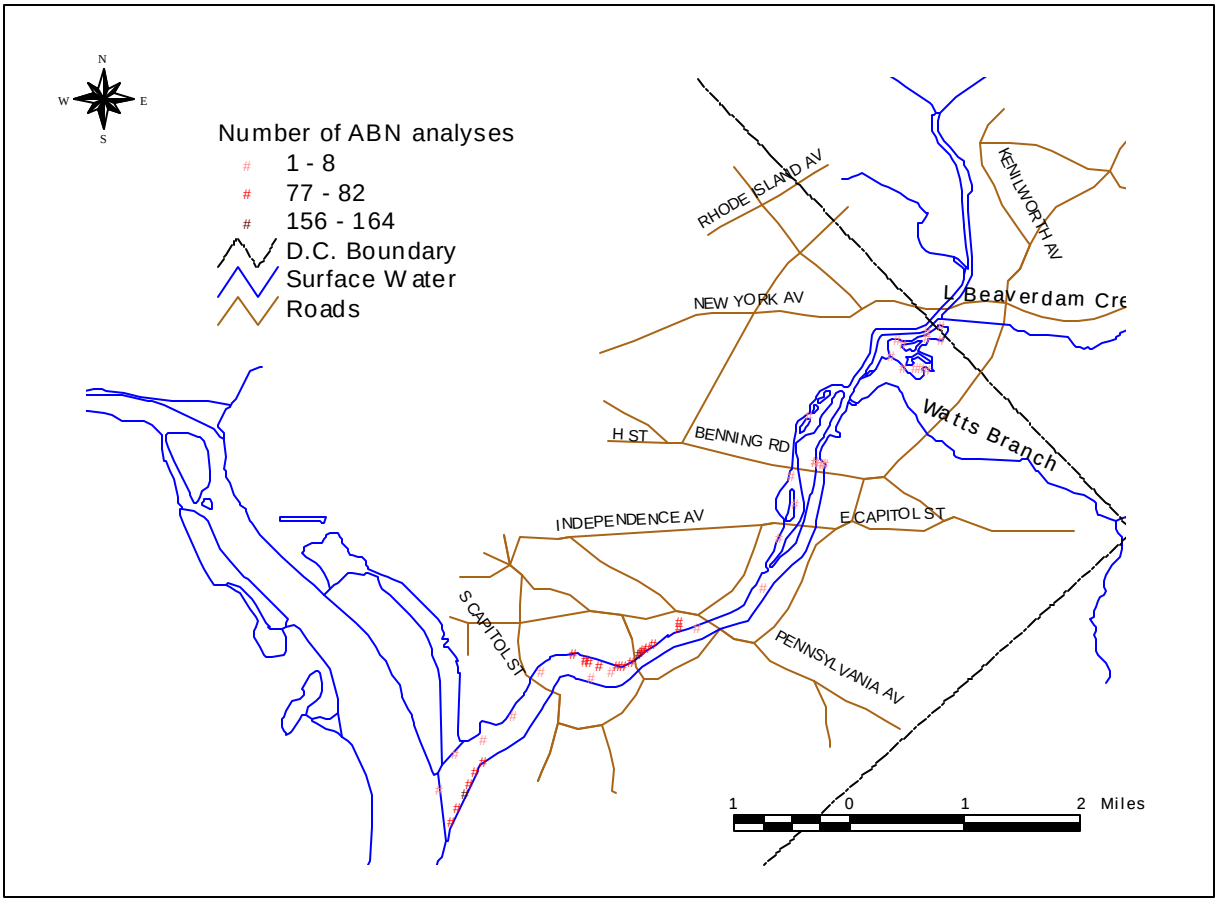

Figure 5-5. Numbers of Analyses for Acid/Base/Neutral Extractables (ABNs) at each Sediment Sampling Station. The majority of analyses have been performed on samples collected from two areas: one near the Navy shipyard and the other near the confluence with the Potomac. In contrast, there is no information in the database on concentrations of ABNs in the sediment in the river channel upstream of Watts Branch.

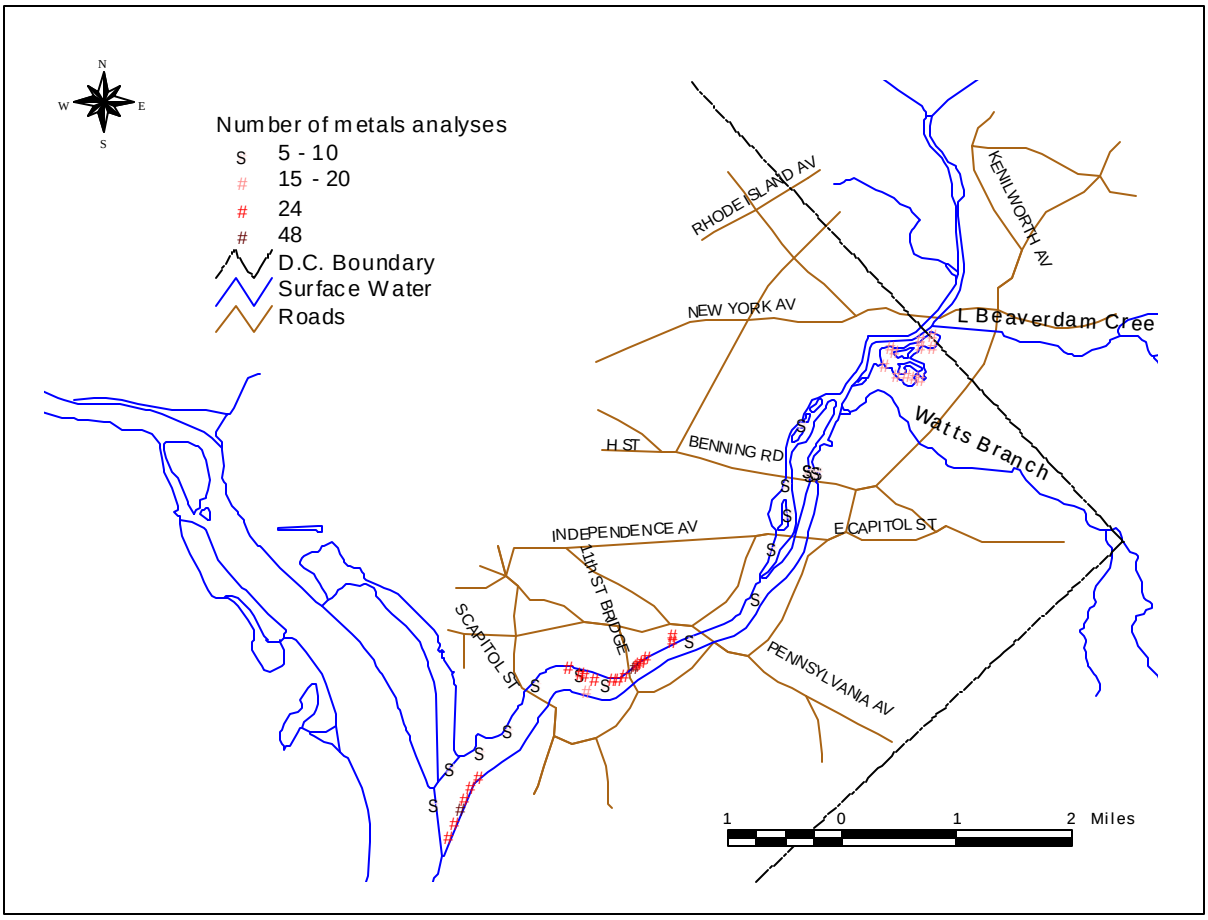

Figure 5-6. Numbers of Analyses for Metals at each Sediment Sampling Station. The majority of analyses have been performed on samples collected from three areas: near the Navy shipyard, near the confluence with the Potomac, and in Kenilworth Marsh. There is no information on the concentration of sediments in the river channel upstream of Watts Branch.

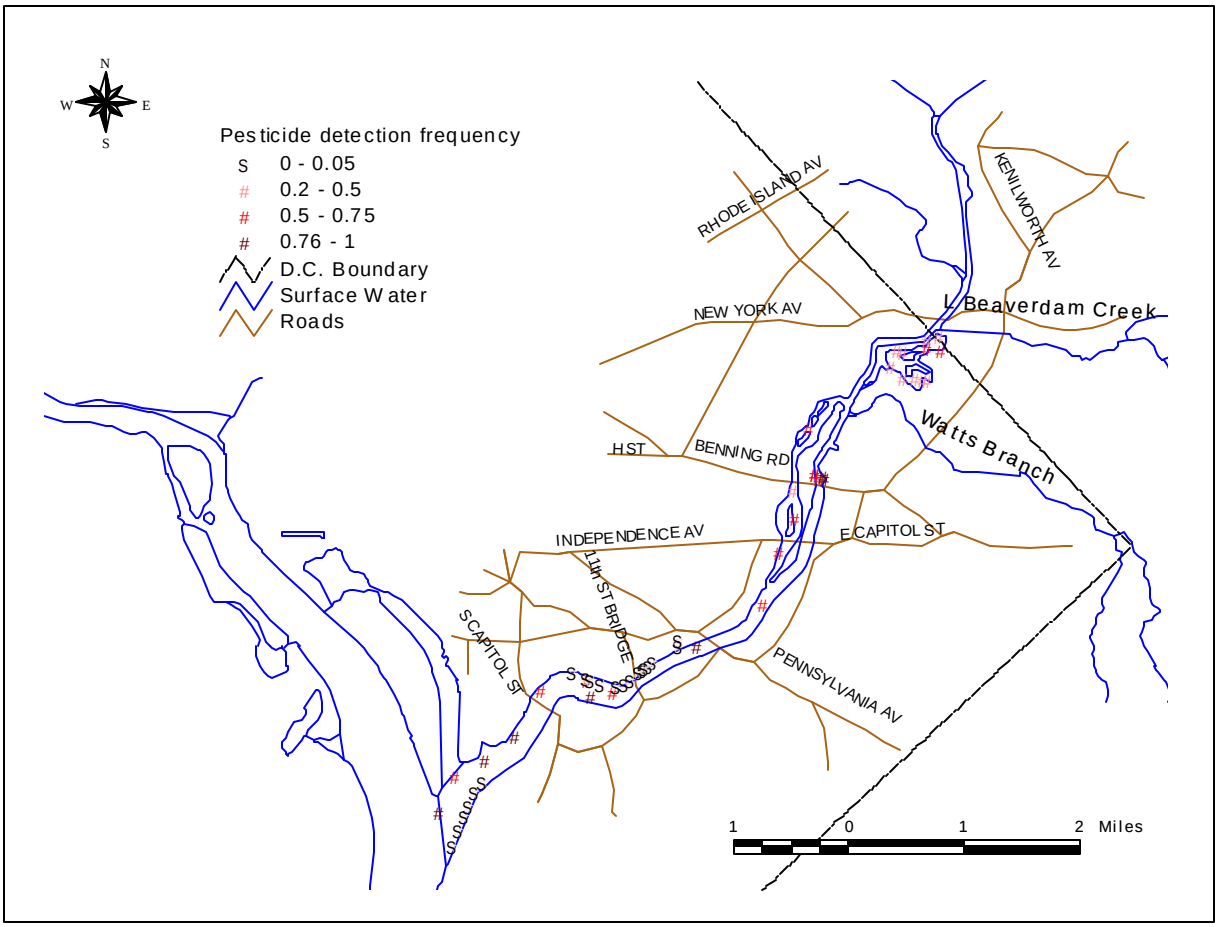

Figure 5-7. Detection Frequencies of Pesticides at Sediment Sampling Locations in the Tidal Anacostia River.

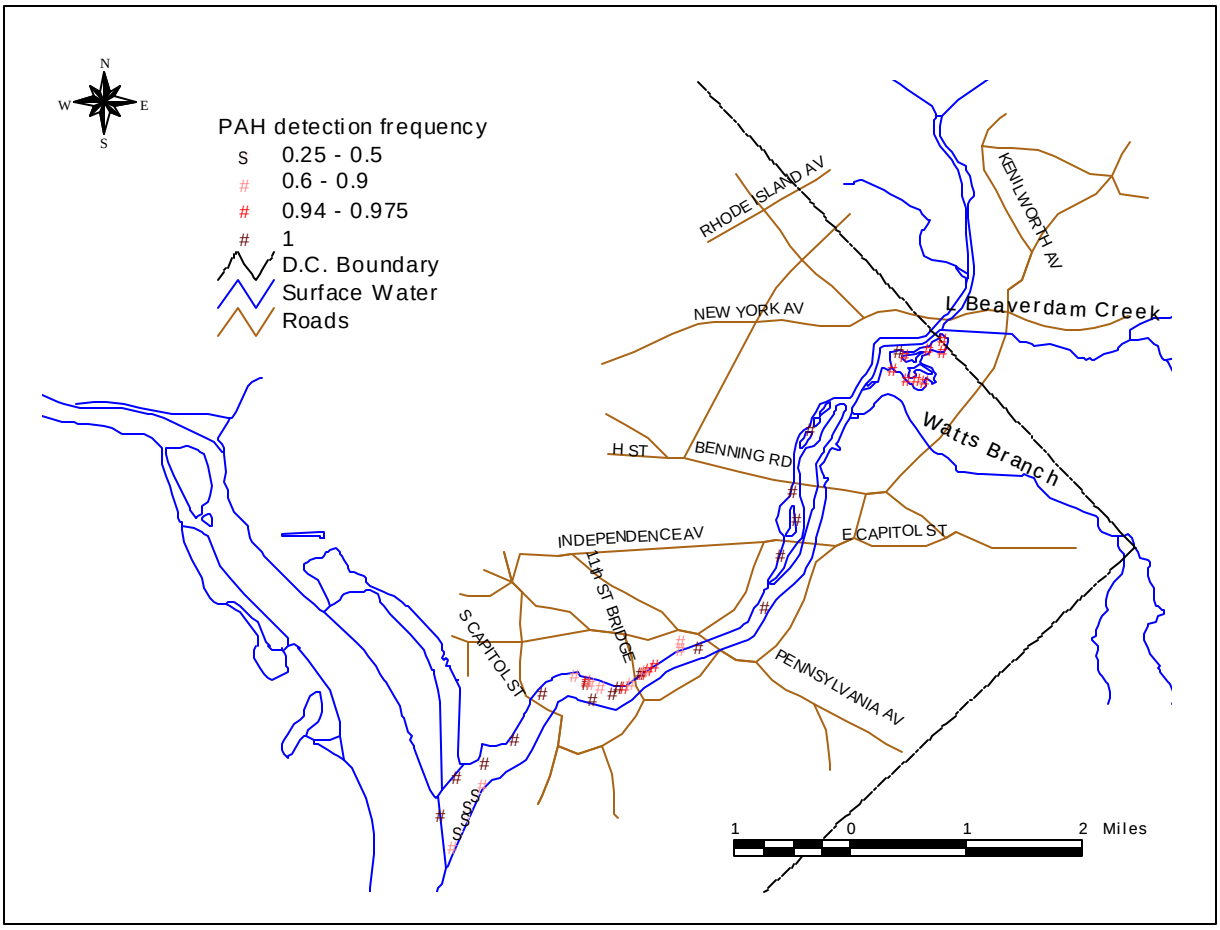

Figure 5-8. Detection Frequencies of PAHs at Sediment Sampling Locations in the Tidal Anacostia River.

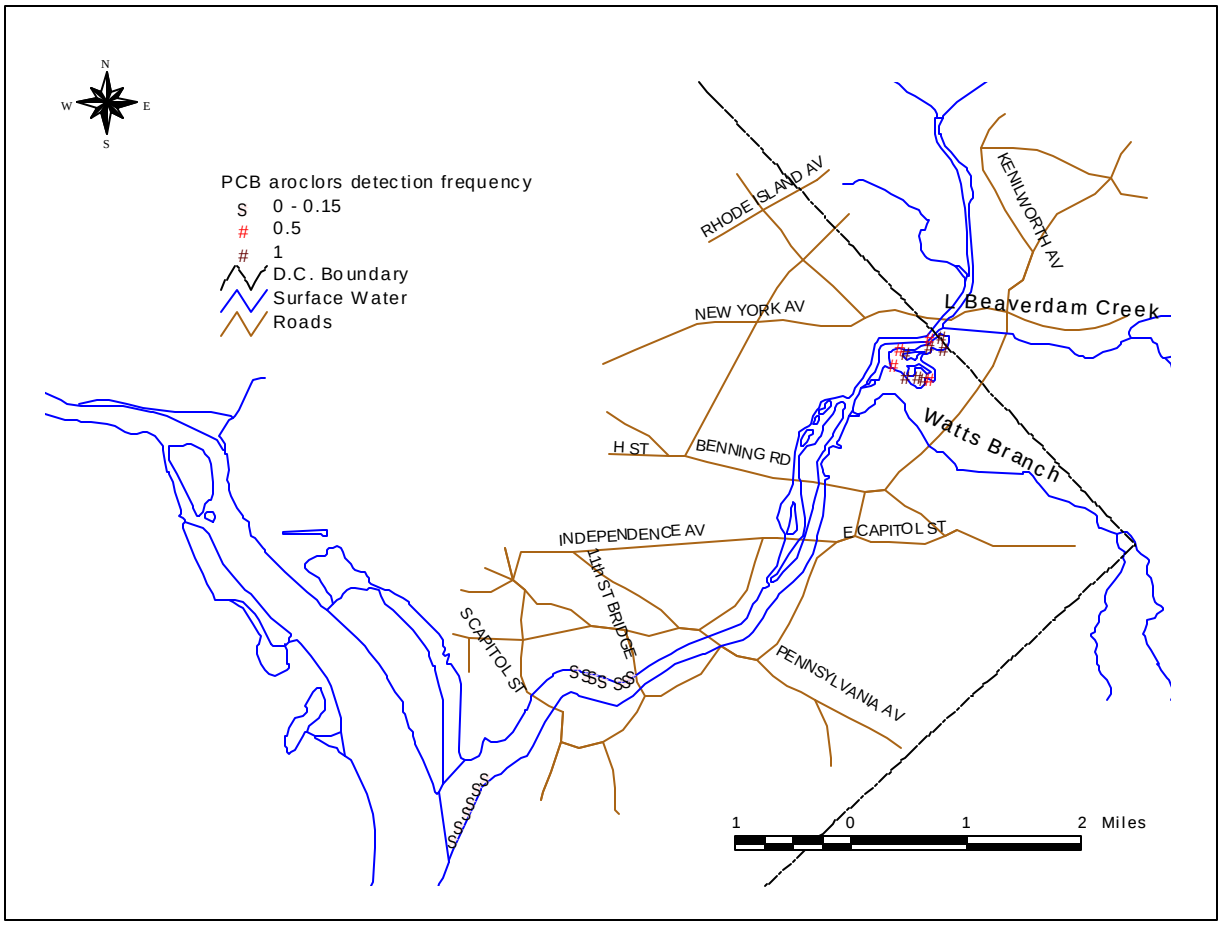

Figure 5-9. Detection Frequencies of PCB aroclors at Sediment Sampling Locations in the Tidal Anacostia River.

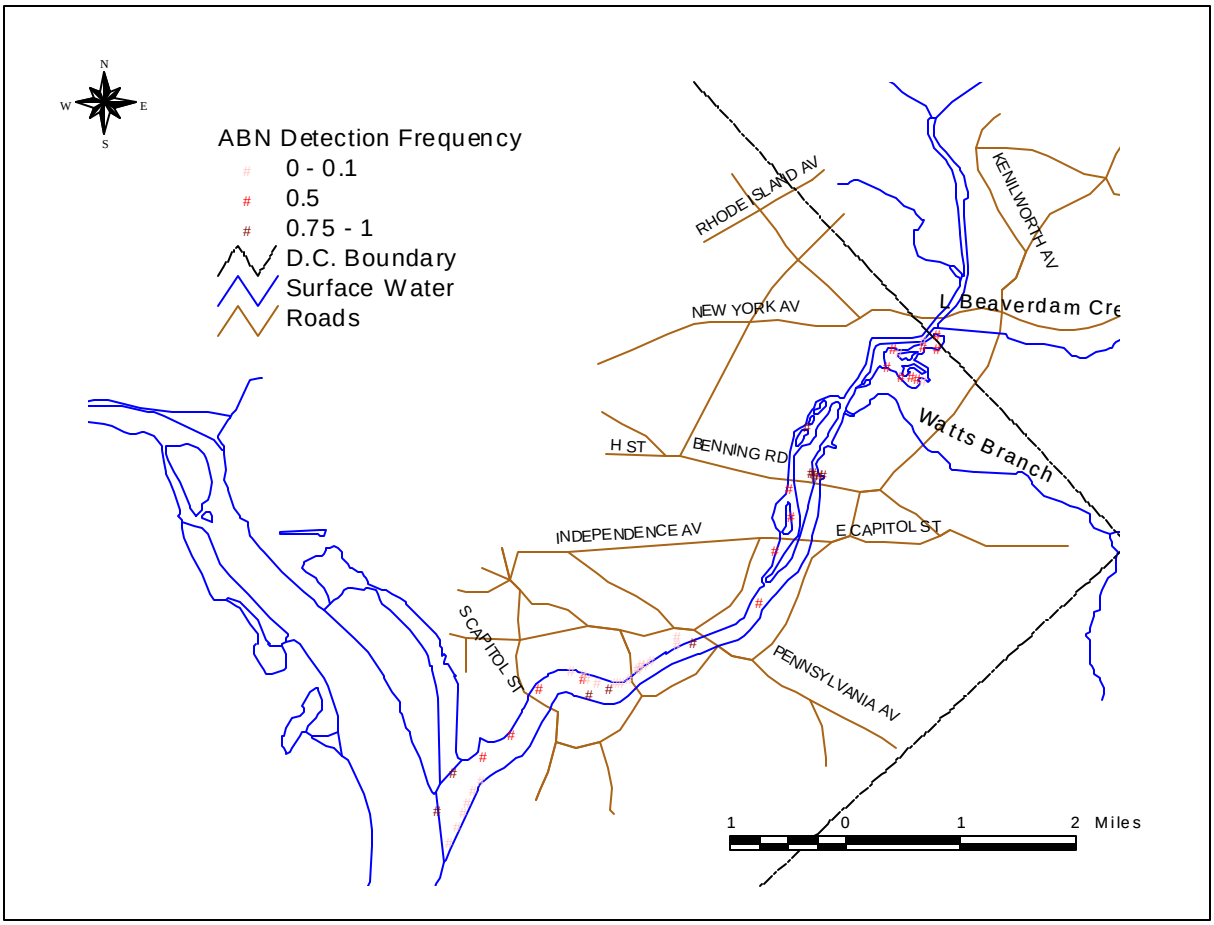

Figure 5-10. Detection Frequencies of acid/base/neutral extractable chemicals (ABNs) at Sediment Sampling Locations in the Tidal Anacostia River.

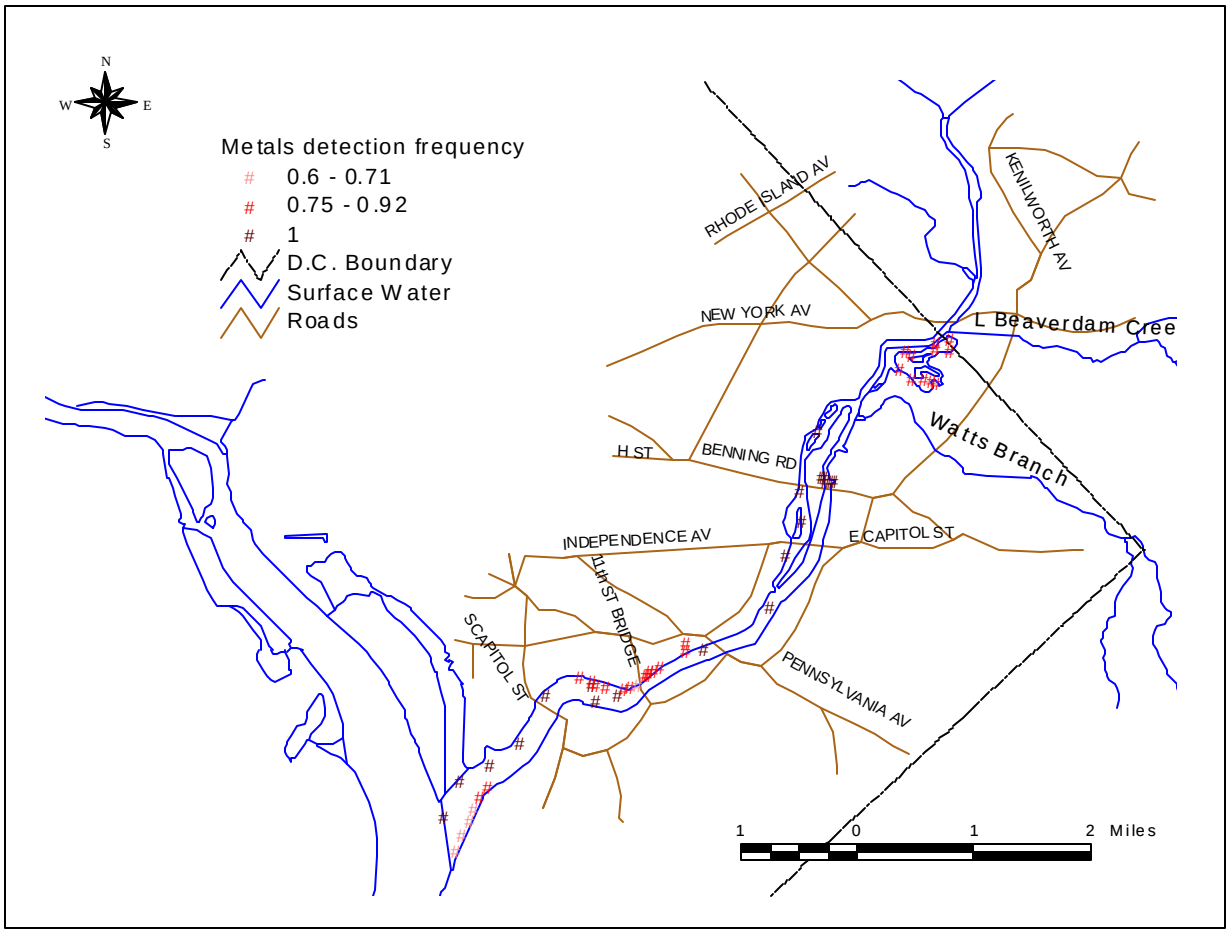

Figure 5-11. Detection Frequencies of Metals at Sediment Sampling Locations in the Tidal Anacostia River.

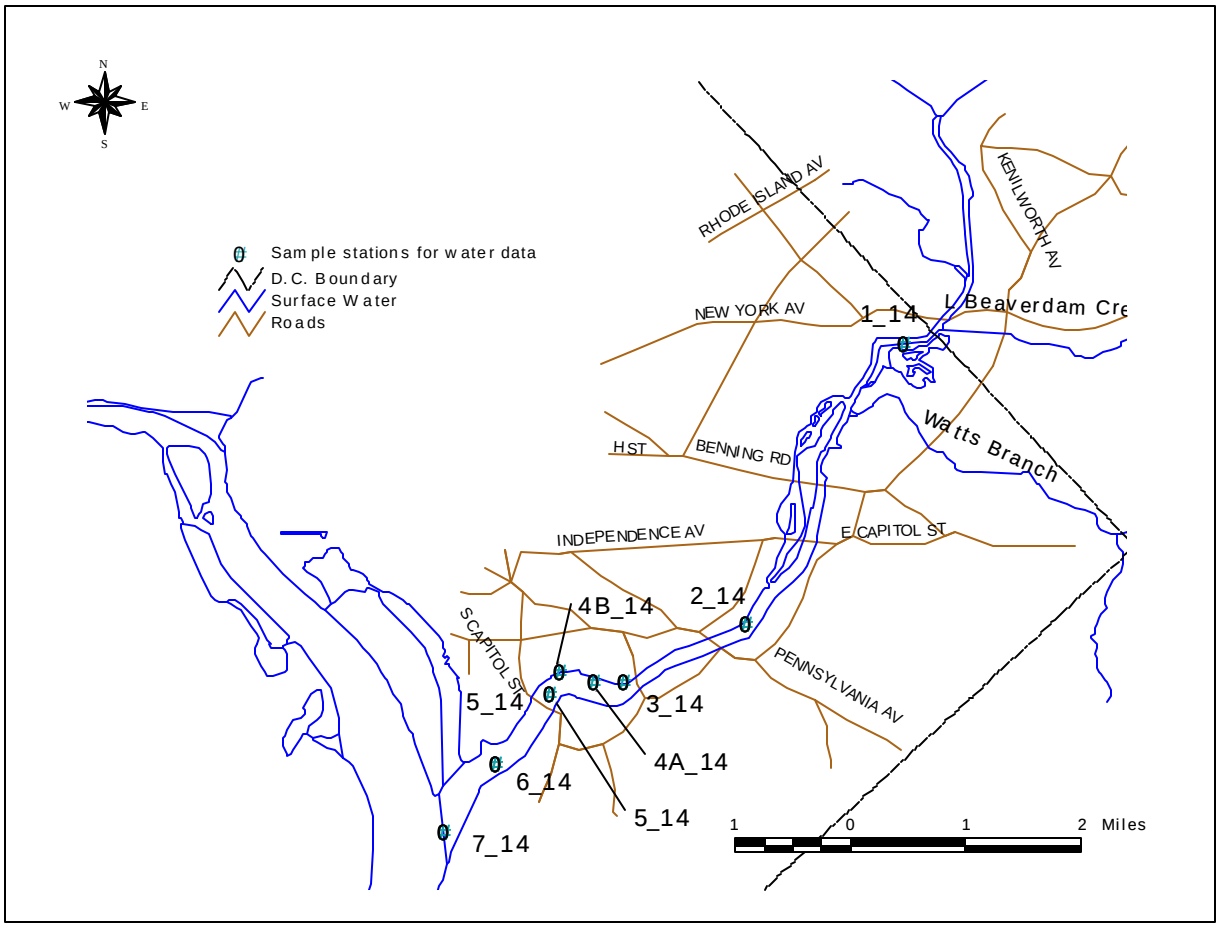

Figure 5-12. Location of Water Sampling Stations within the Tidal Anacostia. Note that there is only one station upstream of the Independence Avenue Bridge and there are no stations upstream of Lower Beaverdam Creek. The sampling stations were located in the lower Anacostia to determine the effects of stormwater runoff on water quality.

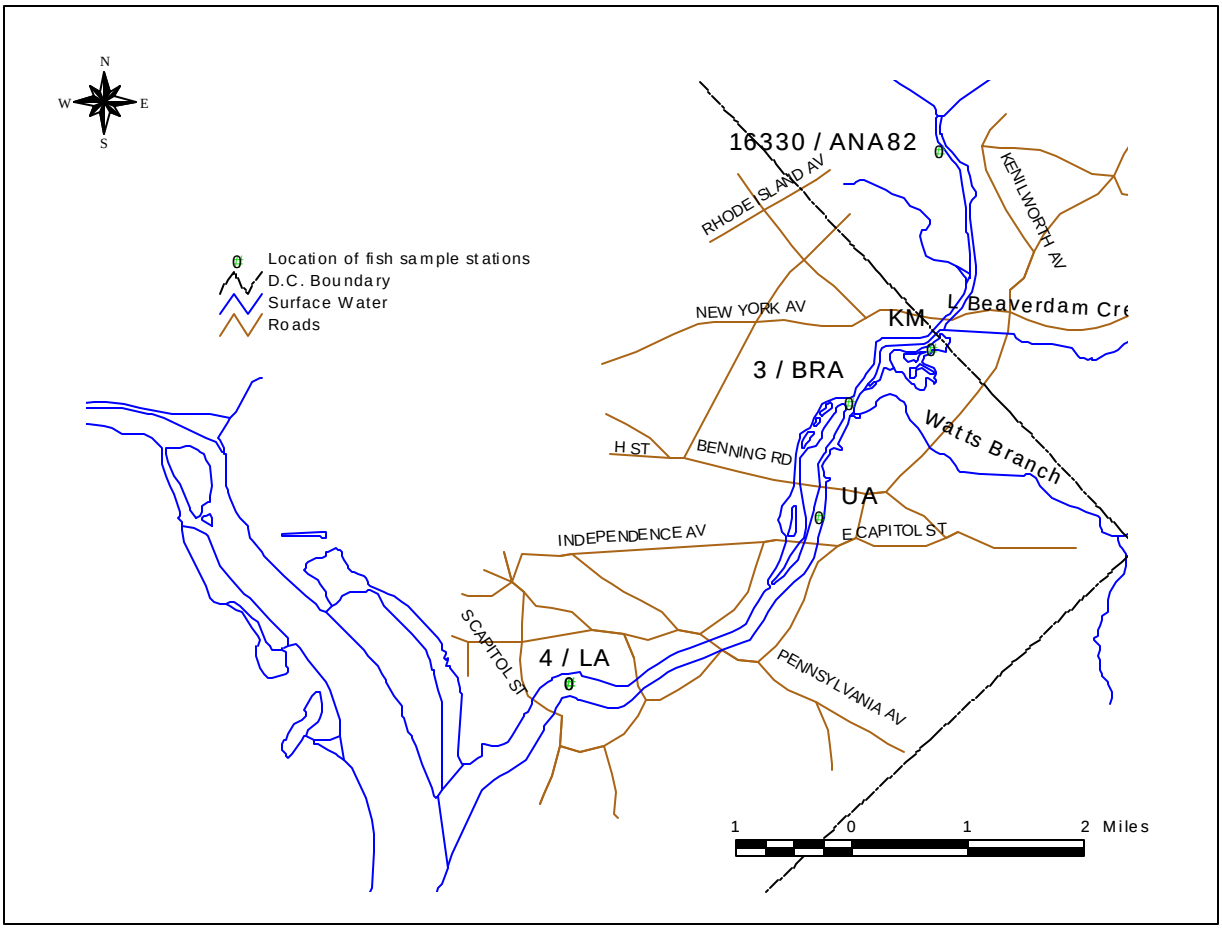

Figure 5-13. Location of Fish Tissue Sampling Stations within the Tidal Anacostia. Note that approximately 95% of the data in the database was obtained from two studies (Cummins and Velinsky 1993; Velinsky and Cummins 1996). Samples analyzed for these studies were collected from two areas: the Lower and Upper Anacostia, stations 4/LA and 3/BRA, respectively.

Table 5-1. Summary of Human Health Risk Screening Assessment Database

Table Names		No. of Records		Content Description
All Data	Screening Data	All Data	Screening Data	
XTISS	HHRAfish	11,009	4,932	Results of analyses of fish tissue samples
XCHEM	HHRASed	12,483	6,917	Results of analyses of surficial sediment samples
XCHEMSB	--	223	--	Results of analyses of subsurface sediment samples
Vel_ID14	HHRA_H20	3,734	2,738	Results of analyses of surface water samples
XCLAS	XCLAS	453	453	CASR numbers, chemical code names and chemical names
XSTN	XSTN	193	193	Latitude and longitude for sample locations in decimal degrees
Total Number of Records		28,095	15,233	

All Data refers to files on chemical concentrations in fish tissue, sediment and water from NOAA (2000) and Velinsky et al. (1999). Screening data refers to the subset of *All Data* that represents the tidal Anacostia as defined in Figure 5-1.

Table 5-2. Sources of Data in the Human Health Screening Database

Study ID	Study Name	Reference	Media
01	Washington Navy Yard	Baker Environmental, 1990[1]	sediment
02	Bolling AFB - SW Corner Landfill	Baker Environmental, 1990[1]	sediment
03	Additional Remedial Investigation and Feasibility Study (Phase IV) East Station Washington, D.C.	Hydro-Terra, 1999	sediment
04	1992 DC Fish Tissue Analysis for Evaluation of Human Health Risk	Cummins and Velinsky, 1993	fish
05	Organochlorine Residue/Histopathology of Fish	Block, 1990	fish
06	1995: PEPCO, Potomac Electric Power Co	Loos, 1999	sediment
08	1980-1995 Biological Tissue, Maryland	NA, 1990[1]	fish
10	Determination of Toxicity and Concentration of Contaminants In Sediment	US Fish and Wildlife Service, 1997	sediment
12	Effects of Wetland Restoration	Murphy et al., 1998	sediment
14	Effects of Stormwater Runoff on the tidal Anacostia	Velinsky et al., 1999	water
17	EMAP - Chesapeake Bay 1990	Strobel et al., 1995[1]	sediment
19	1992 Potomac and Anacostia Sediment Study	Velinsky et al.,1992	sediment
24	1993-1995 Wild Fish Tissue	Velinsky and Cummins, 1996	fish
A1	MD Dept of Natural Resources Data	NA, 1990[1]	fish

NA, Author names not available
[1]Studies were not available for review at the time this report was prepared

Table 5-3. Sample Size and Detection Frequency		
Chemical Class	**Number of Samples**	**Detection Frequency**
Acid/Base/Neutral Extractables	2535	0.10
Chlorinated dibenzodioxins	126	0.92
Chlorinated dibenzofurans	180	0.98
Metals	1426	0.82
Pesticides	1899	0.46
Polycyclic Aromatic Hydrocarbons	2006	0.77
Polychlorinated Biphenyl - Aroclors	127	0.23

Chemical classes are those defined in NOAA, 2000.

Table 5-4. Detection Rates for Water Samples

Chemical Class	Sample Station ID							
	1_14	2_14	3_14	4A_14	4B_14	5_14	6_14	7_14
ABN[1]	4 / 4	5 / 5	7 / 7	1 / 1	5 / 5	7 / 7	3 / 4	5 / 5
Metal	25 / 33	55 / 59	52 / 59	30 / 33	30 / 33	49 / 59	27 / 33	41 / 59
PCB	4 / 4	5 / 5	7 / 7	1 / 1	5 / 5	7 / 7	4 / 4	5 / 5
Pesticides	12 / 20	12 / 25	18 / 35	5 / 5	16 / 25	20 / 35	8 / 20	10 / 25

Values represent the number of times a chemical in the indicated class was detected in a sample collected from the sample station divided by the total number of analyses for that chemical class at the indicated sample station. Note that there is considerable more information on metals and pesticides than there is on ABNs and PCBs.

[1]ABNs = Acid/Base/Neutrals Extractables

Table 5-5. Detection Rates for Fish Samples

Chemical Class	Station ID				
	16330 / ANA82	KM[1]	3 / BRA	UA	4 / LA
ABNs[2]	2 / 3	2 / 2	28 / 328	6 / 6	44 / 344
Dioxins	ns[3]	ns	58 / 63	ns	58 / 63
Furans	ns	ns	87 / 90	ns	89 / 90
Metals	37 / 41	7 / 12	ns	21 / 36	44 /84
PAH	ns	33 / 40	19 / 144	94 / 120	216 / 424
PCBs	3 / 3	1 / 1	14 / 15	3 / 3	22 / 22
Pesticides	15 / 45	19 / 22	94 / 234	55 / 66	226 / 388

Values represent the number of times a chemical in the indicated class was detected in samples collected from the sample station divided by the total number of analyses for that chemical class at the indicated sample station. Note that there is very little information for fish tissue, other than the concentration of metals, for samples collected north of Lower Beaverdam Creek. The apparent difference in the detection rates for PAHs and pesticides between stations 3/BRA and 4/LA indicate the fish tissue concentrations for some contaminants may vary significantly between different areas of the tidal Anacostia River.

[1]KM = Kenilworth Marsh
[2]ABNs = Acid/base/neutral-extractables
[3]NS - No Samples

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Note: The NOAA database lists Block, E. as the author for this document; her name appears on the cover page of the document, for what that is worth.

U.S. Fish and Wildlife Service (1997): Data report: Determination of toxicity and concentrations of inorganic and organic contaminants in sediments used to restore Kenilworth Marsh, Washington, DC. (CBFO-C97-02) U.S. Fish and Wildlife Service, Branch of Water Quality and Environmental Contaminants, Annapolis, MD. 100 pages.

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6. HUMAN HEALTH RISK SCREENING

6.1 CONCEPTUAL CONSTITUENT INFLUX AND TRANSPORT MODEL

A conceptual site model (CSM) describes the processes that link sources of contamination at a site to exposures of human or ecological receptors. Ideally, the model defines the inputs of constituents to a site, the physical and chemical processes that result in transport of the constituents into environmental media to which human or ecological receptors may come into contact, and identifies the receptors that are likely to be impacted by exposure to these media. In its mature form, the model provides a basis for planning of data collection and evaluation needed to support risk assessments and remedial actions. In the early stages of development, the CSM identifies all *potential* links between sources and receptors, which subsequently can be evaluated for their plausibility and relevance with further data collection and analysis. Inputs, fate and transport processes, and exposure scenarios that are subsequently determined to be implausible or of negligible importance can be eliminated based on sufficient evidence.

The draft CSM described here is in the preliminary stages of development. It includes all of the potential inputs and exposure pathways of potential receptors. At this stage, the model does not attempt to quantify the relative importance of the various processes and pathways. The model is generic with respect to constituents. As constituents differ in the degree to which they may be affected by various fate and transport processes, at some point in the risk assessment process individual chemical-specific or chemical class-specific models may need to be developed and evaluated.

The draft CSM for human exposures at the tidal Anacostia River is shown in the attached Figures 6-1 and 6-2. For the purposes of this screening risk assessment, and at the direction of the Alliance, the tidal Anacostia River is defined as the river proper, including the tideplain and floodplain, extending from the confluence of the Northeast and Northwest Branches to the confluence with the Potomac River, as well as the Kenilworth Marsh and Kingman Lake embayments. It should be noted that this geographic constraint needs to be evaluated in terms of whether or not the contamination of the tidal Anacostia River can be adequately understood for the RI/FS process without considering inputs of contamination to the greater Anacostia Watershed. The draft CSM identifies potential exposure pathways linking sources with human receptors at the tidal Anacostia River. The model includes three components: *input pathways*, *tidal Anacostia River pathways*, and *exposure scenarios*, which are illustrated in the left, middle and right sections of Figure 6-1.

The *input pathways* component identifies the transfer mechanisms by which15 potential *antecedent media* enter the tidal Anacostia River as surface water, including suspended solids, which is referred to in Figure 6-1 as *contributed media*. *Antecedent media* is defined here as the various media (e.g., groundwater, Potomac River sediments) that potentially contribute chemical constituents to the Tidal Anacostia River (see Figure 6-1). In a complete CSM for a given chemical or chemical class, the relative contribution of each of the potential antecedent media to total surface water and suspended solids would be represented quantitatively. In the screening assessment, this will be evaluated based on available information, and information gaps will be identified for further study. Information concerning analyte

concentrations in antecedent media could be used in the forthcoming baseline risk assessment to identify potential sources of contamination.

The *tidal Anacostia River pathways* component identifies the transport mechanisms that operate within the tidal Anacostia River by which chemicals entering the system in surface water may be distributed to, and move between, the various media to which receptors may come into contact (*potential contact media*). Constituents may exit or be effectively isolated from contact media through the processes of chemical transformation, air movement, burial in deep riverbed sediments, or transport in surface water outflow to the Potomac River.

The *exposure scenario* component of the model identifies the potential scenarios by which humans may be exposed to contact media and indicates the current state of knowledge regarding the completeness of the exposure pathway for each scenario. Potential exposure scenarios are identified in terms of contact medium, exposure route, and receptor exposure category. Figure 6-2 provides a more detailed exposure scenario component of the CSM in that it identifies specific human receptor activities that would fall into each exposure category. The pathway evaluations shown in Figures 6-1 and 6-2 are based on review of the available information and may require modifications based on additional information provided from subsequent data collection efforts. In particular, currently available information does not support a quantitative analysis of the relative magnitude by which each transfer mechanism contributes to exposures. A more quantitative model is desirable for evaluating remediation strategies. For example, it is our understanding, based on comments from U.S. EPA, that there are no active domestic or commercial wells in the tidal Anacostia area that are used for residential tap or drinking water, therefore, the groundwater pathways are indicated as incomplete in Figures 6-1 and 6-2.

Figure 6-1. Conceptual Site Model for Human Health Risk Screening Assessment of the Tidal Anacostia.

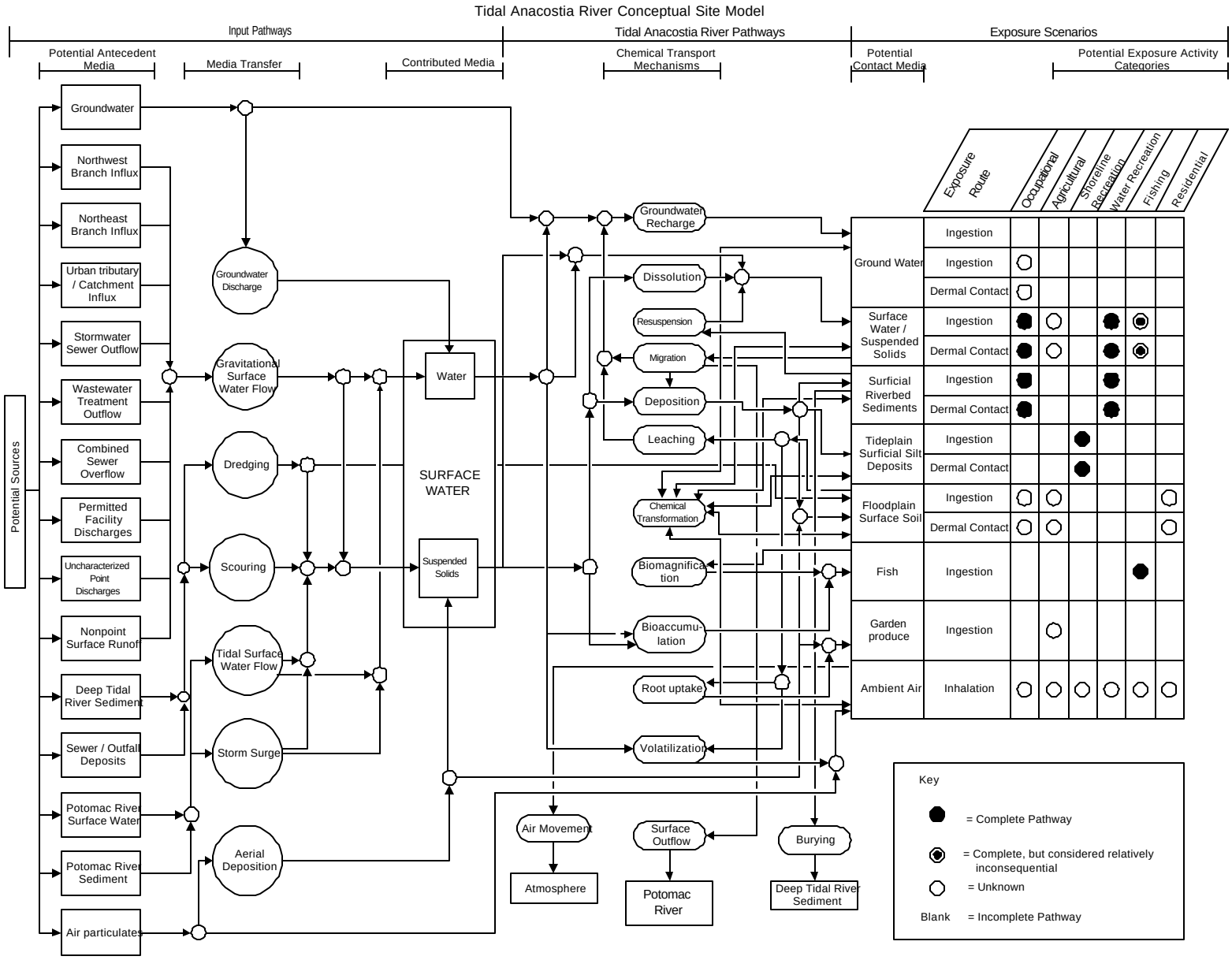


Figure 6-2. Potential Human Exposure Scenarios and Receptors Associated with the Tidal Anacostia River

Contact Media	Exposure Route	Occupational			Agricultural	Shoreline Recreational		Water Recreational			Fishing		Residential		
		Construction	Dredging	Fishing	Gardening	Picnicking	Hiking	Biking	Boating	Skiing	Swimming	Wading	Recreational	Subsistence	Showering	Consuming Drinking Water	Yard Play
Ground Water	Inhalation																
	Ingestion	○															
	Dermal Contact	○															
Surface Water / Suspended Solids	Ingestion		●	●	○				●		●		◉	◉			
	Dermal Contact		●	●	○				●		●		◉	◉			
Surficial Riverbed Sediments	Ingestion		●								●						
	Dermal Contact		●								●						
Tideplain Surficial Silt Deposits	Ingestion	○				●											
	Dermal Contact	○				●											
Floodplain Surface Soil	Ingestion	○			○	○											○
	Dermal Contact	○			○	○											○
Fish	Ingestion												●	●			
Garden Produce	Ingestion				○												
Ambient Air	Inhalation	○	○	○	○	○			○		○		○	○			○

Key — Pathway Analysis

● = Complete Pathway

◉ = Complete, but considered relatively inconsequential

○ = Unknown

Blank = Incomplete

6.2 SCREENING LEVEL ASSESSMENT

6.2.1 DECISION FRAMEWORK FOR SCREENING AND DATA INPUTS

The primary purpose of the screening level human health risk assessment is to categorize chemicals in the tidal Anacostia River with respect to their potential for adversely affecting human health. The chemicals that were considered in the assessment were all chemicals identified in the Anacostia River Watershed Database and Mapping Project (NOAA, 2000) (Table A6-1) (see Section 5- *Existing Data Summary/ Compilation* for additional information on the database). The exposure pathways and receptors that were considered included those indicated in the in the CSM (Figures 6-1 and 6-2)

Figure 6-3 illustrates the decision framework used to screen chemicals. The framework sorts chemical into five categories: 1) Chemicals of Potential Concern (COPC), 2) Not COPC, 3) Insufficient Information Related to Exposure; 4) Insufficient Information Related to Toxicity; or 5) Not Detected in Watershed.

Category 1 (COPC) includes chemicals detected in the tidal Anacostia River whose maximum concentration exceeded an RBC or an Applicable or Relevant and Appropriate Requirement (ARAR), and exceeded the expected site background concentration, if a site background estimate was available. The database does not include samples that would represent local background (i.e., concentrations of chemicals in sediment, water column and aquatic biota that would be expected in the absence of potential inputs to the tidal Anacostia River), therefore, the background component of the screen could not be conducted with available data.

Category 2 (Not COPC) would include any chemicals for which we can be reasonably certain do not pose an unacceptable risk, given the information available at this time. That is, there is sufficient information on exposure and toxicity of each Category 2 chemical to satisfy the screening requirements, and the maximum chemical concentration does not exceed an RBC or ARAR (a background screen could not be conducted).

Category 3 (Insufficient Information Related to Exposure) includes chemicals for which sampling was considered to be inadequate to interpret the maximum concentration reported in terms of potential risks, even though the reported maximum concentration did not exceed an RBC or ARAR. Category 3 also includes chemicals that were not detected in the tidal Anacostia River and for which sampling was considered to be inadequate. Adequacy of sampling was evaluated in terms both the number samples and geographic distribution of sampling within the tidal Anacostia River. The screening criteria for Category 3 was a minimum of three samples representing the upper, middle and lower regions of the tidal Anacostia River, including areas immediately downstream from the major inflows and catchments: 1) Northeast and Northwest Branches; 2) Fort Lincoln Drainage; 3) Lower Beaver Dam Creek; 4) Hickey Run and Watts Branch; 5) Washington Channel area; 6) Kenilworth Marsh; and 7) Kingman Lake. Category 3 would also include any chemicals detected in the watershed outside of the tidal Anacostia River (e.g., the Northeast and Northwest Branches) that were not evaluated in the tidal Anacostia River. Chemicals in Category 3 warrant further characterization with respect to their concentrations and distributions within the tidal Anacostia River before a determination can be made as to whether or not they are COPCs.

Category 4 (Insufficient Information Related to Toxicity) includes detected chemicals for which there were no applicable RBCs or ARARs and, therefore, a determination cannot be made as to whether or not they are COPCs. Should toxicological information become available on any of these chemicals be found sufficient to support the development of provisional RBCs, their status could be reevaluated.

Category 5 (Not Detected in Watershed) would apply to any chemicals that were not evaluated in the tidal Anacostia River, however, they were evaluated in other parts of the watershed and were not detected. These chemicals were included in a separate category because there is no evidence that they would be transported into the tidal Anacostia River from other parts of the watershed; therefore, their possible occurrence in the tidal Anacostia River would be from sources specific to the tidal Anacostia River. The need for further evaluation of the chemicals in Category 5 would be based, in part, on considering the likelihood of the existence of such potential sources. The complement of Category 5 are chemicals that were not evaluated in the tidal Anacostia River but were detected in other parts of the watershed; these were included in Category 3 (Insufficient Information Related to Exposure).

6.2.2 RISK BASED CONCENTRATIONS (RBCS)

Data were available on chemical concentrations in three environmental media in the tidal Anacostia River: river sediment, river surface water and river fish tissue. Chemicals in river surficial sediment were screened against RBCs for soil for a *commercial/industrial exposure scenario*, using the relevant RBCs developed by U.S. EPA Region 3 (U.S. EPA, 1999). The RBCs represent the chronic exposure concentration that would result in a non-cancer health risk equivalent to a Hazard Quotient (HQ) of 0.1 or a Cancer Risk of (CR) of 10^{-6}. The exposure factors integrated into the soil RBCs are summarized in Table 6-1. These factors, when used with the maximum sediment concentration and risk criteria of HQ #0.1 and CR #10^{-6}, introduce an appropriately *conservative* (health protective) *bias* into the sediment screening assessment for the following reasons: 1) potential receptors can be expected to be exposed to an average concentration less than the maximum concentration used in the screening assessment; 2) the risk criteria represent risks that are generally considered acceptable for environmental exposures to chemicals; and 3) the soil ingestion rate of 100 mg/d (and other exposure factors) represents a reasonable maximum exposure (RME) estimate for ingestion of soil and probably overestimates the RME estimate for river sediment.

Chemicals in surface water were screened against RBCs for residential tap water (U.S. EPA, 1999). The exposure factors integrated into the tap water RBCs are summarized in Table 6-2. The factors account for ingestion of tap water as well as inhalation of volatile chemicals during the use of tap water (e.g., showering). For the same reasons noted in reference to the soil RBCs, the tap water RBCs introduce a *conservative bias* into the screening assessment when applied to the surface water exposure scenario for the tidal Anacostia River. In particular, the tap water ingestion rates would be expected to substantially overestimate RME estimates for ingestion of surface water because Anacostia River water is not used for tap water in the region. Residences in the tidal Anacostia River area are supplied with municipal water and there is no documented use of ground water (e.g., wells) to supply household taps.

Chemicals in fish flesh were screened against RBCs for edible fish (U.S. EPA, 1999), using the exposure factors presented in Table 6-3. The RBCs for fish are based on wet weight fillet, however, the screening assessment is based on whole fish as well as fillets; this allowed inclusion of all of the fish tissue data in the assessment. The use of the whole fish data may result in a (health-protective) *conservative bias* in the screening assessment since chemicals in the parts of the fish that may not be ingested (e.g., subcutaneous fat and skeleton), and which may have higher concentrations in these tissues than in lean muscle (e.g., PCBs, lead), are included in the assessment. The fish tissue concentrations in the database are based on composite samples. Maximum concentrations determined from composite samples will tend to be biased low due to the *'averaging'* or *'smoothing'* effect that results from combining samples with high concentrations of contaminants with samples that have lower concentrations. However, the use of the maximum concentration as the RME exposure concentration may offset the low bias in the exposure concentration introduced by compositing samples.

Lead in river sediment was screened against a soil RBC of 800 mg/kg (ppm). The basis for the RBC is the U.S. Interim Adult Lead Methodology and the relevant exposure factors are provided in Table 6-4 (U.S. EPA, 1996). The methodology predicts that chronic exposure of women of childbearing age to 800 mg/kg lead for 219 days per year would result in a 95th percentile fetal blood lead concentration that would not exceed 10 µg/dL. Lead in river water was screened against the ARAR of 15 µg/L, the current U.S. EPA Maximum Contaminant Level for drinking water (U.S. EPA, 1991).

A Toxicity Equivalency Factor (TEF) approach was used to screen *dioxin-like* congeners of chlorinated dibenzo-*p*-dioxins (CDDs) and chlorinated dibenzofurans (CDFs). The maximum concentration of each congener was multiplied by the respective TEF and the resulting product was screened against the RBC for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD) (U.S. EPA, 1999). Separate screening assessments were conducted using TEFs recommended by U.S. EPA (1989) and the World Health Organization (WHO) (Van den Berg et al., 1998) (Table 6-5). However, the U.S. EPA TEFs were used in the final screening because they yielded more conservative estimates of 2,3,7,8-TCDD toxicity equivalent RBCs than did the WHO TEFs.

Aroclor mixtures of polychlorinated biphenyls (PCBs) were screened against respective RBCs (U.S. EPA, 1999). Congeners of PCBs were not screened, as per general procedures for screening assessments conducted by U.S. EPA Region 3. Polycyclic aromatic hydrocarbons (PAHs) were screened individually based on RBC values reported in U.S. EPA (1999).

6.2.3 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)

Chemicals were also screened against medium-specific ARARs and those chemicals for which the maximum detected concentration exceeded an ARAR were also considered COPCs (Category 1, Figure 6-3). ARARs used in the screening assessment are provided in Tables A6-2,3.

Water samples collected from the Tidal Anacostia river were compared to the D.C. surface water quality criteria (DCSWQC) (GDC 1994). If no criterion was provided for a particular chemical in the DCSWQC, the criterion for that chemical was obtained from the National Recommended Water Quality Criteria (NRWQC) (U.S. EPA, 1998), if one was provided. Finally, if no criterion for a particular chemical was provided in the DCSWQC or the NRWQC, the criterion for that chemical was obtained from the Maryland Water Surface Water Quality Criteria (MDE 2000), if one existed. In all cases, the criteria obtained from the above three regulations were developed to be protective of human health.

Fish tissue samples were compared to cancer and noncancer risk-based concentrations established for fish tissue by the U.S. EPA and to U.S. Food and Drug Administration (U.S. FDA) tolerance, action or guidance levels that are provided in Table D-1 of the National Sediment Quality Survey (U.S. EPA 1997). The EPA values in Table D-1 were adjusted to correspond to a lifetime cancer risk of 1E-06 or a hazard quotient of 0.1. When more than one screening value was provided for a given chemical, the lowest was used.

The sediment screening values provided in Table D-1 of the National Sediment Quality Survey (U.S. EPA, 1997) were considered as potential ARARs but were not used because the values provided in Table D-1 were developed to be protective of aquatic organisms rather than humans. The generic soil screening levels (SSLs) provided in the U.S. EPA Soil Screening Guidance Document (U.S. EPA 1996) were also considered as potential ARARs. The SSLs were not used because they assume a residential exposure scenario which is not consistent with the Region 3 RBCs for soil (U.S. EPA, 1999) (which assume an industrial exposure scenario) that were used in the human health screening assessment.

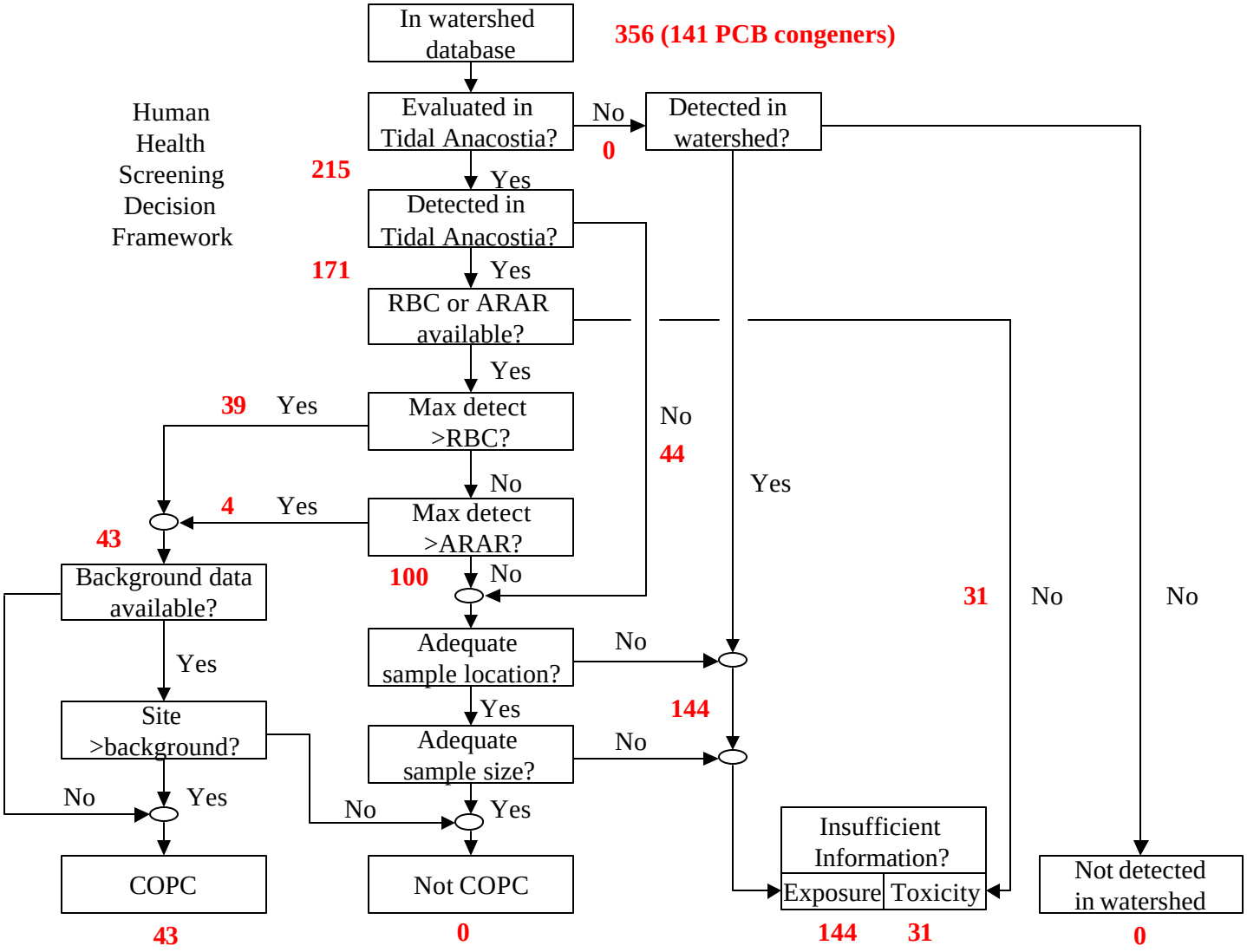


Figure 6-3. Decision Framework for Human Health Risk Screening. The numbers of chemicals that were sorted at each major decision point are shown.

Table 6-1. Exposure Factors Used in Soil RBCs (Industrial Scenario)			
Exposure Variable	**Units**	**Value**	**Symbol**
Target cancer risk	probability	10^{-6}	TR
Target hazard quotient	unitless	0.1	THQ
Carcinogenic potency slope oral	risk/mg/kg/day	chemical-dependent	CPS_o
Reference dose oral	mg/kg/day	chemical-dependent	RfD_o
Body weight, adult	kg	70	BW_a
Averaging time (carcinogens)	days	25,550	AT_c
Averaging time (non-carcinogens)	days	ED x 365	AT_n
Soil ingestion, adult	mg/day	100	IRS_a
Exposure frequency, occupational	days/year	250	EF_o
Exposure duration	year	25	ED_o
Fraction of contaminated soil ingested	unitless	0.5	FC

From U.S. EPA, 1999

Table 6-2. Exposure Factors Used in Tap Water RBCs			
Exposure Variable	**Units**	**Value**	**Symbol**
Target cancer risk	probability	10^{-6}	TR
Target hazard quotient	unitless	0.1	THQ
Carcinogenic potency slope oral	risk/mg/kg/day	chemical-dependent	CPS_o
Carcinogenic potency slope inhaled	risk/mg/kg/day	chemical-dependent	CPS_i
Reference dose oral	mg/kg/day	chemical-dependent	RfD_o
Reference dose inhaled	mg/kg/day	chemical-dependent	RfD_i
Body weight, adult	kg	70	BW_a
Averaging time (carcinogens)	days	25,550	AT_c
Averaging time (non-carcinogens)	days	ED x 365	AT_n
Volatilization factor	L/m^3	0.5	K
Inhalation factor, age-adjusted	m^3-year/kg-day	11.66	IFA_{adj}
Tap water ingestion factor, age-adjusted	L-year/kg-day	1.09	IFW_{adj}
Inhalation rate, adult	m^3/day	20	IRA_a
Tap water ingestion rate, adult	L/day	2	IRW_a
Exposure frequency, residential	days/year	350	EF_r
Exposure duration, total	year	30	ED_{tot}

From U.S. EPA, 1999

Table 6-3. Exposure Factors Used in Fish Tissue RBCs			
Exposure Variable	**Units**	**Value**	**Symbol**
Target cancer risk	probability	10^{-6}	TR
Target hazard quotient	unitless	0.1	THQ
Carcinogenic potency slope oral	risk/mg/kg/day	chemical-dependent	CPS_o
Reference dose oral	mg/kg/day	chemical-dependent	RfD_o
Body weight, adult	kg	70	BW_a
Averaging time (carcinogens)	days	25,550	AT_c
Averaging time (non-carcinogens)	days	ED x 365	AT_n
Fish ingestion rate	g/day	54	IRF
Exposure frequency, residential	days/year	350	EF_r
Exposure duration, total	year	30	ED_{tot}

From U.S. EPA, 1999

Table 6-4. Parameter Values Used in the U.S. Interim Adult Lead Methodology			
Parameter	**Units**	**Value**	**Symbol**
Goal for the 95th percentile blood lead concentration among fetuses	Fg/dL	10	$PbB_{fetal.\ 0.95,\ goal}$
Individual geometric standard deviation of blood lead concentration	unitless	1.8	$GSD_{i,adult}$
Constant of proportionality between fetal and maternal blood lead concentration at birth	unitless	0.9	$R_{fetal,maternal}$
Typical blood lead concentration in adults in absence of exposure to the site that is being assessed	Fg/dL	2.0	$PbB_{adult,0}$
Biokinetic slope factor relating increase in typical adult blood lead level to average daily lead uptake	Fg/dL per Fg/day	0.4	BKSF
Ingestion rate of soil	g/day	0.05	IR_s
Exposure frequency	days/year	219	EF_s
Absolute gastrointestinal absorption fraction for ingested lead in soil	unitless	0.12	AF_s
Averaging time	days/year	365	AT
Parameter values yield a soil RBC of 800 ppm (From U.S. EPA, 1996)			

Table 6-5. Toxicity Equivalency Factors (TEFs) for *Dioxin-like* Congeners of Chlorinated Dibenzo-p-dioxins (CDDs) and Chlorinated Dibenzofurans (CDFs)

CAS No.	Congener or Homolog	CHEMCODE[1]	TEF	
			EPA[2]	WHO[3]
40321764	PCDD12378	PCD12378	0.5	1.0
57117416	PCDF12378	PCF12378	0.05	0.05
57117314	PCDF23478	PCF23478	0.5	0.5
1746016	TCDD2378 (dioxin)	PCD2378	1.0	1.0
51207319	TCDF2378	PCF2378	0.1	0.1
39227286	H6CDD123478	PCD123478	0.1	0.1
57653857	H6CDD123678	PCD123678	0.1	0.1
19408743	H6CDD123789	PCD123789	0.1	0.1
70648269	H6CDF123478	PCF123478	0.1	0.1
57117449	H6CDF123678	PCF123678	0.1	0.1
72918219	H6CDF123789	PCF123789	0.1	0.1
60851345	H6CDF234678	PCF234678	0.1	0.1
35822469	H7CDD1234678	PCD1234678	0.01	0.01
67562394	H7CDF1234678	PCF1234678	0.01	0.01
55673897	H7CDF1234789	PCF1234789	0.01	0.01
39001020	Octachlorodibenzofuran	OCDF	0.001	0.0001
3268879	Octachlorodibenzo-p-dioxin	OCDD	0.001	0.0001

[1]Identifying code used in screening database and NOAA (2000)
[2]U.S. EPA, 1989
[3]Van den Berg et al., 1998

6.2.4 BACKGROUND SCREEN

When site-specific background chemical concentrations are available, the concentrations of chemicals on the preliminary list of COPCs would be compared against background to determine whether the concentration is higher than background; chemicals that are not demonstrably higher than background may then be placed in the not-COPC group. No site-specific background concentrations were identified for tidal Anacostia River media for use in the screening human health risk assessment. In the absence of background data, all chemicals for which the maximum concentration exceeded an RBC or an ARAR were considered to be COPCs.

6.2.5 CATEGORY 1 CHEMICALS - CHEMICALS OF POTENTIAL CONCERN (COPCS)

COPCs include those chemicals that were: 1) detected in tidal Anacostia River sediments, surface water or fish; and 2) for which the maximum concentration in any single medium exceeded an RBC or ARAR. Based on these screening criteria, 43 chemicals were categorized as COPCs (Table 6-6a); 39 chemicals are COPCs in fish, 7 in river sediment and 5 in river water; six of the chemicals are COPCs for more than one media.

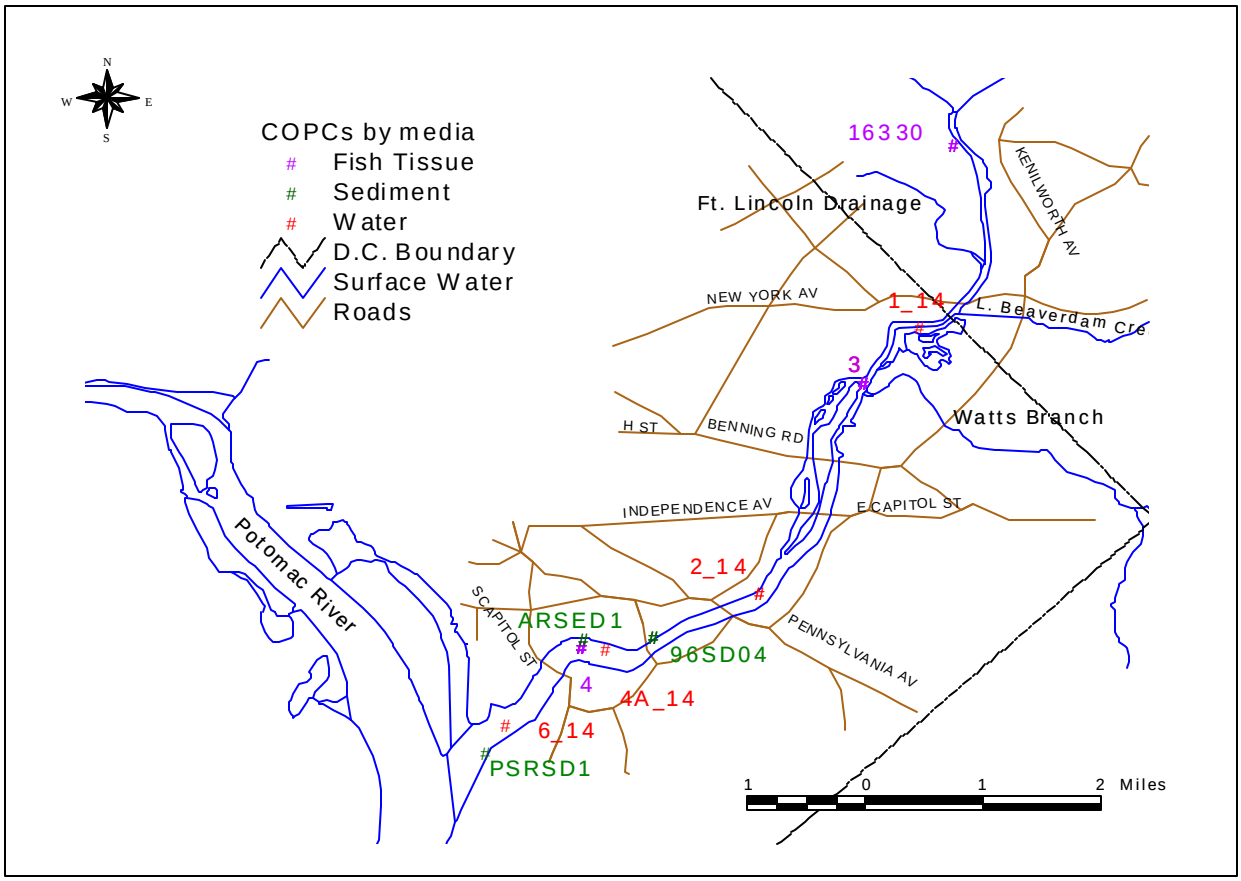
Fish tissue COPCs fall into several chemical classes. Seventeen are chlorinated dibenzodioxins or dibenzofurans; 12 are organic pesticides: aldrin, (-HCH (lindane), HCB, DDT, DDE, dieldrin, chlordane (or transformation products), or heptachlor; 2 are PCBs, including Aroclor 1260; and 4 are metals: lead, mercury, arsenic and cadmium. The remaining fish tissue COPCs are "-HCH, heptachlor epoxide, bis(2-ethylhexyl)phthalate and di-N-octyl phthalate. Four of the COPCs for fish were placed in Category 1 for exceeding an ARAR: transchlordane, cischlordane, gammachlordane and lead.

The 7 COPCs in sediment include two chemicals (or chemical mixtures) that are also COPCs in water and fish tissue: arsenic and total PCBs and one chemical that is also a COPC in fish tissue: Aroclor 1260. The remaining 4 sediment COPCs include the following PAHs: benzo(a)pyrene, dibenz(a,h)anthracene, benz(a)anthracene and benzo(b)fluoranthene.

The 5 COPCs in water include two chemicals (or chemical mixtures) that are also COPCs in fish tissue and sediment: total PCBs and arsenic, and three that are also COPCs in fish tissue: heptachlor (pesticide), DDE and DDT.

Table 6-6b presents the COPCs for each environmental medium, sorted by the ratio of the maximum detected concentration to the RBC (max/RBC). The max/RBC ratio provides the magnitude by which the maximum concentration exceeds the RBC. A high max/RBC ratio would indicate a greater potential for concern that a given chemical may pose a risk at reasonable maximal exposure (RME), given the conservative assumptions in the screening assessment. The max/RBC ratio range was 1.1–2911 for fish tissue and 1.2–34 for sediment. In fish tissue, total PCBs had the highest max/RBC ratio; in sediment, benzo(a)pyrene had the highest ratio. The max/RBC ratio range was 1.1–380 for water, total PCBs had the highest max/RBC ratio. The three sediment COPCs that are also COPCs in fish tissue, total PCBs, Aroclor 1260, and arsenic represent the first, second and fifth highest max/RBC in fish tissue, respectively, and all 3 had max/RBC ratios in fish tissue that exceeded 100.

Figure 6-4 shows the geographic distribution of the maximum concentrations for COPCs, Table 6-6c provides the study identification numbers, sample locations and the sampling dates corresponding to the COPCs. Sampling stations 16330 (downstream from the confluence of the Northwest and Northeast Branches), 3 (near and upstream from Kingman Lake), and stations 4 and LA (nearly co-located with



station 4, near and upstream from the South Capital St Bridge) are the most widely separated stations at which fish contaminants were measured. The considerable commonality of the COPCs and their respective chemical classes detected at these stations would suggest either their relatively widespread Figure 6-4. Sample Stations Where the Maximum Concentrations of the Chemicals of Potential Concern (COPCs) were Detected. Table 6-6c provides the Study ID numbers and the sample dates corresponding to the COPCs.

occurrence in the tidal Anacostia or the ranging patterns of the fish species sampled. COPCs detected at all of these regions of the tidal river include the pesticides chlordane, heptachlor, and lindane; chlorinated dibenzodioxins and dibenzofurans; and polychlorinated biphenyls. Note that co-location of COPCs does not necessarily indicate concurrence, as samples were collected over a time-span of 5 years.

Hazard identification summaries for each COPC are presented in Section 6.2.10

6.2.6 CATEGORY 2 CHEMICALS - NOT CHEMICALS OF POTENTIAL CONCERN (NOT COPCS)

Although 104 chemicals had maximum concentrations that did not exceed an RBC, none of these chemicals qualified for inclusion in the *Not COPC* category. This outcome was primarily the result of either low sample numbers or inadequate geographic distribution of samples, either of which resulted in their inclusion in Category 3 (Insufficient Information Related to Exposure). Four of the 104 chemicals exceeded an ARAR and were placed in Category 1. In addition, 44 chemicals that were not detected in any sample were also placed in Category 3 due to inadequate sample number or inadequate geographic distribution of samples.

6.2.7 CATEGORY 3 CHEMICALS - INSUFFICIENT INFORMATION RELATED TO EXPOSURE

The screening of chemicals against criteria for sample number and geographic distribution (see Section 6.2.1 for criteria) resulted in the inclusion in Category 3 of all 100 detected chemicals that were not categorized as COPCs (Category 1) (Table 6-7a) and the 44 undetected chemicals (Table 6-7b). The primary basis for this outcome is as follows: 1) there are no records in the database of sediment samples for sections of the river channel upstream of Hickey Run; 2) relatively few sediment samples are recorded for the section of the river between Benning Road Bridge and the Pennsylvania Avenue Bridge, none of which were analyzed for Aroclors; and 3) there is only one water sampling station north of the Independence Avenue Bridge. As a result, large sections of the river are not represented in the data on chemical concentrations in sediment and in the water column. These include areas that potentially may have received chemical inputs from the Northeast and Northwest Branches, the Fort Lincoln drainage area, the Kenilworth Marsh, Kingman Lake and other urban drainage sources along these sections of the river. In addition, the database does not contain any information on the concentration of dioxins, furans or PAHs in the water column.

Category 3 includes numerous chemicals that are members of chemical classes represented in the COPC list, including PCBs (Aroclors), several PAHs, a variety of pesticides, several metals. Thus, it would not be particularly surprising if some of these chemicals were to be reclassified as COPCs, based on the results of additional sampling of the river or the inclusion of additional, existing sample information in the database.

The lack of data from the upper tidal Anacostia River is a significant data gap. Several studies have identified dissolved and/or particulate influx from the Northeast and Northwest Branches as potentially significant contributors to chemical loadings to the tidal Anacostia River. In addition, sedimentation rates in the upper tidal river, would suggest that particulate chemical loadings from the upper tributaries may deposit in the upper tidal river. Surface water movement and particulate transport are not sufficiently characterized in the upper tidal Anacostia River to determine whether particulate influx from the upper tributaries typically deposit in, or pass through, the upper tidal river area. The available information is suggestive that concentrations in surface water, sediment, and/or biota in the upper tidal river may be high enough for certain chemicals that are not yet identified as COPCs to be identified as COPCs if further

data were available. The uncertainty regarding chemical concentrations in media in the upper tidal river may be resolved with acquisition of additional data.

The screening assessment also determined if there were any chemicals that were detected in other areas of the watershed but were not evaluated in the tidal Anacostia River. These would have been included in Category 3. No chemicals qualified under this criteria.

6.2.8 CATEGORY 4 - INSUFFICIENT INFORMATION RELATED TO TOXICITY

Thirty-one chemicals could not be evaluated against toxicity criteria because of the lack of an RBC (Table 6-8); however, three of the chemicals were placed in Category 1 for exceeding ARARs: cischlordane, gammachlordane and transchlordane. Twelve of the Category 4 chemicals are PAHs which, as a chemical class, are represented on the COPC list. Twelve Category 4 chemicals are pesticides or structural analogs, including several structural or compositional analogs of the following chemicals that are COPCs: BHCs, hexachlorocyclohexane-delta (lindane), the ortho-para isomers of DDD, DDE and DDT, oxychlordane and transchlordane. Several other chemicals in Category 4 are structurally and/or toxicologically similar to chemicals that are identified as COPCs. Arsenic III is listed as a Category 4 chemical even though the maximum concentration of arsenic III reported in water column samples (1.8E–01 ppm) exceeded the cancer-based RBC for inorganic arsenic (4.46E–02 ppm). Monomethyl and dimethyl arsenic are also included in the Category 4 list.

6.2.9 CATEGORY 5 - NOT EVALUATED IN TIDAL ANACOSTIA RIVER AND NOT DETECTED IN WATERSHED

There were no chemicals in this category.

6.2.10 HAZARD IDENTIFICATION FOR COPCS

Hazard identification information is summarized in Appendix B for each COPC identified in the screening assessment (Category 1). The summaries include the hazard basis for the RBC, cancer or non-cancer effects, and the relevant dose-response information available from U.S. EPA (2000).

6.2.11 UNCERTAINTY ASSESSMENT FOR SCREENING RESULTS

The methodology used in this screening assessment is intended to identify those chemicals in the tidal Anacostia that might be of potential concern as human health risks (COPCs) so that additional data can be collected on these chemicals that would support quantitative estimates of risk. In order to ensure that all COPCs are identified and that no chemicals are misclassified as *Not COPCs*, the risk based screening approach is intentionally designed to have a health protective bias. This bias or conservatism derives from the following:

- use of the maximum concentration as the exposure concentration term in the screening assessment;
- use of risk criteria (e.g., cancer risk of 10^{-6} and hazard quotient of 0.1) that are generally considered acceptable for environmental exposures to chemicals;

- use of exposure factors that represent a reasonable maximum exposure (RME) estimate for ingestion of soil, which probably overestimates the RME estimate for river sediment; and
- use of exposure factors for exposure to residential tap water, which would be expected to substantially overestimate RME estimates for ingestion of surface water because river water is not used for tap water in the region.

The above notwithstanding, important uncertainties attend identification of COPCs based on this methodology, given the available data. The uncertainties were considered too large to support a definitive classification of any chemicals into the *Not COPC* category. As a result, a large number of chemicals were assigned to other categories based on the major source of uncertainty: 1) those related to representativeness of the samples used to estimate a maximum concentration (Category 3) and; 2) those related to the lack of toxicity values to support RBCs for use in the screening assessment (Category 4).

Uncertainties in Representativeness of the Samples

Data from fish, sediment and water samples that are included in NOAA 2000 database were used to estimate the maximum exposure concentrations that would occur in human receptors that contact the river. However, limitations in the geographic and temporal distribution of the samples included in the NOAA 2000 database made such estimates highly uncertain for most of the chemicals that entered the screening assessment. For example, there are no sediment samples for sections of the river channel upstream of Hickey Run and relatively few sediment samples between Benning Road Bridge and the Pennsylvania Avenue Bridge, none of which were analyzed for Aroclors. Furthermore, there is only one water column sampling location upstream of the Independence Avenue Bridge and no stations upstream from Lower Beaverdam Creek. There is no information on the concentration of dioxins, furans, or PAHs in the water column. Existing data were collected at various times and do not represent a random sample of the river either spatially or temporally. As a result of these limitations, there are very little or no data for large sections of the river, including potentially important inputs such as the Northeast and Northwest Branches, Fort Lincoln drainage area, Kenilworth Marsh, Kingman Lake and other urban drainage sources. Therefore, it is possible that some of the chemicals that were not classified as COPCs (e.g., Category 3, Table 6-7a,b) may actually have maximum concentrations that exceed RBCs or ARARs in areas that were not sampled. Also, because of the dynamic nature of the river flow in response to storms and annual weather patterns, the maximum concentrations obtained from the available data may not reflect current or future maximum values.

In order to account for these uncertainties in the screening assessment, the adequacy of sampling was evaluated in terms of both the number of samples and geographic distribution of sampling within the tidal Anacostia River. Chemicals that did not satisfy minimum criteria for number and geographic distribution of samples were placed into Category 3 (Table 6-7a,b). The criteria were a minimum of three samples representing the upper, middle and lower regions of the tidal Anacostia River, including areas immediately downstream from the major inflows and catchments: 1) Northeast and Northwest Branches; 2) Fort Lincoln Drainage; 3) Lower Beaver Dam Creek; 4) Hickey Run and Watts Branch; 5) Washington Channel area; 6) Kenilworth Marsh; and 7) Kingman Lake.

The eight studies that contributed information to the NOAA 2000 data base collected sediment samples from depth intervals ranging from 0–3 to 0–30.48 cm. Ideally, data used in the screening risk assessment should represent the concentrations of chemicals in media to which receptors may come into contact. Given the dynamic erosion/deposition patterns of a river system, it is likely that the appropriate depth for

collecting sediment samples would vary depending upon the location from which samples were collected. However, due to the 'smoothing' effect of averaging concentrations over increasing volumes of media, it is possible that the maximum concentration of a chemical detected in sediment at a particular location may be less than the maximum that would have been detected if a smaller interval of the sediment had been sampled.

Uncertainties Related to Lack of Toxicity Information

Risk-based Concentrations (RBCs) were not available for 29 chemicals that were detected in the tidal Anacostia River (Table 6-8). Several of these chemicals are structurally and/or toxicologically similar to chemicals that are identified as COPCs. These include the ortho-para isomers of DDD, DDE and DDT; arsenic III and mono- and dimethyl arsenic; oxychlordane and transchlordane; hexachlorocyclohexane delta and total BHC, and several PAHs. Had RBCs been available for these chemicals, it is possible that some would have had maximum concentrations that exceeded their respective RBCs.

Table 6-6a. Chemicals of Potential Concern (COPCs) Identified in the Human Health Screening Assessment (sorted by medium and chemical name)

Media	CAS No.	Chemical Name	Det Freq	Max	Units	RBC / ARAR[1]	RBC Basis[2]	Max Location[3]	Max/ RBC
Fish Tissue	309002	Aldrin	8 / 32	2.31E-03	ppm	1.86E-04	C	LA	12
Fish Tissue	11096825	Aroclor 1260	3 / 3	4.50E-01	ppm	1.58E-03	C	16330	285
Fish Tissue	7440382	Arsenic	10 / 16	2.66E-01	ppm	2.10E-03	C	LA	127
Fish Tissue	117817	Bis(2ethylhexyl) phthalate	16 / 18	6.40E-01	ppm	2.25E-01	C	3	2.8
Fish Tissue	7440439	Cadmium	15 / 16	2.00E-01	ppm	1.35E-01	N	16330	1.5
Fish Tissue	319846	Hexachlorocyclohexanealpha	13 / 32	8.00E-03	ppm	5.01E-04	C	16330	16
Fish Tissue	58899	Hexachlorocyclohexanegamma (Lindane)	12 / 32	2.58E-03	ppm	2.43E-03	C	LA	1.1
Fish Tissue	118741	Hexachlorobenzene (HCB)	13 / 32	4.98E-03	ppm	1.97E-03	C	LA	2.5
Fish Tissue	60571	Dieldrin	41 / 44	5.20E-02	ppm	1.97E-04	C	LA	264
Fish Tissue	1024573	Heptachlor epoxide	26 / 32	1.70E-02	ppm	3.47E-04	C	4	49
Fish Tissue	76448	Heptachlor (pesticide)	12 / 32	6.10E-03	ppm	7.01E-04	C	3	8.7
Fish Tissue	117840	DiNoctyl phthalate	16 / 18	6.70E+00	ppm	2.70E+00	N	4	2.5
Fish Tissue	3268879	Octachlorodibenzopdioxin	18 / 18	5.71E-05	pm	2.10E-05	C	4	2.7
Fish Tissue	39001020	Octachlorodibenzofuran	18 / 18	9.22E-05	ppm	2.10E-05	C	3	4.4
Fish Tissue	1336363	PCB, total	43 / 44	4.60E+00	ppm	1.58E-03	C	LA	2911
Fish Tissue	35822469	H7CDD1234678	15 / 18	6.20E-06	ppm	2.10E-06	C	4	3.0
Fish Tissue	39227286	H6CDD123478	16 / 18	5.70E-06	ppm	2.10E-07	C	3	27
Fish Tissue	57653857	H6CDD123678	16 / 18	7.40E-06	ppm	2.10E-07	C	3	35
Fish Tissue	40321764	PCDD12378	16 / 18	3.90E-06	ppm	4.20E-07	C	4	9.3
Fish Tissue	19408743	H6CDD123789	17 / 18	1.03E-05	ppm	2.09E-07	C	3	49
Fish Tissue	1746016	TCDD2378 (dioxin)	18 / 18	2.80E-06	ppm	2.10E-08	C	3	133
Fish Tissue	67562394	H7CDF1234678	18 / 18	1.96E-05	ppm	2.10E-06	C	3	9.3
Fish Tissue	70648269	H6CDF123478	18 / 18	1.00E-05	ppm	2.10E-07	C	3	48
Fish Tissue	55673897	H7CDF1234789	18 / 18	2.55E-06	ppm	2.10E-06	C	4	1.2
Fish Tissue	57117449	H6CDF123678	18 / 18	8.10E-06	ppm	2.10E-07	C	3	39
Fish Tissue	57117416	PCDF12378	17 / 18	5.00E-06	ppm	4.20E-06	C	3	1.2
Fish Tissue	72918219	H6CDF123789	16 / 18	9.50E-06	ppm	2.10E-07	C	3	45
Fish Tissue	60851345	H6CDF234678	17 / 18	5.00E-06	ppm	2.10E-07	C	3	24
Fish Tissue	57117314	PCDF23478	18 / 18	4.75E-06	ppm	4.20E-07	C	3	11
Fish Tissue	51207319	TCDF2378	18 / 18	4.80E-06	ppm	2.10E-07	C	3	23
Fish Tissue	72548	p,p'DDD	42 / 44	4.80E-01	ppm	1.31E-02	C	LA	3
Fish Tissue	72559	p,p'DDE	43 / 44	5.00E-01	ppm	9.28E-03	C	LA	54

Table 6-6a. Chemicals of Potential Concern (COPCs) Identified in the Human Health Screening Assessment (sorted by medium and chemical name)

Media	CAS No.	Chemical Name	Det Freq	Max	Units	RBC / ARAR[1]	RBC Basis[2]	Max Location[3]	Max/ RBC
Fish Tissue	50293	p,p'DDT	30 / 44	5.10E-02	ppm	9.28E-03	C	LA	5.5
Fish Tissue	57749	Total chlordane	13 / 15	8.00E-01	ppm	9.01E-03	C	LA	89
Fish Tissue[4]	5103719	Cischlordane	29 / 29	3.40E-01	ppm	8.30E-03		4	41
Fish Tissue[4]	5566347	Gammachlordane	29 / 29	9.00E-02	ppm	8.30E-03		3	11
Fish Tissue[4]	7439921	Lead	16 / 16	4.20E+00	ppm	1.30E+00		16330	3.2
Fish Tissue	7439976	Mercury	16 / 16	1.59E-01	ppm	1.40E-02	N	16330	11
Fish Tissue[4]	5103742	Transchlordane	10 / 12	2.30E-01	ppm	8.30E-03	N	LA	28
Sediment	11096825	Aroclor 1260	15 / 25	1.20E+01	ppm	2.86E+00	C	ARSED1	4.2
Sediment	7440382	Arsenic	33 / 34	2.69E+01	ppm	3.82E+00	C	PSRSD1	7.0
Sediment	56553	Benz(a)anthracene	44 / 45	1.60E+01	ppm	7.84E+00	C	96SD04	2.0
Sediment	53703	Dibenz(a,h)anthracene	37 / 45	6.90E+00	ppm	7.84E-01	C	96SD04	8.8
Sediment	50328	Benzo(a)pyrene	44 / 45	2.70E+01	ppm	7.84E-01	C	96SD04	34
Sediment	205992	Benzo(b)fluoranthene	41 / 44	9.20E+00	ppm	7.84E+00	C	96SD04	1.2
Sediment	1336363	PCB, total	33 / 45	1.20E+01	ppm	2.86E+00	C	ARSED1	4.2
Water	7440382	Arsenic	33 / 33	6.60E-01	ppb	4.46E-02	C	1-14	15
Water[4]	76448	Heptachlor (pesticide)	9 / 38	2.85E-04	ppb	2.1E-04		4A_14	1.4
Water[4]	1336363	PCBs (total)	38 / 38	1.72E-02	ppb	4.5E-05		2_14	380
Water[4]	72559	p,p'-DDE	38 / 38	1.45E-03	ppb	5.9E-04		2_14	2.5
Water[4]	50293	p,p'-DDT	27 / 38	6.49E-04	ppb	5.9E-04		6_14	1.1

Det Freq, detection frequency (number of detects/number to samples); Max, maximum concentration; RBC, risk-based concentration

[1](a)E(b) refers to [a*10^b]

[2] C, cancer; N, non-cancer

[3]Refers to location codes in NOAA (2000)

[4]Chemicals that were placed in Category 1 for exceeding an ARAR

Table 6-6b Chemicals of Potential Concern (COPCs) Identified in the Human Health Screening Assessment (sorted by medium and Max/RBC)

Media	CAS No.	Chemical Name	Det Freq	Max	Units	RBC / ARAR[1]	RBC Basis[2]	Max Location[3]	Max/ RBC
Fish Tissue	1336363	PCB, total	43 / 44	4.60E+00	ppm	1.58E-03	C	LA	2911
Fish Tissue	11096825	Aroclor 1260	3 / 3	4.50E-01	ppm	1.58E-03	C	16330	285
Fish Tissue	60571	Dieldrin	41 / 44	5.20E-02	ppm	1.97E-04	C	LA	264
Fish Tissue	1746016	TCDD2378 (dioxin)	18 / 18	2.80E-06	ppm	2.10E-08	C	3	133
Fish Tissue	7440382	Arsenic	10 / 16	2.66E-01	ppm	2.10E-03	C	LA	127
Fish Tissue	57749	Total chlordane	13 / 15	8.00E-01	ppm	9.01E-03	C	LA	89
Fish Tissue	72559	p,p'DDE	43 / 44	5.00E-01	ppm	9.28E-03	C	LA	54
Fish Tissue	19408743	H6CDD123789	17 / 18	1.03E-05	ppm	2.09E-07	C	3	49
Fish Tissue	1024573	Heptachlor epoxide	26 / 32	1.70E-02	ppm	3.47E-04	C	4	49
Fish Tissue	70648269	H6CDF123478	18 / 18	1.00E-05	ppm	2.10E-07	C	3	48
Fish Tissue	72918219	H6CDF123789	16 / 18	9.50E-06	ppm	2.10E-07	C	3	45
Fish Tissue[4]	5103719	Cischlordane	29 / 29	3.40E-01	ppm	8.30E-03		4	41
Fish Tissue	57117449	H6CDF123678	18 / 18	8.10E-06	ppm	2.10E-07	C	3	39
Fish Tissue	72548	p,p'DDD	42 / 44	4.80E-01	pm	1.31E-02	C	LA	37
Fish Tissue	57653857	H6CDD123678	16 / 18	7.40E-06	ppm	2.10E-07	C	3	35
Fish Tissue[4]	5103742	Transchlordane	10 / 12	2.30E-01	ppm	8.30E-03	N	LA	28
Fish Tissue	39227286	H6CDD123478	16 / 18	5.70E-06	ppm	2.10E-07	C	3	27
Fish Tissue	60851345	H6CDF234678	17 / 18	5.00E-06	ppm	2.10E-07	C	3	24
Fish Tissue	51207319	TCDF2378	18 / 18	4.80E-06	ppm	2.10E-07	C	3	23
Fish Tissue	319846	Hexachlorocyclohexanealpha	13 / 32	8.00E-03	ppm	5.01E-04	C	16330	16
Fish Tissue	309002	Aldrin	8 / 32	2.31E-03	ppm	1.86E-04	C	LA	12
Fish Tissue[4]	5566347	Gammachlordane	29 / 29	9.00E-02	ppm	8.30E-03		3	11
Fish Tissue	7439976	Mercury	16 / 16	1.59E-01	ppm	1.40E-02	N	16330	11
Fish Tissue	57117314	PCDF23478	18 / 18	4.75E-06	ppm	4.20E-07	C	3	11
Fish Tissue	67562394	H7CDF1234678	18 / 18	1.96E-05	ppm	2.10E-06	C	3	9.3
Fish Tissue	40321764	PCDD12378	16 / 18	3.90E-06	ppm	4.20E-07	C	4	9.3
Fish Tissue	76448	Heptachlor (pesticide)	12 / 32	6.10E-03	ppm	7.01E-04	C	3	8.7
Fish Tissue	50293	p,p'DDT	30 / 44	5.10E-02	ppm	9.28E-03	C	LA	5.5
Fish Tissue	39001020	Octachlorodibenzofuran	18 / 18	9.22E-05	ppm	2.10E-05	C	3	4.4
Fish Tissue[4]	7439921	Lead	16 / 16	4.20E+00	ppm	1.30E+00		16330	3.2
Fish Tissue	35822469	H7CDD1234678	15 / 18	6.20E-06	ppm	2.10E-06	C	4	3.0
Fish Tissue	117817	Bis(2ethylhexyl) phthalate	16 / 18	6.40E-01	ppm	2.25E-01	C	3	2.8

Table 6-6b Chemicals of Potential Concern (COPCs) Identified in the Human Health Screening Assessment (sorted by medium and Max/RBC)

Media	CAS No.	Chemical Name	Det Freq	Max	Units	RBC / ARAR[1]	RBC Basis[2]	Max Location[3]	Max/ RBC
Fish Tissue	3268879	Octachlorodibenzopdioxin	18 / 18	5.71E-05	ppm	2.10E-05	C	4	2.7
Fish Tissue	118741	Hexachlorobenzene (HCB)	13 / 32	4.98E-03	ppm	1.97E-03	C	LA	2.5
Fish Tissue	117840	DiNoctyl phthalate	16 / 18	6.70E+00	ppm	2.70E+00	N	4	2.5
Fish Tissue	7440439	Cadmium	15 / 16	2.00E-01	ppm	1.35E-01	N	16330	1.5
Fish Tissue	57117416	PCDF12378	17 / 18	5.00E-06	ppm	4.20E-06	C	3	1.2
Fish Tissue	55673897	H7CDF1234789	18 / 18	2.55E-06	ppm	2.10E-06	C	4	1.2
Fish Tissue	58899	Hexachlorocyclohexanegamma (Lindane)	12 / 32	2.58E-03	ppm	2.43E-03	C	LA	1.1
Sediment	50328	Benzo(a)pyrene	44 / 45	2.70E+01	ppm	7.84E-01	C	96SD04	34
Sediment	53703	Dibenz(a,h)anthracene	37 / 45	6.90E+00	ppm	7.84E-01	C	96SD04	8.8
Sediment	7440382	Arsenic	33 / 34	2.69E+01	ppm	3.82E+00	C	PSRSD1	7.0
Sediment	11096825	Aroclor 1260	15 / 25	1.20E+01	ppm	2.86E+00	C	ARSED1	4.2
Sediment	1336363	PCBS, total	33 / 45	1.20E+01	ppm	2.86E+00	C	ARSED1	4.2
Sediment	56553	Benz(a)anthracene	44 / 45	1.60E+01	ppm	7.84E+00	C	96SD04	2.0
Sediment	205992	Benzo(b)fluoranthene	41 / 44	9.20E+00	ppm	7.84E+00	C	96SD04	1.2
Water[4]	1336363	PCBs (total)	38 / 38	1.72E-02	ppb	4.5E-05		2_14	380
Water	7440382	Arsenic	33 / 33	6.60E-01	ppb	4.46E-02	C	1_14	15
Water[4]	72559	p,p'-DDE	38 / 38	1.45E-03	ppb	5.9E-04		2_14	2.5
Water[4]	76448	Heptachlor (pesticide)	9 / 38	2.85E-04	ppb	2.1E-04		4A_14	1.4
Water[4]	50293	p,p'-DDT	27 / 38	6.49E-04	ppb	5.9E-04		6_14	1.1

Det Freq, detection frequency (number of detects/number to samples); Max, maximum concentration; RBC, risk-based concentration

[1](a)E(b) refers to [a*10^b]

[2] C, cancer; N, non-cancer

[3]Refers to location codes in NOAA (2000)

[4]Chemicals that were placed in Category 1 for exceeding an ARAR

Table 6-6c. Category 1 - COPCs (grouped by medium and sampling station)			
Media	**Sample Station**	**COPCs**	**Sampling Date / Study ID**
Fish Tissue	16330	Aroclor 1260, cadmium, chlordane, Hexachlorocyclohexanealpha, lead, mercury	Unknown / Study ID #A1
	3	Bis(2ethylhexyl) phthalate, Gammachlordane, Heptachlor (pesticide), Octachlorodibenzofuran, H6CDD123478, H6CDD123678, H6CDD123789, TCDD2378 (dioxin), H7CDF1234678, H6CDF123478, H6CDF123678, PCDF12378, H6CDF123789, H6CDF234678, PCDF23478, TCDF2378	1989-1992 / Study ID #4
	4	Alphachlordane, Heptachlor epoxide, DiNoctyl phthalate, Octachlorodibenzopdioxin, H7CDD1234678, PCDD12378, H7CDF1234789	1989-1992 / Study ID #4
	LA[1]	Aldrin, Arsenic, Hexachlorocyclohexanegamma (Lindane), Hexachlorobenzene (HCB), Dieldrin, PCBS (total), p,p'DDD, p,p'DDE, p,p'DDT, Total chlordane, (alpha+cis+oxy+trans), Transchlordane	August 1987 / Study ID #5
Sediment	96SD04	Benz(a)anthracene, Dibenz(a,h)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene	June 1996 / Study ID #3
	ARSED1	Aroclor 1260, PCBS (total)	June 1995 / Study ID #1
	PSRSD1	Arsenic	September 1992 / Study ID#2
Water	1_14	Arsenic	May 1998 / Study ID #14
	2_14	p,p'-DDE, PCBS (total)	July 1998 / Study ID #14
	4A_14	Heptachlor (pesticide)	February 1998 / Study ID #14
	6_14	p,p'-DDT	February 1998 / Study ID #14

[1]Sample stations 4 and LA were nearly co-located

Study ID A1: MD Dept of Natural Resources Data. 1990. (Not available for review at the time this report was prepared.)

Study ID 1: Baker Environmental. ND. Washington Navy Yard. Baker Environmental. (Not available for review at the time this report was prepared.)

Study ID 2: Baker Environmental. ND. Bolling AFB - SW Corner Landfill. (Not available for review at the time this report was prepared.)

Study ID 3: ChemWorld Environmental. 1997. WA Gas, East Station Project, 1996. (Not available for review at the time this report was prepared.)

Study ID 4: Cummins, J.D. and D.J. Velinsky. 1993. 1992 D.C. fish tissue analysis for the evaluation of human health risks. District of Columbia, Department of Consumer and Regulatory Affairs, Water Quality Control Branch, Water Resources Management Division, Washington, D.C. 7 pages.

Study ID 5: Block, E. 1990. Organochlorine residues and histopathological examination of fish from the Potomac and Anacostia Rivers, Washington, DC. U.S. Fish and Wildlife Service, Environmental Contaminants Division, Annapolis, MD. AFO-C90-01 30 pages.

Table 6-7a. Category 3 - Detected Chemicals
(sorted by chemical class and name)

CAS No.	Chemical Name	Chemical Class
95943	1,2,4,5Tetrachlorobenzene	ABN
120821	1,2,4Trichlorobenzene	ABN
95501	1,2Dichlorobenzene	ABN
541731	1,3Dichlorobenzene	ABN
106467	1,4Dichlorobenzene	ABN
95954	2,4,5Trichlorophenol	ABN
88062	2,4,6Trichlorophenol	ABN
120832	2,4Dichlorophenol	ABN
105679	2,4Dimethylphenol	ABN
51285	2,4dinitrophenol	ABN
121142	2,4Dinitrotoluene	ABN
606202	2,6Dinitrotoluene	ABN
78933	2Butanone	ABN
91587	2Chloronaphthalene	ABN
95578	2Chlorophenol	ABN
591786	2Hexanone	ABN
95487	2Methylphenol	ABN
88744	2Nitroaniline	ABN
88755	2Nitrophenol	ABN
91941	3,3'Dichlorobenzidine	ABN
99092	3Nitroaniline	ABN
101553	4Bromophenyl phenyl ether	ABN
59507	4Chloro3methylphenol	ABN
106478	4Chloroaniline	ABN
7005723	4Chlorophenyl phenyl ether	ABN
108101	4Methyl2pentanone	ABN
106445	4Methylphenol	ABN
100016	4Nitroaniline	ABN
100027	4Nitrophenol	ABN
67641	Acetone	ABN
71432	Benzene	ABN
65850	Benzoic acid	ABN
100516	Benzyl alcohol	ABN
111911	Bis(2chloroethoxy)methane	ABN
111444	Bis(2chloroethyl)ether	ABN
39638329	Bis(2chloroisopropyl) ether	ABN
85687	Butylbenzyl phthalate	ABN
108907	Chlorobenzene	ABN
132649	Dibenzofuran	ABN
84662	Diethyl phthalate	ABN
131113	Dimethyl phthalate	ABN
84742	Dinbutyl phthalate	ABN
100414	Ethylbenzene	ABN
87683	Hexachlorobutadiene	ABN
77474	Hexachlorocyclopentadiene	ABN
67721	Hexachloroethane	ABN
75092	Methylene chloride	ABN
98953	Nitrobenzene	ABN
621647	NnitrosodiNpropylamine	ABN
86306	Nnitrosodiphenylamine	ABN

Table 6-7a. Category 3 - Detected Chemicals (sorted by chemical class and name)

CAS No.	Chemical Name	Chemical Class
608935	Pentachlorobenzene	ABN
87865	Pentachlorophenol	ABN
108952	Phenol	ABN
100425	Styrene	ABN
108883	Toluene	ABN
95476	Xylene, ortho	ABN
1330207	Xylenes, total	ABN
11097691	Aroclor 1254	PCB
55722275	TCDF, total	CDF
7429905	Aluminum	METAL
7440360	Antimony	METAL
7440393	Barium	METAL
7440417	Beryllium	METAL
7440428	Boron	METAL
16065831	Chromium III	METAL
18540299	Chromium VI	METAL
7.44047e+006	Chromium, total	METAL
7440484	Cobalt	METAL
7440508	Copper	METAL
57125	Cyanide	METAL
7439896	Iron	METAL
7439965	Manganese	METAL
7440020	Nickel	METAL
7782492	Selenium	METAL
7440224	Silver	METAL
7440246	Strontium	METAL
7440315	Tin	METAL
7440622	Vanadium	METAL
7440666	Zinc	METAL
22967926	Methylmercury	ORGANOMETAL
91576	2Methylnaphthalene	PAH
83329	Acenaphthene	PAH
120127	Anthracene	PAH
207089	Benzo(k)fluoranthene	PAH
92524	Biphenyl	PAH
218019	Chrysene	PAH
206440	Fluoranthene	PAH
86737	Fluorene	PAH
193395	Indeno(1,2,3c,d)pyrene	PAH
91203	Naphthalene	PAH
129000	Pyrene	PAH
115322	Dicofol	PESTICIDE
1031078	Endosulfan sulfate	PESTICIDE
72208	Endrin	PESTICIDE
319857	Hexachlorocyclohexanebeta	PESTICIDE
78591	Isophorone	PESTICIDE
2385855	Mirex (dechlorane)	PESTICIDE
2921882	Chlorpyrifos	PESTICIDE
1861321	Dacthal	PESTICDE
534521	4,6dinitro2methylphenol	UNCLASSIFIED

Table 6-7a. Category 3 - Detected Chemicals (sorted by chemical class and name)

CAS No.	Chemical Name	Chemical Class

Category 3 chemicals that have been detected in the tidal Anacostia River and their maximum concentrations do not exceed an RBC; however, limitations in sample numbers or geographic distribution of sampling do not support a Not COPC classification. ABN, acid/base/neutral extractable; CDF, chlorinated dibenzofuran; PAH, polycyclic aromatic hydrocarbon; PCB, polychlorinated biphenyl; PEST, pesticide

Table 6-7b. Category 3 - *Not Detected* Chemicals (sorted by chemical class and name)

CAS No.	Chemical Name	Chemical Class
71556	1,1,1Trichloroethane	ABN
79345	1,1,2,2Tetrachloroethane	ABN
79005	1,1,2Trichloroethane	ABN
75343	1,1Dichloroethane	ABN
75354	1,1Dichloroethene	ABN
107062	1,2Dichloroethane	ABN
540590	1,2Dichloroethene	ABN
78875	1,2Dichloropropane	ABN
108601	2,2'Oxybis(1chloropropane)	ABN
118796	2,4,6Tribromophenol	ABN
110758	2Chloroethylvinyl ether	ABN
92875	Benzidine	ABN
75274	Bromodichloromethane	ABN
75252	Bromoform	ABN
74839	Bromomethane	ABN
86748	Carbazole	ABN
75150	Carbon disulfide	ABN
56235	Carbon tetrachloride	ABN
75003	Chloroethane	ABN
67663	Chloroform	ABN
74873	Chloromethane	ABN
156592	cis1,2Dichlorethene	ABN
10061015	cis1,3Dichloropropene	ABN
124481	Dibromochloromethane	ABN
62759	Nnitrosodimethylamine	ABN
127184	Tetrachloroethylene	ABN
156605	Trans1,2Dichloroethene	ABN
10061026	trans1,3Dichloropropene	ABN
79016	Trichloroethene	ABN
108054	Vinyl acetate	ABN
75014	Vinyl chloride	ABN
11104282	Aroclor 1221	PCB
11141165	Aroclor 1232	PCB
12672296	Aroclor 1248	PCB
12674112	Aroclor 1016	PCB
53469219	Aroclor 1242	PCB
7439987	Molybdenum	METAL
7440280	Thallium	METAL
	Monobutyl tin	ORGANOMETAL
959988	Endosulfanalpha	PESTICIDE

Table 6-7b. Category 3 - *Not Detected* Chemicals (sorted by chemical class and name)

CAS No.	Chemical Name	Chemical Class
7421934	Endrin aldehyde	PESTICIDE
53494705	Endrin ketone	PESTICIDE
72435	Methoxychlor	PESTICIDE
8001352	Toxaphene	PESTICIDE

Category 3 chemicals that have not been detected in tidal Anacostia, however, limitations in sample numbers or geographic distribution of sampling do not support a COPC classification. ABN, acid/base/neutral extractable; PCB, polychlorinated biphenyl

Table 6-8. Category 4 Chemicals (sorted by chemical class and name)

CAS No.	Chemical Name	Chemical Class
132650	Dibenzothiophene	ABN
1002535	Dibutyl tin	ABN
26601649	Hexachlorobiphenyl	ABN
20763886	Tributyl tin	ABN
22569728	Arsenic III	METAL
	Dimethylarsenic	ORGANOMETAL
	Monomethylarsenic	ORGANOMETAL
90120	1Methylnaphthalene	PAH
832699	1Methylphenanthrene	PAH
2245387	2,3,5Trimethylnaphthalene	PAH
581420	2,6Dimethylnaphthalene	PAH
208968	Acenaphthylene	PAH
192972	Benzo(e)pyrene	PAH
191242	Benzo(g,h,i)perylene	PAH
28804888	Dimethylnaphthalene	PAH
198550	Perylene	PAH
85018	Phenanthrene	PAH
28652779	Trimethylnaphthalene	PAH
5103731	cisNonachlor	PESTICDE
33213659	Endosulfanbeta[1]	PESTICDE
319868	Hexachlorocyclohexanedelta[1]	PESTICIDE
53190	o,p'DDD[1]	PESTICDE
3424826	o,p'DDE[1]	PESTICIDE
789026	o,p'DDT[1]	PESTICIDE
27304138	Oxychlordane	PESTICIDE
39765805	Trans nonachlor	PESTICIDE
5103742	Transchlordane[2]	PESTICIDE
5103719	Cischlordane[2]	PESTICIDE
5566347	Gammachlordane[2]	PESTICIDE
	BHCs, total	PESTICIDE
1825214	Pentachloroanisole	UNCLASSIFIED

Category 4 includes chemicals that have been detected in the tidal Anacostia and for which RBCs were not available. ABN, acid/base/neutral extractable; PAH, polycyclic aromatic hydrocarbon

[1]Chemicals for which an ARAR value for fish tissue was available; the maximum concentration was less than the ARAR value.

[2]Chemicals for which an ARAR value for fish tissue was available; the maximum concentration exceeded the ARAR value and the chemical was also placed in Category 1.

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7. ECOLOGICAL RISK SCREENING

7.1 INTRODUCTION

The goal of this screening-level ecological risk assessment (SLERA) is to evaluate risk associated with contaminants present in the water column and sediments throughout the lower Anacostia River. The identification and assessment of specific sources of contamination within this area were not considered as part of this assessment.

This assessment was conducted in accordance with U.S. Environmental Protection Agency Risk Assessment Guidance (U.S. EPA, 1997). This report of findings is organized into ten sections. Section 7.2 presents results from the problem formulation, including discussions of resources and risk; selection of contaminants of potential concern (COPCs); the fate, transport, and ecotoxicity of COPCs; selection of receptors of concern (ROCs); identification of exposure pathways; and assessment and measurement endpoints. Section 7.3 is an evaluation of risk to benthic invertebrates, Section 7.4 is an evaluation of risk to fish, Section 7.5 is an evaluation of risk to birds, and Section 7.6 is an evaluation of risk to mammals. Section 7.7 is a qualitative analysis of the uncertainty in these risk evaluations. Section 7.8 provides the results of additional evaluations that were conducted. A summary of the results of risk evaluations conducted as part of the SLERA are provided in Section 8.3. Recommendations with regard to further work that could be conducted as part of a baseline risk assessment or an evaluation of remedial options are provided in Section 9.

Ecological risk assessment is a process whereby the likelihood that adverse biological impacts are occurring or may occur as a result of exposure to one or more stressors (U.S. EPA, 1992) is evaluated. Screening level risk assessments are simplified evaluations to decide whether further investigations are warranted or not. These screenings can be done quickly because they can be based upon existing data with generic or standard, conservative assumptions applied for many of the parameters involved in estimating the mobility and toxicity of contaminants of concern (U.S. EPA, 1997). When the stressors of concern are toxic substances, these assumptions are appropriate because of the conservative bias that must be applied to these types of evaluations. For investigations of sites where toxic hazardous materials have been released, it is important to minimize the probability of a conclusion that the site poses no risk when in fact it does (the so-called false negative outcome). To ensure that sites which could pose an ecological risk are thoroughly evaluated, the focus of the initial screening is to determine whether data exist to conclusively prove that a site does not pose significant risk. Although the standard, conservative assumptions applied are often considered unrealistic, a strong bias in the direction of overestimating risk minimizes the probability of a false negative conclusion. If a site is shown to present a risk, or sufficient data does not exist to eliminate the potential for risk, then the site continues through a more rigorous evaluation process which refines the estimations of actual risk.

For the screening ecological risk assessment, assessment endpoints are chosen that represent the significant ecological functions valued by society. These assessment endpoints include adverse ecological effects of organisms that are exposed to the contaminants of concern, i.e., receptors, as determined according to the conceptual model developed for how contaminants move throughout the system. The assessment endpoints are typically expressed in terms of ensuring the viability of a population of species

of interest or species that is representative of groups of organisms of interest. If threatened or endangered species are an assessment endpoint, then impacts to individuals (versus populations) becomes more critical. The estimation of risk for these assessment endpoints is made upon the measurement endpoints. Measurement endpoints are the measurable ecological characteristics that are directly related to the condition of an assessment endpoint. For instance, measurements of survival and of normal reproduction and juvenile development are measurable parameters which contribute to an understanding of the long-term viability of a population. An ecological risk may have multiple assessment endpoints and there maybe multiple measurement endpoints for each individual assessment endpoint.

7.2 ENVIRONMENTAL SETTING AND CONTAMINANTS

7.2.1 SITE HISTORY

The natural and human use history of the Anacostia River watershed is described in Section 2. Aspects of these topics that are particularly relevant to the ecological assessment are summarized here. Land use in the Anacostia watershed is typical for major urban areas with high density development concentrated near the urban center. The average impervious surface coverage of the lower tidal river watershed is 27%. This leads to large influx of street runoff, non-point source inputs, and combined storm sewer inputs to the river. There is a large area of open space on National Park Service land adjacent to the tidal river. However, this land is managed as urban parks and, therefore, does not provide the natural vegetation and canopy cover usually associated with stream buffers.

The loss of tidal wetlands along the river has been a major factor in the degradation of aquatic habitat. The structure of the tidal river system has been dramatically altered over time to manage the massive sediment inputs historically generated by upstream development and agricultural erosion. This alteration has occurred through seawall construction, navigational dredging of the mainstem, and associated filling. These actions have collectively led to the destruction of the river's once-thriving fringe wetlands. The Army Corps of Engineers estimates that approximately 2,500 acres of tidal emergent wetlands have been destroyed in the lower Anacostia. This represents an overall loss of more than 90% of the originally-occurring tidal wetlands from the river. Even with the creation of 32 acres at Kenilworth Marsh, less than 100 acres of tidal emergent wetlands still exist.

7.2.2 SITE DESCRIPTION

This assessment is focused on the mainstem of the lower, tidal Anacostia River and its associated aquatic habitats. For the purposes of this screening risk assessment, the tidal Anacostia River is defined as the river proper, including the associated tideplains, floodplains, and wetlands, extending from the confluence of the Northeast and Northwest Branches to the confluence with the Potomac River, including the Kenilworth Marsh and Kingman Lake embayments. The entire study area is freshwater, but is tidally influenced with an average amplitude of 2.8 feet (Velinsky et al., 1992). The biological communities and habitats present within the study area suggest that the river can be divided into three separate zones—the lower river zone, upper river zone, and the Washington Ship Channel/Tidal Basin zone (Figure 7-1).

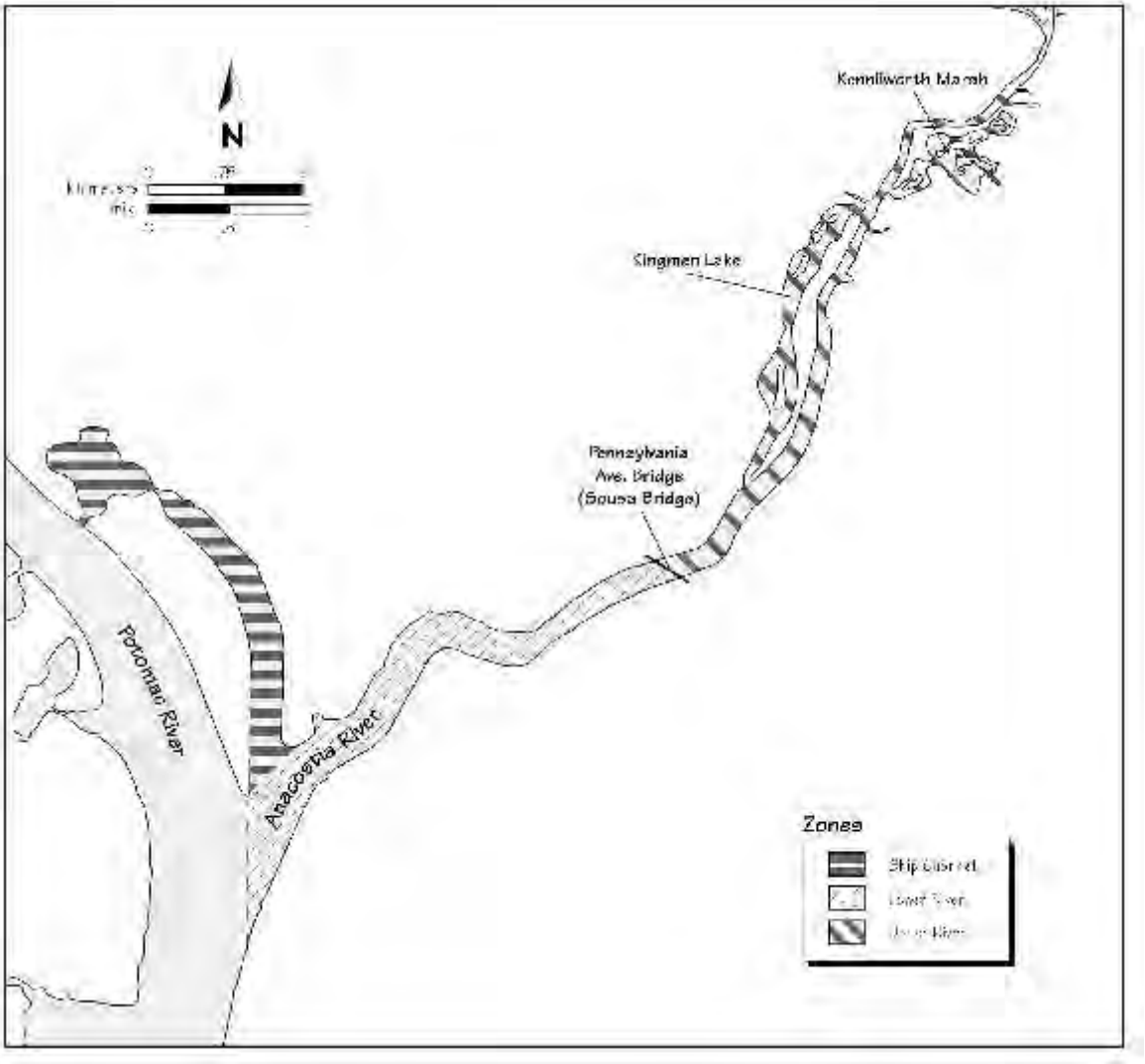

Figure 7-1. Delineation of zones for estimation of exposure for the ecological risk characterization.

The lower river zone extends about 4 miles from the river mouth to the Sousa Bridge (at Pennsylvania Avenue). The mouth of the Anacostia joins the Potomac River at Hains Point in Washington, D.C., 108 miles upstream from the Potomac River's mouth to the Chesapeake Bay. Sixty-two percent of the lower tidal Anacostia drainage area of 4,561 acres is in the District of Columbia, with the remaining 38% in Prince George's County.

The river in the lower zone is wide and channelized. This section of the river contains the federal navigation channel. The navigation channel is authorized for 300 to 600 feet wide, through much of this zone, and a depth of 16 feet at the mouth, dropping to 13 feet, and then reduced again to 6 feet above the Anacostia Bridge (at 11th Street).

The upper river zone extends from the lower river boundary for about 4.5 miles to the confluence of the Northwest and Northeast Branches, in the vicinity of Bladensburg, Maryland. This section of the river is less channelized, variable in width, and shallow, ranging from <1 to 15 feet in depth (Velinsky et al., 1992). The upper river zone also includes the Kenilworth Marsh, a 75 acre wetland which is the last remaining tidal freshwater wetland in the Washington D.C. area. Kingman Lake is also a part of the upper river zone. The lake is a channel to the river, running parallel for about 2 miles. The island separating the lake from the river was formed with dredged material. Like the upper river, the lake is shallow with average depths ranging from 5 to 10 feet. The upper river zone also contains the Anacostia federal navigation channel, which is currently being dredged.

The Washington Ship Channel is a northward trending channel, running parallel to the Potomac River for about a mile. The mouth of the channel is along the northern shoreline of the Anacostia River, just at its mouth with the Potomac. The Washington Ship Channel is about 500 feet wide and is periodically dredged to a depth of about 10 feet. The Tidal Basin connects with the upper end of the Ship Channel and with the Potomac River through culverts. The basin has a surface area of about 100 acres, and an average depth of 6 feet (Velinsky et al., 1992).

7.2.3 HABITAT DESCRIPTION

The Anacostia River watershed encompasses the south-eastern half of the District of Columbia and stretches northward into Prince George and Montgomery counties of Maryland. The entire watershed drains approximately 122 square miles. There are three major drainage areas comprising the Anacostia watershed: the Northwest Branch, the Northeast Branch, and the tidal drainage.

The entire watershed is an ecologically diverse system which contains both free-flowing and freshwater tidal segments. The watershed also covers two distinct geologic features: the Piedmont province which is characterized by relatively narrow and steep-sloped valleys of moderately thin soils, and the Coastal Plain which has gentler, more-rolling hillsides comprised of deeper sedimentary soil complexes. The Coastal Plain tends to support broader meandering streams than the Piedmont feature. The tidal drainage area does have small, non-tidal streams that flow directly to the tidal river, though most of these streams are enclosed in storm sewer systems.

Very little natural aquatic habitat is present in the lower river and Ship Channel zones. Most shorelines are composed of seawalls, docks, piers, and marinas (Herson-Jones et al., 1994; Velinsky et al., 1992). The upper river zone contains less channelized areas then the lower, but natural habitats are still substantially reduced. Lake Kingman was created by dredge spoils in the 1920s and is surrounded by park land and a golf course. The Kenilworth Marsh occupies approximately 75 acres on the east shore of the river immediately upstream of Kingman Lake. Much of the marsh has been restored as an emergent

tidal freshwater wetland. Small areas of emergent wetlands are present near the river shore upstream of Kenilworth Marsh to the Northwest and Northeast Branches (Velinsky et al., 1992; NPS, 2000)

The Anacostia River can be classified as a warm-water stream with mean temperatures ranging from 3° C (Celsius) in January to 26° C in August. Summer temperatures range from 18 to 32° C and can be an environmental stressor to some fish species. Similarly, dissolved oxygen concentrations during the summer months have been reported at below water quality standards of 5 mg/L. Water in the study area has a long residence time (~35 days) due to the large volume-to-flow ratio. The long residence time and the tidal nature of the river allow the substantial deposition of suspended sediments in the study area (Herson-Jones et al., 1994).

The following sections provide descriptions of the primary biological communities present in the aquatic habitats of the study area. A benthic, macroinvertebrate community associated with fine-grained, organically enriched sediments is present in the lower Anacostia River, as well as populations of benthic and pelagic fish and aquatic birds and mammals.

7.2.3.1 MACROINVERTEBRATE COMMUNITY

Sediment and the surface of submerged objects, such as rocks and pilings, provide habitat for many species of bottom-dwelling animals known as benthic organisms. A healthy community of benthic animals is usually dominated by a large number of small invertebrates (worms, amphipods, etc.) from diverse groups of animal families. The organisms that live below the sediment surface, called infauna, have a significant role in the riverine ecosystem as prey for larger animals, such as fish and crabs, and in cycling of nutrients. Larger, more visible and often more mobile invertebrates, such as crab, shrimp, and clams, are another substantial component of a benthic community. A macroinvertebrate community associated with fine-grained sediments highly enriched with organic matter is present in the lower Anacostia River. These animals are critical, not only because of their role in the ecosystem, but also because of the way that they feed often exposes them to sediment-associated contaminants. Many infaunal species ingest organic material deposited on the bottom, as part of the sediment. Most feed selectively on a particular size range of particles which have relatively higher levels of organic matter. These same organic-rich particles are those which are typically, also relatively, concentrated with contaminants.

Benthic studies, conducted in association with sediment investigations, collected benthic samples within the Anacostia River, Washington Ship Channel, and Tidal Basin. The number of benthic species (or species groups) observed ranged from 5 to 12 per station. Pollution-tolerant oligochaetes (freshwater worms) constituted 73 to 96 percent of the taxa observed at 8 of 9 stations within the study area. Chironomids (midges), another pollution-tolerant group was the second most abundant taxa. Together, the two groups of animals composed between 96 and 99 percent of all benthic organisms per station (Velinsky et al., 1992). Small numbers of mollusks (bivalves), amphipods (scuds), and other aquatic insects were also observed. The largest difference between the Ship Channel and the Tidal Basin was the percentage of chironomids in the sediments. Benthic samples collected in the Tidal Basin had a higher percentage of chironomids (mean = 44.5 percent) compared to the Ship Channel (mean = 12.5 percent) or the river (mean = 11.4 percent).

In general the benthic community within the study area can be characterized as having relatively few taxa, dominated by pollution tolerant species (Velinsky et al., 1992). The oligochaetes are considered the most pollution tolerant group of freshwater macroinvertebrates. The chironomids are also a pollution tolerant group compared to many taxa of aquatic insects and crustaceans. Oligochaetes and chironomids generally occupy habitats of very fine sediments with high organic content. The two groups are relatively less sensitive to organic and inorganic contamination and oxygen depletion (U.S. EPA, 1990; Burton, 1991).

7.2.3.2 FISH COMMUNITY

The finfish of the Anacostia River are among the more notable, more visible species of the river because of their commercial and recreational or subsistence value. Many of those fish that are not directly fished by humans may serve as prey for predatory species. Since many fish are near the top of a food web, and therefore rely on the health and abundance of all the food web levels below them, the general health of the fish community is often a broad indicator for the general state of a riverine ecosystem.

At any given time, the fish community in a river may be comprised of year-round residents of any age class, adults which are spawning in the area or adults which are migrating through the area to reach their spawning grounds, early life stages which use the area as a nursery ground, and various age classes of fish which are feeding within the area. There are seasonal patterns for many fish, linked to either their reproductive cycle or their habitat preference, e.g., a move to warmer waters during winter. The distribution of fish is also partially determined by their living requirements, primarily as determined by salinity and temperature.

Finfish surveys have been conducted throughout tidal portions of the Anacostia River. A recent fish survey cited by Herson-Jones et al. (1994) reported 25 species in the river, of which 11 species comprised over 98 percent of the total (Table 7-1). Survey data indicate that the study area provides substantial spawning and nursery habitat for the anadromous *Alosids* (river herring and shads). Blueback herring and alewife dominate the fish community, particularly in the lower river. Other studies have shown that juvenile blueback herring concentrate near the confluence of the Anacostia and Potomac Rivers, suggesting that this area may be a nursery for the species (Herson-Jones et al., 1994). Alewife and blueback herring migrate and spawn in the study area from late-March to mid-May, with most spawning adults gone by mid-summer. Eggs hatch in 2 to 6 days depending upon temperature (Scott and Crossman, 1973) and larvae and juveniles use the study area as a nursery through September before out-migrating to Chesapeake Bay and the Atlantic Ocean (Lippson et al., 1980). One other *Alosid* present in substantial numbers was the gizzard shad, comprising between 2 and 10 percent of the total number of fish collected in the lower and upper river (Herson-Jones et al., 1994).

The anadromous white perch was the most frequently encountered species, occurring in nearly 70 percent of all samples collected in the lower and upper Anacostia River. White perch were distributed fairly evenly throughout the study area, relative to the total number of fish collected (Herson-Jones et al., 1994). Lippson et al. (1980) reported that the study area is a secondary spawning ground for the species. White perch are also spring spawners, spawning in the study area in April and May. Juveniles use the area as a nursery through October before out-migrating to estuarine portions of the Potomac River and Chesapeake Bay (Lippson et al., 1980).

Three freshwater residents, pumpkinseed, brown bullhead, and spottail shiner, were common in samples collected in the upper river. In the upper river, three euryhaline species, inland silversides, mummichog, and banded killifish, were observed in lower numbers. In the lower river, all of these species were observed at one percent or less in total abundance because of the dominance of the *Alosids* (Table 7-1). One other anadromous species, the striped bass, was found at less than one percent abundance in both the upper and lower river (Herson-Jones et al., 1994). This species is not known to spawn in the Anacostia River, so it would not be expected in large numbers (Lippson et al., 1980).

Table 7-1. Finfish Species and Composition Observed in a Recent Fish Survey in the Anacostia River (Herson-Jones et al. 1994)

Fish Species	Scientific Name	Percent Total Lower River	Percent Total Upper River	Percent Total Entire Study Area
Anadromous Species				
Blueback herring/ Alewife*	Alosa spp.	75	26	63
White perch	Morone americana	18	19	18
Gizzard shad	Dorosoma cepedianum	2	10	4
Striped bass	Morone saxatilis	0.7	0.1	0.5
Estuarine/Euryhaline Species				
Banded killifish	Fundulus diaphanus	0.3	7	4
Inland silverside	Menidia berylina	1	2	1
Mummichog	Fundulus heteroclitus	0.2	5	1
Freshwater Resident Species				
Pumpkinseed	Lepomis gibbosus	0.9	12	4
Brown bullhead	Ameiurus nebulosus	0.6	14	2
Spottailed shiner	Notropis hudsonius	0.6	4	1
Other species		0.7	0.9	1.5

* Blueback herring and alewife were not separated in the study

Several other freshwater species not observed in the fish survey have been reported in the Anacostia watershed. These include the non-parasitic least brook and American brook lampreys (*Lampetra aepyptera* and *L. appendix*), chain pickerel (Esox niger), mosquito fish (*Gambusia affinis*), large and smallmouth bass (*Micropterus salmoides* and *M. dolomieu*), black crappie (*Pomoxis nigromaculatus*), and several other sunfish species (*Lepomis* spp.). These species are generally more abundant in the upper watershed upstream of the study area and in tributary streams, where the degree of habitat modification and degradation is not as extensive (Lippson et al., 1980).

Other anadromous species reported in the watershed include the sea lamprey (*Petromyzon marinus*), American shad (*Alosa sapidissima*), Atlantic sturgeon (*Acipenser oxyrhynchus*), and the Federally endangered shortnose sturgeon (*A. brevirostrum*). Estuarine species include the hogchoker (*Trinectes maculatus*), which can be found as far upstream as the Washington D.C. area (Lippson et al., 1980).

7.2.3.3 AQUATIC BIRDS

The National Parks Service has listed 188 species of terrestrial, riparian, and aquatic birds in the lower Anacostia watershed, of which over 50 are associated with the aquatic environment (Table 7-2; NPS 2000). The habitats in the study area are used by aquatic birds that are year round residents, by local breeding populations, and by highly migratory species that either overwinter in the area or pass through on the way to northern or southern destinations. Most breeding areas are limited to the Kenilworth Marsh, Kenilworth Park, and Kingman Lake. Outside of these areas, much of the mainstem of the Anacostia River, Washington Ship Channel, and Tidal Basin have developed shorelines and are only used for foraging. The habitat use and feeding strategies of the aquatic birds in the lower Anacostia are summarized in Table7-2.

Table 7-2. Aquatic Birds Documented Within the Lower Anacostia River Watershed, Habitat Use and Feeding Strategy

Common Name	Scientific Name	Habitat Use			Feeding Strategy
		Resident	Overwinter	Breeding	
Duck-Like Birds					
Bufflehead	Bucephala albeola		,		Omnivore
Canvasback	*Aythya valisineria*		,		Grazer
Gadwall	*Anas strepera*		,		Omnivore
Goldeneye	*Bucephala clangula*		,		Invertebrates
Mallard	*Anas platyrhynchos*		,	,	Omnivore
Oldsquaw	*Clangula hyemalis*		,		Invertebrates
Pintail	*Anas acuta*		,		Omnivore
Ringneck duck	*Aythya collaris*		,		Grazer
Northern shoveler	*Anas clypeata*		,		Omnivore
Ruddy duck	*Oxyjura jamaicensis*		,		Grazer
Blue-winged teal	*Anas discors*		,		Omnivore
Green-winged teal	*Anas crecca*		,		Omnivore
American widgeon	*Anas americana*		,		Grazer
Wood duck	*Aix sponsa*		,	,	Grazer
Canada goose	*Branta canadensis*		,		Grazer
Snow goose	*Chen caerulescens*		,		Grazer
Common merganser	*Mergus merganser*		,		Piscivore
Hooded merganser	*Lophodytes cucullatus*		,		Invertebrates
Red-breasted merganser	*Mergus serrator*		,		Piscivore
American coot	*Fulica americana*		,		Grazer
Eared grebe	*Podiceps nigricollis*		,		Piscivore
Horned grebe	*Podiceps auritus*		,		Piscivore
Pied-billed grebe	*Podilymbus podiceps*		,		Piscivore
Red-necked grebe	*Podiceps grisegena*		,		Piscivore
Common loon	*Gavia immer*		,		Piscivore
Red-throated loon	*Gavia stellata*		,		Piscivore
Sora rail	*Porzana carolina*	,		,	Omnivore
Virginia rail	*Rallus limicola*	,		,	Omnivore
Common gallinule	*Gallinula chloropus*	,		,	Omnivore
Wading Birds					
American bittern	*Botaurus lentiginosus*	,		,	Piscivore/ Invertebrates
Least bittern	*Ixobrychus exilis*	,			Piscivore/ Invertebrates
Cattle egret	*Bubulcus ibis*	,			Invertebrates
Great egret	*Casmerodius albus*	,			Invertebrates
Snowy egret	*Egretta thula*	,			Invertebrates

Table 7-2. Aquatic Birds Documented Within the Lower Anacostia River Watershed, Habitat Use and Feeding Strategy

Common Name	Scientific Name	Habitat Use			Feeding Strategy
		Resident	Overwinter	Breeding	
Black-crowned night heron	*Nycticorax nyticorax*	,			Piscivore/ Invertebrates
Great blue heron	*Ardea herodias*	,			Piscivore
Green heron	*Butorides virescens*	,			Piscivore/ Invertebrates
Little blue heron	*Egretta caerulea*	,			Piscivore/ Invertebrates
Gulls and Terns					
Herring gull	*Larus argentatus*	,			Omnivore
Laughing gull	*Larus atricilla*	,			Piscivore
Ring-billed gull	*Larus delawarensis*		,		Omnivore
Caspian tern	*Sterna caspia*	,			Piscivore
Forsters tern	*Sterna forsteri*	,			Piscivore
Least tern	*Sterna antillarum*	,			Piscivore
Sandpipers					
Dunlin	*Calidris alpina*				Invertebrates
Sanderling	*Calidris alba*				Invertebrates
Least sandpiper	*Calidris minutilla*		,		Invertebrates
Pectoral sandpiper	*Calidris melanotos*				Invertebrates
Semipalmated sandpiper	*Calidris pusilla*				Invertebrates
Solitary sandpiper	*Tringa solitaria*				Invertebrates
Spotted sandpiper	*Acitis macularia*		,	,	Invertebrates
Stilt sandpiper	*Calidris himantopus*				Invertebrates
Blackbirds					
Red-ringed blackbird	*Agelaius phoeniceus*	,		,	Omnivore
Rusty blackbird	*Euphagus carolinus*	,		,	Omnivore
Other Species					
Double-crested cormorant	*Phalacrocorax auritus*	,			Piscivore
Belted kingfisher	*Ceryle alcyon*	,		,	Piscivore
Osprey	*Pandion haliaetus*	,			Piscivore

The largest group of aquatic birds present in the study area are the duck-like species within the families *Anatidae* (ducks and geese), *Gaviidae* (loons), *Podicipedidae* (grebes), and *Rallidae* (coots and rails). Nearly 30 species represent these four families in the study area, most of which are associated with the Kenilworth Marsh, Kingman Lake, and the mainstem Anacostia River in the upper river zone (NPS 2000).

The ducks, geese, coots, and rails are largely grazers and omnivorous. Canvasback, ringnecked duck, ruddy duck, widgeon, wood duck, Canada goose, and snow goose are primarily grazers of aquatic and

terrestrial vegetation. Several other species, such as mallards, goldeneye, bufflehead, oldsquaw, and common gallinule, are omnivorous feeding on vegetation, insects, and small aquatic invertebrates. The mergansers, loons, and grebes are strong divers and swimmers and feed on fish and aquatic invertebrates (Udvardy and Farrand, 1998).

The ducks and geese primarily use the study area for overwintering, although a few species such as wood duck, mallard, and rails may breed during the spring and summer in the upper zone (NPS 2000; Udvardy and Farrand, 1998).

Nine species of wading birds within the family *Ardeidae*, which includes the herons, bitterns, and egrets, have been documented in less developed shoreline habitats in the study area (NPS 2000). The large great blue heron is primarily a piscivore while the smaller herons, bitterns, and egrets feed on fish, frogs, crustaceans, other aquatic invertebrates, and insects. Most of the wading birds are permanent residents of the study area, although cattle egrets are largely an inland species that breed near water (Udvardy and Farrand, 1998).

Three species of gulls and three species of terns, within the family *Laridae*, have been documented in the study area (NPS 2000). The laughing gull is a piscivore while the herring gull is a scavenging omnivore. Both are permanent residents of the region. The ring-billed gull only overwinters in the study area, breeding inland. The terns are primarily piscivores with the exception of the small least tern, which also feeds on aquatic invertebrates. The terns and gulls are colony breeders with most breeding in the region, but it is not known if colonies are present within the study area (Udvardy and Farrand, 1998).

Eight species of sandpiper within the family *Scolopacidae* have been documented in the study area (NPS 2000). Most of the sandpipers breed in the Arctic or sub-Arctic and overwinter in central to South America, so are transient within the study area. The exception is the spotted sandpiper which breeds in the region. The sanderling and dunlin also overwinter in the region, but usually occupy coastal beaches. All of the sandpipers feed primarily on benthic invertebrates found in shallow water sediments (Udvardy and Farrand, 1998).

Two species of blackbird within the family *Emberizidae* have been documented in the study area (NPS 2000). Both species are common year round residents of marshes and bogs of the upper zone. The blackbirds are omnivores, feeding on aquatic invertebrates, grains, and seeds (Udvardy and Farrand, 1998).

Three other important piscivores present within the study area include the osprey (family *Accipitridae*), kingfisher (family *Alcedinidae*), and double crested cormorant (family *Phalacrocoracidae*) (NPS 2000). The osprey is one of the few raptor species that has a strong association with water. The species is a permanent resident of the region, but any specimens that occupy the upper zone likely have a very large home range. Osprey feed almost exclusively on fish, although they have been observed on occasion taking other prey such as birds, frogs, and crustaceans (U.S. EPA, 1993; Udvardy and Farrand, 1998). The kingfisher is a permanent resident of the region, occupying areas of the Kenilworth Marsh and Kingman Lake in the upper river zone (NPS 2000). The kingfisher is highly piscivorous. The double crested cormorant is also a permanent resident of the region that breeds in both coastal and inland areas. The cormorant is also highly piscivorous (Udvardy and Farrand, 1998).

7.2.3.4 MAMMAL COMMUNITY

The National Parks Service has listed 17 species of mammals that reside in the entire Anacostia watershed, of which beaver, river otter, muskrat, mink, and raccoons are commonly-to-exclusively associated with aquatic environments (NPS 2000). As with the aquatic bird community, aquatic mammal populations are found primarily in the upper zone and Kenilworth Marsh.

Beaver (*Castor canadensis*) are almost exclusively aquatic, occupying rivers, streams, and wetlands. The species has been documented in the study area and is a likely common inhabitant of the upper zone (NPS 2000). Beaver are entirely herbivorous, most commonly consuming bark of certain hardwoods such as poplar, aspen, birch, cherry, willow, maple, and alder. Aquatic vegetation is also consumed. Beaver are active year round.

River otter (*Lutra canadensis*) are almost exclusively aquatic, occupying rivers, lakes, and other waters that show little human impact (U.S. EPA, 1993). The species has been documented within the study area, but is likely limited to less developed areas in the upper zone (NPS 2000). The species is primarily piscivorous, but will opportunistically consume crustaceans, aquatic insects, amphibians, insects, birds, mammals, and turtles. River otter are active the whole year (U.S. EPA, 1993).

Muskrat (*Ondatra zibethicus*) inhabit freshwater streams, lakes, wetlands, ponds, brackish marshes, and salt marshes (U.S. EPA, 1993). They likely occupy surface waters of Kingman Lake, Kenilworth Marsh, and the upper zone of the Anacostia River (NPS 2000). Muskrats are primarily herbivorous, feeding on roots and basal portions of plants, as well as shoots, stems, and leaves. Omnivorous populations are also known to exist, supplementing vegetation with crayfish, fish, frogs, turtles, and young birds. Muskrats are active the whole year, using constructed dens to insulate themselves from summer heat and winter cold (U.S. EPA, 1993).

Mink (*Mustela vison*) are found associated with aquatic habitats of all kinds, including rivers, streams, lakes, and ditches, as well as wetlands, and backwater areas (U.S. EPA, 1993). Within the study area, they are most likely associated with the upper zone, Kenilworth Marsh, and Kingman Lake (NPS 2000). Mink are opportunistic predators, taking whatever prey is abundant. Mammals are the mink's most important prey in many parts of their range, but mink also hunt aquatic prey such as fish, amphibians, and crustaceans. The species is active year round (U.S. EPA, 1993).

Raccoons (*Procyon lotor*) are the most abundant and widespread medium-sized mammal in North America (U.S. EPA, 1993) and may be common within the study area (NPS 2000). The species is found near virtually every aquatic habitat, particularly various freshwater wetlands and salt marshes. The raccoon is an omnivorous and opportunistic feeder. They feed on fruits, nuts, grains, insects, frogs, crayfish, eggs, and virtually any animal and vegetable matter. The proportion of different foods in their diet depends on location and season, although plants are usually a more important component. They may focus on a preferred food when it is available. In the region of the study area, raccoons undergo a winter dormancy lasting up to four months (U.S. EPA, 1993).

7.2.4 ECOTOXICITY AND POTENTIAL RECEPTORS

7.2.4.1 CONTAMINANTS OF POTENTIAL CONCERN

COPCs were selected for each potential ecological receptor group. Reviewing the compiled sediment and tissue data for the Anacostia River identified five classes of contaminants: polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), dioxins and furans, chlorinated pesticides, and trace elements.

7.2.4.2 ECOTOXICITY OF THE CONTAMINANTS OF POTENTIAL CONCERN

7.2.4.2.1 POLYCYCLIC AROMATIC HYDROCARBONS

PAHs are a class of nonpolar organic compounds characterized by highly aromatic, fused-ring structures. Environmental sources of PAHs include petroleum, petroleum products, and combustion residues (i.e., soot particles). Because of their low water solubilities (0.0003 to 34 mg/L) and high octanol-water partition coefficients (log K_{ow} = 3.4 to 7.6), PAHs in aquatic systems tend to be associated with sediments and biota (Eisler, 1987).

In the Anacostia River, the fate and transport of PAHs will be largely controlled by sediment organic carbon content and dissolved organic carbon concentrations in the sediment porewater and water column. The extent to which an individual PAH compound will tend to be associated with either sediment or dissolved organic carbon depends on the relative hydrophobicity of the compound, which can be predicted from its molecular weight (Clement, 1985).

Low-molecular-weight PAHs (LPAHs), with three aromatic rings or less, are more water soluble and more easily degraded. High-molecular-weight PAHs (HPAHs), with 4 or more aromatic rings, will tend to persist in sediments where they are subjected to burial, resuspension, and degradation reactions. The available literature suggests that microbes degrade HPAHs slower than LPAHs. Half-lives for these compounds range from months to years. Furthermore, biodegradation probably occurs more slowly in aquatic systems than in soil (Clement Associates 1985).

PAHs vary substantially in their toxicity to aquatic organisms. LPAHs such as naphthalene, fluorene, phenanthrene, and anthracene are acutely toxic to aquatic organisms. Acute lethality increases with increasing alkyl substitution on the lower molecular weight compounds (Van Luik 1984). Many of the HPAHs, such as chrysene and benzo(a)pyrene, are less acutely lethal but demonstrably carcinogenic, mutagenic, or teratogenic to a wide variety of organisms including fish, amphibians, birds, and mammals (Moore and Ramamoorthy 1984; Eisler 1987). Among aquatic organisms, acute lethality is most pronounced among crustaceans and least among teleost fish (Eisler 1987).

Benthic Invertebrates – Effects of PAHs observed in benthic invertebrates include inhibited reproduction, delayed emergence, sediment avoidance, and mortality (Eisler, 1987; Landrum et al., 1991). In a study of PAH toxicity to the amphipod *Diporeia*, the mechanism identified as most likely responsible for observed acute toxic responses to PAHs was narcosis (Landrum et al., 1991). Generally, aquatic invertebrates are less able to metabolize PAHs than aquatic vertebrates, although metabolization rates vary widely within and between phyla (Meador et al., 1995). Thus, invertebrates tend to be susceptible to PAHs due to acute lethality by narcosis more so than for other organisms which actively metabolize these compounds.

Fish – Since PAHs are generally hydrophobic compounds, they must be metabolized to more water-soluble forms before they are excreted. In most fish, uptake of PAHs is rapid, but metabolism and excretion are too, so that concentrations found in tissues are generally low. The major route of elimination is through excretion into bile. The biotransformation and excretion rates can vary widely among fish species (Meador et al., 1995). Fish exposed to PAHs may be induced to produce higher levels of enzymes capable of transforming PAHs to more excretable, but occasionally more carcinogenic, metabolites (O'Connor and Huggett, 1988).

Because fish rapidly metabolize and excrete PAHs, fish tissue concentrations of the original, untransformed parent PAH compounds do not provide a useful measure of exposure to fish (Varanasi et al., 1989). Determining concentrations of PAHs in sediment is a useful measure of exposure because

exposure to PAH-contaminated sediment has been linked to adverse effects in fish. These impacts include reproductive impairment, immune dysfunction, increased incidence of liver lesions, and other histopathological endpoints (Malins et al., 1987; Johnson et al., 1988; Varanasi et al., 1992, Baumann et al., 1996). Fin erosion and liver abnormalities have also been observed in fish exposed to extracts from PAH-contaminated sediments (Fabacher et al., 1991). Other studies report sublethal effects on the cellular immune system (reduced macrophage activities) in fish exposed to PAH-contaminated sediments, that could result in increased susceptibility to disease (Weeks and Warinner, 1984, 1986; Weeks et al., 1986). The most common diseases generally affect the liver, although cataracts and pollution-related disorders of the skin and gills may also occur (O'Connor and Huggett, 1988).

Birds – Very little data are available on the toxicity of PAHs in birds. In one study, Patton and Dieter (1980) fed mallards diets that contained 4,000 mg PAHs/kg for a period of 7 months. No mortality or visible signs of toxicity were evident during the exposure; however, liver weights increased 25 percent and blood flow to the liver increased 30 percent when compared to controls (Eisler, 1985). In addition, PAH mixtures applied to the surface of mallard eggs have been shown to result in increased embryo mortality and increased embryo deformation (Hoffman and Gay, 1981).

Mammals – In mammals, several PAH compounds have been shown to be potent carcinogens. In general, PAH carcinogens transform cells through genetic injury involving metabolism of the parent compound to a reactive diol epoxide (Eisler, 1985). In the case of benzo(a) pyrene, one isomer of the 7,8-diol, 9,10-epoxide is an exceptionally potent carcinogen to newborn mice and is believed to be the ultimate carcinogenic metabolite of this PAH (Slaga et al., 1978). One of the most toxicologically significant processes involved in response to PAH exposure is the interaction with drug metabolizing enzyme systems. Increased production of mixed-function oxidase enzymes in various small mammals has been induced by numerous PAH compounds (U.S. EPA, 1980). Interspecies differences in sensitivity to PAH-induced carcinogenesis are due largely to differences in levels of mixed function oxidase activities and these will affect rates at which active metabolites are converted to less active products (Neff, 1979).

7.2.4.2.2 POLYCHLORINATED BIPHENYLS

The fate and transport of PCBs in environmental systems is controlled by distribution or partitioning of PCBs between sediment, suspended particulates, surface water, and biota. The observed partitioning of nonionic organic chemicals, such as PCBs, is due to sorption to organic matter. The extent to which PCB congeners are associated with organic matter, relative to their dissolved aqueous concentrations, is related to their levels of chlorination. The more chlorinated congeners have stronger tendencies to be associated with particulate and dissolved organic matter than the less chlorinated congeners.

Bioaccumulation of PCBs occurs as a result of the partitioning of the congeners between an organism's tissues, particularly its lipids, and the ambient environment. Therefore, bioaccumulation is highly dependent on the organism's lipid content and trophic level, and on the hydrophobicity of the PCB congener. In addition, PCBs are subject to biomagnification through the food chain.

Although PCBs are generally persistent, they can be degraded *in situ* to a limited extent by resident microorganisms.

Benthic Invertebrates – PCBs have a wide variety of effects on aquatic organisms. There are significant interspecies differences in sensitivities to PCBs, even among species that are closely related taxonomically (Eisler 1986). Most studies of the effects of PCBs on benthic invertebrates have shown reproductive impairment and effects on survival and growth (Eisler, 1986).

Fish – Effects of PCBs on fish include mortality, growth-related impacts, behavior responses, biochemical alterations, and reproductive impairment. Of particular concern are the effects of dioxin-like PCB congeners, which have the same toxic mechanism as 2,3,7,8-TCDD (Walker and Peterson, 1991; Zabel et al., 1995). These dioxin-like PCB congeners cause early life stage mortality associated with blue-sac disease, which involves subcutaneous yolk sac edema (Wisk and Cooper, 1990; Walker et al., 1991).

In addition, numerous field studies have reported increased mortality, pathologic anomalies, and biochemical changes in feral fish collected from ecosystems where PCBs have been reported and correlated with the concentrations of PCBs in tissue (Niimi, 1996). These observations include reduced hatchability and poor survival of larvae taken from feral organisms and reared in the laboratory (Ankley et al., 1991; Mac and Schwartz, 1992). This impact is clearly important from an ecological perspective. Other impacts, such as behavioral responses and biochemical alterations, are more difficult to interpret, although some biochemical alterations may adversely affect reproduction (Sivarajah et al., 1978; Chen et al., 1986; Thomas, 1988).

Birds – A substantial amount of research has been conducted demonstrating adverse reproductive effects in piscivorous bird populations exposed to PCBs (Tillitt et al., 1992; Jones et al., 1993, 1994; Giesy et al., 1994 a,b). The bulk of the research has focused on double-crested cormorants because deformities were first discovered in this species. Some work has been done to evaluate reproductive effects of PCBs in the great blue heron (Sanderson et al., 1994, 1997). Piscivorous birds display a number of symptoms similar to those observed in other avian species exposed to planar halogenated hydrocarbons in the laboratory (i.e., dioxin-like toxicity), including altered biochemical homeostasis, physical deformities, fetotoxicity, and teratogenesis. In addition to embryo mortality, PCBs cause edema and beak malformations often recognized as crossed beaks in double-crested cormorants (Firestone, 1973; Schrankel et al., 1982; Brunström and Darnerud, 1983: all as cited in Brunström, 1990).

Mammals – Mammals are susceptible to adverse effects from exposure to specific PCB congeners, including non-ortho and mono-ortho substituted PCBs, because their mechanism of action is similar to 2,3,7,8- TCDD (Leonards et al., 1995). Exposure to PCBs can cause mortality or serious reproductive complications in mammals. Other effects associated with PCB toxicity include anorexia, liver and kidney degeneration, and gastric ulcers, which have been observed in mink fed PCB-contaminated coho salmon (Wren, 1991).

7.2.4.2.3 DIOXINS AND FURANS

Polychlorinated dibenzo-*p*-dioxins (dioxins) and polychlorinated dibenzofurans (furans) are byproducts of several industrial reactions. The most significant sources of dioxins and furans appear to be their thermal formation during the incineration of municipal, industrial, and medical wastes (U.S. EPA, 1994). There are 75 individual dioxin congeners and 135 individual furan congeners with a range of levels of chlorination with 1 to 8 chlorines.

Benthic Invertebrates – Invertebrates appear to be relatively less sensitive to the effects of dioxin exposure than vertebrates such as fish, birds and mammals. However, reduced reproduction has been observed in snail and earthworm populations resulting from dioxin exposure (Eisler, 1986).

Fish – Early life stages of fish are more sensitive to mortality resulting from dioxin exposure. Species suffering from early life stage mortality include zebrafish, Japanese medaka, northern pike, rainbow trout, brook trout, and lake trout (Peterson and Walker, 1992). In salmonid sac fry, dioxin toxicity is

characterized by pericardial and yolk-sac edema, subcutaneous hemorrhages, craniofacial malformations, and arrested growth and development (Spitsbergen et al., 1991; Walker et al., 1991).

Birds – Bird species in which dioxins and furans have been shown to cause embryo mortality include the chicken, ring-necked pheasant, turkey, eastern bluebird, mallard duck, domestic duck, golden-eye, herring gull, and black-headed gull (Brunstrom, 1988). Birds exhibit developmental toxicity in two ways (Peterson and Walker, 1992; Peterson et al. 1993). In the chicken embryo, pericardial, and subcutaneous edema, liver lesions, lymphoid toxicity, structural malformations, and mortality occur. In other bird species these embryotoxic effects are not seen; the only toxic effect that appears to be common to all bird species is embryo mortality (Carey et al., 1998).

Mammals – Tetrachlorodibenzo-*p*-dioxin can also adversely effect pregnancy maintenance, embryo or fetotoxicity, and postnatal development in mammals (Carey et al., 1998). Prenatal mortality has been observed in the mouse, rat, hamster, guinea pig, rabbit, mink, and rhesus monkey following dioxin exposure during pregnancy (Carey et al., 1998). Gestational exposure to dioxin produces a characteristic suite of responses that include, thymic hypoplasia, subcutaneous edema, and decreased fetal growth (Couture et al., 1990, Peterson et al., 1993).

7.2.4.2.4 CHLORINATED PESTICIDES

Chlordane, dieldrin, endrin, and heptachlor epoxide are members of the cyclodiene pesticides that are environmentally persistent and bioaccumulative chemicals that are stable in soil and resistant to photodegradation. As a result, they were used in greatest quantity as soil insecticides for the control of termites and soil-borne insects (Ware, 1997).

Gamma-BHC is a moderately toxic compound that is highly persistent in the environment. It is very stable in both freshwater and marine environments, and is resistant to photodegradation (EXTOXNET, 1996). It will disappear from water through secondary mechanisms such as adsorption to sediment, biological breakdown, and adsorption by aquatic animals through gills, skin, and food (EXTOXNET, 1996).

DDT and its metabolites are highly persistent in the environment, with reported half-lives of between 2 and 15 years in soil (ATSDR, 1992). Because of its persistence in soil, DDT can reach surface waters through erosion and atmospheric transport. The reported half-life for DDT in lake water is 56 days, while that in river water is 28 days. Field and laboratory studies have demonstrated very little breakdown of DDT in estuary sediments over the course of 46 days (EXTOXNET, 1996).

The mechanisms by which organochlorine pesticides cause ecotoxicity include narcosis (nonspecific toxicity) and more specific mechanisms that result in enhanced toxicity, such as respiratory uncouplers, acetylcholine esterase (AChE) inhibitors, and central nervous system convulants (Lipnick, 1993; McCarty and Mackay, 1993).

Benthic Invertebrates – Relatively little information was found on the toxicity of dieldrin to benthic invertebrates. The 5-hour median lethal concentration (LC_{50}) for brown shrimp was reported to range between 25 and 500 µg/L.

Heptachlor is highly toxic to freshwater invertebrates. LC_{50}s for freshwater invertebrates range from 0.9 µg/L for a 96-hour exposure with the stonefly, *Pteronarcella badia*, to 80 µg/L for a 48-hour exposure in the cladoceran, *Simnocephalus serrulatus* (U.S. EPA, 1980).

The only information found relating sediment concentrations of gamma-BHC to toxicity to benthic invertebrates was the freshwater TEL of 0.94 µg/L (NOAA, 1999). In the water column, gamma-BHC is highly toxic to aquatic invertebrates. Reported 96-hour LC_{50}s in aquatic invertebrates ranged from 4.5 µg/L in stoneflies to 460 µg/L in *Daphnia* sp. (EXTOXNET, 1996).

The toxicity of DDT-contaminated sediments to aquatic organisms has not been extensively studied. Spiked sediment bioassays using the freshwater amphipod *Hyalella azteca* found that the 10-day LC50s ranged from 11.0 to 49.7 mg/kg (TOC = 3.0 to 10.5 percent) (Nebeker, 1988).

In addition to direct toxicity, organochlorine pesticides are bioaccumulated in the tissues of benthic invertebrates. Trophic transfer and biomagnification of these compounds has been observed in a wide range of aquatic ecosystems (Carey et al., 1998).

Fish – Dieldrin is a relatively potent toxin in fish. The 96-hour LC_{50} for bluegill is 7.9 µg/L, while that in goldfish is 37 µg/L. In one study, exposure to 50 µg/L for five hours resulted in 100 percent mortality in mullet (Environmental Health Data Search, 1999).

Freshwater fish species are generally less sensitive to heptachlor than are invertebrate species. For freshwater fish species, 96-hour LC_{50}s ranged from 10.0 µg/L in rainbow trout to 320 µg/L in goldfish (U.S. EPA, 1986). A 40-week chronic study was conducted using fathead minnows (*Pimephales promelas*) in which growth, reproduction, and survival were monitored. Concentrations of heptachlor tested were 1.84, 0.86, 0.43, 0.20, and 0.11 µg/L. All fish exposed to 1.84 µg/L were dead within 60 days. No adverse effects were reported in parental fish or their offspring at the other concentrations (U.S. EPA, 1980).

Gamma-BHC is also highly toxic to fish, with reported 96-hour LC_{50}s ranging from 1.7 to 90 µg/L in freshwater fish species.

Numerous acute toxicity studies demonstrate that DDT is acutely lethal to many aquatic organisms at low concentrations (Table 7-3). Additionally, the DDT metabolites DDD and DDE have also been shown to be acutely toxic to a number of fish species. Table 7-3 summarizes toxicity data for DDT, DDE, and DDD in a number of freshwater fish species.

Table 7-3. Acute Toxicity Data for DDT and Its Metabolites in Fish

Species	Concentration (µg/L)	Effect	Reference
DDT			
Fish (24 species)	0.6 – 180	LC_{50}	U.S. EPA 1980
Fish (19 species)	1.8 – 21.5	96-hour LC_{50}	Mayer & Ellersieck 1986
Fathead minnow	0.74	Chronic	U.S. EPA 1980
DDE			
Fish (3 species	32-240	96-hour LC_{50}	Mayer & Ellersieck 1986
DDD			
Fish (6 species)	14 – 4,400	96-hour LC_{50}	Mayer & Ellersieck 1986

In addition to its toxic effects, DDT bioaccumulates significantly in fish and other aquatic species, leading to long-term exposure. A half-life for elimination of DDT from rainbow trout was estimated to be 160 days (EXTOXNET, 1996). The reported bioconcentration factor for DDT ranges between 1,000 and 1,000,000 in various aquatic species (EXTOXNET, 1996). DDT and its metabolites biomagnify through the food web (ATSDR, 1992).

Birds – Birds are less sensitive to dieldrin than aquatic organisms. A medial lethal dose (LD_{50}) of 381 mg/kg body weight/day was reported in unspecified waterfowl (Environmental Health Data Search, 1999).

Heptachlor is moderately-to-highly toxic to birds. The reported acute oral LD_{50} in mallard ducks was 2,080 mg/kg, while the 5-day dietary LC_{50} in Japanese quail was 99 mg/kg. Other reported 8-day dietary LC_{50}s for heptachlor were 450 to 700 mg/kg in bobwhite quail, and 250 to 275 mg/kg in pheasant (EXTOXNET, 1996).

Gamma-BHC is slightly to moderately toxic to birds, with a reported LD_{50} of more than 2,000 mg/kg body wt/day in the mallard duck. The 5-day dietary LC_{50} of gamma BHC in Japanese quail was 490 mg/kg, while an LC_{50} of 561 mg/kg has been reported in pheasant. Eggshell thinning and reduced egg production has also occurred in birds exposed to gamma-BHC (EXTOXNET, 1996).

DDT may be slightly toxic to nearly non-toxic in birds. Reported dietary LD_{50}s ranged from greater than 2,240 mg/kg in mallard to 841 mg/kg in Japanese quail (EXTOXNET, 1996). There has been much concern over chronic exposure of bird species to DDT and effects on reproduction, especially eggshell thinning and embryo mortality. The mechanisms of eggshell thinning are not fully understood, although it is believed that predatory species of birds may be more sensitive to these effects. Laboratory studies on avian reproduction have demonstrated the potential for DDT and DDE to cause subtle changes in courtship behavior, delays in pairing and egg laying, and decreases in egg weight in ring doves and Bengalese finches (EXTOXNET, 1996).

Mammals – Some organochlorine pesticides such as o,p'-DDT, kepone and methoxychlor have estrogenic activity in wildlife. Many of these compounds, such as o,p'-DDT and kepone, have been shown to act by binding to the estrogen receptor. However, other organochlorine compounds can exert estrogenic or anti-estrogenic effects by other mechanisms (Carey et al., 1998). The overall impact of such estrogenic activity is disruption of normal reproductive functioning.

In addition, several chlorinated pesticides are known to affect mammalian immune system function. These pesticides include hexachlorobenzene, mirex, lindane, chlordane, dieldrin, and DDT and its metabolites (Carey, 1994). The immunotoxicity of these compounds has been demonstrated in several species and includes the loss of resistance to infections. In most cases, the mechanisms of action for these compounds are not well known.

7.2.4.2.5 TRACE ELEMENTS

Key factors that affect the form of sediment-associated trace metals present (speciation) include Eh (redox conditions), pH, porewater hardness, and the organic carbon content of the sediment. The redox conditions, pH, and the concentration of dissolved organic carbon in porewater influence the oxidation state and, thus, the dissolved concentration of the trace element. In this way, these factors provide some indication of the bioavailability of the metals present. Trace elements exhibit a range of binding affinities, with both organic and inorganic phases present in the sediment, resulting in varying concentrations of

dissolved versus particulate metals. In addition, trace elements exhibit a range of stability constants with dissolved ligands, which determines the ratio of complexed to freely dissolved species in solution.

Total concentrations of trace elements in sediment are generally not predictive of their bioavailability. For certain metals, concentrations in porewater have been correlated with biological effects (DiToro et al., 1990). For several divalent metals, a key partitioning phase controlling cationic metal activity and toxicity in sediments appears to be acid-volatile sulfide (AVS) (DiToro et al., 1990, 1992; Carlson et al., 1991; Allen et al., 1993; Ankley et al. 1993). Simultaneously extracted metals (SEM) and AVS measurements can be made to assess the potential bioavailability of cadmium, copper, lead, nickel, and zinc.

The bioavailability of trace elements that form stable organo-metallic compounds is particularly complex. For example, methylmercury compounds are extremely toxic and are efficiently bioaccumulated through aquatic food chains (Wiener and Spry, 1996). Methylmercury is formed in aquatic sediments by microbial methylation of inorganic mercury (Eisler, 1987).

In freshwater, increasing water hardness decreases the toxicity of cadmium, chromium, copper, lead, nickel, silver, and zinc. The form of metal also effects toxicity. For example, methylmercury is more toxic than inorganic mercury. The combination of trace elements in the environment may result in additive, synergistic, or antagonistic effects, with the overall effect depending on the toxicity of the metals in question, the specific physical and chemical conditions of the site, and internal synergistic or antagonistic effects within organisms.

Benthic Invertebrates – Toxicity of trace elements to benthic organisms ranges widely, from slight reduction in growth rates to mortality. Oligochaetes and mollusks are generally less sensitive than other aquatic phyla (Leland and Kuwabara 1985). The most sensitive life stages of benthic organisms are generally the embryonic and larval stages.

Fish – Fish are exposed to trace elements both in the water column and through the consumption of contaminated prey organisms. Freshwater fish are generally more sensitive to the effects of trace elements than marine species, and the larval stages are generally most sensitive. Commonly observed effects include reductions in growth, survival, and fecundity.

Birds – Avian dietary toxicity studies have been conducted with a wide range of trace elements. The observed acute toxicity of the trace element can depend on the levels of metallothioneins in the bird. Ducks contained the highest levels of metallothioneins of a range of surveyed wildlife species (Brown et al., 1970, as cited in Eisler, 1985). Sublethal effects can include reproductive and behavioral modifications. Teratogenic effects have been documented in chicken embryos after eggs were injected with chromium (Ridgeway and Karnofsky, 1952; Gilani and Marano, 1979, as cited in Eisler, 1986). Similarly, the immersion of mallard eggs in solutions of methylmercury resulted in a significant incidence of skeletal embryonic malformations (Hoffman and Moore, 1979, as cited in Eisler, 1987).

Mammals – The only route of exposure for mammals that is being evaluated in this document is exposure through the aquatic food chain. Therefore, only trace elements that are known to be biomagnified through the food chain will be discussed. Methylmercury and lead are two trace elements that have been shown to be subject to trophic transfer and biomagnification. Organomercury compounds, especially methylmercury, are the most toxic mercury species for mammals. Larger mammals such as deer and seals appear to be more resistant to mercury than smaller mammals such as mink, cats, dogs, and river otters (Eisler, 1987). The reasons for these differences in sensitivity are unknown, but may be related to differences in metabolism and detoxification. Diet provides the major pathway for lead exposure. Food chain biomagnification of lead may be important for carnivorous marine mammals, such as the California sea lion and harbor seal (Eisler, 1988b).

7.2.4.3 RECEPTORS OF CONCERN

Biological studies indicate that a diverse aquatic community occupying several trophic levels is present in the lower Anacostia River. The selection of Receptors of Concern (ROCs) is based upon their potential presence in the study area, their sensitivity to contamination, and their potential for exposure to contaminants based on the identification of primary exposure pathways. The availability of appropriate toxicity information, exposure factors, and consumption data are also important considerations in the selection of ROCs.

Individual species have been selected for screening-level assessment to be representative ROCs for the fish and bird populations. These species were selected to be surrogate representatives of specific feeding strategies and of the potential transfer of specific classes of contaminants through the food chain.

Benthic invertebrates were evaluated as receptors of concern. These organisms are directly exposed to sediment contaminants. These organisms play a significant role in the functioning of riverine ecosystems as prey for larger animals, such as fish and crabs, and in the cycling of nutrients.

The largemouth bass was selected as a representative of a piscivorous fish species. The species is known to consume fish, crayfish, and insects (Scott and Crossman, 1973). Largemouth bass were not documented in the study area in the fish survey reported by Herson-Jones et al, (1994), but the species is known to reside in the watershed. Bass are more sensitive to habitat and water quality degradation than many of the other freshwater bass and sunfishes (Scott and Crossman, 1973), so may avoid many reaches of the study area.

The brown bullhead was selected as a representative opportunistic benthic feeder. The species consumes a wide variety of benthic prey including mollusks, insects, crustaceans, worms, algae, fish, and fish eggs (Scott and Crossman, 1973). Brown bullheads were the most common freshwater resident observed in a fish survey conducted in the study area (Herson-Jones et al., 1994).

Birds and mammals associated with the study area may be exposed to contaminants through the consumption of forage fish and aquatic invertebrate species. The green heron and raccoon were selected as representative birds and mammals. The green heron consumes a variety of small nearshore fishes and invertebrates and has been documented in the Anacostia watershed. The raccoon is ubiquitous omnivore in the study area feeding on fish, aquatic and terrestrial invertebrates, and fruits.

7.2.5 EXPOSURE PATHWAYS

Potential exposure pathways are evaluated to determine which pathways are complete and important at the site. Identifying complete exposure pathways prior to a quantitative evaluation allows the assessment to focus on only those contaminants that can reach ecological receptors (U.S. EPA, 1997). An exposure pathway is considered complete if a contaminant can travel from a source to ecological receptors and can be taken up by the receptors via one or more exposure routes (U.S. EPA, 1997). Often many pathways are complete, but are of varying importance. It is therefore important to identify the key pathways that reflect maximum exposures within the ecosystem and constitute exposure pathways to ecological receptors sensitive to the contaminant (U.S. EPA, 1997). Pathways of exposure to PAHs, PCBs, dioxins and furans, pesticides, and trace elements for benthic invertebrates, fish, aquatic birds and mammals are relevant at this site. The exposure pathways for ROCs in the Anacostia River are illustrated in Figure 7-2. This assessment will not examine the sources of contaminants to the river and will focus on the risks associated with exposure to contaminants present in sediments and the water column throughout the lower river.

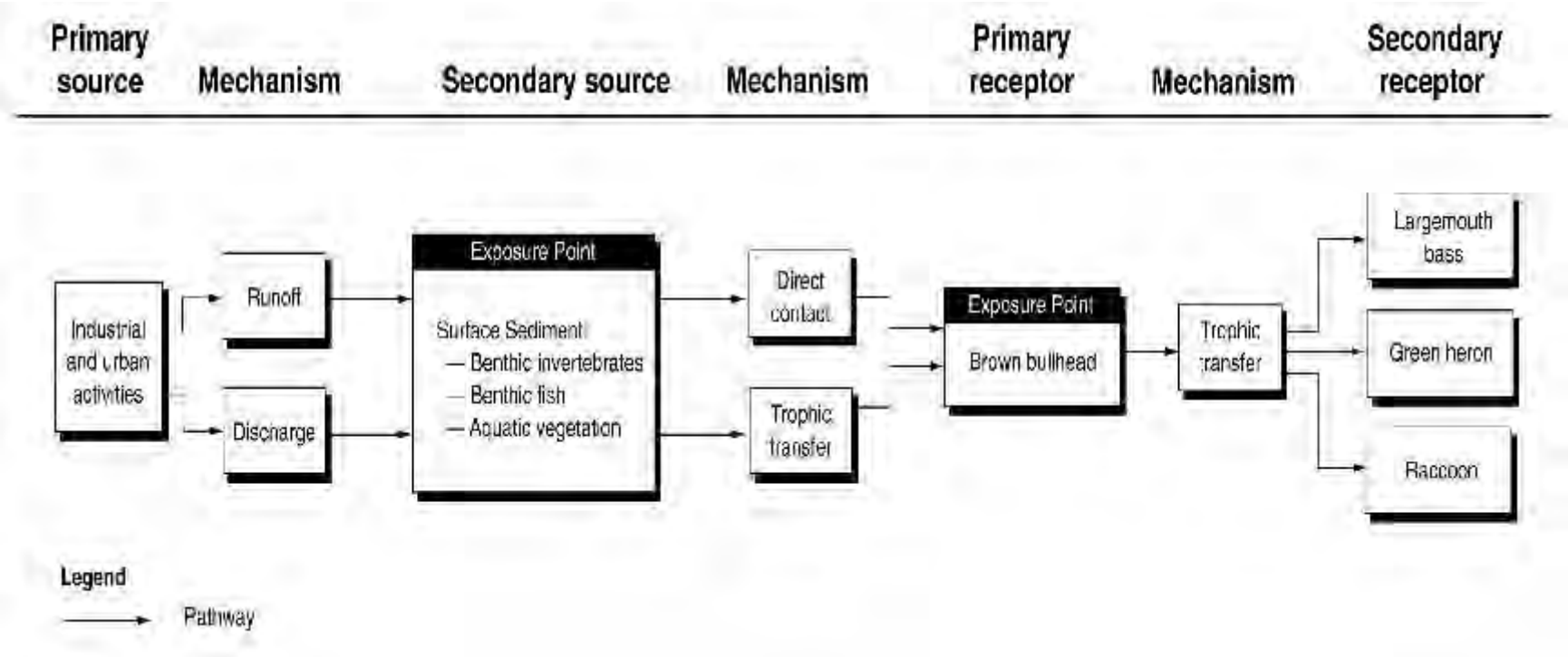

Figure 7-2. Potential exposure pathways for ecological receptors.

For benthic invertebrates, direct contact with water or sediment by the gills or integument are the primary exposure pathways (U.S. EPA, 1997). For lower-trophic-level fish, diet, and direct contact with water or sediment by the gills are the primary exposure pathways (U.S. EPA, 1997). For higher-trophic-level fish, diet can be an important exposure pathway for COPCs that are bioaccumulated or biomagnify, such as certain PCB congeners and methylmercury. The primary exposure pathway for birds and mammals is through the consumption of prey that have accumulated site-related contamination.

7.2.6 ASSESSMENT ENDPOINTS

As defined in U.S. EPA (1992), assessment endpoints are explicit expressions of the actual environmental values that are to be protected, such as ecological resources. Assessment endpoints are generally tied to the response of ecological receptor species to environmental stresses. Unless an ecological receptor is listed as a protected or endangered species, assessment endpoints are selected that are relevant to population-level rather than individual effects.

Assessment endpoints for the lower Anacostia River include:

- **Benthic invertebrates:** Assess the potential for adverse effects on diversity, abundance, growth, and survival of the benthic community

- **Fish:** Assess the potential for reproductive impairment and other adverse effects in both benthic fish and pelagic, predatory fish

- **Birds and mammals:** Assess the potential for adverse reproductive effects in aquatic birds and mammals

Measurement endpoints are measurable biological responses to the valued characteristics chosen as assessment endpoints; this definition is subject to change (U.S. EPA, 1997). The measurement endpoints corresponding to the assessment endpoints selected for this SLERA are presented below:

Benthic invertebrates:

- Sediment toxicity testing results compared to control sediment results

- Compare concentrations of COPCs in sediment to relevant screening concentrations

Fish:

- Compare surface water concentrations of COPCs to corresponding Ambient Water Quality Criteria (AWQC) values for the protection of aquatic biota

- Compare measured tissue concentrations of bioaccumulative COPCs in the brown bullhead as a representative benthic fish and largemouth bass as a predatory fish to literature values of toxic tissue residue levels

- Compare measured sediment concentrations of PAHs to relevant screening concentrations

Aquatic birds and mammals: Estimate concentrations of COPCs in prey, estimate dose to ROCs, and compare with literature toxicity values

7.3 BENTHIC INVERTEBRATES EVALUATION

The benthic invertebrates evaluation was conducted in two ways. First, the results of sediment toxicity testing that has been conducted using sediments collected within the Anacostia River are presented. Then, the maximum sediment contaminant concentrations are compared to corresponding benchmark values.

7.3.1 SCREENING LEVEL EXPOSURE ESTIMATE

7.3.1.1 SEDIMENT TOXICITY TESTING

Results of sediment toxicity testing conducted using sediments were available from two studies. The test organism, the amphipod *Hyalella azteca*, was the same in both studies however. Sediments were collected within Kenilworth Marsh (USFWS, 1997) and the Anacostia River (Velinsky et al., 1992) for bioassessment. In the Kenilworth Marsh study, toxicity testing was conducted with both bulk sediment samples and porewater samples. Significant toxicity was observed in three out of a total of nineteen tests conducted (USFWS, 1997). The Anacostia River sediments were tested as bulk sediment samples and significant toxicity was observed in four out of a total of thirty-two samples tested.

7.3.1.2 SEDIMENT CHEMISTRY SCREENING

Maximum sediment contaminant concentrations were selected from the sediment data sets compiled in the NOAA watershed database. In conducting the screening evaluation the lower Anacostia was divided into three zones, the Upper River zone, the Lower River zone, and the Washington Ship Channel/Tidal Basin zone. The boundaries of these zones are discussed in Section 2.2 and illustrated in Figure 7-1.

7.3.2 SCREENING LEVEL EFFECTS ASSESSMENT

Sediment benchmark concentrations were selected from the literature to represent effects to benthic invertebrates. The selected sediment benchmark concentrations are presented in Table 7-4.

Table 7-4. Sediment benchmarks (µg/g dry weight)

		TEL
Trace elements		
	Arsenic	10.8
	Barium	0.7
	Cadmium	0.6
	Chromium, total	36.3
	Copper	28
	Lead	34.2
	Manganese	615
	Mercury	0.17
	Nickel	19.5
	Selenium	0.29
	Silver	<0.5
	Strontium	49
	Vanadium	50
	Zinc	94.2
PAHs	Benzo(a) anthracene	0.032
	Benzo(a)pyrene	0.032
	Chrysene	0.057
	Fluoranthene	0.11
	Phenanthrene	0.042
	Pyrene	0.053
	LPAHs	0.076
	HPAHs	0.193
	Total PAHs	0.264
PCBs	Aroclor 1254	0.032
	Aroclor 1260	0.032
	Total PCBs	0.032
Pesticides	Chlordane	0.0045
	Dieldrin	0.0029
	Heptaclor Epoxide	0.0006
	Lindane	0.0009
	DDD	0.00354
	DDE	0.0014
	total DDT	0.007
	Endrin	0.00267

Threshold effects levels (TELs) from the U.S. EPA ARCS program (U.S. EPA, 1996) were used as sediment benchmarks. TELs have been defined as the concentrations below which toxic effects are rarely observed (U.S. EPA, 1996). TELs were derived from freshwater exposures of *Hyalella azteca* using 28-day survival, growth, and reproductive endpoints (U.S. EPA, 1996). TELs were calculated as the geometric mean of the lower 15th percentile concentrations of the effects data and the 50th percentile of the no-effects data. In addition, TELs derived for freshwater sediments (Smith et al., 1996) were used for comparison for the pesticides because ARCS did not provide TELs for these contaminants. These TELs were calculated in the same manner as the ARCS values (U.S. EPA, 1996), but are based on a

wider variety of bioassays and benthic community metrics. For several trace elements (barium, selenium, silver, and strontium) no TEL values were available, so background values were used (NOAA, 1999).

7.3.3 SCREENING LEVEL RISK CALCULATION

For screening-level risk calculations, the exposure estimates and the screening ecotoxicity values were combined using the hazard quotient approach to estimate risk (U.S. EPA, 1997). Hazard quotients (HQs) are defined as the ratio of the estimated dose or environmental exposure concentration at the site to a no observed effects level (NOAEL) for the contaminant. An HQ less than one indicates that that single contaminant alone is unlikely to cause the adverse biological effect reflected by the NOAEL (U.S. EPA, 1997).

The values for the upper river zone (Figure 7-1) are presented in Table 7-5. HQ values greater than one were calculated for all trace elements except arsenic and strontium. All maximum sediment PAH and pesticide concentrations were greater than the corresponding TEL values. Finally, the HQ calculated for the maximum total PCB concentration was fifty times greater then the total PCB TEL value.

Table 7-5. Sediment Benchmarks, Maximum Concentrations and Calculated Hazard Quotients for the Upper River

		TEL	Maximum Sediment Concentration (ppm)	$HQ_{(TEL)}$
Trace elements				
	Arsenic	10.8	6.46	0.60
	Barium	0.7	156.40	**223.43**
	Cadmium	0.6	2.62	**4.37**
	Chromium, total	36.3	134.00	**3.69**
	Copper	28	100.10	**3.58**
	Lead	34.2	224.00	**6.55**
	Manganese	615	643.10	**1.05**
	Mercury	0.17	0.59	**3.47**
	Nickel	19.5	50.51	**2.59**
	Selenium	0.29	nd	
	Silver	<0.5	nd	
	Strontium	49	21.72	0.44
	Vanadium	50	65.54	**1.31**
	Zinc	94.2	477.00	**5.06**
PAHs	Benzo(a) anthracene	0.032	0.78	**24.41**
	Benzo(a)pyrene	0.032	0.70	**21.72**
	Chrysene	0.057	1.10	**19.30**
	Fluoranthene	0.111	1.79	**16.13**
	Phenanthrene	0.042	0.85	**20.24**
	Pyrene	0.053	1.58	**29.81**
	LPAHs	0.076	1.68	**22.11**
	HPAHs	0.193	6.60	**34.20**
	Total PAHs	0.264	7.89	**29.89**
PCBs	Aroclor 1254	0.032	1.630	**50.94**
	Aroclor 1260	0.032	0.015	0.47
	Total PCBs	0.032	1.630	**50.94**
Pesticides	Chlordane	0.0045	0.196	**43.56**
	Dieldrin	0.0029	0.005	**1.72**
	Heptaclor Epoxide	0.0006	0.004	**6.67**
	Lindane	0.0009	0.002	**2.22**
	DDD	0.00354	0.082	**23.16**
	DDE	0.0014	0.047	**33.57**
	total DDT	0.007	0.149	**21.29**
	Endrin	0.00267	0.003	**1.12**

Table 7-6 presents the maximum sediment concentrations and calculated hazard quotients for the lower river zone. HQ values greater than one were calculated for all the trace elements, PAHs, total PCBs, and several of the chlorinated pesticides (dieldrin, DDD, DDE, total DDT, and endrin). The largest HQ values were calculated for the PAH compounds with HQ values ranging from 658–8,570.

Table 7-6. Sediment Benchmarks, Maximum Concentrations and Calculated Hazard Quotients for the Lower River

		TEL	Maximum Sediment Concentration (ppm)	$HQ_{(TEL)}$
Trace elements				
	Arsenic	10.8	26.90	**2.49**
	Barium	0.7	170.00	**242.86**
	Cadmium	0.6	3.18	**5.30**
	Chromium, total	36.3	155.50	**4.28**
	Copper	28	631.00	**22.54**
	Lead	34.2	775.00	**22.66**
	Manganese	615	800.00	**1.30**
	Mercury	0.17	2.70	**15.88**
	Nickel	19.5	69.70	**3.57**
	Selenium	0.29	1.10	**3.79**
	Silver	< 0.5	64.40	**128.80**
	Vanadium	50	68.10	**1.36**
	Zinc	94.2	512.00	**5.44**
PAHs	Benzo(a) anthracene	0.032	100.00	**3125.00**
	Benzo(a)pyrene	0.032	27.00	**843.75**
	Chrysene	0.057	86.00	**1508.77**
	Fluoranthene	0.111	110.00	**990.99**
	Phenanthrene	0.042	360.00	**8571.43**
	Pyrene	0.053	320.00	**6037.74**
	LPAHs	0.076	98.80	**1300.00**
	HPAHs	0.193	127.00	**658.03**
	Total PAHs	0.264	211.00	**799.24**
PCBs	Aroclor 1254	0.032	nd	
	Aroclor 1260	0.032	12.00	**375.00**
	Total PCBs	0.032	12.00	**375.00**
Pesticides	Chlordane	0.0045	0.0001	0.03
	Dieldrin	0.0029	0.0050	**1.72**
	Heptaclor Epoxide	0.0006	0.0003	0.53
	Lindane	0.0009	0.0001	0.11
	DDD	0.00354	0.17	**48.31**
	DDE	0.0014	0.07	**52.14**
	total DDT	0.007	0.32	**46.29**
	Endrin	0.00267	0.00	**1.28**

The Ship Channel and Tidal Basin sediments are evaluated in Table 7-7. HQ values greater than one were calculated for the trace elements, PAHs, total PCBs and all the organochlorine pesticides except endrin. The magnitude of the PAH HQ values were all greater than 100 and they were lower than those seen in the lower river with HQ values ranging from 155–396.

Table 7-7. Sediment Benchmarks, Maximum Concentrations and Calculated Hazard Quotients for the Ship Channel

		TEL	Maximum Sediment Concentration (ppm)	$HQ_{(TEL)}$
Trace elements				
	Arsenic	10.8	nd	
	Barium	0.7	nd	
	Cadmium	0.6	3.31	**5.52**
	Chromium, total	36.3	176.00	**4.85**
	Copper	28	348.00	**12.43**
	Lead	34.2	3630.00	**106.14**
	Manganese	615	nd	
	Mercury	0.17	9.22	**54.21**
	Nickel	19.5	nd	
	Selenium	0.29	nd	
	Silver	<0.5	nd	
	Vanadium	50	nd	
	Zinc	94.2	1090.00	**11.57**
PAHs	Benzo(a) anthracene	0.032	8.98	**280.63**
	Benzo(a)pyrene	0.032	6.48	**202.50**
	Chrysene	0.057	8.84	**155.09**
	Fluoranthene	0.111	19.71	**177.57**
	Phenanthrene	0.042	16.64	**396.19**
	Pyrene	0.053	14.61	**275.66**
	LPAHs	0.076	23.44	**308.42**
	HPAHs	0.193	65.98	**341.87**
	Total PAHs	0.264	89.41	**338.67**
PCBs	Aroclor 1254	0.032	nd	
	Aroclor 1260	0.032	nd	
	Total PCBs	0.032	3.3500	**104.69**
Pesticides	Chlordane	0.0045	0.1300	**28.89**
	Dieldrin	0.0029	0.0093	**3.21**
	Heptaclor Epoxide	0.0006	0.0028	**4.67**
	Lindane	0.0009	0.0018	**2.00**
	DDD	0.00354	0.1970	**55.65**
	DDE	0.0014	0.1420	**101.43**
	total DDT	0.007	0.8030	**114.71**
	Endrin	0.00267	0.0015	0.56

7.4 FISH EVALUATION

The exposure of fish in the Anacostia River to bioaccumulative compounds such as dioxins and furans, PCBs, pesticides, trace elements, plus PAHs was evaluated using three approaches:

- Aqueous contaminant concentrations presented by Velinsky et al. (1999) were compared to their corresponding AWQC values.

- The exposures to bioaccumulative compounds (dioxins and furans, PCBs, pesticides, and trace elements) were assessed using a tissue residue effects approach. The concentrations of these compounds that accumulate in tissues are an integrative measure of all exposure pathways (i.e., dietary, respiratory, etc.). These tissue concentrations were compared to those known to cause injuries or those that have been associated with observations of adverse impacts.

- For PAHs, tissue effects concentrations are not relevant, as fish rapidly metabolize and excrete PAH compounds (Varanasi et al., 1989). Risks to fish from exposure to PAHs were evaluated by contrasting concentrations of the PAHs in sediments to sediment concentrations known to be injurious to fish or associated with observations of adverse effects.

In conducting the screening evaluation the lower Anacostia was divided into three zones, the Upper river zone, the Lower river zone, and the Washington Ship Channel/Tidal Basin zone. The boundaries of these zones are discussed in Section 7.2.2 and illustrated in Figure 7-1.

7.4.1 SCREENING LEVEL EXPOSURE ESTIMATE

7.4.1.1 WATER COLUMN SCREENING

Water column concentrations of a wide range of inorganic and organic contaminants from a recent study of the effects of stormwater runoff on water quality in Anacostia River were examined (Velinsky et al., 1999). This data was collected throughout 1998 and represents water quality both before and after major storm events. Water quality data will be screened using Ambient Water Quality Criteria (AWQC) for the protections of aquatic life (U.S. EPA, 1993). The AWQC values used in the screening are presented in Table 7-8.

Table 7-8. Chronic AWQC Values (µg/L)

	Criteria	
INORGANICS		
NH4-N [(a)]	2,280	
As(III)	150	
Total As	150	
Dissolved Cd	2.2	[(b)]
Dissolved Cr (VI)	11	
Dissolved Cu	9	[(b)]
Dissolved Ni	52	[(b)]
Dissolved Pb	2.5	[(b)]
Dissolved Zn	120	[(b)]
ORGANICS		
otal PCBs	0.014	
Heptachlor	0.0019	
Aldrin	1.5	[(c)]
p,p'-DDE	1050	[(c)]
p,p'-DDT	0.0005	

[(a)] chronic criterion as total ugN/L calculated based on pH=7.5 (EPA 1998)
[(b)] criteria calculated based on hardness of 100 mg/L CaCO3
[(c)] acute criteria used

7.4.1.2 TISSUE CONCENTRATION SCREENING

Tissue concentrations of contaminants in fish from the Anacostia have been measured in a range of studies that have been compiled into the NOAA Watershed Database. Only whole body tissue concentrations for the two representative species, the brown bullhead and the largemouth bass, were evaluated. In addition, tissue concentrations reported for dead fish carcasses were not included due to potential changes in the fish tissue mass, as well as contaminant concentrations, following the death of the fish.

In the upper river zone, tissue concentrations of dioxins, PCBs, pesticides, and PAH were available for both the brown bullhead and the largemouth bass; concentrations of trace elements were only available for the brown bullhead. In the lower river zone, tissue concentrations of dioxins, PCBs, and pesticides were available for both the brown bullhead and the largemouth bass, only largemouth bass trace element tissue concentrations were available. In the Washington Ship Channel/Tidal Basin zone, only pesticide data was available for the largemouth bass.

There are no promulgated criteria for evaluating contaminant concentrations in fish tissue. However, concentrations associated with effects in toxicity tests and field studies are available and were reviewed. Lowest observed effects concentrations (LOECs) were selected from these studies to screen the estimated tissue concentrations against. Studies were identified from the U.S. Army Corps of Engineers (ACOE) ERED electronic database and from recent reviews of tissue residue effects data (Jarvinen and Ankley, 1999; Suter et al., 1999; Monosson, 1999; ESI, 1998).

7.4.1.2.1 POLYCHLORINATED BIPHENYLS

PCBs were marketed in the United States as mixtures of congeners known as Aroclors. Individual Aroclors contain different amounts of toxicologically important congeners. Therefore, it is important to know the identity of the individual Aroclors being summed to calculate a reported total PCB concentration. However, for the purposes of the screening-level risk evaluation, total PCB concentrations were screened. The type of PCB associated with each of the residue effects concentrations are identified in Table 7-9.

Selected LOECs for freshwater fish are presented in Table 7-9. The effects concentrations were selected as the lowest whole body concentrations associated with effects in freshwater species from two recent reviews (ESI, 1998; Suter et al., 1999). The results are consistent with the results of another review which estimated that whole body Aroclor 1254 concentrations of 5 µg/g wet weight or greater can result in reduced larval survival (Monosson, 1999). It should be noted that lower tissue concentrations associated with reproductive effects were reported for ovaries from baltic flounder (Von Westernhagen et al., 1981) and eggs from starry flounder, lake trout, and rainbow trout (Hogan and Brauhn, 1975; Hendricks et al., 1981; Spies et al., 1985; Mac and Edsall, 1991). In addition, increased mortality was seen in yearling coho salmon associated with PCB concentrations of 0.5 to 1.2 µg/g wet weight in the liver (Folmar et al., 1982). However, only whole-body concentrations were selected as screening concentrations.

Table 7-9. Lowest Observed Effects Concentrations of PCBs in Fish

Species	PCB Type	LOEC (µg/g wet wt)	Effects Endpoint	Reference
Lake Trout	Aroclor 1254	0.7[a]	fry mortality	Berlin et al. 1981 as cited in Suter et al. 1999
Atlantic salmon	Mixture of Aroclors 1016, 1221,1254,1260	3.0	reduced growth in alevins	Fisher et al. 1994
Adult fathead minnow	Aroclor 1254	13.7	reduced fecundity and frequency of reproduction	ACOE 1988
Fingerling channel catfish	Aroclor 1242	14.33	reduced growth	Hansen et al. 1976

[a] Geometric mean of the LOEC and NOEC

7.4.1.2.2 DIOXINS AND FURANS

Polychlorinated dibenzo-*p*-dioxins (dioxins) and polychlorinated dibenzofurans (furans) are byproducts of several industrial reactions. The most significant sources of dioxins and furans appear to be their thermal formation during the incineration of municipal, industrial, and medical wastes (U.S. EPA, 1994). There are 75 individual dioxin congeners and 135 individual furan congeners with a range of levels of chlorination with 1 to 8 chlorines.

Selected LOECs for freshwater fish are presented in Table 7-10. The effects concentrations associated with the lowest whole body concentrations associated with effects in freshwater species were obtained from a recent review of tissue effects concentrations (Jarvinen and Ankley, 1999).

Table 7-10. Lowest Observed Effects Concentrations of Dioxins and Furans

Species	Congener	LOEC (µg/g wet wt)	Effects Endpoint	Reference
Coho salmon	2,3,7,8-TCDD	0.125	survival	Miller et al., 1979
Rainbow trout	2,3,7,8-TCDD	0.00065-0.00258	growth	Branson et al., 1975
Rainbow trout	2,3,7,8-TCDD	0.00025	survival	Kleeman et al., 1986
Fathead minnow	2,3,7,8-TCDD	0.014	survival	Adams et al., 1986
Rainbow trout	2,3,7,8-TCDF	0.0093-0.0119	growth	Mehrle et al., 1988

7.4.1.2.3 PESTICIDES

There were fewer LOECs available for pesticides than for PCBs and mercury. Whole-body tissue concentrations associated with effects in freshwater fish species obtained from the ACOE ERED database were reviewed and the lowest reported LOEC or NOEC value was selected for each pesticide. The effects concentrations are presented in Table 7-11.

Table 7-11. Effects Concentrations of Pesticides in Fish

Contaminant	Species	Effects Concentration (µg/g ww)	Effects Endpoint	Reference
Dieldrin	Guppy	10.7	Reduced growth	Burnett and Liss 1990
Heptaclor Epoxide	Spot	0.016[a]	Mortality	Schimmel et al. 1976
Lindane	Fathead minnow	0.537[a]	Mortality	Macek et al. 1976
4,4'-DDD	Fathead minnow	0.6	Reproduction	Jarvinen et al. 1977
4,4'-DDE	Lake Trout	1.09	Mortality	Burdick et al. 1964
4,4'-DDT	Cutthroat Trout	0.567	Mortality	Cuerrier et al. 1967
	Brook Trout	0.89	Mortality	Macek 1968
	Lake Trout	2.93	Mortality	Burdick et al. 1964

[a]Value is an NOEC.

7.4.1.2.4 TRACE ELEMENTS

Tissue concentrations for the following trace elements were reported for the brown bullhead and the largemouth bass: arsenic, cadmium, lead, mercury, nickel, selenium, and zinc. In the following sections, the LOECs for whole body freshwater fish are presented. No effects concentrations for whole body freshwater fish were found for chromium or nickel.

Arsenic – The effect of temperature on the chronic toxicity of arsenate to rainbow trout has been studied (McGeachy and Dixon, 1990). Fish tested at 15° C were significantly less sensitive to the arsenate than fish tested at the same concentrations and lower temperatures (5° C). Both groups of fish had similar tissue residue concentrations and the greater sensitivity at lower temperatures might be related to different toxicokinetics (Jarvinen and Ankley, 1999). In addition, juvenile fish appear to be more sensitive than adult fish to effects of arsenic species. The LOEC values for whole body freshwater fish are presented in Table 7-12.

Table 7-12. Lowest Observed Effects Concentrations of Arsenic in Fish

Species	Arsenic Species	Effects Concentration (µg/g wet wt)	Effects Endpoint	Reference
Rainbow Trout	Sodium arsenate	3.0	Reduced growth	McGeachy and Dixon 1990
Green sunfish	Sodium arsenate	6.7	mortality	Sorensen 1976
Bluegill	Sodium arsenite	2.24 - 11.7	Reduced growth and mortality	149

Cadmium – Cadmium is a surface active toxicant that causes mortality by disrupting ion-regulation by inhibiting ion-specific ATPases and opening tight junctions in the fish gill. This leads to a depletion of whole body ions as the higher internal concentrations of sodium and calcium ions diffuse into the surrounding water. Freshwater species appear to be more sensitive to the effects of cadmium than saltwater species. LOEC values for freshwater fish are presented in Table 7-13.

Table 7-13. Lowest Observed Effects Concentrations of Cadmium in Fish

Species	Effects Concentration (µg/g wet wt)	Effects Endpoint	Reference
Rainbow Trout	0.7 - 1.0	mortality	Pascoe et al., 1986
	0.96	growth	Kumada et al., 1973
	0.25	growth	Benoit et al., 1976
	0.14	survival	Hamilton et al., 1987a,b
Bluegill	0.35[a]	survival	Cearley and Coleman 1974
Bluegill		Reduced growth and mortality	

Lead – Holcombe et al. (1976) studied the effect of long-term lead exposure on three generations of brook trout. The tissue residue lead concentrations were measured in gill, liver, and kidney of the first- and second-generation adult fish. Whole body concentrations were reported for the third-generation embryos. The second- and third-generation fish exhibited acute and chronic effects at lower aqueous and tissue residue lead concentrations compared to the first generation fish. LOEC values from this study are summarized in Table 7-14.

Table 7-14. Lowest Observed Effects Concentrations of Lead in Fish

Species	Effects Concentration (µg/g wet wt)	Effects Endpoint	Reference
Brook trout[a]	0.40	mortality	Holcombe et al., 1976
	1.0-8.8	reduced growth	

[a] – third generation embryos
[b] – reduced survival measured in terms of hatchability

Mercury – Almost all of the studies reviewed were laboratory studies that dosed fish with either methylmercury or mercuric chloride in food or water. Uptake of methylmercury by aquatic organisms is both more rapid and more extensive than uptake of inorganic mercury (Biesinger et al., 1982 and others). LOECs for mercury in freshwater fish species are presented in Table 7-15. The selected concentrations represent the lowest whole-body mercury concentrations associated with effects from an extensive literature review (ESI, 1998). Lower effects concentrations were reported for the gonads of adult rainbow trout, associated with reduced larval survival in their offspring (Birge et al., 1979). For the purposes of this assessment, only whole-body tissue concentrations were selected as screening concentrations.

Table 7-15. Lowest Observed Effects Concentrations of Mercury in Fish

Species	Mercury Species	Effects Concentration (µg/g wet wt)	Effects Endpoint	Reference
Larval fathead minnow	Mercuric chloride	1.24	Reduced growth (length)	Snarski and Olson 1982
Larval fathead minnow	Mercuric chloride	1.36	Reduced growth (weight)	Snarski and Olson 1982
Rainbow trout	Methylmercury	1.8	Mortality	Hawryshyn and Mackay 1979
Juvenile walleye	Methylmercury	2.37	Reduced growth	Friedmann et al., 1996

Selenium – A recent review of effects associated with selenium tissue concentrations concluded that the toxicity of selenium depended both on the form of selenium and the route of exposure (i.e., aqueous vs. dietary) (Jarvinen and Ankley, 1999). LOEC concentrations for whole body freshwater fish are presented in Table 7-16.

Table 7-16. Lowest Observed Effects Concentrations of Selenium in Fish

Species	Selenium Species	Effects Concentration (µg/g wet wt)	Effects Endpoint	Reference
Rainbow Trout	Sodium selenite	1.9	mortality	Gissel-Nielsen and Gissel-Nielsen 1978
Chinook salmon[a]	Inorganic selenium	1.3	mortality	Hamilton et al. 1990
		0.66	Reduced growth	
Fathead minnow[a]	Sodium selenate	8.6	Reduced growth	Bennett et al. 1986
Fathead minnow	Selenate, selenite and seleno-L-methionine mixture	1.22	Reduced growth	Ogle and Knight 1989
Fathead minnow	Sodium selenate	9.5	Reduced growth	117
Bluegill	6:1 mixture of selenate to selenite	1.08	mortality	Cleveland et al. 1993

[a] - larvae

Zinc – Very few whole body zinc concentrations were found for freshwater fish species. The majority of values in a recently compiled database were either no-effect concentrations or organ concentrations (Jarvinen and Ankley, 1999). LOEC concentrations for whole-body freshwater fish are presented in Table 7-17.

Table 7-17. Lowest Observed Effects Concentrations of Zinc in Fish

Species	Effects Concentration (µg/g wet wt)	Effects Endpoint	Reference
Flagfish	44	mortality	Spehar 1976
	40	Reduced growth	

7.4.1.3 SEDIMENT THRESHOLD SCREENING OF PAHS

Pinkney et al. (2000) reported that 55 percent of brown bullheads collected from the Anacostia River had hepatic tumors. The prevalence of orocutaneous tumors was 23 percent. Baumann et al. (1996) reviewed the bullhead tumor survey data from the Great Lakes and stated that liver tumor rates greater than 9 percent and skin tumor rates greater than 20 percent were nearly always indicative of sites with contaminated sediments. Pinkney et al. (2000) reported a statistical association between PAH metabolite concentrations in fish bile and liver tumors, a further indication of a possible relationship between tumors and sediment PAH exposure. Correlations between sediment PAH concentrations and neoplasms in feral fish, and the induction of neoplasms in fish by exposure to contaminated sediment extracts, both support the hypothesis that some fish neoplasms and chronic responses result from exposure to PAHs present in the fish's environment (Black et al., 1980; Baumann et al., 1982; Baumann, 1984; Baumann et al., 1991; Horness et al., 1998).

A sediment quality threshold of 2 µg/g, derived from the relationship observed between sediment PAH concentrations and the prevalence of hepatic lesions in English sole (Horness et al., 1998), was selected for evaluating the potential exposure of fish to the PAHs in the sediments of the Anacostia River.

7.4.2 SCREENING-LEVEL RISK CALCULATIONS

7.4.2.1 SURFACE WATER SCREENING

The maximum surface water concentrations observed in this study are compared to the corresponding ambient water quality criteria in Tables 7-18 and 7-19. Only the upper river and lower river zones were evaluated as there was no corresponding water quality data for the Ship Channel from this study.

HQ values greater than one were calculated for lead and total PCBs in the upper river zone. In the lower river zone, none of the calculated HQ values were greater than one.

Table 7-18. Upper River Aqueous Contaminant Concentrations (Pinkney et al., 1993) and Corresponding AWQC Values (µg/L)

	Criteria	Max. Value	HQ
INORGANICS			
NH4-N [a]	2,280	371	0.16
As(III)	150	0.18	0.001
Total As	150	0.66	0.004
Dissolved Cd	2.2 [b]	0.041	0.02
Dissolved Cr (VI)	11	0.4	0.04
Dissolved Cu	9 [b]	4.02	0.45
Dissolved Ni	52 [b]	3.59	0.07
Dissolved Pb	2.5 [b]	3.32	**1.33**
Dissolved Zn	120 [b]	17.04	0.14
ORGANICS			
Total PCBs	0.014	0.017	**1.23**
Heptachlor	0.0019	0.000	0.02
Aldrin	1.5 [c]	nd	
p,p'-DDE	1050 [c]	0.001	0.000001
p,p'-DDT/IUPAC 176 [d]	0.0005	0.00032	0.64

[a] chronic criterion as total µgN/L calculated based on pH=7.5 (EPA 1998)
[b] criteria calculated based on hardness of 100 mg/L CaCO3
[c] acute criteria used
[d] co-elution of p,p'-DDT and PCB congener IUPAC #176

Table 7-19. Lower River Aqueous Concentrations (Pinkney et al., 1993) and Corresponding AWQC Values (µg/L)

	Criteria	Max. Value	HQ
INORGANICS			
NH4-N [a]	2,280	902	0.40
As(III)	150	0.17	0.001
Total As	150	0.59	0.004
Dissolved Cd	2.2 [b]	0.3	0.14
Dissolved Cr (VI)	11	3.73	0.34
Dissolved Cu	9 [b]	2.35	0.26
Dissolved Ni	52 [b]	1.94	0.04
Dissolved Pb	2.5 [b]	1.26	0.50
Dissolved Zn	120 [b]	15.08	0.13
ORGANICS			
Total PCBs	0.014	0.0094	0.67
Heptachlor	0.0019	0.0003	0.16
Aldrin	1.5 [c]	0.00012	0.0001
p,p'-DDE	1050 [c]	0.00068	0.000001
p,p'-DDT/IUPAC 176 [d]	0.0005	0.00065	1.30

[a] chronic criterion as total ugN/L calculated based on pH=7.5 (EPA 1998)
[b] criteria calculated based on hardness of 100 mg/L CaCO3
[c] acute criteria
[d] co-elution of p,p'-DDT and PCB congener IUPAC #176

7.4.2.2 TISSUE EFFECT CONCENTRATIONS

Risk were estimated as HQs, calculated using the lowest of the LOECs for PCBs, dioxins and furans, pesticides, and trace elements from Tables 7-9 through 7-17. When the LOEC value was based on a mortality endpoint, a screening value was calculated as the LOEC/10 in order to estimate the chronic LOEC value from the acute value.

The maximum tissue concentrations and corresponding LOEC values for the upper river zone are presented in Table 7-20. The only HQ greater than one for the brown bullhead was the value for lead (HQ equal to 2.59). The only HQ greater than one calculated for the largemouth bass was for total PCBs (HQ equal to 1.39).

Table 7-20. Upper River Maximum Fish Tissue Concentrations Compared to Corresponding LOEC

	LOEC (ug/g wet wt)	Upper River Brown Bullhead	HQ	Largemouth bass	HQ
Dioxins and Furans:					
2,3,7,8-TCDD	0.000025 [(a)]	0.0000002	0.0088	0.0000005	0.0180
2,3,7,8-TCDF	0.0093	0.0000007	0.0001	0.0000006	0.0001
PCBs:					
Total PCB	0.7	0.29300	0.42	0.97	**1.39**
Trace Elements:					
Arsenic	2.24	0.034	0.02	NA	
Cadmium	0.014 [(a)]	0.006	0.40	NA	
Lead	0.04 [(a)]	0.104	**2.59**	NA	
Mercury	1.24	0.051	0.04	NA	
Selenium	0.66	0.193	0.29	NA	
Zinc	40	5.920	0.15	NA	
Pesticides:					
Dieldrin	10.7	0.009	0.001	0.020	0.002
Heptaclor Epoxide	0.016	0.0001	0.01	0.001	0.056
Lindane	0.537	0.0003	0.001	NA	
DDD	0.6	0.040	0.07	0.120	0.200
DDE	0.109 [(a)]	0.049	0.45	0.100	0.917
DDT	0.0567 [(a)]	0.001	0.03	0.001	0.009

[(a)] Original LOEC was based on mortality endpoint; screening value = LOEC/10

The calculated HQ values for the lower river zone are presented in Table 7-21. HQ values greater than one were calculated for total PCB concentrations in both the brown bullhead and the largemouth bass (HQs equal to 1.82 and 1.36, respectively). In addition, the HQ calculated for lead in the largemouth bass was 1.08. Finally, the HQ values calculated for the pesticides, DDD and DDE, were greater than one for both the brown bullhead and the largemouth bass.

Table 7-21. Lower River Maximum Fish Tissue Concentrations Compared to Corresponding LOEC

	LOEC (ug/g wet wt)	Lower River Brown Bullhead	HQ	Largemouth bass	HQ
Dioxins and Furans:					
2,3,7,8-TCDD	0.000025 (a)	0.00001	0.31	0.00000322	0.13
2,3,7,8-TCDF	0.0093	0.0000024	0.0003	0.0000004	0.00004
PCBs:					
Total PCB	0.7	1.27400	**1.82**	0.954	**1.36**
Trace Elements:					
Arsenic	2.24	NA		0.099	0.04
Cadmium	0.014 (a)	NA		0.004	0.30
Lead	0.04 (a)	NA		0.043	**1.08**
Mercury	1.24	NA		0.078	0.06
Selenium	0.66	NA		0.274	0.42
Zinc	40	NA		4.559	0.11
Pesticides:	10.7				
Dieldrin	0.016	0.00025	0.0156	0.020	**1.25**
Heptaclor Epoxide	0.537	0.01700	0.03	0.005	0.01
Lindane	0.6	0.00120	0.002	0.000	0.0003
DDD	0.109 (a)	0.14000	**1.28**	0.130	**1.19**
DDE	0.0567 (a)	0.13000	**2.29**	0.150	**2.65**
DDT	0.567	0.01000	0.02	0.004	0.01

(a) Original LOEC was based on mortality endpoint; screening value = LOEC/10

The only tissue data available for the Ship Channel and Tidal Basin were PCB and pesticide data for largemouth bass (Table 7-22). HQ values greater than one were calculated for total PCB, dieldrin, DDD, and DDE. The largest HQ value was calculated for DDE (HQ equal to 11.1).

Table 7-22. Ship Channel Maximum Fish Tissue Concentrations Compared to the Corresponding LOEC

	LOEC (ug/g wet wt)	Ship Channel Brown Bullhead	HQ	Largemouth bass	HQ
Dioxins and Furans:					
2,3,7,8-TCDD	0.000025 [(a)]	NA		NA	
2,3,7,8-TCDF	0.0093	NA		NA	
PCBs:					
Total PCB	0.7	NA		4.7	**6.71**
Trace Elements:					
Arsenic	2.24	NA		NA	
Cadmium	0.014 [(a)]	NA		NA	
Lead	0.04 [(a)]	NA		NA	
Mercury	1.24	NA		NA	
Selenium	0.66	NA		NA	
Zinc	40	NA		NA	
Pesticides:	10.7				
Dieldrin	0.016	NA		0.04	**2.500**
Heptaclor Epoxide	0.537	NA		NA	
Lindane	0.6	NA		NA	
DDD	0.109 [(a)]	NA		0.36	**3.30**
DDE	0.0567 [(a)]	NA		0.63	**11.11**
DDT	0.567	NA		0.06	0.11

[(a)] Original LOEC was based on mortality endpoint; screening value = LOEC/10

7.4.2.3 RESULTS OF SEDIMENT THRESHOLD SCREENING OF PAHS

The maximum sediment total PAH concentration in each area was compared to the sediment quality threshold of 2 µg/g. The resulting HQ for the upper river zone was 3.9. The HQ values calculated for the lower river and the Ship Channel sediments were considerably higher (HQs of 105 and 45, respectively).

7.5 AQUATIC BIRD EVALUATION

In conducting the screening evaluation for aquatic birds, the lower Anacostia was divided into three zones, the Upper river zone, the Lower river zone, and the Washington Ship Channel/Tidal Basin zone. The boundaries of these areas are discussed in Section 2.2 and illustrated in Figure 7-1.

7.5.1 SCREENING LEVEL EXPOSURE ESTIMATE

Exposure of avian receptors to COPCs associated with Anacostia River sediments was estimated based on the assumption that contaminant exposure was entirely through diet. The selected bird receptor is the green heron which consumes a mixed diet of fish, invertebrates, and various insects. Dietary composition for the green heron was reported to have a lower fraction of fish than some reported diets for the larger great blue heron. In order to assure a conservative exposure estimate, the dietary composition reported for the larger great blue heron (U.S. EPA, 1993) was used for the green heron (Table 7-23).

Table 7-23. Dietary Composition for Green Heron (U.S. EPA, 1993)

Species	Percent fish	Percent Invertebrates	Percent incidental sediment ingestion
Green Heron[1]	94	6	1.8[2]

[1] – composition data for the great blue heron from USEPA (1993) used for green heron

[2] – calculated from sediment ingestion rate for sandpiper of 30 percent multiplied by the percent invertebrates consumed by the heron

The maximum measured fish tissue contaminant concentrations was used to calculate the dose resulting from the fish portion of the diet of the raccoon and the green heron. No invertebrate tissue concentrations are available so the invertebrate tissue concentrations were estimated from the maximum sediment concentrations using biota to sediment accumulation factors (BSAFs). For organic contaminants such as PCBs and pesticides, BSAFs are calculated by dividing the lipid-normalized concentrations of a chemical in an organism by the organic-carbon-normalized (OC-normalized) concentrations of the same chemical in sediment (Equation 1):

$$\text{BSAF} = \frac{\text{lipid-normalized tissue concentration}}{\text{OC-normalized sediment concentration}} \qquad \textbf{Eq. 7-1}$$

An estimated tissue concentration can thus be calculated by multiplying the BSAF by the OC-normalized sediment concentration (Equation 2):

$$\text{Estimated lipid-normalized tissue concentration} = \text{BSAF} \times \text{OC-normalized sediment concentration} \qquad \textbf{Eq. 7-2}$$

BSAFs used to estimate tissue concentrations of PCBs and pesticides are presented in Table 7-24. BSAFs for PCBs and pesticides represent median BSAFs for benthic organisms, including benthically-associated fish (spot, channel catfish, croaker white perch, fathead minnow, and scup), calculated by Tracey and Hansen (1995). An extensive analysis of differences in BSAFs for individual species and trophic levels concluded that the calculated BSAFs were similar for various species both within the same trophic level and between different trophic levels (Tracey and Hansen, 1995). However, the use of a single BSAF for an entire class of contaminants, such as PCBs or pesticides, is a simplification of the complexity of the chemistry of the individual compounds.

Table 7-24. BSAF Values for PCBs and Pesticides

Contaminant	BSAF	Reference
PCBs	1.64	Tracey and Hansen (1995)
Pesticides	1.96	Tracey and Hansen (1995)

A biota-to-sediment ratio of 1 was used to estimate the invertebrate trace element tissue concentrations. This value appears to be conservative for mercury based on the sediment and tissue concentrations presented by Suter et al. (1999) for largemouth bass, bluegill, gizzard shad, and channel catfish collected from a large river-reservoir system.

Invertebrate tissue concentrations of PCBs, trace elements, and pesticides in the upper river, the lower river, and the Ship Channel zones were estimated, using these values, and are presented in Tables 7-24 through 7-27.

Table 7-25. Estimated Maximum Invertebrate Tissue Concentrations in the Upper River

		Maximum sediment conc (ppm dry wt)	C_{org} TOC normalized	BSAF	Tissue conc dry wt		Tissue conc wet weight [a]
Trace elements							
	Arsenic	6.46	1		6.46		1.292
	Cadmium	2.62	1		2.62		0.524
	Lead	224.00	1		224		44.800
	Mercury	0.59		1	0.59		0.118
	Selenium	nd		1			
	Zinc	477.00		1	447		89.400
PCBs	Aroclor 1254	1.630	45.79	1.64	3.75	[b]	0.751
	Aroclor 1260	0.015	0.42	1.64	0.03	[b]	0.007
	Total PCBs	1.630	45.79	1.64	3.75	[b]	0.751
							0.000
Pesticides	Chlordane	0.196	5.51	1.96	0.54	[b]	0.108
	Dieldrin	0.005	0.14	1.96	0.01	[b]	0.003
	Heptaclor Epoxide	0.004	0.11	1.96	0.01	[b]	0.002
	Lindane	0.002	0.06	1.96	0.01	[b]	0.001
	DDD	0.082	2.30	1.96	0.23	[b]	0.045
	DDE	0.047	1.32	1.96	0.13	[b]	0.026
	total DDT	0.149	4.19	1.96	0.41	[b]	0.082
	Endrin	0.003	0.08	1.96	0.01	[b]	0.002

[a] calculated assuming 80 percent moisture (Stephan et al., 1985)
[b] calculated assuming 5 percent lipid and using area average TOC of 3.56 percent

Table 7-26. Estimated Maximum Invertebrate Tissue Concentrations in the Lower River

		Maximum sediment conc (ppm dry wt)	C_{org} TOC normalized	BSAF	Tissue conc dry wt	Tissue conc wet weight [a]
Trace elements						
	Arsenic	26.90		1	26.9	5.380
	Cadmium	3.18		1	3.18	0.636
	Lead	775.00		1	775	155.000
	Mercury	2.70		1	2.7	0.540
	Selenium	1.10		1	1.1	0.220
	Zinc	512.00		1	512	102.400
PCBs	Aroclor 1254	nd		1.64		
	Aroclor 1260	12.00	353.98	1.64	29.03 [b]	5.805
	Total PCBs	12.00	353.98	1.64	29.03 [b]	5.805
Pesticides	Chlordane	0.0045	0.13	1.96	0.01 [b]	0.003
	Dieldrin	0.0029	0.09	1.96	0.01 [b]	0.002
	Heptaclor Epoxide	0.0006	0.02	1.96	0.00 [b]	0.00035
	Lindane	0.0009	0.03	1.96	0.00 [b]	0.001
	DDD	0.00354	0.10	1.96	0.01 [b]	0.002
	DDE	0.0014	0.04	1.96	0.00 [b]	0.001
	total DDT	0.007	0.21	1.96	0.02 [b]	0.004
	Endrin	0.00267	0.08	1.96	0.01 [b]	0.002

[a] calculated assuming 80 percent moisture (Stephan et al., 1985)
[b] calculated assuming 5 percent lipid and using area average TOC of 3.39 percent

Table 7-27. Estimated Maximum Invertebrate Tissue Concentrations in the Ship Channel

		Maximum sediment conc (ppm dry wt)	C_{org} TOC normalized	BSAF	Tissue conc dry wt	Tissue conc wet weight [a]
Trace elements						
	Arsenic	nd		1	nd	
	Cadmium	3.31		1	3.31	0.662
	Lead	3630.00		1	3630.00	726.000
	Mercury	9.22		1	9.22	1.843
	Selenium	nd		1	nd	
	Zinc	1090.00		1	1090.00	218.000
PCBs	Aroclor 1254	nd				
	Aroclor 1260	nd				
	Total PCBs	3.3500	87.01	1.64	7.14 [b]	1.427
						0.000
Pesticides	Chlordane	0.1300	3.38	1.96	0.33 [b]	0.066
	Dieldrin	0.0093	0.24	1.96	0.02 [b]	0.005
	Heptaclor Epoxide	0.0028	0.07	1.96	0.01 [b]	0.001
	Lindane	0.0018	0.05	1.96	0.00 [b]	0.001
	DDD	0.1970	5.12	1.96	0.50 [b]	0.100
	DDE	0.1420	3.69	1.96	0.36 [b]	0.072
	total DDT	0.8030	20.86	1.96	2.04 [b]	0.409
	Endrin	0.0015	0.04	1.96	0.00 [b]	0.001

[a] calculated assuming 80 percent moisture (Stephan et al., 1985)
[b] calculated assuming 5 percent lipid and using area average TOC of 3.85 percent

Food ingestion rates for the green heron and raccoon were estimated using the procedures outlined in U.S. EPA's *Wildlife Exposure Factors Handbook* (1993). The rate of food consumption that an animal must achieve to meet its metabolic needs can be calculated by dividing its free-living (or field) metabolic rate (FMR) by the metabolizable energy in its food. Metabolizable energy (ME) is the gross energy in a unit of food consumed minus the energy lost in urine and feces (U.S. EPA, 1993).

The generic equation for estimating oral doses of contaminants in food for wildlife species is:

$$ADD_{pot} = \sum_{k=1}^{m} (C \times FR_k \times NIR_k) \qquad \textbf{Eq. 7-3}$$

where:

ADD_{pot} = potential average daily dose (e.g., mg/kg/day)

C_k = average contaminant concentration in food type k (e.g., mg/kg wet weight)

FR_k = fraction of intake of food type k that is contaminated (unitless). For example, if k in an animal's diet were salmon, FR_k for salmon would equal the fraction of the salmon consumed that is contaminated at level C_k. If all of the salmon consumed were contaminated at level C_k, then FR_k would equal one.

NIR_k = Normalized ingestion rate of food type k on a wet-weight basis (e.g., in g/g-day)

m = number of contaminated food types

Estimation of contaminant dose for heron in the Anacostia River is based only on consumption of benthic invertebrates and fish with incidental sediment ingestion, and it is assumed that 100 percent of the prey items are contaminated, so that FR_k is equal to 1. Therefore, the only item left to calculate is the normalized ingestion rate.

The normalized ingestion rate can be calculated as follows:

$$\text{NIR} = \frac{\text{FMR} \cdot \text{ME}_{\text{avg}}}{\text{BW}} \qquad \textbf{Eq. 7-4}$$

where:

NIR = normalized ingestion rate (g/g BW/day)
BW = body weight in grams
FMR = estimated field metabolic rate (kcal/day)
ME_{avg} = estimated average metabolizable energy of diet (kcal/g wet wt)

FMRs have been calculated for a number of animal species, including birds and mammals. The FMR for non-passerine birds, as presented in U.S. EPA (1993), is:

$$FMR_{(kcal/day)} = 1.146(BW)^{0.749} \quad \textbf{Eq. 7-5}$$

Mean body weight is 212 g for the green heron. For this risk assessment the body weight was calculated by taking the average of the mean male and female body weights.

The metabolizable energy (ME) of a fish diet as presented in U.S. EPA (1993) is 0.95 kcal/g ww for birds. The estimated normalized ingestion rates for the green heron is 0.28g/g body weight/day.

7.5.2 DIOXINS AND FURANS TEQ EVALUATION

Although individual dioxin and furan congeners have similar modes of toxic action, they all have differing degrees of potency due to their specific stereochemistry. Toxicity Equivalency Factors (TEFs) have been developed to express the toxicity of individual dioxin and furan concentrations in terms of the equivalent toxicity of a particular benchmark concentration, that of 2,3,7,8-TCDD. A number of TEF values have been developed to calculate 2,3,7,8-TCDD equivalent concentrations (TEQ) for birds. The WHO TEF values presented by Ahlborg et al. (1994) were used to calculate TEQ values for the green heron. The maximum fish tissue concentration reported for either the largemouth bass or the brown bullhead for each dioxin and furan congener was selected for use in this screening evaluation. The congener concentrations, TEF values and calculated TEQ values for the upper river and lower river zones are presented in Tables 7-28 and 7-29, respectively.

Table 7-28. WHO TEF Values for Birds and Calculated TEQ Values Based on the Maximum Fish Tissue Concentrations for the Upper River

	Congeners	Bird WHO TEF	Max. fish conc. ng/kg	Bird TEQ
Dioxins				
	2,3,7,8-TCDD	1	0.45	0.45
	1,2,3,78-PeCDD	1	0.55	0.55
	1,2,3,4,7,8-HxCDD	0.05	1.05	0.0525
	1,2,3,6,7,8-HxCDD	0.01	na	
	1,2,3,7,8,9-HxCDD	0.1	na	
	1,2,3,4,6,7,8-HpCDD	0.001	0.8	0.0008
	OCDD	na	na	
Furans				
	2,3,7,8-TCDF	1	0.7	0.7
	1,2,3,7,8-PeCDF	0.1	5	0.5
	2,3,4,7,8-PeCDF	1	4.75	4.75
	1,2,3,4,7,8-HxCDF	0.1	0.6	0.06
	1,2,3,6,7,8-HxCDF	0.1	na	
	1,2,3,7,8,9-HxCDF	0.1	na	
	2,3,4,6,7,8-HxCDF	0.1	0.95	0.095
	1,2,3,4,6,7,8-HpCDF	0.01	13.5	0.135
	1,2,3,4,7,8,9-HpCDF	0.01	na	
	OCDF	0.0001	31.5	0.00315
			Sum TEQ	7.29645

Table 7-29. WHO TEF Values for Birds and Calculated TEQ Values Based on the Maximum Fish Tissue Concentrations for the Lower River

	Congeners	Bird WHO TEF	Max. fish conc. ng/kg	Bird TEQ
Dioxins				
	2,3,7,8-TCDD	1	2.8	2.8
	1,2,3,78-PeCDD	1	3.9	3.9
	1,2,3,4,7,8-HxCDD	0.05	1.5	0.075
	1,2,3,6,7,8-HxCDD	0.01	4.9	0.049
	1,2,3,7,8,9-HxCDD	0.1	na	
	1,2,3,4,6,7,8-HpCDD	0.001	6.2	0.0062
	OCDD	na	57.1	
Furans				
	2,3,7,8-TCDF	1	2.4	2.4
	1,2,3,7,8-PeCDF	0.1	3	0.3
	2,3,4,7,8-PeCDF	1	4.6	4.6
	1,2,3,4,7,8-HxCDF	0.1	2.5	0.25
	1,2,3,6,7,8-HxCDF	0.1	1.6	0.16
	1,2,3,7,8,9-HxCDF	0.1	3.6	0.36
	2,3,4,6,7,8-HxCDF	0.1	0.2	0.02
	1,2,3,4,6,7,8-HpCDF	0.01	1.85	0.0185
	1,2,3,4,7,8,9-HpCDF	0.01	2.55	0.0255
	OCDF	0.0001	17.7	0.00177
			Sum TEQ	14.96597

The TRVs used to evaluate the green heron TEQ dose were derived from feeding studies conducted by Summer et al. (1996a,b). The studies were conducted with Babcock white leghorn chickens which were fed carp from Saginaw Bay at three treatment levels. The high dose treatment resulted in reduced hatchability of eggs and an increase in the overall deformity rate in embryos and chicks during weeks 1 through 10 compared with controls.

The TEQ dose, TRV values, and calculated HQ values for the green heron in both the upper river and lower river zones are presented in Table 7-30. HQs greater than one were calculated for both the raccoon and the green heron in both the upper and lower river zones using the NOAEL TEQ value as the TRV. The largest HQ value (HQ: 12.2) was calculated for the raccoon in the lower river. When the LOAEL TEQ values were used as TRV values, all the resulting HQ values were less than one.

Table 7-30. Comparison to 2,3,7,8-TCDD TEQs to NOAEL Doses

		TEQ	Ingestion	Dose	NOAEL TEQ	HQ	LOAEL TEQ	HQ
Upper River								
	Green Heron	7.30	0.28	2.04	1.05	**1.95**	9.94	0.21
Lower River								
	Green Heron	14.97	0.28	4.19	1.05	**3.99**	9.94	0.42

7.5.3 SCREENING LEVEL EFFECTS ASSESSMENT

The estimated wildlife NOAELs for great blue heron reported by Sample et al. (1996) were used as TRV values for the green heron. The TRV values and the calculated dose for both species are presented in Tables 7-31 through 7-33 for the upper river zone, the lower river zone, and the Ship Channel and Tidal Basin. The speciation of mercury in the fish tissues was not reported. Therefore, the dose of mercury to each species was evaluated twice, first assuming that the concentration was entirely inorganic mercury, then assuming the concentration was entirely methyl mercury.

In the upper river zone, green heron HQs greater than one were calculated for total DDT and methyl mercury (Table 7-31). The largest HQ was calculated for methyl mercury in the green heron (HQ = 26.4).

Table 7-31. Green Heron Dose Compared to TRV Values for the Upper River

	Fish Tissue Max conc. (µg/g ww)	Invertebrates µg/g ww	Sediment µg/g ww [a]	Dose (µg/gbw/d) [b]	TRV	HQ
Dioxins and furans						
2378-TCDD	0.0000005	na	na	0.0000001	0.000014	0.01
2378-TCDF	0.0000007	na	na	0.0000002	0.000001	0.18
PCBs						
Total PCB	0.97	0.751	0.2445	0.269	0.41	0.66
Pesticides						
Dieldrin	0.0095	0.003	0.00075	0.003	0.077	0.03
Heptachlor Epoxide	0.0001	0.002	0.0006	0.0001	na	
Lindane	0.00031	0.001	0.0003	0.0001	2	0.00005
Total DDT	0.0901	0.082	0.022	0.025	0.003	**8.40**
Trace Elements						
Arsenic	0.034	1.292	0.969	0.036	2.5	0.01
Cadmium	0.0057	0.524	0.393	0.012	1.45	0.01
Lead	0.104	44.8	33.6	0.949	1.13	0.84
Mercury	0.051	0.118	0.0885	0.016	0.45	0.04
Methyl mercury	0.051	0.118	0.0885	0.016	0.0006	**26.42**
Selenium	0.193	nd	nd	0.051	0.5	0.10
Zinc	5.92	89.4	71.55	3.421	14.5	0.24

[a] calculated from dry weight concentrations assuming 85 percent moisture
[b] based on diet of 94 percent fish, 6 percent invertebrates, and 1.8 percent incidental sediment ingestion, body weight of 212 g and a calculated ingestion rate of 0.28 g/g body weight/day

In the lower river zone, HQs greater than one were calculated for total PCBs, total DDT, lead, and methyl mercury in the green heron (Table 7-32). The largest HQs were calculated for total DDT and methyl mercury (HQs of 24.6 and 40.9, respectively).

Table 7-32. Green Heron Dose Compared to TRV Values for the Lower River

	Fish Tissue Max conc. (µg/g ww)	Invertebrates µg/g ww	Sediment µg/g ww [a]	Dose (µg/gbw/d) [b]	TRV	HQ
Dioxins and furans						
2378-TCDD	0.00001	na	na	0.000003	0.000014	0.19
2378-TCDF	0.0000024	na	na	0.000001	0.000001	0.63
PCBs						
Total PCB	1.27	5.805	1.8	0.441	0.41	**1.08**
Pesticides						
Dieldrin	0.02	0.002	0.000675	0.005	0.077	0.07
Heptachlor Epoxide	0.017	0.00035	0.00009	0.004	na	
Lindane	0.0012	0.001	0.000135	0.0003	2	0.0002
Total DDT	0.28	0.004	0.001	0.074	0.003	**24.59**
Trace Elements						
Arsenic	0.099	5.38	4.04	0.137	2.5	0.05
Cadmium	0.0041	0.636	0.477	0.014	1.45	0.01
Lead	0.043	155	116	3.200	1.13	**2.83**
Mercury	0.078	0.54	0.405	0.032	0.45	0.07
Methyl mercury	0.078	0.54	0.405	0.026	0.0006	**43.78**
Selenium	0.27	0.22	0.165	1.792	0.5	**3.58**
Zinc	4.56	102.4	76.8	1.587	14.5	0.11

[a] calculated from dry weight concentrations assuming 85 percent moisture
[b] based on diet of 94 percent fish, 6 percent invertebrates, and 1.8 percent incidental sediment ingestion, body weight of 212 g and a calculated ingestion rate of 0.28 g/g body weight/day

Finally, in the Washington Ship Channel/Tidal Basin zone, HQs greater than one were calculated for total PCBs, total DDT, and methyl mercury for the green heron (Table 7-33). The largest HQ calculated for this area was for total DDT (HQ of 93).

Table 7-33. Green Heron Dose Compared to TRV Values for the Ship Channel

	Fish Tissue Max conc. (µg/g ww)	Invertebrates µg/g ww	Sediment µg/g ww [a]	Dose (µg/gbw/d) [b]	TRV	HQ
Dioxins and furans						
2378-TCDD	na	na	na		1.4E-05	
2378-TCDF	na	na	na		1E-06	
PCBs						
Total PCB	4.7	1.43	0.5025	1.264	0.41	**3.08**
Pesticides						
Dieldrin	0.04	0.003	0.00075	0.011	0.077	0.14
Heptachlor Epoxide	0	0.002	0.0006	0.00004	na	
Lindane	0	0.001	0.0003	0.00002	2	0.00001
Total DDT	1.05	0.082	0.022	0.278	0.003	**92.62**
Trace Elements						
Arsenic	na				2.5	
Cadmium	na	0.662	0.497	0.014	1.45	0.01
Lead	na	726.000	544.5	14.941	1.13	**13.22**
Mercury	na	1.843	1.383	0.038	0.45	0.08
Methyl mercury	na	1.843	1.383	0.038	0.0006	**63.23**
Selenium	na		na		0.5	
Zinc	na	218.000	163.5	4.486	14.5	0.31

[a] calculated from dry weight concentrations assuming 85 percent moisture
[b] based on diet of 94 percent fish, 6 percent invertebrates, and 1.8 percent incidental sediment ingestion, body weight of 212 g and a calculated ingestion rate of 0.28 g/g body weight/day

7.6 AQUATIC MAMMAL EVALUATION

7.6.1 SCREENING LEVEL EXPOSURE ESTIMATE

Several different dietary regimes were reported for the raccoon in U.S. EPA, 1993, the dietary regime with the greatest aquatic component was selected for the screening assessment. Therefore, the raccoon dietary composition used for this estimate corresponds to the diet observed for raccoons feeding in tidal mudflats in southwestern Washington (Tyson, 1950). In addition to the consumption of fish and invertebrates, the incidental ingestion of sediment associated with the consumption of invertebrates will also be considered (Table 7-34).

Table 7-34. Dietary Composition for Raccoon (U.S. EPA 1993)

SPECIES	PERCENT FISH	PERCENT INVERTEBRATES	PERCENT INCIDENTAL SEDIMENT INGESTION
Raccoon	10	90	9.4

The normalized ingestion rate for the raccoon was calculated using the approach described in Section 5. The following values were used for the raccoon (non-herbivorous mammal) calculations:

$$FMR_{(kcal/day)} = 0.6167\ (BW)^{0.862} \qquad \textbf{Eq. 7-6}$$

Mean body weight is 5.8 kg for the raccoon. For this risk assessment, body weights were calculated by taking the average of the mean male and female body weights.

The estimated normalized ingestion rate for the raccoon was 0.17g/g body weight/day.

7.6.2 DIOXINS AND FURANS TEQ EVALUATION

TEFs have been developed which can be used to express the toxicity of individual dioxin and furan concentrations in terms of the equivalent toxicity of a particular concentration of 2,3,7,8-TCDD. A number of TEF values have been developed to calculate 2,3,7,8-TCDD TEQs for fish, birds and mammals. The calculated TEQ dose for the raccoon was evaluated using TRVs calculated from a study conducted by Heaton et al. (1995). In this study, adult mink were fed carp collected from the mouth of the Saginaw River and were then evaluated for reproductive effects. Even at the lowest dietary dose, significant reductions in gestation duration, kit body weight, and kit survival at 3 and 6 weeks of age were seen. The NOAEL was generated using the control group data.

The maximum fish tissue concentration reported for either the largemouth bass or the brown bullhead for each dioxin and furan congener was selected for use in this screening evaluation. The congener concentrations, TEF values and calculated TEQ values for the upper river and lower river zones are presented in Tables 7-35 and 7-36, respectively.

Table 7-35. WHO TEF Values for Mammals and Calculated TEQ Values Based on the Maximum Fish Tissue Concentrations for the Upper River

	Congeners	Mammals WHO TEF	Fish tissue max conc ng/kg	TEQ
Dioxins				
	2,3,7,8-TCDD	1	0.45	0.45
	1,2,3,78-PeCDD	1	0.55	0.55
	1,2,3,4,7,8-HxCDD	0.1	1.05	0.105
	1,2,3,6,7,8-HxCDD	0.1	na	
	1,2,3,7,8,9-HxCDD	0.1	na	
	1,2,3,4,6,7,8-HpCDD	0.01	0.8	0.008
	OCDD	0.0001	na	
Furans				
	2,3,7,8-TCDF	0.1	0.7	0.07
	1,2,3,7,8-PeCDF	0.05	5	0.25
	2,3,4,7,8-PeCDF	0.5	4.75	2.375
	1,2,3,4,7,8-HxCDF	0.1	0.6	0.06
	1,2,3,6,7,8-HxCDF	0.1	na	
	1,2,3,7,8,9-HxCDF	0.1	na	
	2,3,4,6,7,8-HxCDF	0.1	0.95	0.095
	1,2,3,4,6,7,8-HpCDF	0.01	13.5	0.135
	1,2,3,4,7,8,9-HpCDF	0.01	na	
	OCDF	0.0001	31.5	0.00315
			SUM TEQ	4.10115

Table 7-36. WHO TEF Values for Mammals and Calculated TEQ Values Based on the Maximum Fish Tissue Concentrations for the Lower River

	Congeners	Mammals WHO TEF	Fish tissue max conc ng/kg	TEQ
Dioxins				
	2,3,7,8-TCDD	1	2.8	2.8
	1,2,3,78-PeCDD	1	3.9	3.9
	1,2,3,4,7,8-HxCDD	0.1	1.5	0.15
	1,2,3,6,7,8-HxCDD	0.1	4.9	0.49
	1,2,3,7,8,9-HxCDD	0.1	na	
	1,2,3,4,6,7,8-HpCDD	0.01	6.2	0.062
	OCDD	0.0001	57.1	0.00571
Furans				
	2,3,7,8-TCDF	0.1	2.4	0.24
	1,2,3,7,8-PeCDF	0.05	3	0.15
	2,3,4,7,8-PeCDF	0.5	4.6	2.3
	1,2,3,4,7,8-HxCDF	0.1	2.5	0.25
	1,2,3,6,7,8-HxCDF	0.1	1.6	0.16
	1,2,3,7,8,9-HxCDF	0.1	3.6	0.36
	2,3,4,6,7,8-HxCDF	0.1	0.2	0.02
	1,2,3,4,6,7,8-HpCDF	0.01	1.85	0.0185
	1,2,3,4,7,8,9-HpCDF	0.01	2.55	0.0255
	OCDF	0.0001	17.7	0.00177
			SUM TEQ	10.93348

The TEQ dose, TRV values, and calculated HQ values for raccoon in both the upper river and lower river zones are presented in Table 7-37. HQs greater than one were calculated for the raccoon in both the upper and lower river zones using the NOAEL TEQ value as the TRV. The largest HQ value (HQ: 12.2) was calculated for the raccoon in the lower river. When the LOAEL TEQ values were used as TRV values, all the resulting HQ values were less than one.

Table 7-37. Comparison of 2,3,7,8-TCDD TEQs to NOAEL Doses

		TEQ	Ingestion	Dose	NOAEL TEQ	**HQ**	LOAEL TEQ	**HQ**
Upper River								
	Raccoon	4.10	0.17	0.70	0.153	**4.56**	3.757	0.19
Lower River								
	Raccoon	10.93	0.17	1.86	0.153	**12.15**	3.757	0.49

7.6.3 SCREENING LEVEL EFFECTS ASSESSMENT

The estimated wildlife NOAELs for mink reported by Sample et al. (1996) were used as TRV values for the raccoon. The TRV values and the calculated dose for the raccoon are presented in Tables 7-38, 7-39, and 7-40 for the upper river zone, the lower river zone, and the Ship Channel/Tidal Basin zone. The speciation of mercury in the fish tissues was not reported. Therefore, the dose of mercury to each species was evaluated twice, first assuming that the concentration was entirely inorganic mercury, then assuming the concentration was entirely methyl mercury.

In the upper river zone, HQs greater than one were calculated for the estimated dose of total PCBs, arsenic, lead, and methyl mercury to the raccoon (Table 7-38). In the lower river zone, HQs greater than one were calculated for total PCBs, arsenic, cadmium, lead, mercury, methyl mercury, and zinc in the raccoon (Table 7-39). The largest HQs were calculated for arsenic, cadmium, and lead in raccoons with and HQ of 2,660 for lead in raccoons.

Table 7-38. Raccoon Dose Compared to TRV Values for Upper River

	Fish Tissue Max conc. (ug/g ww)	Invertebrates ug/g ww	Sediment ug/g ww [a]	Dose (ug/gbw/d) [b]	TRV	HQ
Dioxins and furans						
2378-TCDD	0.0000005	na	na	0.00000001	0.0000008	0.01
2378-TCDF	0.0000007	na	na	0.00000001	na	
PCBs						
Total PCB [c]	0.97	0.751	0.2445	0.135	0.069	**1.96**
Pesticides						
Dieldrin	0.0095	0.003	0.00075	0.001	0.015	0.04
Heptachlor Epoxide	0.0001	0.002	0.0006	0.0003	0.1	0.0032
Lindane	0.00031	0.001	0.0003	0.000	6.15	0.00003
Total DDT	0.0901	0.082	0.022	0.014	0.62	0.02
Trace Elements						
Arsenic	0.034	1.292	0.969	0.214	0.052	**4.11**
Cadmium	0.0057	0.524	0.393	0.087	0.742	0.1166
Lead	0.104	44.8	33.6	7.393	6.15	**1.2021**
Mercury	0.051	0.118	0.0885	0.020	1	0.02
Methyl mercury	0.051	0.118	0.0885	0.020	0.015	**1.36**
Selenium	0.193	nd	nd	0.003	0.154	0.02
Zinc	5.92	89.4	71.55	14.922	123.1	0.12

[a] calculated from dry weight concentrations assuming 85 percent moisture
[b] based on diet of 10 percent fish, 90 percent invertebrates and 9.4 percent incidental sediment ingestion (EPA 1993), body weight of 5.8 Kg and a calculated ingestion rate of 0.17g/g body weight/day
[c] Total PCB TRV based on Aroclor 1242 in mink

Table 7-39. Raccoon Dose Compared to TRV Values for Lower River

	Fish Tissue Max conc. (µg/g ww)	Invertebrates µg/g ww	Sediment µg/g ww [a]	Dose (ug/gbw/d) [b]	TRV	HQ
Dioxins and furans						
2378-TCDD	0.00001	na	na	0.00000017	0.0000008	0.2125
2378-TCDF	0.0000024	na	na	0.00000004	na	
PCBs						
Total PCB [c]	1.27	5.805	1.8	0.939	0.069	**13.60**
Pesticides						
Dieldrin	0.02	0.002	0.000675	0.001	0.015	0.04
Heptachlor Epoxide	0.017	0.00035	0.00009	0.0003	0.1	0.0034
Lindane	0.0012	0.001	0.000135	0.0002	6.15	0.00003
Total DDT	0.28	0.004	0.001	0.0054	0.62	0.01
Trace Elements						
Arsenic	0.099	5.38	4.04	0.89	0.052	**17.10**
Cadmium	0.0041	0.636	0.477	0.11	0.742	0.14
Lead	0.043	115	116	19.45	6.15	**3.16**
Mercury	0.078	0.54	0.405	0.09	1	0.09
Methyl mercury	0.078	0.54	0.405	0.09	0.015	**6.03**
Selenium	0.27	0.22	0.165	0.04	0.154	0.27
Zinc	4.56	102.4	76.8	16.97	123.1	0.14

[a] calculated from dry weight concentrations assuming 85 percent moisture
[b] based on diet of 10 percent fish, 90 percent invertebrates and 9.4 percent incidental sediment ingestion (EPA 1993), body weight of 5.8 Kg and a calculated ingestion rate of 0.17g/g body weight/day
[c] Total PCB TRV based on Aroclor 1242 in mink

Finally, in the Washington Ship Channel/Tidal Basin zone, HQs greater than one were calculated for total PCBs, arsenic, lead, and methyl mercury in the raccoon (Table 7-40). The largest HQ value was calculated for arsenic and PCBs with HQs of 4.1 and 4.5, respectively.

Table 7-40. Raccoon Dose Compared to TRV Values for Ship Channel

	Fish Tissue Max conc. (µg/g ww)	Invertebrates µg/g ww	Sediment µg/g ww [a]	Dose (µg/gbw/d) [b]	TRV	HQ
Dioxins and furans						
2378-TCDD	na	na	na	na	0.0000008	
2378-TCDF	na	na	na	na	na	
PCBs						
Total PCB [c]	4.7	1.43	0.5025	0.307	0.069	**4.45**
Pesticides						
Dieldrin	0.04	0.003	0.00075	0.001	0.015	0.08
Heptachlor Epoxide	0	0.002	0.0006	0.0003	0.1	0.003
Lindane	0	0.001	0.0003	0.0002	6.15	0.00003
Total DDT	1.05	0.082	0.022	0.031	0.62	0.05
Trace Elements						
Arsenic	na					
Cadmium	na	0.662	0.497	0.109	0.742	0.15
Lead	na	726	544.5	119.779	6.15	**19.48**
Mercury	na	1.843	1.383	0.304	1	0.30
Methyl mercury	na	1.843	1.383	0.304	0.015	**20.27**
Selenium	na	na	na		0.154	
Zinc	na	218	163.5	35.967	123.1	0.29

[a] calculated from dry weight concentrations assuming 85 percent moisture
[b] based on diet of 10 percent fish, 90 percent invertebrates and 9.4 percent incidental sediment ingestion (EPA 1993), body weight of 5.8 Kg and a calculated ingestion rate of 0.17g/g body weight/day
[c] Total PCB TRV based on Aroclor 1242 in mink

7.7 UNCERTAINTY ANALYSIS

The lack of sediment dioxin and furan concentrations resulted in uncertainty in the benthic invertebrate, plus the aquatic bird and mammal evaluations. Sediment dioxin and furan data was not available to be screened against criteria for the benthic invertebrates. In addition, benthic prey tissue concentrations of dioxins and furans could not be estimated in the aquatic bird and mammal evaluation due to the lack of sediment data.

Amphibians were not evaluated as potential receptors. Amphibians are present within the Anacostia River. Recent research has shown that effects in frogs can occur at concentrations below AWQC for nitrite (Marco et al, 1999). Further research is required to develop exposure parameters and criteria appropriate for this receptor group before screening level assessments can be conducted. Without this information it is difficult to assess the potential for risk to amphibians in the context of a screening level assessment.

7.7.1 BENTHIC INVERTEBRATES EVALUATION

Sediment toxicity data was taken from only two studies, both of which used the same test organism, the amphipod *Hyalella azteca*. Therefore, there is some uncertainty associated with this evaluation and it cannot be considered a definitive assessment of sediment toxicity within the lower Anacostia. The sparse distribution of sampling locations for these bioassay studies was also not sufficient to adequately characterize the entire study area or to delineate regions within the study area as toxic or non-toxic.

The comparison of maximum sediment concentrations to sediment criteria was conducted in order to assess risk for benthic invertebrates. The use of maximum concentrations provides a very conservative estimate of exposure in the Anacostia River sediments. In addition, there may be some uncertainty associated with the use of sediment benchmarks that do not explicitly address many of the factors that can affect the bioavailability of the sediment contaminants, such as, the speciation of trace elements, the presence or absence of acid volatile sulfides (AVS), or the organic carbon content of the sediments which can affect the availablility of organic contaminants. For such uncertainty to have a major influence on the conclusions of this screening level estimate, bioavailability of contaminants would have to be shown to be substantially less than that predicted. Since bioavailability of COPCs is corroborated by tissue residue measurements, this assumption does not appear unreasonable. Therefore, these uncertainty factors have marginal bearing on the results of this screening.

7.7.2 FISH EVALUATION

Fish species were evaluated in three ways: the surface water contaminant concentrations were compared to AWQC values; fish tissue concentrations were compared to tissue residue effects concentrations; and sediment PAH concentrations were screened against sediment criteria associated with the occurance of neoplams and reproductive impairment in fish. The uncertainties associated with each of these approaches is discussed.

The surface water data that was compared to AWQC values represented only one study using discrete samples collected seven times throughout 1998. This data does not provide a basis for determining the exposure of fish over a longer period of time. The criteria values are generally developed to be protective of an average concentration over a set time period (e.g., 4 hours or 14 days).

Using tissue residue effects concentrations in fish to evaluate the potential for risk available in the published literature is complicated by a number of factors including:

- Differences in species sensitivity
- Differences in the tissues analyzed
- Differences in exposure scenarios in laboratory and field studies
- Lack of consistency in the endpoints evaluated
- Differences in the species of the contaminant (e.g., inorganic mercury vs. methylmercury)

Finally, there is some uncertainty associated with the exposure assessment used to screen sediment PAH concentrations. Although PAHs are known to cause adverse effects in fish, methodologies to quantify this risk are still being developed. Some researchers have used PAH concentrations in sediment associated with elevated rates of neoplasia and reproductive impairment in fish as an evaluation value, but this approach is subject to confounding factors such as the presence of co-occurring contaminants in the field. In addition, the database that was used for this purpose contained a comparatively small number of data points. The ecological significance of neoplasms in fish populations has yet to be firmly established,

and no further information is currently published for determining sediment effects concentrations for other, possibly more sensitive endpoints such as reproductive impairment and immune dysfunction. Baumann et al. (1990) reported that in the Black River, a system with a high prevalence of liver tumors, there were few fish of age 5 and no fish of age 6 or 7. In an uncontaminated reference system age 6 and 7 fish comprised 18 percent of the sampled population. The authors hypothesized that there was an age-selective mortality associated with a high prevalence of liver tumors.

Finally, the movement of fish populations introduces another source of uncertainty in the fish evaluation. Fish collected in the Anacostia River could have been exposed elsewhere. Therefore, tissue concentrations and tumors present in these fish could reflect exposure conditions outside the Anacostia.

7.7.3 AQUATIC BIRD AND MAMMAL EVALUATION

The use of generic equations to estimate the normalized ingestion rate, the field metabolic rate, and the estimated average metabolizable energy of bird and mammal diets provide reasonable estimates of these values for the calculation of normalized ingestion rates for the receptor species in the absence of species-specific data. However, there is some uncertainty with regard to the resulting estimated species-specific ingestion rates.

In addition, the use of BSAF values to estimate invertebrate tissue concentrations introduces some uncertainty into the estimated dose calculation. The BSAF values that were used were average values derived from an extremely large data set. The use of an average value for entire classes of compounds, such as PCBs and pesticides, simplifies the complex chemistry of the individual compounds within the contaminant class. For the purposes of this assessment, the BSAFs provide a reasonable estimate of concentrations in benthic invertebrates resulting from exposure to sediment contaminants. However, site-specific conditions could influence the uptake of contaminants by invertebrates in the Anacostia River.

Uncertainties due to interspecific differences in toxicity of the COPCs were not addressed in the development of the TRV values or in the risk calculation. Toxicity data for ducks, chicken, kestrel, pheasant, barn owl, and pelicans were used to derive TRV values for great blue heron (Sample et al., 1996). These TRV values were then used to calculate risks to the green heron. Similarly, for the mammal assessment, toxicity data for rats, mice, and mink were used to derive TRV values for mink (Sample et al., 1996). These TRV values were then used to calculate risks for the raccoon.

7.8 ADDITIONAL EVALUATIONS

Screening level risk assessments are simplified assessments that can be conducted with limited data, using conservative assumptions for the parameters for which site-specific data are lacking (U.S. EPA, 1997). Conservative approaches are used to minimize the potential of failing to identify a potential risk. This approach ensures that sites that have the potential to pose risks to ecological receptors are further evaluated in a baseline risk assessment. Such a conservative approach may use unrealistic assumptions though. For instance, it is unrealistic to assume that 100% of ingested contaminants are assimilated upon ingestion. Before a complete baseline risk assessment is conducted, reassessment using more realistic parameters should be conducted to help focus future efforts.

Additional evaluations were conducted for benthic invertebrates, fish, birds, and mammals using more realistic assumptions than those used in the evaluations described in Sections 7.3, 7.4, 7.5, and 7.6. For example, evaluations were conducted using mean sediment contaminant concentrations in addition to the maximum concentrations. The results of these evaluations are presented in the following sections.

When dose estimates are derived from average exposure point estimates for the Upper and Lower river using the alternate diet (Tables 7-40a and 7-40b, respectively) only arsenic exceeds the TRV benchmark (HQs of 1.35 and 2.12, respectively).

Table 7-40a. Alternate Raccoon Dose Based on Average Exposure Compared to TRV Values for Upper River

	Fish Tissue average conc. (ug/g ww)	Invertebrates ug/g ww	Sediment ug/g ww[a]	Dose (ug/gbw/d)[b]	TRV	HQ
Dioxins and furans						
2378-TCDD	0.000000450	na	na	0.000000002	0.0000008	0.003
2378-TCDF	0.000000625	na	na	0.000000003	na	
PCBs						
Total PCB [c]	0.531	0.303123596	0.0987	0.023	0.069	0.34
Pesticides						
Dieldrin	0.008	0.001	0.0003	0.00011	0.015	0.01
Heptachlor Epoxide	0.002	0.001	0.0003	0.00008	0.1	0.0008
Lindane	0.00021	0.0006	0.00015	0.00004	6.15	0.00001
Total DDT	0.08	0.044	0.012	0.003	0.62	0.01
Trace Elements						
Arsenic	0.034	0.938	0.7035	0.070	0.052	**1.35**
Cadmium	0.0047	0.35	0.263	0.026	0.742	0.035
Lead	0.019	31.2	23.4	2.337	6.15	0.380
Mercury	0.037	0.058	0.0435	0.005	1	0.005
methyl mercury	0.037	0.058	0.0435	0.005	0.015	0.30
Selenium	0.14	nd	nd	0.001	0.154	0.00
Zinc	3.93	71	53.3	5.338	123.1	0.04

[a] calculated from dry weight concentrations assuming 85 percent moisture
[b] based on diet of 3 percent fish, 37 percent invertebrates and 9.4 percent incidental sediment ingestion, body weight of 5.8 Kg and a calculated ingestion rate of 0.17 g/g body weight/day (EPA 1993)
[c] Total PCB TRV based on Aroclor 1242 in mink

Table 7-40b. Alternate Raccoon Dose Based on Average Exposure Compared to TRV Values for Lower River

	Fish Tissue Ave. conc. (ug/g ww)	Invertebrates ug/g ww	Sediment ug/g ww[a]	Dose (ug/gbw/d)[c]	TRV	HQ
Dioxins and furans						
2378-TCDD	0.00000245	na	na	0.000000012	0.0000008	0.02
2378-TCDF	0.0000014	na	na	0.000000007	na	
PCBs						
Total PCB [c]	0.703	0.595044248	0.184	0.044	0.069	0.64
Pesticides						
Dieldrin	0.01000	0.000578171	0.00015	0.00009	0.015	0.01
Heptachlor Epoxide	0.00580	0.000173451	0.000045	0.00004	0.1	0.00041
Lindane	0.000513	0.000	0.00006	0.00002	6.15	0.000003
Total DDT	0.174	0.058	0.015	0.005	0.62	0.01
Trace Elements						
Arsenic	0.09902	1.462	1.1	0.110	0.052	**2.12**
Cadmium	0.00413	0.292	0.219	0.022	0.742	0.03
Lead	0.04332	38.8	29.1	2.906	6.15	0.47
Mercury	0.078	0.112	0.084	0.009	1	0.01
Methyl mercury	0.078	0.112	0.084	0.009	0.015	0.59
Selenium	0.27	0.146	0.11	0.012	0.154	0.08
Zinc	4.56	54.8	41.1	4.127	123.1	0.03

[a] calculated from dry weight concentrations assuming 85 percent moisture
[b] based on diet of 3 percent fish, 37 percent invertebrates and 9.4 percent incidental sediment ingestion, body weight of 5.8 Kg and a calculated ingestion rate of 0.17 g/g body weight/day (EPA 1993)
[c]Total PCB TRV based on Aroclor 1242 in mink

7.8.1 BENTHIC INVERTEBRATES

In addition to screening the maximum sediment contaminant concentrations, the mean sediment concentrations were screened (Table 7-41). The screening was conducted using two sediment benchmark values, TELs and Probable Effects Levels (PELs). PELs are differentiated from TEL values in that they are intended to define threshold values above which toxicity is highly probable.

PELs were derived by calculating the geometric mean of the 50th percentile of the effect data set and the 85th percentile of the no-effect dataset. PELs were intended to estimate the sediment concentration of a chemical above which adverse biological effects frequently occurred (Smith et al., 1996). Most of the PELs presented in Table 7-41 were obtained from Smith et al. (1996). The PELs reported for LPAH, HPAH, and total PAH concentrations were taken from the ARCS data for the 28-day exposure of *Hyalella azteca* to freshwater sediments (U.S. EPA, 1996).

Table 7-41. Sediment Benchmarks

		TEL	PEL
Trace elements			
	Arsenic	10.8	17
	Barium [(a)]	0.7	na
	Cadmium	0.6	3.53
	Chromium, total	36.3	90
	Copper	28	197
	Lead	34.2	91.3
	Manganese	615	na
	Mercury	0.17	0.486
	Nickel	19.5	35.9
	Selenium [(a)]	0.29	na
	Silver [(a)]	<0.5	na
	Strontium [(a)]	49	na
	Vanadium [(a)]	50	na
	Zinc	94.2	315
PAHs			
	Benzo(a) anthracene	0.032	0.385
	Benzo(a)pyrene	0.032	0.782
	Chrysene	0.032	0.862
	Fluoranthene	0.11	2.35
	Phenanthrene	0.042	0.515
	Pyrene	0.053	0.875
	LPAHs	0.076	1.17
	HPAHs	0.193	2.34
	Total PAHs	0.264	3.37
PCBs			
	Aroclor 1254	0.032	0.277
	Aroclor 1260	0.032	0.277
	Total PCBs	0.032	0.277
Pesticides			
	Chlordane	0.0045	0.0089
	Dieldrin	0.0029	0.0067
	Heptaclor Epoxide	0.0006	0.00274
	Lindane	0.0009	0.00138
	DDD	0.00354	0.00851
	DDE	0.0014	0.00675
	total DDT	0.007	4.45
	Endrin	0.00267	0.0624

[(a)] background freshwater sediment values (Buchman 1999)

The HQ values calculated from the screening of maximum and mean sediment concentrations for the upper river zone are presented in Table 7-42. TEL-HQs greater than one were calculated for both maximum and mean concentrations of most of the trace elements, PAHs, PCBs and pesticides. The largest TEL-HQ values were calculated for barium and total PCB concentrations. Sediment concentrations were compared to the corresponding PEL values to calculate PEL-HQ values. PEL-HQs greater than one were calculated for chromium, lead, mercury, nickel, and zinc, as well as most of the PAH compounds, total PCBs, and many of the organochlorine pesticides. The largest PEL-HQ was calculated for the maximum chlordane concentration (HQ of 22).

Table 7-42. Sediment Benchmarks, Maximum Concentrations and Calculated Hazard Quotients for the Upper River

	TEL	PEL	Sediment concentration		n	$HQ_{(TEL)}$	$HQ_{(PEL)}$
Trace elements							
Arsenic	10.8	17	max	6.46		0.60	0.38
			mean	4.69	8	0.43	0.28
Barium [(a)]	0.7	na	max	156.40		**223.43**	
						172.14	
Cadmium	0.6	3.53	max	2.62		**4.37**	0.74
			mean	1.75	20	**2.91**	0.50
Chromium, total	36.3	90	max	134.00		**3.69**	**1.49**
			mean	82.46	13	**2.27**	0.92
Copper	28	197	max	100.10		**3.58**	0.51
			mean	60.63	13	**2.17**	0.31
Lead	34.2	91.3	max	224.00		**6.55**	**2.45**
			mean	156.00	20	**4.56**	**1.71**
Manganese	615	na	max	643.10		**1.05**	
			mean	471.49	8	0.77	
Mercury	0.17	0.486	max	0.59		**3.47**	**1.21**
			mean	0.29	20	**1.72**	0.60
Nickel	19.5	35.9	max	50.51		**2.59**	**1.41**
			mean	41.96	8	**2.15**	**1.17**
Selenium [(a)]	0.29	na	max	nd			
			mean				
Silver [(a)]	< 0.5	na	max	nd			
			mean				
Strontium [(a)]	49	na	max	21.72		0.44	
			mean	16.48	8	0.34	
Vanadium [(a)]	50	na	max	65.54		**1.31**	
			mean	51.31	8	**1.03**	
Zinc	94.2	315	max	477.00		**5.06**	**1.51**
			mean	355.27	20	**3.77**	**1.13**
PAHs							
Benzo(a) anthracene	0.032	0.385	max	0.78		**24.41**	**2.03**
			mean	0.56	13	**17.47**	**1.45**
Benzo(a)pyrene	0.032	0.782	max	0.70		**21.72**	0.89
			mean	0.51	13	**16.03**	0.66
Chrysene	0.032	0.862	max	1.10		**34.38**	**1.28**
			mean	0.802	13	**25.06**	0.93
Fluoranthene	0.11	2.35	max	1.79		**16.27**	0.76
			mean	0.936	13	**8.51**	0.40
Phenanthrene	0.042	0.515	max	0.85		**20.24**	**1.65**
			mean	0.557	13	**13.26**	**1.08**
Pyrene	0.053	0.875	max	1.58		**29.81**	**1.81**
			mean	0.840	13	**15.85**	0.96
LPAHs	0.076	1.17	max	1.68		**22.11**	**1.44**
			mean	1.075	13	**14.14**	0.92
HPAHs	0.193	2.34	max	6.60		**34.20**	**2.82**
			mean	4.450	13	**23.06**	**1.90**
Total PAHs	0.264	3.37	max	7.89		**29.89**	**2.34**
			mean	5.520	13	**20.91**	**1.64**
PCBs							
Aroclor 1254	0.032	0.277	max	1.63		**50.94**	**5.88**

Table 7-42. Sediment Benchmarks, Maximum Concentrations and Calculated Hazard Quotients for the Upper River

	TEL	PEL	Sediment concentration		n	$HQ_{(TEL)}$	$HQ_{(PEL)}$
			mean	0.671	8	**20.97**	**2.42**
Aroclor 1260	0.032	0.277	max	0.02		0.47	0.05
			mean	0.008	7	0.26	0.03
Total PCBs	0.032	0.277	max	1.63		**50.94**	**5.88**
			mean	0.658	19	**20.56**	**2.38**
Pesticides							
Chlordane	0.0045	0.0089	max	0.20		**43.56**	**22.02**
			mean	0.146	13	**32.44**	**16.40**
Dieldrin	0.0029	0.0067	max	0.01		**1.72**	0.75
			mean	0.002	16	0.59	0.25
Heptaclor Epoxide	0.0006	0.00274	max	0.004		**6.67**	**1.46**
			mean	0.002	3	**2.67**	0.58
Lindane	0.0009	0.00138	max	0.002		**2.22**	**1.45**
			mean	0.001	5	0.62	0.40
DDD	0.00354	0.00851	max	0.08		**23.16**	**9.64**
			mean	0.037	19	**10.45**	**4.35**
DDE	0.0014	0.00675	max	0.05		**33.57**	**6.96**
			mean	0.027	19	**19.29**	**4.00**
total DDT	0.007	4.45	max	0.15		**21.29**	0.03
			mean	0.080	27	**11.43**	0.02
Endrin	0.00267	0.0624	max	0.00		**1.12**	0.05
			mean	0.001	2	0.37	0.02

[(a)] background freshwater sediment values (Buchman 1999)

In the lower river zone, the largest TEL-HQs were reported for PAH concentrations (Table 7-43). TEL-HQs greater than one were reported for both the maximum and mean concentrations of most of the trace elements, all of the PAHs, PCBs, and many of the pesticides. The largest PEL-HQs were also reported for the PAH compounds. All of the PEL-HQs calculated for maximum and mean PAH concentrations were greater than one and PEL-HQs greater than one hundred were reported for the maximum concentrations of benzo(a)anthracene, phenanthrene, and pyrene.

Table 7-43. Sediment Benchmarks, Maximum Concentrations and Calculated Hazard Quotients for the Lower River

	TEL	PEL	Sediment concentration		n	$HQ_{(TEL)}$	$HQ_{(PEL)}$
Trace elements							
Arsenic	10.8	17	max	26.90		**2.49**	**1.58**
			mean	7.31	22	0.68	0.43
Barium [(a)]	0.7	na	max	170.00		**242.86**	
			mean	111.73	22	**159.62**	
Cadmium	0.6	3.53	max	3.18		**5.30**	0.90
			mean	1.46	30	**2.43**	0.41
Chromium, total	36.3	90	max	155.50		**4.28**	**1.73**
			mean	62.32	37	**1.72**	0.69
Copper	28	197	max	631.00		**22.54**	**3.20**
			mean	102.62	37	**3.67**	0.52
Lead	34.2	91.3	max	775.00		**22.66**	**8.49**
			mean	193.98	37	**5.67**	**2.12**
Manganese	615	na	max	800.00		**1.30**	
			mean	448.87	23	0.73	
Mercury	0.17	0.486	max	2.70		**15.88**	**5.56**
			mean	0.56	29	**3.27**	**1.14**
Nickel	19.5	35.9	max	69.70		**3.57**	**1.94**
			mean	33.24	23	**1.70**	0.93
Selenium [(a)]	0.29	na	max	1.10		**3.79**	
			mean	0.73	2	**2.50**	
Silver [(a)]	<0.5	na	max	64.40		**128.80**	
			mean	6.57	14	**13.14**	
Vanadium [(a)]	50	na	max	68.10		**1.36**	
			mean	34.34	22	0.69	
Zinc	94.2	315	max	512.00		**5.44**	**1.63**
			mean	273.77	37	**2.91**	0.87
PAHs							
Benzo(a) anthracene	0.032	0.385	max	100.00		**3125.00**	**259.74**
			mean	5.08	46	**158.69**	**13.19**
Benzo(a)pyrene	0.032	0.782	max	27.00		**843.75**	**34.53**
			mean	2.89	44	**90.34**	**3.70**
Chrysene	0.057	0.862	max	86.00		**1508.77**	**99.77**
			mean	5.03	48	**88.30**	**5.84**
Fluoranthene	0.11	2.35	max	110.00		**1000.00**	**46.81**
			mean	7.86	49	**71.45**	**3.34**
Phenanthrene	0.042	0.515	max	360.00		**8571.43**	**699.03**
			mean	17.23	48	**410.24**	**33.46**
Pyrene	0.053	0.875	max	320.00		**6037.74**	**365.71**
			mean	13.96	49	**263.40**	**15.95**
LPAHs	0.076	1.17	max	98.80		**1300.00**	**84.44**
			mean	13.10	33	**172.37**	**11.20**
HPAHs	0.193	2.34	max	127.00		**658.03**	**54.27**
			mean	19.10	37	**98.96**	**8.16**
Total PAHs	0.264	3.37	max	211.00		**799.24**	**62.61**
			mean	30.78	37	**116.59**	**9.13**
PCBs							
Aroclor 1254	0.032	0.277	max	nd			
			mean				
Aroclor 1260	0.032	0.277	max	12.00		**375.00**	**43.32**

Table 7-43. Sediment Benchmarks, Maximum Concentrations and Calculated Hazard Quotients for the Lower River

	TEL	PEL	Sediment concentration		n	$HQ_{(TEL)}$	$HQ_{(PEL)}$
			mean	2.13	6	**66.50**	**7.68**
Total PCBs	0.032	0.277	max	12.00		**375.00**	**43.32**
			mean	1.23	17	**38.44**	**4.44**
Pesticides							
Chlordane	0.0045	0.0089	max	0.1400		**31.11**	**15.73**
			mean	0.0650	15	**14.44**	**7.30**
Dieldrin	0.0029	0.0067	max	0.0050		**1.72**	0.75
			mean	0.0010	14	0.34	0.15
Heptaclor Epoxide	0.0006	0.00274	max	0.0003		0.53	0.12
			mean	0.0003	1	0.53	0.12
Lindane	0.0009	0.00138	max	0.0010		**1.11**	0.72
			mean	0.0004	5	0.43	0.28
DDD	0.00354	0.00851	max	0.1710		**48.31**	**20.09**
			mean	0.0074	14	**2.09**	0.87
DDE	0.0014	0.00675	max	0.0730		**52.14**	**10.81**
			mean	0.0005	8	0.38	0.08
total DDT	0.007	4.45	max	0.3240		**46.29**	0.07
			mean	0.0957	14	**13.67**	0.02
Endrin	0.00267	0.0624	max	0.0034		**1.28**	0.05
			mean	0.0013	8	0.49	0.02

[(a)] background freshwater sediment values (Buchman 1999)

In the Ship Channel zone, TEL-HQs greater than one were calculated for both the maximum and mean concentrations of all the trace elements, the PAHs, the PCBs, and most of the pesticides (Table 7-44). The highest TEL-HQ values were reported for the PAH compounds. PEL-HQ values greater than one were calculated for most of the trace elements, PAHs, PCBs and several pesticides (chlordane, dieldrin, heptaclor epoxide, lindane, DDD, and DDE).

Table 7-44. Sediment Benchmarks, Maximum Concentrations and Calculated Hazard Quotients for the Ship Channel

	TEL	PEL		Sediment concentration	n	$HQ_{(TEL)}$	$HQ_{(PEL)}$
Trace elements							
Arsenic	10.8	17	max	nd			
			mean				
Barium [(a)]	0.7	na	max	nd			
			mean				
Cadmium	0.6	3.53	max	3.31		5.52	0.94
			mean	1.12	20	1.86	0.32
Chromium, total	36.3	90	max	176.00		4.85	1.96
			mean	94.06	20	2.59	1.05
Copper	28	197	max	348.00		12.43	1.77
			mean	89.64	20	3.20	0.46
Lead	34.2	91.3	max	3630.00		106.14	39.76
			mean	498.54	20	14.58	5.46
Manganese	615	na	max	nd			
			mean				
Mercury	0.17	0.486	max	9.22		54.21	18.96
			mean	0.79	20	4.67	1.63
Nickel	19.5	35.9	max	nd			
			mean				
Selenium [(a)]	0.29	na	max	nd			
			mean				
Silver [(a)]	<0.5	na	max	nd			
			mean				
Vanadium [(a)]	50	na	max	nd			
			mean				
Zinc	94.2	315	max	1090.00		11.57	3.46
			mean	340.78	20	3.62	1.08
PAHs							
Benzo(a) anthracene	0.032	0.385	max	8.98		280.63	23.32
			mean	0.9260	21	28.94	2.41
Benzo(a)pyrene	0.032	0.782	max	6.48		202.50	8.29
			mean	0.7960	21	24.88	1.02
Chrysene	0.057	0.862	max	8.84		155.09	10.26
			mean	1.1610	21	20.37	1.35
Fluoranthene	0.11	2.35	max	19.71		179.18	8.39
			mean	2.2610	21	20.55	0.96
Phenanthrene	0.042	0.515	max	16.64		396.19	32.31
			mean	1.5930	21	37.93	3.09
Pyrene	0.053	0.875	max	14.61		275.66	16.70
			mean	1.8560	21	35.02	2.12
LPAHs	0.076	1.17	max	23.44		308.42	20.03
			mean	2.7640	21	36.37	2.36
HPAHs	0.193	2.34	max	65.98		341.87	28.20
			mean	8.1440	21	42.20	3.48
Total PAHs	0.264	3.37	max	89.41		338.67	26.53
			mean	10.9100	21	41.33	3.24
PCBs							

Table 7-44. Sediment Benchmarks, Maximum Concentrations and Calculated Hazard Quotients for the Ship Channel

	TEL	PEL		Sediment concentration	n	$HQ_{(TEL)}$	$HQ_{(PEL)}$
Aroclor 1254	0.032	0.277	max	nd			
			mean				
Aroclor 1260	0.032	0.277	max	nd			
			mean				
Total PCBs	0.032	0.277	max	3.35		104.69	12.09
			mean	0.8050		25.16	2.91
Pesticides							
Chlordane	0.0045	0.0089	max	0.13		28.89	14.61
			mean	0.0250	21	5.56	2.81
Dieldrin	0.0029	0.0067	max	0.01		3.21	1.39
			mean	0.0024	19	0.83	0.36
Heptaclor Epoxide	0.0006	0.00274	max	0.0028		4.67	1.02
			mean	0.0009	5	1.45	0.32
Lindane	0.0009	0.00138	max	0.0018		2.00	1.30
			mean	0.0004	16	0.44	0.29
DDD	0.00354	0.00851	max	0.20		55.65	23.15
			mean	0.0390	21	11.02	4.58
DDE	0.0014	0.00675	max	0.14		101.43	21.04
			mean	0.0430	21	30.71	6.37
total DDT	0.007	4.45	max	0.80		114.71	0.18
			mean	0.1290	21	18.43	0.03
Endrin	0.00267	0.0624	max	0.0015		0.56	0.02
			mean	0.0005	9	0.19	0.01

[(a)] background freshwater sediment values (Buchman 1999)

7.8.2 FISH

The fish receptors were evaluated in three ways: surface water concentrations were compared to AWQC, tissue concentrations were compared to tissue residue effects concentrations, and sediment PAH concentrations were compared to sediment benchmark concentrations. The additional evaluations consist of a comparison of mean surface water concentrations to AWQC values and a comparison of mean sediment PAH concentrations to sediment benchmark concentrations. Additional evaluations of the tissue concentrations were not conducted because many of the tissue residue effects concentrations were derived from LOEC values at which effects were seen in fish. It would not be appropriate to compare mean tissue concentrations to concentrations associated with effects as a screening evaluation.

The average surface water contaminant concentrations are presented in Table 7-45. The contaminants were selected based on the HQ values calculated in Section 7.5. Only those contaminants whose maximum concentrations exceeded the corresponding AWQC values were selected. In both the upper river zone and the lower river zone, mean ammonia concentrations exceeded the corresponding AWQC value (HQs of 1.7 in both areas). The mean concentrations of lead and total PCBs in the upper river zone did not exceed the corresponding AWQC.

Table 7-45. Average Surface Water Concentrations Compared to AWQC for Lower River Area and Upper River Area

		Mean Aqueous Conc.	n	AWQC	$HQ_{(AWQC)}$
Upper River					
	NH4-N	178.29	14	105.00	1.70
	Pb	0.85	14	2.50	0.34
	total PCBs	0.01	9	0.017	0.43
Lower River					
	NH4-N	179	43	105.00	1.70

The exposure of fish in the Anacostia River to PAHs was evaluated by comparing the maximum measured sediment PAH concentration to sediment benchmark concentrations.

In Table 7-46, the average PAH concentrations in each area is compared to the sediment benchmark of 2µg/g total PAH concentration. HQ values greater than one were calculated for all areas. The largest HQ value was calculated for the lower river zone (HQ of 15).

Table 7-46. Mean PAH Sediment Concentrations Compared to Sediment Benchmark Concentrations (µg/g)

LOCATION	MEAN PAH CONCENTRATION	SEDIMENT BENCHMARK	HQ
Upper river zone	5.52	2	2.8
Lower river zone	30.8	2	15
Ship channel	10.9	2	5.5

7.8.3 AQUATIC BIRDS AND MAMMALS

Additional evaluations of the green heron and raccoon were conducted. First, the average tissue and sediment concentrations were used to estimate doses to each of these species using the conservative dietary compositions presented in Sections 7.5 and 7.6. Then, an alternative exposure was calculated for the raccoon based on a less conservative dietary composition.

The average fish tissue concentrations were calculated using the fish tissue concentrations reported for the largemouth bass and the brown bullhead (Table 7-47). In addition, average sediment concentrations were used to calculate invertebrate tissue concentrations using the BSAF method presented in Section 7.6. These values were used to estimate dose to the green heron and raccoon using the dietary compositions presented in Section 7.6. The results of these calculations are compared to TRV values in Tables 7-48 through 7-53.

Table 7-47. Average Fish Tissue Concentrations (µg/g wet weight)

		Upper River		Lower River		Ship Channel	
Dioxins and Furans:			n		n		n
2,3,7,8-TCDD	[a]	0.00000045	2	0.00000245	2		
2,3,7,8-TCDF		0.000000625	2	0.0000014	2		
PCBs:							
Total PCB		0.531	2	0.703	6	4.7	1
Trace Elements:							
Arsenic		0.0339	1	0.09902	1		
Cadmium	[a]	0.0047	3	0.00413	1		
Lead	[a]	0.0193	3	0.04332	1		
Mercury		0.0366	3	0.07839	1		
Selenium		0.1406	3	0.27438	1		
Zinc		3.9255	3	4.55923	1		
Pesticides:							
Dieldrin		0.008	6	0.01000	6	0.04000	1
Heptaclor Epoxide		0.002	5	0.00580	4		
Lindane		0.00021	3	0.000513	3		
DDD	[a]	0.037	6	0.077	6	0.36000	1
DDE	[a]	0.041	6	0.093	6	0.63000	1
DDT		0.08	6	0.174	6	0.06000	1

[a] Original LOEC was based on mortality endpoint, screening value = LOEC/10

In the upper river zone, HQ values greater than one were calculated for arsenic in the raccoon and, total DDT, and methyl mercury in the green heron using the average tissue and sediment concentrations (Table 7-48). The largest HQ value was calculated for methylmercury in the green heron (HQ of 18.2). Only one HQ greater than one was calculated for the raccoon (Table 7-49) for arsenic (HQ = 2.99)

Table 7-48. Green Heron Dose Based on Average Exposure Compared to TRV Values for the Upper River

	Fish Tissue average conc. (µg/g ww)	Invertebrates µg/g ww	Sediment µg/g ww [a]	Dose (µg/gbw/d) [b]	TRV	HQ
Dioxins and furans						
2378-TCDD	0.000000450	na	na	0.0000001	0.000014	0.01
2378-TCDF	0.000000625	na	na	0.0000002	0.000001	0.16
PCBs						
Total PCB	0.531	0.3031	0.0987	0.145	0.41	0.35
Pesticides						
Dieldrin	0.008	0.001	0.0003	0.002	0.077	0.03
Heptachlor Epoxide	0.002	0.001	0.0003	0.001	na	
Lindane	0.00021	0.0006	0.00015	0.0001	2	0.00003
Total DDT	0.08	0.044	0.012	0.022	0.003	**7.29**
Trace Elements						
Arsenic	0.034	0.938	0.7035	0.028	2.5	0.01
Cadmium	0.0047	0.35	0.263	0.008	1.45	0.01
Lead	0.019	31.2	23.4	0.647	1.13	0.57
Mercury	0.037	0.058	0.0435	0.011	0.45	0.02
Methyl mercury	0.037	0.058	0.0435	0.011	0.0006	**18.22**
Selenium	0.14	nd	nd	0.037	0.5	0.07
Zinc	3.93	71	53.3	2.496	14.5	0.17

[a] calculated from dry weight concentrations assuming 85 percent moisture
[b] based on diet of 94 percent fish, 6 percent invertebrates and incidental sediment ingestion of 1.8 percent, body weight of 212 g and a calculated ingestion rate of 0.28 g/g body weight/day (EPA 1993)

Table 7-49. Raccoon Dose Based on Average Exposure Compared to TRV Values for Upper River

	Fish Tissue average conc. (µg/g ww)	Invertebrates µg/g ww	Sediment µg/g ww[a]	Dose (µg/gbw/d)[b]	TRV	HQ
Dioxins and furans						
2378-TCDD	0.000000450	na	na	0.00000001	0.0000008	0.01
2378-TCDF	0.000000625	na	na	0.00000001	na	
PCBs						
Total PCB [c]	0.531	0.303123596	0.0987	0.057	0.069	0.83
Pesticides						
Dieldrin	0.008	0.001	0.0003	0.00029	0.015	0.02
Heptachlor Epoxide	0.002	0.001	0.0003	0.00019	0.1	0.0019
Lindane	0.00021	0.0006	0.00015	0.00010	6.15	0.00002
Total DDT	0.08	0.044	0.012	0.008	0.62	0.01
Trace Elements						
Arsenic	0.034	0.938	0.7035	0.155	0.052	**2.99**
Cadmium	0.0047	0.35	0.263	0.058	0.742	0.0779
Lead	0.019	31.2	23.4	5.148	6.15	0.8370
Mercury	0.037	0.058	0.0435	0.010	1	0.01
Methyl mercury	0.037	0.058	0.0435	0.010	0.015	0.68
Selenium	0.14	nd	nd	0.002	0.154	0.02
Zinc	3.93	71	53.3	11.782	123.1	0.10

[a] calculated from dry weight concentrations assuming 85 percent moisture
[b] based on diet of 94 percent fish, 6 percent invertebrates and incidental sediment ingestion of 1.8 percent, body weight of 212 g and a calculated ingestion rate of 0.28 g/g body weight/day (EPA 1993)
[c] Total PCB TRV based on Aroclor 1242 in mink

In the lower river zone, HQ values greater than one were calculated for total DDT and methyl mercury in the green heron (Table 7-50) and arsenic, cadmium, lead, mercury, methyl mercury, and zinc in the raccoon (Table 7-51). The largest HQ value was calculated for lead in the raccoon (HQ of 870).

Table 7-50. Green Heron Dose Based on Average Exposure Compared to TRV Values for the Lower River

	Fish Tissue Ave conc. (µg/g ww)	Invertebrates µg/g ww	Sediment µg/g ww [a]	Dose (µg/gbw/d)[b]	TRV	HQ
Dioxins and furans						
2378-TCDD	0.00000245	na	na	0.0000006	0.000014	0.05
2378-TCDF	0.0000014	na	na	0.0000004	0.000001	0.37
PCBs						
Total PCB	0.703	0.595044248	0.184	0.196	0.41	0.48
Pesticides						
Dieldrin	0.01000	0.000578171	0.00015	0.003	0.077	0.03
Heptachlor Epoxide	0.00580	0.000173451	0.000045	0.002	na	
Lindane	0.000513	0.000	0.00006	0.00014	2	0.0001
Total DDT	0.174	0.058	0.015	0.047	0.003	**15.61**
Trace Elements						
Arsenic	0.09902	1.462	1.1	0.056	2.5	0.02
Cadmium	0.00413	0.292	0.219	0.007	1.45	0.00
Lead	0.04332	38.8	29.1	0.810	1.13	0.72
Mercury	0.078	0.112	0.084	0.023	0.45	0.05
Methyl mercury	0.078	0.112	0.084	0.023	0.0006	**38.06**
Selenium	0.27	0.146	0.11	0.074	0.5	0.15
Zinc	4.56	54.8	41.1	2.328	14.5	0.16

[a] calculated from dry weight concentrations assuming 85 percent moisture
[b] based on diet of 94 percent fish, 6 percent invertebrates and incidental sediment ingestion of 1.8 percent, body weight of 212 g and a calculated ingestion rate of 0.28 g/g body weight/day (EPA 1993)

Table 7-51. Raccoon Dose Based on Average Exposure Compared to TRV Values for Lower River

	Fish Tissue Ave. conc. (ug/g ww)	Invertebrates ug/g ww	Sediment ug/g ww [a]	Dose (ug/gbw/d)[b]	TRV	HQ
Dioxins and furans						
2378-TCDD	0.00000245	na	na	0.00000004	0.0000008	0.1
2378-TCDF	0.0000014	na	na	0.00000002	na	
PCBs						
Total PCB [c]	0.703	0.595044248	0.184	0.106	0.069	**1.54**
Pesticides						
Dieldrin	0.01000	0.000578171	0.00015	0.0003	0.015	0.02
Heptachlor Epoxide	0.00580	0.000173451	0.000045	0.0001	0.1	0.001
Lindane	0.000513	0.000	0.00006	0.00005	6.15	0.00001
Total DDT	0.174	0.058	0.015	0.0120	0.62	0.02
Trace Elements						
Arsenic	0.09902	1.462	1.1	0.24	0.052	**4.67**
Cadmium	0.00413	0.292	0.219	0.05	0.742	0.07
Lead	0.04332	38.8	29.1	6.40	6.15	**1.04**
Mercury	0.078	0.112	0.084	0.02	1	0.02
Methyl mercury	0.078	0.112	0.084	0.02	0.015	**1.32**
Selenium	0.27	0.146	0.11	0.03	0.154	0.19
Zinc	4.56	54.8	41.1	9.12	123.1	0.07

[a] calculated from dry weight concentrations assuming 85 percent moisture
[b] based on diet of 10 percent fish, 90 percent invertebrates and 9.4 percent incidental sediment ingestion, body weight of 5.8 Kg and a calculated ingestion rate of 0.17g/g body weight/day (EPA 1993)
[c] Total PCB TRV based on Aroclor 1242 in mink

In the Ship Channel, HQs greater than on were calculated for total PCB and methyl mercury in the green heron (Table 7-52) and total PCBs, lead, and methyl mercury in the raccoon (Table 7-53). The largest HQ value was calculated for methyl mercury in the green heron.

Table 7-52. Green Heron Dose Based on Average Exposure Compared to TRV Values for the Ship Channel

	Fish Tissue [a] Ave. conc. (µg/g ww)	Invertebrates µg/g ww	Sediment µg/g ww[b]	Dose (µg/gbw/d)[c]	TRV	HQ
Dioxins and furans						
2378-TCDD	na	na	na		0.000014	
2378-TCDF	na	na	na		0.000001	
PCBs						
Total PCB	4.7	0.343	0.121	1.243	0.41	**3.03**
Pesticides						
Dieldrin	0.04	0.001	0.00036	0.011	0.077	0.14
Heptachlor Epoxide	0	0.00046	0.000135	0.000008	na	
Lindane	0	0.0002	0.00006	0.000004	2	0.000002
Total DDT	1.05	0.066	0.01935	0.278	0.003	92.52
Trace Elements						
Arsenic	na				2.5	
Cadmium	na	0.224	0.168	0.005	1.45	0.00
Lead	na	99.8	74.7	2.053	1.13	1.82
Mercury	na	0.158	0.12	0.003	0.45	0.01
Methyl mercury	na	0.158	0.12	0.003	0.0006	**5.43**
Selenium	na	na	na		0.5	
Zinc	na	68.200	51.2	1.404	14.5	0.10

[a] average and maximum fish tissue concentrations are the same (n=1)
[b] calculated from dry weight concentrations assuming 85 percent moisture
[c] based on diet of 94 percent fish, 6 percent invertebrates and incidental sediment ingestion of 1.8 percent, body weight of 212 g and a calculated ingestion rate of 0.28 g/g body weight/day

Table 7-53. Raccoon Dose Based on Average Exposure Compared to TRV Values for Ship Channel

	Fish Tissue [a] Ave. conc. (ug/g ww)	Invertebrates ug/g ww	Sediment ug/g ww[b]	Dose (ug/gbw/d)[c]	TRV	HQ
Dioxins and furans						
2378-TCDD	na	na	na	na	0.0000008	
2378-TCDF	na	na	na	na	na	
PCBs						
Total PCB [d]	4.7	0.343	0.121	0.134	0.069	**1.95**
Pesticides						
Dieldrin	0.04	0.001	0.00036	0.001	0.015	0.06
Heptachlor Epoxide	0	0.00046	0.000135	0.00007	0.1	0.00073
Lindane	0	0.0002	0.00006	0.00003	6.15	0.00001
Total DDT	1.05	0.066	0.01935	0.028	0.62	0.05
Trace Elements						
Arsenic	na				0.052	
Cadmium	na	0.224	0.168	0.037	0.742	0.05
Lead	na	99.8	74.7	16.463	6.15	**2.68**
Mercury	na	0.158	0.12	0.026	1	0.03
Methyl mercury	na	0.158	0.12	0.026	0.015	**1.74**
Selenium	na	na	na		0.154	
Zinc	na	68.200	51.2	11.253	123.1	0.09

[a] average and maximum fish tissue concentrations are the same (n=1)
[b] calculated from dry weight concentrations assuming 85 percent moisture
[c] based on diet of 10 percent fish, 90 percent invertebrates and incidental sediment ingestion of 9.4 percent, body weight of 5.8kg and a calculated ingestion rate of 0.17 g/g body weight/day (EPA 1993)
[d] Total PCB TRV based on Aroclor 1242 in mink

It is important to note that the methyl mercury dose was calculated based on the assumption that 100 percent of the sediment mercury concentration was methyl mercury. This is a conservative estimate of the actual sediment methyl mercury concentrations.

The raccoon diet for the screening level assessment was selected based on the fact that the diet was dominated by consumption of aquatic prey. Another raccoon diet reported for raccoons living in forested bottomland of Maryland (Llewellyn and Uhler, 1952). This diet contained a much lower contribution from aquatic prey, fish represented 3 percent of the total diet, and aquatic invertebrates represented 37 percent of the total diet. The maximum fish tissue and sediment concentrations were used to estimate the dose due to aquatic prey.

When the dose estimates for the Upper River were compared to the corresponding TRV values only one HQ value exceeded one, arsenic (HQ of 1.86) (Table 7-54). In the Lower River, HQ values greater than one were calculated for total PCBs, arsenic cadmium, lead, mercury, methyl mercury, and zinc (Table 7-55). The largest HQ was calculated for lead (HQ of 1200). Finally, in the Ship Channel, HQ values greater than one were calculated for lead and methyl mercury (Table 7-56).

Table 7-54. Alternate Raccoon Dose Based on Maximum Exposure Compared to TRV Values for Upper River

	Fish Tissue Max conc. (µg/g ww)	Invertebrates µg/g ww	Sediment µg/g ww[a]	Dose (µg/gbw/d)[b]	TRV	HQ
Dioxins and furans						
2378-TCDD	0.0000005	na	na	0.000000002	0.0000008	0.003
2378-TCDF	0.0000007	na	na	0.000000004	na	
PCBs						
Total PCB [c]	0.97	0.751	0.2445	0.056	0.069	0.81
Pesticides						
Dieldrin	0.0095	0.003	0.00075	0.00025	0.015	0.02
Heptachlor Epoxide	0.0001	0.002	0.0006	0.00014	0.1	0.0014
Lindane	0.00031	0.001	0.0003	0.00007	6.15	0.00001
Total DDT	0.0901	0.082	0.022	0.006	0.62	0.01
Trace Elements						
Arsenic	0.034	1.292	0.969	0.097	0.052	**1.86**
Cadmium	0.0057	0.524	0.393	0.039	0.742	0.053
Lead	0.104	44.8	33.6	3.355	6.15	0.546
Mercury	0.051	0.118	0.0885	0.009	1	0.01
methyl mercury	0.051	0.118	0.0885	0.009	0.015	0.61
Selenium	0.193	nd	nd	0.001	0.154	0.01
Zinc	5.92	89.4	71.55	6.797	123.1	0.06

[a] calculated from dry weight concentrations assuming 85 percent moisture
[b] based on diet of 3 percent fish, 37 percent invertebrates and incidental sediment ingestion of 9.4 percent, body weight of 5.8kg and a calculated ingestion rate of 0.17 g/g body weight/day
[c]Total PCB TRV based on Aroclor 1242 in mink

Table 7-55. Alternate Raccoon Dose Based on Maximum Exposure Compared to TRV Values for Lower River

	Fish Tissue Max conc. (µg/g ww)	Invertebrates µg/g ww	Sediment µg/g ww[a]	Dose (µg/gbw/d)[b]	TRV	HQ
Dioxins and furans						
2378-TCDD	0.00001	na	na	0.00000005	0.0000008	0.06
2378-TCDF	0.0000024	na	na	0.00000001	na	
PCBs						
Total PCB [c]	1.27	5.805	1.8	0.400	0.069	**5.80**
Pesticides						
Dieldrin	0.02	0.002	0.000675	0.00024	0.015	0.02
Heptachlor Epoxide	0.017	0.00035	0.00009	0.00011	0.1	0.00
Lindane	0.0012	0.001	0.000135	0.00007	6.15	0.00
Total DDT	0.28	0.004	0.001	0.002	0.62	0.00
Trace Elements						
Arsenic	0.099	5.38	4.04	0.403	0.052	**7.76**
Cadmium	0.0041	0.636	0.477	0.048	0.742	**0.06**
Lead	0.043	115	116	9.087	6.15	**1.48**
Mercury	0.078	0.54	0.405	0.041	1	**0.04**
Methyl mercury	0.078	0.54	0.405	0.041	0.015	**2.72**
Selenium	0.27	0.22	0.165	0.018	0.154	0.12
Zinc	4.56	102.4	76.8	7.691	123.1	**0.06**

[a] calculated from dry weight concentrations assuming 85 percent moisture
[b] based on diet of 3 percent fish, 37 percent invertebrates and 9.4 percent incidental sediment ingestion, body weight of 5.8 kg and a calculated ingestion rate of 0.17 g/g body weight/day (EPA 1993)
[c]Total PCB TRV based on Aroclor 1242 in mink

Table 7-56. Alternate Raccoon Dose Based on Maximum Exposure Compared to TRV Values for Ship Channel

	Fish Tissue Max conc. (µg/g ww)	Invertebrates µg/g ww	Sediment µg/g ww[a]	Dose (µg/gbw/d)[b]	TRV	HQ
Dioxins and furans						
2378-TCDD	na	na	na	na	0.0000008	
2378-TCDF	na	na	na	na	na	
PCBs						
Total PCB [c]	4.7	1.43	0.5025	0.122	0.069	**1.77**
Pesticides						
Dieldrin	0.04	0.003	0.00075	0.0004	0.015	0.03
Heptachlor Epoxide	0	0.002	0.0006	0.0001	0.1	0.0014
Lindane	0	0.001	0.0003	0.0001	6.15	0.00001
Total DDT	1.05	0.082	0.022	0.011	0.62	0.02
Trace Elements						
Arsenic	na		0.969	0.015	0.052	0.30
Cadmium	na	0.662	0.393	0.048	0.742	0.06
Lead	na	726.000	33.6	46.202	6.15	**7.51**
Mercury	na	1.843	0.0885	0.117	1	0.12
Methyl mercury	na	1.843	0.0885	0.117	0.015	**7.82**
Selenium	na	na	na		0.154	
Zinc	na	218.000	71.55	14.856	123.1	0.12

[a] calculated from dry weight concentrations assuming 85 percent moisture
[b] based on diet of 3 percent fish, 37 percent invertebrates and 9.4 percent incidental sediment ingestion, body weight of 5.8 Kg and a calculated ingestion rate of 0.17 g/g body weight/day (EPA 1993)
[c]Total PCB TRV based on Aroclor 1242 in mink

REFERENCES FOR CHAPTER 7

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8. CONCLUSION AND SUMMARY

8.1 CONCEPTUAL SITE MODEL

A preliminary conceptual site model (CSM) of the tidal Anacostia River was developed that identifies the major pathways and receptors that may contact the river (Figure 6-1). A CSM describes the processes that link sources of contamination at a site to exposures of human or ecological receptors. Ideally, the model defines the inputs of constituents to a site, the physical and chemical processes that result in transport of the constituents into environmental media to which human or ecological receptors may come into contact, and identifies the receptors that are likely to be impacted by exposure to these media. In its mature form, the model provides a basis for planning of data collection and evaluation needed to support risk assessments and remedial actions. In the early stages of development, the CSM identifies all *potential* links between sources and receptors, which subsequently can be evaluated for their plausibility and relevance with further data collection and analysis. Inputs, fate and transport processes, and exposure scenarios that are subsequently determined to be implausible or of negligible importance can be eliminated based on sufficient evidence.

The CSM described here is in the preliminary stages of development. It includes all of the potential inputs and exposure pathways of potential receptors. At this stage, the model does not attempt to quantify the relative importance of the various processes and pathways. While a more quantitative model is desirable for evaluating remediation strategies, currently available information do not support a quantitative analysis of the relative magnitude by which each transfer mechanism contributes to exposures. The development, validation, and calibration of hydrodynamic and sediment transport models that will accurately simulate the physical and chemical processes that contribute to transport of COPCs in the river and associated environmental media will be important component of a completing the conceptual site model. Although, progress has been made in this direction (see discussion of Tidal Anacostia Model in Section 9.1), additional efforts in data collection and model development will be needed. Such models need to be developed to the point where they can support estimation of contaminant mass fluxes. This will require a more complete understanding of transport mechanisms for affected media, and, accurate estimates of contaminant loadings. The CSM described in this report model is generic with respect to constituents. As constituents differ in the degree to which they may be affected by various fate and transport processes, at some point in the risk assessment process individual chemical-specific or chemical class-specific models may need to be developed and evaluated.

The currently available data do not satisfy requirements for the development of such models. In general, data concerning chemical loadings from sources, chemical concentrations in various media, chemical transformation, and chemical transport processes have been collected over the course of several decades and throughout the Anacostia River watershed, and as such comprise a spatio-temporal patchwork picture of chemical contamination in the tidal Anacostia. In addition, analytical methods and target analytes differed between studies. The tidal Anacostia is a complex, dynamic system. Data have not been collected and analyzed in a coordinated manner in order to develop a comprehensive understanding of

chemical contamination sufficient for quantifying current human exposures to various media, or for predicting future human exposures or future contamination conditions under various remediation scenarios. Some specific data gaps are itemized below.

- Some permitted and other known discharges (e.g., certain CSOs in the lower tidal Anacostia) to Anacostia watershed water bodies are relatively well characterized. However, the Anacostia watershed, particularly the portion adjacent to the tidal Anacostia, has a long history of industrial and military activity. A detailed historical and geographic assessment of the identity, activities, and location of industrial, government, military, and research facilities in the watershed is currently unavailable, but would be useful for identifying potential locations of uncharacterized (i.e., unreported and/or unpermitted) discharges to the tidal Anacostia, its tributaries, or adjacent groundwater, and for locating additional advisable surface water and ground water sampling locations.
- NPDES permits identify allowable discharge levels of specific waste stream constituents. It is possible that other chemicals are also discharged from those facilities. Chemical loadings of contaminants that were not specified in active permits in wastewater streams from facilities holding NPDES permits are largely uncharacterized in documents available for the screening level assessment.

- Flows, first-flush and peak fluvial chemical loadings from tributaries to the tidal Anacostia during storm events have not been quantified in available documents.

- The exchange of surface water and sediment between the Potomac and Anacostia Rivers during tidal flux has not been quantified in available documents.

- The exchange of ground water and surface water within the tidal Anacostia River has not been quantified in available documents.

- Spatio-temporal human use patterns (shoreline fishing, boat fishing, boating, sailing, waterskiing, wading, swimming, etc.) at the tidal Anacostia river have not been sufficiently characterized, although consumption of contaminated fish is suspected to be a potentially significant route of human exposure to chemicals in the tidal Anacostia river (GDC, 1998; McCabe, 1997).

- The potential contribution of aerially deposited particles to chemical contamination in the tidal Anacostia River has not been evaluated. While locations and identity of industrial stacks with permitted emissions have been identified (McCabe, 1997), chemical composition and quantity of emitted particles and deposition patterns relative to the location of the tidal Anacostia have not been characterized in available documents.

- The frequency and extent of dredging deep tidal river sediments have not been characterized in available documents; deep dredging may promote the resuspension of formerly buried contaminated sediment.

- The Warner et al. (1997) pollution source study is the most comprehensive treatment of pollution sources to the tidal Anacostia River. The review considered total loading of several types of pollution, evaluated for only a limited number of individual chemicals, and considered loadings from only three types of sources: nonpoint stormwater runoff, CSOs, and permitted industrial and municipal discharges; however, the estimated loadings were based in whole or in part on modeling rather than entirely on site specific data.. The study did not consider loadings from ground water.

This study was not sufficiently focused on chemical loadings to identify primary sources of many chemicals that are suspected to be potential problems in the river, such as PCBs, pesticides, and dioxins and dibenzofurans.

- Depositional patterns of sediments transported into the tidal Anacostia from tributaries, including the Northeast and Northwest branches, during and between storm events have not been characterized.

- Conditions under which deposited sediments are resuspended and transported, and the relative importance of this mechanism for transport of chemical contaminants, have not been characterized.

- Particulate deposition on the floodplain during storm events or during spring snowmelt in areas of the tidal Anacostia and tributaries that have not yet been channelized has not been addressed relative to human exposures to chemical contaminants.

8.2 HUMAN HEALTH SCREENING ASSESSMENT

The screening assessment utilized existing data and information to identify COPCs in the tidal Anacostia River. The overall results of the sorting of chemicals is shown in Figure 6-3. Of 215 chemicals that entered the human health screen, 43 chemicals were identified as COPCs, based on their maximum concentrations exceeding an human health RBC or ARAR. Thirty-nine are COPCs in fish tissue, 7 in river sediment and 5 in river water; six of the chemicals (or chemical mixtures) are COPCs for more than one media (Table 6-6a).

Fish tissue COPCs fall into several chemical classes. Seventeen (17) are chlorinated dibenzodioxins or dibenzofurans; 12 are organic pesticides: aldrin, (-HCH (lindane), HCB, DDT, DDE, dieldrin, chlordane (or transformation products), or heptachlor; 2 are PCBs, including Aroclor 1260; and 4 are elements: arsenic, cadmium, lead, and mercury. The remaining fish tissue COPCs, not accounted for in the latter chemical classes, are "-HCH, heptachlor epoxide, bis(2-ethylhexyl)phthalate, and di-N-octyl phthalate.

The 7 COPCs in sediment include two chemicals (or chemical mixtures) that are also COPCs in water and fish tissue: arsenic and total PCBs and one chemical that is also a COPC in fish tissue: Aroclor 1260. The remaining 4 sediment COPCs include the following PAHs: benzo(a)pyrene, dibenz(a,h)anthracene, benz(a)anthracene and benzo(b)fluoranthene.

The 5 COPCs in water include two chemicals (or chemical mixtures) that are also COPCs in fish tissue and sediment: total PCBs and arsenic, and three that are also COPCs in fish tissue: heptachlor (pesticide), DDE and DDT.

A high max/RBC ratio would indicate a greater potential for concern that a given chemical may pose a risk at reasonable maximal exposure (RME), given the conservative assumptions in the screening assessment (Table 6-6b). Chemicals with the highest max/RBC ratios (greater than 100) in fish tissue included total PCBs (2911), Aroclor 1260 (285), dieldrin (264) 2,3,7,8-TCDD (133) and arsenic (127). The highest max/RBC ratio in sediment was for benzo(a)pyrene (34). Total PCBs and arsenic had max/RBC ratios in surface water of 380 and 15, respectively. The three sediment COPCs that are also COPCs in fish tissue, total PCBs, Aroclor 1260, and arsenic, represent the first, second and fifth highest max/RBC in fish tissue, respectively, and all 3 had max/RBC ratios in fish tissue that exceeded 100. There was no apparent spatial trend in the distribution of either the maximum concentrations of COPCs (Figure 6-4) or

frequency of detections of chemical classes represented in the COPC list (Figures 5-2 through 5-11). However, the data are not adequate for a robust analysis for spatial and temporal trends.

No chemicals could be definitively ruled out as COPCs. Of the 172 chemicals that could not be classified as COPCs, 144 were classified as Category 3 chemicals *(Insufficient Information on Exposure)* because of high uncertainty in the interpretation of the maximum concentrations (100) reported or the lack of detects (44) (Table 6-7a,b) either due to inadequate sample numbers or to inadequate geographic distribution of samples. Thirty-one chemicals were classified as Category 4 chemicals *(Insufficient Information on Toxicity)* because of the lack of an appropriate human health RBC. Additional data on exposure concentrations and toxicity will be needed in order to determine if any of these 176 chemicals are actually COPCs.

8.2.1 DATA GAPS RELATED TO EXPOSURE INFORMATION FOR THE SCREENING LEVEL RISK ASSESSMENT

The major data gaps related to exposure information used in the Anacostia River human health risk screening assessment can be classified into three categories: 1) inadequate geographic coverage of sampling in the tidal Anacostia; 2) inadequate numbers of samples; and 3) lack of data for a chemical class in a specific media.

Sediment. The database does not contain information on the concentration of contaminants in sediment upstream of Lower Beaverdam Creek. In general, there is very little information on the concentration of contaminants in sediment upstream of Benning Road Bridge and the majority of this information was collected from Kenilworth Marsh and Kingman Lake (Figures 5-2 through 5-6). More specifically, there is very little information on the concentration of metals, acid/base/neutral-extractables (ABNs) and PCBs in sediment within the Anacostia River channel, upstream of the Pennsylvania Avenue bridge.

Downstream of the Pennsylvania Avenue Bridge, the geographic coverage tends to improve with the exception of the Aroclors analyses. In the lower Anacostia, samples that were analyzed for Aroclors are limited to two areas of the river: one near and downstream of the 11th Street bridge, along the northern bank; the other area is along the southeastern bank, near the Potomac (Figure 5-4). The database does not contain information on the concentration of dioxins or furans in sediment.

Relatively few samples were analyzed for total Aroclors, ABNs and metals in areas with high detection rates for these chemical classes (i.e., Benning Road Bridge, Kenilworth Marsh and Kingman Lake) (Figures 5-9 through 5-11). These areas should be considered as potential targets for additional data collection efforts.

Approximately 73% of the sediment data contained in the database is from the analyses of samples that were collected before 1996. Since the data are not adequate to support predictions of temporal trends in sediment concentrations, additional data may need to be collected to support a human health risk screening assessment that reflects the most current conditions of the river.

Fish Tissue. There is very little information in the database on the concentration of contaminants in fish collected upstream of Watts Branch, with the exception of the pesticides and metals classes (Figure 5-4; Table 5-5). The database contains no information on the level of dioxins, furans or PAHs in fish collected north of Watts Branch.

Most of the chemical concentrations in the database were determined from the analysis of composite fish samples. Composite samples often provide a reasonable estimate of the mean concentration of a chemical but the variability of the measured concentrations will be lower. Therefore, the actual maximum concentration of a particular chemical in fish tissue may be higher than the measured concentration determined from the composite samples.

Approximately 95% of the data on chemical concentrations in fish tissue is based on samples that were collected between 1989–1995 (Cummins and Velinsky, 1993; Velinsky and Cummins, 1996).

Surface Water. Data are available for just one location upstream of the Independence Avenue Bridge (Figure 5-3). Data on the concentration of dioxins, furans and PAHs in surface water are not included in the database. There is very little information in the database on the concentration of ABNs and PCBs in surface water (Table 5-4). The data on chemical concentrations in Anacostia River water is from one study (Velinsky, 1999). The data were collected over an approximately 10 month period in 1998. The sampling events were scheduled before and after rainfall events to determine the effects of stormwater runoff on water quality in the Anacostia River, but samples were not collected during first-flush or at peak flow.

Additional data on particulate-bound and dissolved contaminant concentrations should be collected from an array of sampling stations, at various depths and at regular time intervals to characterize spatial and temporal trends. The collection of additional data on general water quality parameters such as TSS, pH, eH, particulate and dissolved organic carbon, dissolved oxygen and temperature, should be coordinated with the collection of data on contaminant concentrations and river hydrodynamics to support the development of a hydrodynamic model of the river.

Background. The database does not contain information on background concentrations. For purposes of a screening level human health risk assessment, U.S. EPA risk assessment guidance suggests inorganic chemicals present at naturally occurring background levels can be removed from the COPC list (U.S. EPA, 1989). Note that the U.S. EPA guidance (U.S. EPA, 1989) specifies that comparing concentrations of organic chemicals detected at a site to naturally occurring concentrations or anthropogenic levels (non-site related concentrations) is inappropriate at the screening level risk assessment.

Estimation of Concentration Term Parameters for Risk Estimates. An additional issue for use of the existing data in a human health risk assessment is the lack of adequate information on detection and sample quantitation limits for the various analytes captured in the database. This limitation has no effect on the human health screening assessment, which is based entirely on maximum concentrations detected; however, it may severely compromise the estimation of statistical parameters such as the mean and associated confidence limits. The latter would be needed to estimate the concentration terms for each chemical that would enter the calculations of baseline risk.

8.2.2 DATA GAPS RELATED TO TOXICITY INFORMATION

Thirty-one chemicals could not be evaluated against toxicity criteria because of the lack of an RBC (Table 6-8). Had RBCs been available for these chemicals, it is possible that some would have had maximum concentrations that exceeded their respective RBCs. Many of the chemicals in this category are structural analogs, similar mixtures or are toxicologically similar to other COPCs. For example, 12 chemicals in this category are PAHs which, as a chemical class, are represented on the COPC list. Twelve chemicals are pesticides or structural analogs, including several structural or compositional

analogs of chemicals that are COPCs: BHCs, hexachlorocyclohexane-delta, the ortho-para isomers of DDD, DDE and DDT, oxychlordane. At least one chemical, arsenic III, can probably be eliminated from this list based on an interpretation of the RBC for arsenic to apply to all forms of inorganic arsenic. It may also be possible to eliminate several of the PAHs and pesticides (e.g., the various lindane-like mixtures and the ortho-para isomers of DDD, DDE and DDT) from this category based on their toxicologic similarity (or an assumed similarity as a conservative assumption) to other chemicals for which RBCs are available. It is also possible that a search of existing toxicology literature on these chemicals may discover data or reference values that would be adequate to support a provisional RBC for use in the screening assessment. Potential sources for reference values may be the U.S. EPA Superfund Health Risk Technical Support Center; the U.S. EPA Health Effects Assessment Summary Tables (HEAST), ATSDR or WHO.

8.3 ECOLOGICAL SCREENING ASSESSMENT

8.3.1 BENTHIC INVERTEBRATES ASSESSMENT

The potential for effects in benthic invertebrates was assessed by comparing the maximum and mean concentrations of COPCs in sediment to corresponding screening benchmarks (TELs and PELs). The results of this screening were HQs calculated as the ratio of the sediment concentration to the corresponding screening benchmark.

In the Upper River, TEL-HQ values greater than 100 were calculated for the maximum and mean sediment barium concentrations. TEL-HQs greater than 20 were calculated for maximum concentrations of all the PAH compounds and several pesticides, chlordane, DDD, DDE, and DDT. The only PEL-HQ greater than 20 was calculated for chlordane.

In the Lower River, TEL-HQ values greater than 100 were calculated for the maximum and mean concentrations of barium, many of the PAH compounds, and maximum Aroclor 1260 and total PCB concentrations. PEL-HQs greater than 100 were calculated for the maximum concentrations of three PAH compounds, benzo(a)anthracene, pyrene, and phenanthrene.

Finally, in the Ship Channel, TEL-HQ values greater than 100 were calculated for the maximum concentrations of lead, all of the PAH compounds, total PCBs, DDE, and total DDTs. PEL-HQs greater than 20 were calculated for maximum concentrations of lead, benzo(a)anthracene, phenanthrene, LPAHs, HPAHs, total PAHs, DDD and DDE.

Limited toxicity testing has been conducted with sediments collected from both Kenilworth Marsh and the Anacostia River. Significant toxicity was observed with a subset of the samples collected from both locations.

The results of this assessment suggest that exposure to COPCs in Anacostia River sediments may result in deleterious effects in benthic invertebrates.

8.3.2 FISH ASSESSMENT

The exposure of fish in the Anacostia River to COPCs was evaluated using three approaches. First, surface water contaminant concentrations were compared to AWQC. Then, tissue concentrations were compared to tissue concentrations associated with adverse impacts in freshwater fish. Finally, the exposure to PAHs was evaluated by comparing the measured sediment PAH concentrations to sediment concentrations associated with adverse effects.

In the Upper River, the maximum dissolved lead and total PCB concentrations exceeded the corresponding AWQC with HQs less than 2.

The maximum measured fish tissue concentrations in the brown bullhead and the largemouth bass exceeded the corresponding LOEC value in the Upper River, the Lower River and the Ship Channel. In addition, maximum lead tissue concentrations exceeded the corresponding LOEC in both the Upper River and the Lower River. Finally, tissue concentrations of three pesticides, dieldrin, DDD, and DDE exceeded the corresponding LOEC values in the Lower River and the Ship Channel.

Maximum sediment concentrations in all three areas exceeded the PAH sediment screening threshold value of 2 µg/g. The highest sediment PAH concentrations were measured in the lower river zone. Mean sediment total PAH concentrations in all three areas also exceeded the threshold value.

The results of this assessment suggest that fish tissue concentrations of PCBs, lead, and pesticides may indicate the potential for adverse effects due to exposure to these contaminants. Finally, sediment PAH concentrations throughout the lower Anacostia River are higher than concentrations associated with adverse effects in benthic fish.

8.3.3 AQUATIC BIRD ASSESSMENT

The exposure of aquatic birds to COPCs associated with the Anacostia River was estimated based on the assumption that the contaminant exposure was entirely through dietary exposure. The risk associated with dioxin and furan exposure to the green heron was estimated using a TEQ based approach. The estimated doses of the other COPCs to the green heron were compared to TRVs derived for the great blue heron (Sample et al. 1996).

The doses of dioxins and furans, when calculated as TEQs, for the Upper River and Lower River were higher than the corresponding NOAEL TEQ values for the green heron. However, these doses did not exceed LOAEL TEQ values.

The estimated doses of methyl mercury and total DDT to green heron in all three areas were greater than the TRV values for doses calculated either on maximum or mean fish tissue concentrations. In addition, the calculated dose of lead to green heron in the lower river based on the maximum lead concentrations exceeded the corresponding TRV. Finally, the dose of total PCBs calculated using both maximum and mean fish tissue concentrations in the Ship Channel exceeded TRV values for the green heron.

The results of this assessment suggest that dioxins and furans, lead, methyl mercury, total DDT, and PCBs are present in fish tissues within the lower Anacostia River at concentrations that may result in adverse impacts on the green heron. Some of these risk calculations are likely biased high however. For instance, methyl mercury concentrations were not available so total mercury was used as a surrogate. The diet of the great blue heron, which has a greater aquatic component than the green heron, was

applied using the smaller body weight of the green heron. Also, complete assimilation of ingested COPCs was assumed.

8.3.4 AQUATIC MAMMAL ASSESSMENT

The exposure of a mammal, the raccoon, to COPCs associated with the Anacostia River was estimated based on the assumption that the contaminant exposure was entirely through dietary exposure. The risk associated with dioxin and furan exposure to the raccoon was estimated using a TEQ based approach. The estimated doses of the other COPCs to the raccoon were compared to TRVs derived for the mink (Sample et al. 1996).

Calculated doses of total PCBs and certain trace elements for the raccoon in all three areas were greater than TRV values when the maximum tissue and sediment concentrations were used to calculate the dose. The highest HQ values were calculated for trace elements in the lower river zone. When average tissue and sediment concentrations were used to calculate the dose for the raccoon, TRV values were exceeded for certain trace elements in all three areas. The TRV for total PCBs were also exceeded using average values for the Washington Ship Channel/Tidal Basin zone. The PCB TRV was not exceeded by estimated doses based upon averages from either the upper or lower river zone.

A large range in the diet of raccoons can be found in the literature. For initial, conservative screening, a diet that emphasizes aquatic prey, especially fish, was used for estimating COPC doses. An alternative diet reported for raccoons in Maryland, for which fish comprise only 3% of the total diet, was also used to calculate alternative COPC doses. Using this alternative diet with maximum exposure estimates, TRVs for certain metals were exceeded in all three zones and the PCB TRV was exceeded only by estimated doses for the lower river zone.

The results of this assessment suggest that trace elements and PCBs associated with sediments and fish tissues may possibly be high enough within the lower Anacostia River to result in adverse effects for the raccoon. There is a fair degree of variability and uncertainty associated with this indication however. Actual use of the habitat, the specific diet of animals in the Anacostia, plus the bioavailability and assimilation efficiency of ingested COPCs are major factors which would influence the actual risk to aquatic wildlife as represented by the raccoon.

8.4 POTENTIAL SOURCES OF COPCS

As discussed in Section 2.2.5, current point sources of ongoing chemical release to the tidal river may include releases from current activity (e.g., pesticide application) as well as transport of chemicals from point sources of previous contamination (e.g., PCB migration in runoff from contaminated soil). Both above-ground and subsurface releases may occur; subsurface releases may result from, for example, leaching of BTEX from a leaking underground storage tank to groundwater followed by seepage into the river. From the information currently available, it is not possible to assign specific COPCs or chemical classes to a specific source or activity. It is also not possible from the data available, to discern point sources of a particular contaminant that also has significant non-point sources because insufficient information is available to determine if a pattern is present. However, it is possible to assign COPC chemical classes to types of activities and processes that are known to have occurred in the watershed. Whether these activities and processes actually have contributed COPCs to the tidal Anacostia River, or the extent of any contribution cannot be ascertained from the information evaluated in this assessment.

Potential local, current and/or historical, sources of release of mercury include production and disposal of alkaline batteries, electrical switches, certain types of lighting discharge tubes, and various medical devices, including thermometers, manometers and amalgam dental fillings materials. Mercury is also used in the manufacture of plastics, including vinyl chloride polymers, chlorine, and caustic soda. Historically, mercury compounds have been used as paint pigments and fungicides, and in the extraction and purification of gold Mercury is released to the air during the combustion of fossil fuels (ATSDR, 1999).

Potential local, current and/or historical, sources of release of PCBs include power utilities, which historically have used PCBs in electrical capacitors and transformers, and any other activities involving the production, installation, maintenance or removal of capacitors and transformers. The latter would include local facility power plants, including those on ships. PCBs have also been used as plasticisers, surface coatings, and inks, as pesticide extenders and in carbonless duplicating paper (ATSDR 1998).

Potential local, current and/or historical, sources of release of PAHs include incomplete combustion of fossil fuels, including automobiles, wood stoves and furnaces, and fossil fuel power plants; and transport, storage or processing of crude oil, shale oil, coal tar and other petroleum containing materials. Natural wood fires can also release PAHs to the air (ATSDR, 1990).

Potential local, current and/or historical, sources of release of CDDs include incineration of chlorine-containing materials (including plastics, wood and paper) and handling and disposal of ash from such facilities. Natural wood fires can also release CDDs to the air. CDDs can also be produced a side-product in the manufacture of chlorinated phenols (ATSDR, 1989).

Potential local, current and/or historical, sources of release of lead include copper, silver and lead smelting; combustion of leaded gasoline; leaching and transport of dust and debris from surfaces coated with lead-based paints, including older houses, bridges, ships; leachate and transport from firing ranges; and manufacture, disposal, storage or reprocessing of lead-acid batteries, electrical conduit and other products containing lead. (ATSDR, 1999).

Potential local, current and/or historical, sources of release of arsenic may include copper and lead smelting operations, arsenic-containing pesticides and wood preservatives, and leachate from older cemeteries (arsenic-containing materials were historically used as a tissue preservative). (ATSDR, 2000).

Potential sources of the various pesticides that were identified as COPCs would include commercial or residential agriculture and lawn care, and facility pest control processes.

REFERENCES FOR CHAPTER 8

ATSDR. 1998. Toxicological profile for polychlorinated biphenyls (PCBs). Atlanta, GA: U.S. Department of Health & Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry.

ATSDR. 1989. Toxicological profile for 2,3,7,8-tetra dibenzo-p-dioxins (TCDDs). Atlanta, GA: U.S. Department of Health & Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry.

ATSDR. 1990. Toxicological profile for polycyclic aromatic hydrocarbons (PAHs). Atlanta, GA: U.S. Department of Health & Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry.

ATSDR. 2000. Toxicological profile for arsenic. Agency for Toxic Substances and Disease Registry. Atlanta, GA.

ATSDR. 1999. Toxicological profile for lead. Agency for Toxic Substances and Disease Registry. Atlanta, GA.

ATSDR. 1999. Toxicological Profile for Mercury. Atlanta, GA: Agency for Toxic Substances and Disease Registry, Public Health Service, U.S. Department of Health and Human Services.

9. RECOMMENDATION FOR FUTURE ACTION

Data gaps identified in Section 8 are considered here in terms of possible targets for future activities in Phase II of a risk characterization of the tidal Anacostia River. Specific requirements for data collection are not provided, and would be developed in the scoping of Phase II activities.

9.1 CONCEPTUAL SITE MODEL AND PREDICTIVE MODEL OF SITE CONTAMINATION AND HUMAN HEALTH RISKS

The ultimate goal of the risk assessment process is to achieve a sufficiently detailed understanding of the tidal Anacostia River so that 1) current ecological and human health risks can be reliably estimated; and 2) changes in risk that may attend remediation strategies can be predicted with sufficient confidence to support risk management decisions. The latter goal demands the development, validation, and calibration of hydrodynamic and a sediment transport models that will accurately simulate the physical and chemical processes that contribute to transport of COPCs in the river and associated environmental media. Such models need to be developed to the point where they can support estimation of contaminant mass fluxes. This will require a more complete understanding of transport mechanisms for affected media, and accurate estimates of contaminant loadings.

At this time, the available data and information fall short of what is needed to achieve these objectives, in part because they do not adequately address the dynamic nature of the tidal Anacostia River. Major data gaps have been summarized in Section 8 and elsewhere in this report and will not be reiterated in detail here; however, the important limitations of the available data, in terms of estimating and predicting risks, are as follows:

- Spatial and temporal profiles of the chemical concentrations in the sediment and water column have not been sufficiently characterized to identify chemicals of concern or to estimate exposure concentrations of these chemicals.

- Chemical inputs from major point sources (including aerial sources) and from non-point sources (including ground water) have not been adequately identified, characterized and quantified to support quantitative models of loadings to the river.

- The spatial distribution, magnitude and mobility of historical contamination of sediments and ground water are not sufficiently understood to model their contribution to contamination of surficial sediments or the water column.

- The hydrodynamics and sediment transport in the river are not understood sufficiently to enable predictions of contaminant concentration profiles over the length of the river, or to identify future high impact areas and estimate associated concentrations. This limitation is particularly relevant to

extreme (high and low) flow conditions and disturbances that might be imposed on the river as part of remediation or other modifications to the river (e.g., dredging).

- Spatial and temporal patterns of human uses of the river, including shoreline fishing, boat fishing, boating, sailing, waterskiing, wading, swimming, picnicking (etc.) at the tidal Anacostia river have not been sufficiently characterized to ensure that all potential human receptors are considered in risk estimates, or to estimate values for exposure factors for potential exposure scenarios.

Based on the above considerations, a long-term, multi-year sampling program is recommended for satisfying the data needs for risk characterization as well as predictive modeling of the river. Such efforts could be considered as targets for data collection in a second phase of this risk assessment. Ideally, this program should have the following major features:

- Sediment and water sampling should include target areas of the river immediately downstream from major inflows and suspected point sources or inputs from non-point sources (e.g., sewer pipes and flood channels), as well as those areas of the tidal river where particulate deposition is demonstrably greatest.

- The sediment sampling design should use a stratified random or adaptive sampling approach to support unbiased parameter estimates of exposure concentrations (e.g., mean and confidence limits). The design should ensure collection of adequate numbers of samples and eliminate or account for sampling bias (temporal, spatial, nonrandomness) that might affect the parameter estimates.

- Surface water samples should be collected during extreme (high and low) flow conditions and during disturbances of the sediment by other anticipated human activities (e.g. dredging).

- Water flows and channel volumes should be determined over a sufficient geographic and temporal scale to support the development of a hydrodynamic model of both the “average” long-term behavior of the river and the behavior of the river during extreme events (e.g., storms, drought).

- A model calibration data set should be collected. This would include sediment and water column concentrations of representative chemicals at various locations in the river, including predicted high impact areas, at various times, including during and after extreme events (e.g. storms).

- Surveys of human uses of the tidal river area should be conducted throughout at least one annual cycle.

Future sampling efforts in the Anacostia watershed by AWTA members and other organizations should be coordinated to avoid duplication of effort.

The above sampling program would provide data to satisfy both the requirements for estimating current human health risks and the requirements for model development and calibration. The development of a preliminary model early in the sampling program would be highly desirable, as the model may identify other important data collection needs. Progress towards developing hydrodynamic and sediment transport

models of the tidal Anacostia River may benefit from earlier and on-going efforts. For example, a one-dimensional hydrodynamic model was developed in 1988 as a component of the Tidal Anacostia Model (TAM), which has been used in several past efforts to study dissolved oxygen levels in the river. This includes the District of Columbia's Total Maximum Daily Load (TMDL) program which models for dissolved oxygen, fecal coliforms, and suspended solids and which incorporates the hydrodynamic component of TAM, and modified versions of the U.S. EPA's Water Quality Analysis Simulation Program (WASP). The TAM/WASP model for suspended solids also incorporates algorithms for simulating the deposition and re-suspension of sediments from the U.S. EPA's HSPF (Hydrologic Simulation Program FORTRAN) model. The major inputs to the TAM hydrodynamic model include estimates of daily flows from the NE and NW Branches, CSO's, tributaries, and storm sewers, hourly tidal heights at the downstream boundary of the model (confluence with the Potomac), and model segment geometry, including tidally-averaged depths and cross-sectional areas of the sixteen model transects.

9.2 SPECIFIC IMPROVEMENTS AND ENHANCEMENTS TO DATA COLLECTION EFFORTS

In addition to the above more general recommendations, specific recommendations regarding data collection approaches that would greatly enhance the value of any additional data that is collected, in terms of its use in human health risk screening or risk estimation, include the following:

Compositing of samples and sampling design.

- Some of the sediment and fish tissue chemical concentrations in the database were determined from the analysis of grab samples while others were determined from composite samples. While composite samples are useful for determining average concentrations of chemicals, some information on the variability of the chemical concentration is lost. With respect to sediment samples, information on concentration variability for individual grab samples is useful for identifying areas of high contamination (i.e., hot spots), mapping chemical concentrations and predicting concentrations in unsampled locations. Accurate estimates of the variability of chemical concentrations are particularly important if the concentration data will be used to develop hydrodynamic models of the watershed. Underestimating the variability of measured or predicted chemical concentrations will tend to overestimate the precision in model predictions, thereby underestimating the uncertainty in decisions that are based on those model predictions.
- An issue related to sample compositing is the relationship between sample size and the variance of measured concentrations. The sampling plan design to support risk estimates should consider the interactions between sample volume and the variability of the measured concentrations. As the sample volume increases, the variance of the measured concentrations will tend to decrease. The relationship between sample volume and variance effects not only the reasonable maximum exposure concentration used in risk assessment but also decisions made during the remedial investigation and remedial design phases. For this reason it is important that the sampling plan design specify sample sizes that are appropriate for the data quality objectives (DQOs) developed for a site.

Sediment. As noted in Section 8, approximately 73% of the data on the concentration of chemicals in sediment was collected prior to 1996. Additional sediment samples should be collected throughout the Anacostia River to update the information contained in the database. Detailed suggestions for additional sediment sampling efforts are as follows:

- Collect additional sediment samples in the upper Anacostia (north of the Pennsylvania Avenue Bridge); analyze for the seven chemical classes: ABNs, dioxins, furans, metals, PAHs, total PCBs, PCB Aroclors and pesticides.

- Characterize the spatial distribution of total PCBs and PCB Aroclors in the lower as well as the upper Anacostia.
- Characterize the spatial distribution of the concentration of dioxins and furans in Anacostia River sediment.

- Collect additional samples in areas with apparently high detection rates that were sparsely sampled: Kenilworth Marsh (ABNs, total PCBs, PCB Aroclors) and the Anacostia River channel north of the Pennsylvania Ave. Bridge (ABNs, metals).
- Characterize the bioavailability and risk of sediment contamination through toxicity testing concurrent with chemical analysis at sufficient spatial scale to characterize areas of elevated risk.

- Identify major sediment deposits and probe for depth estimates. Collect core samples to evaluate sediment types and sediment coring techniques required for sampling large-scale sampling.
- Analyze of sediment transport to identify potential depositional, scour, and source areas in order to provide a sound basis for interim and final remedial decisions, including possible recontamination issues.

Fish tissue. Approximately 95% of the data on the concentration of chemicals in fish tissue was collected between 1989–1995. Additional fish tissue samples should be collected throughout the Anacostia River to update the information contained in the database. Based on the data gaps identified in Section 8, the following recommendations for additional fish tissue sampling efforts are provided:

- Future sampling efforts should ensure that an adequate quantity of fish tissue samples are collected north of Watts Branch; additional data are needed on the concentration of chemicals in fish tissue samples for all the chemical classes previously defined.

- Individual samples should be collected and analyzed so the variability of chemical concentrations in fish tissue can be characterized.

- The coordinates of the fish sampling locations should be provided so spatial analyses of the data can be performed as part of the risk assessment.

- In order to refine the relationships between tissue residue levels with both observed impacts and sediment contamination, more detailed information on the migratory habits of selected species should be developed.

Surface water. The data on chemical concentrations in Anacostia River water were collected over an approximately 10-month period in 1998. Additional data should be collected to determine the spatial and temporal distribution of chemicals in the Anacostia River. Based on the data gaps identified in Section 8, additional recommendations are:

- The concentration of dioxins, furans and PAHs in surface water should be determined.

- Additional data should be collected to determine the concentration of chemicals at surface water sampling stations located north of the Independence Ave Bridge.

- Additional data should be collected to determine the concentration of ABNs and PCBs in surface water throughout the tidal Anacostia River.

- Additional data on particulate-bound and dissolved contaminant concentrations should be collected from an array of sampling stations, at various depths and at regular time intervals to characterize spatial and temporal trends. The collection of additional data on general water quality parameters such as TSS, pH, eH (redox potential), particulate and dissolved organic carbon, dissolved oxygen and temperature, should be coordinated with the collection of data on contaminant concentrations and river hydrodynamics to support the development of a hydrodynamic model of the river.

Background chemical concentrations. Data on naturally occurring and local background concentrations of inorganic chemicals in each media (i.e., surface water, sediment, fish tissue) should be collected..

Chemical loadings. The following specific types of information are needed:

- Flow rates from tributaries and point discharges, including CSOs, should be quantified.

- First-flush and peak fluvial chemical loadings from tributaries to the tidal Anacostia during storm events should be quantified.

- A detailed historical and geographic assessment of the identity, activities, and location of industrial, government, military, and research facilities in the watershed would be useful for identifying potential locations of uncharacterized (i.e., unreported and/or unpermitted) discharges to the tidal Anacostia, its tributaries, or adjacent groundwater, and for locating additional advisable surface water and ground water sampling locations.

- Chemical composition, quantity of emissions, and particulate deposition patterns from known aerial point sources should be determined in order to assess the potential contribution of aerially deposited particles to chemical contamination in the tidal Anacostia River.

- Potential loadings from ground water should be quantified.

- A detailed historical and geographic assessment of the identity, activities, and location of industrial, government, military, and research facilities in the watershed would be useful for identifying potential locations of uncharacterized (i.e., unreported and/or unpermitted) discharges to the tidal Anacostia, its tributaries, or adjacent groundwater, and for locating additional advisable surface water and ground water sampling locations.

- A detailed historical review of the frequency and extent of dredging deep tidal river sediments would be useful for identifying impacted areas and targeting sampling.

Hydrodynamics and sediment transport. The following information is needed to support predictive modeling of exposure concentrations:

- Rates and amounts of exchange of surface water and sediment between the Potomac and Anacostia Rivers during tidal flux.

- Rates and amounts of exchange of ground water and surface water within the tidal Anacostia River.

- Water flows and channel volumes should be determined over a sufficient geographic and temporal scale to support the development of a hydrodynamic model of both the "average" long-term behavior of the river and the behavior of the river during extreme events (e.g., storms, drought).

- Depositional patterns of sediments transported into the tidal Anacostia from tributaries, including the Northeast and Northwest branches, during and between storm events.

- Deposition of sediments on the floodplain, particularly within Kenilworth Marsh and Kingman Lake, during large flow events

- Conditions under which deposited sediments are resuspended and transported, and the relative importance of this mechanism for transport of chemical contaminants.

- Particulate deposition on the floodplain during storm events or during spring snow melt in areas of the tidal Anacostia and tributaries that have not yet been channeled.

- Partitioning of COPCs between sediment and surface water

- Degradation rates or environmental half-times of COPCs

Potential receptors and behavior. The following specific types of information are needed to characterize receptors and exposures to receptors:

- Spatial and temporal patterns of human use of the river channel and shoreline are needed. For example, estimates of site-specific estimates of seasonal consumption of locally harvested fish are needed (amounts and species) are needed. Estimates of the frequency and types of shoreline uses of the river are needed.
- Bioavailability and bioaccumulation potential to environmental receptors should be characterized in such a manner as to identify source areas. This might be accomplished through in situ deployment of caged organisms or semi-permeable membrane devices. This would complement loading information by indicating whether and where contaminants released are bioavailable, plus provide information on the relative importance of different types of sources.
- Larval anadromous fish originating from spawning and nursery grounds throughout the Anacostia watershed may be at risk to exposure to contamination during outmigration. The success of planned restocking/restoration efforts for certain anadromous species may be compromised if the viability of outmigrating larvae is severely diminished. This potential risk might be estimated by either in situ or laboratory toxicity tests. In situ testing could also be designed to integrate cumulative, individual exposure episodes and thus provide a more complete estimation of risk.

9.3 IMPROVEMENTS TO THE EXISTING DATABASE.

If the existing data are to be used to estimate human health risks, a thorough review of the quality of the historic analytical data are needed. This review should include the verification and reporting of detection and/or sample quantification limits on all analytical results so that appropriate surrogate values can be assigned to reported non-detects. This will be needed to estimate parameters of the exposure concentrations (e.g., mean and confidence limits).

APPENDIX A - TABLES

Table A5-1. Descriptive Statistics for Chemicals in tidal Anacostia Sediment (sorted by chemical name)

CAS No.	CHEMNAME	Count	Det Freq	Min (ppm)	Max (ppm)	Avg (ppm)	Std Dev
83329	Acenaphthene	45	39 / 45	8.53E-03	2.20E+01	1.79E+00	4.71E+00
208968	Acenaphthylene	45	34 / 45	4.23E-03	2.90E+00	4.76E-01	7.24E-01
67641	Acetone	22	11 / 22	1.20E-02	2.90E-01	8.00E-02	8.25E-02
309002	Aldrin	42	15 / 42	4.00E-05	4.90E-02	9.03E-03	1.11E-02
7429905	Aluminum	34	33 / 34	1.01E+03	9.47E+04	1.17E+04	1.57E+04
120127	Anthracene	45	36 / 45	1.97E-02	5.80E+00	6.87E-01	1.26E+00
7440360	Antimony	23	3 / 23	4.80E-01	5.50E+00	2.14E+00	1.76E+00
12674112	Aroclor 1016	14		4.40E-02	4.90E-01	1.69E-01	1.33E-01
11104282	Aroclor 1221	14		8.90E-02	4.90E-01	2.10E-01	1.11E-01
11141165	Aroclor 1232	14		4.40E-02	4.90E-01	1.69E-01	1.33E-01
53469219	Aroclor 1242	16		4.40E-02	4.90E-01	1.54E-01	1.30E-01
12672296	Aroclor 1248	16		4.40E-02	4.90E-01	1.54E-01	1.30E-01
11097691	Aroclor 1254	25	11 / 25	4.40E-02	1.63E+00	4.42E-01	4.16E-01
11096825	Aroclor 1260	25	15 / 25	1.80E-03	1.20E+01	6.64E-01	2.38E+00
7440382	Arsenic	34	33 / 34	1.30E+00	2.69E+01	6.23E+00	4.30E+00
111444	Bis(2chloroethyl)ether	22		3.80E-01	2.30E+00	7.02E-01	4.10E-01
39638329	Bis(2chloroisopropyl) ether	8		4.50E-01	6.60E-01	5.09E-01	8.03E-02
117817	Bis(2ethylhexyl) phthalate	22	20 / 22	7.10E-02	7.20E+00	2.02E+00	2.04E+00
56553	Benz(a)anthracene	45	44 / 45	6.80E-02	1.60E+01	1.85E+00	3.17E+00
53703	Dibenz(a,h)anthracene	45	37 / 45	2.80E-02	6.90E+00	6.12E-01	1.20E+00
50328	Benzo(a)pyrene	45	44 / 45	6.90E-02	2.70E+01	2.52E+00	5.17E+00
7440393	Barium	33	33 / 33	3.19E+01	1.70E+02	1.12E+02	3.45E+01
205992	Benzo(b)fluoranthene	44	41 / 44	1.20E-01	9.20E+00	1.60E+00	2.07E+00
	Benzo(b,k)fluoranthene	1	1 / 1	5.37E-01	5.37E-01	5.37E-01	
111911	Bis(2chloroethoxy)methane	22		3.80E-01	2.30E+00	6.76E-01	4.20E-01
71432	Benzene	22	1 / 22	6.00E-04	1.50E-02	7.25E-03	5.43E-03
65850	Benzoic acid	13		2.00E+00	2.20E+01	1.14E+01	7.49E+00
100516	Benzyl alcohol	20		4.10E-01	4.30E+00	1.85E+00	1.35E+00
192972	Benzo(e)pyrene	23	23 / 23	1.26E-01	7.63E-01	4.28E-01	1.73E-01
7440417	Beryllium	33	30 / 33	3.10E-01	3.07E+00	1.31E+00	6.88E-01
191242	Benzo(g,h,i)perylene	45	39 / 45	8.00E-02	1.30E+01	1.28E+00	2.33E+00
92524	Biphenyl	23	15 / 23	1.41E-03	4.69E-02	1.59E-02	8.89E-03
207089	Benzo(k)fluoranthene	45	41 / 45	9.30E-02	9.50E+00	1.38E+00	1.98E+00
7440428	Boron	11	11 / 11	1.60E+01	3.58E+01	2.27E+01	5.30E+00
101553	4Bromophenyl phenyl ether	22		3.80E-01	2.30E+00	9.71E-01	4.81E-01

Table A5-1. Descriptive Statistics for Chemicals in tidal Anacostia Sediment (sorted by chemical name)

CAS No.	CHEMNAME	Count	Det Freq	Min (ppm)	Max (ppm)	Avg (ppm)	Std Dev
124481	Dibromochloromethane	22		2.00E-04	1.50E-02	6.91E-03	5.77E-03
74839	Bromomethane	22		6.00E-04	3.00E-02	1.27E-02	1.10E-02
75252	Bromoform	22		1.00E-04	1.50E-02	6.86E-03	5.83E-03
78933	2Butanone	22	6 / 22	1.60E-03	7.20E-02	2.35E-02	1.69E-02
85687	Butylbenzyl phthalate	22	3 / 22	1.00E-01	2.30E+00	6.77E-01	4.47E-01
156592	cis1,2Dichlorethene	8		4.00E-04	6.00E-04	4.63E-04	9.16E-05
10061015	cis1,3Dichloropropene	22		4.00E-04	1.50E-02	6.98E-03	5.69E-03
7440439	Cadmium	54	47 / 54	2.80E-01	3.18E+00	1.60E+00	6.16E-01
7440702	Calcium	22	22 / 22	2.09E+03	2.18E+05	1.61E+04	4.56E+04
86748	Carbazole	2		3.80E-01	4.00E-01	3.90E-01	1.41E-02
56235	Carbon tetrachloride	22		5.00E-04	1.50E-02	7.02E-03	5.64E-03
5103742	Transchlordane	14	14 / 14	7.16E-03	8.05E-02	2.88E-02	2.29E-02
27304138	Oxychlordane	30	14 / 30	7.30E-04	1.74E-02	6.07E-03	5.30E-03
5103719	Chlordane alpha	45	31 / 45	2.02E-03	4.90E-01	6.42E-02	1.00E-01
5566347	Chlordane gamma	44	30 / 44	2.30E-03	4.90E-01	7.03E-02	9.98E-02
67663	Chloroform	22		5.00E-04	1.50E-02	7.03E-03	5.63E-03
2921882	Chlorpyrifos	2	2 / 2	1.06E-03	2.76E-03	1.91E-03	1.20E-03
	Chromium, total	47	47 / 47	6.90E-02	1.23E+02	3.44E+01	2.96E+01
218019	Chrysene	45	44 / 45	8.10E-02	1.60E+01	2.17E+00	3.34E+00
319846	Hexachlorocyclohexanealpha	44	6 / 44	5.00E-05	4.90E-02	8.69E-03	1.18E-02
319857	Hexachlorocyclohexanebeta	44	7 / 44	1.00E-04	4.90E-02	8.54E-03	1.18E-02
319868	Hexachlorocyclohexanedelta	44	5 / 44	5.00E-05	4.90E-02	9.02E-03	1.22E-02
58899	Hexachlorocyclohexanegamma (Lindane)	44	8 / 44	9.00E-05	4.90E-02	7.98E-03	1.18E-02
59507	4Chloro3methylphenol	22		3.80E-01	2.30E+00	7.72E-01	3.98E-01
106478	4Chloroaniline	22		3.80E-01	4.30E+00	1.72E+00	1.36E+00
108907	Chlorobenzene	22	3 / 22	3.00E-04	2.00E-02	8.01E-03	5.96E-03
95501	1,2Dichlorobenzene	22		3.80E-01	2.40E+00	1.17E+00	6.73E-01
120821	1,2,4Trichlorobenzene	22	1 / 22	3.80E-01	2.30E+00	8.25E-01	4.08E-01
541731	1,3Dichlorobenzene	22		3.80E-01	2.30E+00	1.02E+00	5.17E-01
106467	1,4Dichlorobenzene	22		3.80E-01	2.30E+00	1.01E+00	5.13E-01
608935	Pentachlorobenzene	6	5 / 6	1.20E-04	7.50E-04	4.73E-04	2.19E-04
118741	Hexachlorobenzene (HCB)	52	10 / 52	4.00E-05	2.30E+00	3.79E-01	4.68E-01
75274	Bromodichloromethane	22		4.00E-04	1.50E-02	7.01E-03	5.65E-03
87683	Hexachlorobutadiene	22		3.80E-01	2.30E+00	9.16E-01	4.46E-01
	1,2,4,4 Tetrachlorobenzene	6	6 / 6	3.60E-04	1.79E-03	1.04E-03	4.61E-04

Table A5-1. Descriptive Statistics for Chemicals in tidal Anacostia Sediment (sorted by chemical name)

CAS No.	CHEMNAME	Count	Det Freq	Min (ppm)	Max (ppm)	Avg (ppm)	Std Dev
95943	1,2,4,5Tetrachlorobenzene	6	6 / 6	3.80E-04	3.11E-03	1.97E-03	1.07E-03
91941	3,3'Dichlorobenzidine	22		3.80E-01	8.70E+00	3.07E+00	2.92E+00
77474	Hexachlorocyclopentadiene	22		3.80E-01	2.30E+00	9.16E-01	4.46E-01
79345	1,1,2,2Tetrachloroethane	22		3.00E-04	1.50E-02	6.96E-03	5.71E-03
75003	Chloroethane	22		8.00E-04	3.00E-02	1.28E-02	1.09E-02
75343	1,1Dichloroethane	22		5.00E-04	1.50E-02	7.02E-03	5.64E-03
71556	1,1,1Trichloroethane	22		5.00E-04	1.50E-02	7.02E-03	5.64E-03
79005	1,1,2Trichloroethane	22		4.00E-04	1.50E-02	6.98E-03	5.69E-03
107062	1,2Dichloroethane	22		3.00E-04	1.50E-02	6.97E-03	5.70E-03
67721	Hexachloroethane	22		3.80E-01	2.30E+00	9.48E-01	4.66E-01
75354	1,1Dichloroethene	22		1.00E-03	1.50E-02	7.22E-03	5.41E-03
540590	1,2Dichloroethene	14		6.00E-03	1.50E-02	1.07E-02	3.31E-03
79016	Trichloroethene	22		1.20E-03	1.50E-02	7.33E-03	5.28E-03
127184	Tetrachloroethylene	8		6.00E-04	8.00E-04	6.50E-04	9.26E-05
110758	2Chloroethylvinyl ether	8		6.00E-04	9.00E-04	6.75E-04	1.16E-04
74873	Chloromethane	22		1.10E-03	3.00E-02	1.30E-02	1.07E-02
91587	2Chloronaphthalene	22		3.80E-01	2.30E+00	8.14E-01	4.00E-01
95578	2Chlorophenol	22		3.80E-01	2.30E+00	9.85E-01	4.91E-01
120832	2,4Dichlorophenol	22		3.80E-01	2.30E+00	8.66E-01	4.17E-01
95954	2,4,5Trichlorophenol	22		9.30E-01	5.90E+00	1.94E+00	1.18E+00
88062	2,4,6Trichlorophenol	22		3.80E-01	2.30E+00	8.95E-01	4.31E-01
87865	Pentachlorophenol	22		9.30E-01	5.90E+00	2.30E+00	1.00E+00
78875	1,2Dichloropropane	22		5.00E-04	1.50E-02	7.05E-03	5.61E-03
7440484	Cobalt	22	21 / 22	2.60E+00	2.26E+01	1.31E+01	5.86E+00
7440508	Copper	47	47 / 47	1.62E+01	6.31E+02	8.97E+01	9.70E+01
7005723	4Chlorophenyl phenyl ether	22		3.40E-01	2.30E+00	6.36E-01	4.40E-01
75150	Carbon disulfide	22		8.00E-04	1.50E-02	7.13E-03	5.51E-03
57125	Cyanide	22	3 / 22	5.80E-01	4.88E+01	5.65E+00	1.22E+01
84662	Diethyl phthalate	22		3.80E-01	2.30E+00	6.94E-01	4.12E-01
132649	Dibenzofuran	23	14 / 23	4.37E-02	4.30E+00	1.05E+00	1.20E+00
132650	Dibenzothiophene	22	21 / 22	9.69E-03	1.04E-01	3.52E-02	2.07E-02
1002535	Dibutyl tin	1	1 / 1	5.00E-03	5.00E-03	5.00E-03	
115322	Dicofol	6	6 / 6	1.60E-04	4.28E-03	1.71E-03	1.43E-03
60571	Dieldrin	45	25 / 45	4.00E-05	9.90E-02	1.10E-02	2.08E-02
84742	Dinbutyl phthalate	22	3 / 22	1.30E-01	2.30E+00	9.20E-01	5.05E-01
131113	Dimethyl phthalate	22	1 / 22	8.20E-02	2.30E+00	6.31E-01	4.49E-01

Table A5-1. Descriptive Statistics for Chemicals in tidal Anacostia Sediment (sorted by chemical name)

CAS No.	CHEMNAME	Count	Det Freq	Min (ppm)	Max (ppm)	Avg (ppm)	Std Dev
534521	4,6dinitro2methylphenol	22		9.30E-01	5.90E+00	2.53E+00	1.01E+00
51285	2,4dinitrophenol	8		1.40E+00	2.10E+00	1.60E+00	2.56E-01
959988	Endosulfanalpha	14		2.30E-03	4.90E-02	1.49E-02	1.47E-02
33213659	Endosulfanbeta	20	2 / 20	7.80E-04	9.90E-02	2.65E-02	2.89E-02
1031078	Endosulfan sulfate	14		4.40E-03	9.90E-02	2.97E-02	2.96E-02
72208	Endrin	44	8 / 44	1.00E-05	9.90E-02	1.48E-02	2.36E-02
7421934	Endrin aldehyde	7		4.40E-03	1.00E-02	8.00E-03	2.43E-03
53494705	Endrin ketone	14		4.40E-03	9.90E-02	2.97E-02	2.96E-02
100414	Ethylbenzene	22	2 / 22	9.00E-04	1.50E-02	7.65E-03	5.18E-03
206440	Fluoranthene	45	45 / 45	1.30E-01	3.20E+01	4.01E+00	6.69E+00
86737	Fluorene	45	40 / 45	9.86E-03	1.40E+01	1.29E+00	2.98E+00
1024573	Heptachlor epoxide	44	4 / 44	1.00E-04	4.90E-02	9.13E-03	1.21E-02
76448	Heptachlor (pesticide)	42	9 / 42	5.00E-05	4.90E-02	7.69E-03	1.16E-02
591786	2Hexanone	22	1 / 22	8.00E-04	3.00E-02	1.29E-02	1.08E-02
26601649	Hexachlorobiphenyl	1	1 / 1	1.50E-04	1.50E-04	1.50E-04	
193395	Indeno(1,2,3c,d)pyrene	45	42 / 45	6.90E-02	6.30E+00	9.23E-01	1.26E+00
7439896	Iron	54	54 / 54	5.09E+03	5.82E+04	3.09E+04	1.31E+04
78591	Isophorone	22		3.80E-01	2.30E+00	6.70E-01	4.23E-01
7439921	Lead	54	54 / 54	3.90E+01	7.75E+02	1.84E+02	1.38E+02
108101	4Methyl2pentanone	22	1 / 22	5.00E-04	3.00E-02	1.35E-02	1.07E-02
7439954	Magnesium	33	33 / 33	1.05E+03	1.31E+04	3.36E+03	1.99E+03
7439965	Manganese	34	34 / 34	1.00E+02	8.00E+02	4.47E+02	1.82E+02
2245387	1,6,7Trimethylnaphthalene	9	9 / 9	5.39E-02	2.60E-01	1.52E-01	7.67E-02
7439976	Mercury	54	46 / 54	1.00E-01	2.70E+00	3.67E-01	3.85E-01
28804888	Dimethylnaphthalene	13	13 / 13	1.24E-02	4.83E-01	7.75E-02	1.24E-01
90120	1Methylnaphthalene	23	22 / 23	4.23E-03	9.80E-02	3.40E-02	2.03E-02
91576	2Methylnaphthalene	45	32 / 45	9.86E-03	1.80E+01	1.19E+00	2.92E+00
28652779	Trimethylnaphthalene	13	13 / 13	1.17E-02	4.66E-01	6.80E-02	1.21E-01
72435	Methoxychlor	14		2.30E-02	4.90E-01	1.49E-01	1.47E-01
75092	Methylene chloride	22	6 / 22	2.10E-03	8.40E-02	1.20E-02	1.71E-02
581420	2,6Dimethylnaphthalene	10	10 / 10	8.45E-03	1.45E-01	8.45E-02	4.13E-02
832699	1Methylphenanthrene	23	23 / 23	2.51E-02	2.70E-01	8.42E-02	5.52E-02
95487	2Methylphenol	22		3.80E-01	4.30E+00	1.72E+00	1.36E+00
106445	4Methylphenol	22		3.80E-01	4.30E+00	1.72E+00	1.36E+00
2385855	Mirex (pesticide = dechlorane)	30	9 / 30	1.60E-04	1.72E-02	3.12E-03	4.80E-03
	Monobutyl tin	1		1.00E-02	1.00E-02	1.00E-02	

Table A5-1. Descriptive Statistics for Chemicals in tidal Anacostia Sediment (sorted by chemical name)

CAS No.	CHEMNAME	Count	Det Freq	Min (ppm)	Max (ppm)	Avg (ppm)	Std Dev
7439987	Molybdenum	11		5.00E+00	5.05E+00	5.01E+00	1.68E-02
105679	2,4Dimethylphenol	22		3.80E-01	2.80E+00	1.28E+00	8.09E-01
2245387	2,3,5Trimethylnaphthalene	1	1 / 1	7.05E-03	7.05E-03	7.05E-03	
88744	2Nitroaniline	22		9.30E-01	2.20E+01	7.68E+00	7.34E+00
99092	3Nitroaniline	22		9.30E-01	2.20E+01	7.68E+00	7.34E+00
100016	4Nitroaniline	22		9.30E-01	2.20E+01	7.68E+00	7.34E+00
91203	Naphthalene	45	33 / 45	1.41E-02	6.90E+00	6.73E-01	1.33E+00
98953	Nitrobenzene	22		3.80E-01	2.30E+00	8.40E-01	4.07E-01
7440020	Nickel	34	34 / 34	1.32E+01	6.97E+01	3.56E+01	1.14E+01
621647	NnitrosodiNpropylamine	22		3.80E-01	2.30E+00	7.26E-01	4.03E-01
86306	Nnitrosodiphenylamine	22		3.80E-01	2.30E+00	8.89E-01	4.29E-01
117840	DiNoctyl phthalate	22	5 / 22	9.30E-02	2.30E+00	8.13E-01	6.28E-01
39765805	Trans nonachlor	31	31 / 31	7.90E-04	3.94E-02	2.10E-02	1.21E-02
5103731	cisNonachlor	17	15 / 17	1.54E-03	2.06E-02	1.26E-02	5.55E-03
88755	2Nitrophenol	22		3.80E-01	2.30E+00	1.03E+00	5.37E-01
100027	4Nitrophenol	22		9.30E-01	2.20E+01	7.68E+00	7.34E+00
51285	2,4Dinitrophenol	14		9.30E-01	5.90E+00	2.43E+00	1.23E+00
121142	2,4Dinitrotoluene	22		3.30E-01	2.30E+00	6.35E-01	4.41E-01
606202	2,6Dinitrotoluene	22		3.00E-01	2.30E+00	6.21E-01	4.50E-01
95476	Xylene, ortho	8	2 / 8	5.00E-04	1.40E-02	2.60E-03	4.70E-03
53190	o,p'DDD	30	26 / 30	6.90E-04	1.97E-02	6.81E-03	5.40E-03
3424826	o,p'DDE	30	10 / 30	8.00E-05	1.72E-02	2.94E-03	4.72E-03
789026	o,p'DDT	30	19 / 30	5.20E-04	1.72E-02	4.56E-03	4.54E-03
108601	2,2'Oxybis(1chloropropane)	14		3.80E-01	2.30E+00	7.83E-01	4.98E-01
1336363	PCBS, total	45	33 / 45	3.40E-02	1.20E+01	8.03E-01	1.76E+00
1825214	Pentachloroanisole	6	6 / 6	2.50E-04	1.08E-03	6.58E-04	2.90E-04
198550	Perylene	23	23 / 23	5.07E-02	6.33E-01	2.25E-01	1.47E-01
85018	Phenanthrene	45	44 / 45	8.30E-02	4.20E+01	4.65E+00	9.46E+00
108952	Phenol	22	4 / 22	2.70E-01	2.30E+00	6.90E-01	4.33E-01
7440097	Potassium	22	22 / 22	1.52E+02	2.40E+03	1.02E+03	6.51E+02
72548	p,p'DDD	44	29 / 44	4.00E-04	9.90E-02	3.10E-02	2.39E-02
72559	p,p'DDE	45	30 / 45	3.91E-03	9.90E-02	2.71E-02	2.00E-02
50293	p,p'DDT	44	20 / 44	3.70E-04	9.90E-02	1.40E-02	2.17E-02
129000	Pyrene	45	45 / 45	1.10E-01	3.60E+01	4.39E+00	8.08E+00
7782492	Selenium	34	2 / 34	2.40E-01	1.80E+00	1.01E+00	4.85E-01
7440224	Silver	23	14 / 23	5.10E-01	6.44E+01	4.50E+00	1.31E+01

Table A5-1. Descriptive Statistics for Chemicals in tidal Anacostia Sediment (sorted by chemical name)

CAS No.	CHEMNAME	Count	Det Freq	Min (ppm)	Max (ppm)	Avg (ppm)	Std Dev
7440235	Sodium	22	22 / 22	5.35E+01	1.69E+03	3.00E+02	3.34E+02
7440246	Strontium	11	11 / 11	9.43E+00	2.17E+01	1.54E+01	3.58E+00
100425	Styrene	22	1 / 22	4.00E-04	1.50E-02	7.19E-03	5.51E-03
156605	Trans1,2Dichloroethene	8		8.00E-04	1.20E-03	9.00E-04	1.60E-04
10061026	trans1,3Dichloropropene	22		4.00E-04	1.50E-02	6.97E-03	5.70E-03
20763886	Tributyl tin	1	1 / 1	1.00E-02	1.00E-02	1.00E-02	
127184	Tetrachlorethene	14		6.00E-03	1.50E-02	1.07E-02	3.31E-03
7440280	Thallium	22		4.60E-01	3.60E+00	1.68E+00	1.07E+00
7440315	Tin	1	1 / 1	8.64E+00	8.64E+00	8.64E+00	
108883	Toluene	22	4 / 22	5.00E-04	1.80E-02	8.21E-03	5.69E-03
	Total chlordane (alpha+cis+oxy+trans)	25	25 / 25	9.33E-03	2.26E-01	1.19E-01	6.02E-02
8001352	Toxaphene	16		4.96E-02	9.90E-01	4.13E-01	2.45E-01
7440622	Vanadium	33	33 / 33	6.90E+00	6.81E+01	3.93E+01	1.64E+01
108054	Vinyl acetate	8		1.40E-03	2.10E-03	1.64E-03	2.62E-04
75014	Vinyl chloride	22		8.00E-04	3.00E-02	1.28E-02	1.09E-02
1330207	Xylenes, total	14	1 / 14	6.00E-03	1.50E-02	1.05E-02	3.52E-03
7440666	Zinc	54	54 / 54	4.56E+01	5.12E+02	3.01E+02	1.19E+02

This table includes analytes that were omitted from the count of total analytes reported in Sections 5.2 and 6.2.5–6.2.8 (to avoid redundancy); therefore, the number of analytes in this table will differ from those reported in the aforementioned sections. Blanks in the *Det Frequency* column indicate the chemical was not detected in any of the samples. Averages and standard deviations were calculated with non-detects assigned values provided in the concentration field of the NOAA (2000) database. The averages and standard deviations do not include records where negative concentrations were assigned as missing data values to indicate detection limits that were unknown. CHEMNAME refers to the name code in the database; Det Freq, detection frequency (number of detects/number of samples); Min, minimum concentration; Max, maximum concentration; Mean, arithmetic mean; Std Dev, standard deviation of the mean; (a)E(b) refers to [a$\times 10^{b}$]

Table A5-2. Descriptive Statistics for Chemicals in Water (sorted by chemical name)

CAS No.	CHEMNAME	Count	Det Freq	Min (ppm)	Max (ppm)	Avg (ppm)	Std Dev
309002	Aldrin	38	2 / 38	1.65E-07	2.33E-05	1.38E-06	5.21E-06
309002	Aldrin, dissolved	38		1.18E-05	1.18E-05	1.18E-05	2.51E-13
309002	Aldrin, particulate	38	2 / 38	1.65E-07	2.33E-05	1.38E-06	5.21E-06
7440382	Arsenic	33	33 / 33	2.10E-01	6.60E-01	4.43E-01	1.11E-01
22569728	Arsenic III	33	33 / 33	1.00E-02	1.80E-01	8.59E-02	5.09E-02
7440439	Cadmium	57	24 / 57	2.00E-02	4.80E-01	1.09E-01	9.41E-02
7440439	Cadmium, acid soluble	21	21 / 21	8.00E-03	9.30E-02	3.77E-02	2.13E-02
7440439	Cadmium, dissolved	57	56 / 57	1.00E-03	4.10E-02	8.75E-03	7.90E-03
	Chromium, total	57	39 / 57	6.00E-02	4.37E+00	9.74E-01	1.09E+00
118741	Hexachlorobenzene (HCB)	38	37 / 38	1.47E-07	4.07E-04	8.05E-05	7.82E-05
118741	Hexachlorobenzene (HCB), dissolved	38	31 / 38	4.01E-06	1.22E-04	4.36E-05	3.33E-05
118741	Hexachlorobenzene (HCB), particulate	38	26 / 38	1.47E-07	2.85E-04	4.06E-05	5.53E-05
7440508	Copper	57	56 / 57	1.10E-01	9.50E+00	3.64E+00	2.11E+00
7440508	Copper, acid soluble	21	21 / 21	6.90E-01	6.70E+00	2.85E+00	1.37E+00
7440508	Copper, dissolved	57	57 / 57	6.20E-01	4.02E+00	1.55E+00	6.52E-01
	Chromium, acid soluble	21	21 / 21	2.40E-01	5.59E+00	1.22E+00	1.27E+00
16065831	Chromium III	21	21 / 21	2.00E-02	1.54E+00	3.60E-01	3.50E-01
18540299	Chromium VI	21	19 / 21	1.00E-02	4.30E-01	1.49E-01	1.24E-01
	Dimethylarsenic	33	32 / 33	1.00E-02	1.19E-01	4.61E-02	2.76E-02
76448	Heptachlor (pesticide)	38	9 / 38	1.56E-07	2.85E-04	1.90E-05	5.68E-05
76448	Heptachlor (pesticide), dissolved	38	5 / 38	1.28E-06	1.81E-04	1.97E-05	3.80E-05
76448	Heptachlor (pesticide), particulate	38	7 / 38	1.56E-07	1.18E-04	9.44E-06	2.35E-05
	Mercury, dissolved	3	3 / 3	5.00E-04	9.00E-04	6.67E-04	2.08E-04
7439921	Lead	57	52 / 57	2.00E-02	9.70E+00	2.41E+00	1.86E+00
7439921	Lead, dissolved	57	57 / 57	1.20E-02	3.32E+00	6.04E-01	6.53E-01
22967926	Methylmercury	3	3 / 3	3.50E-05	5.80E-05	4.63E-05	1.15E-05
	Monomethylarsenic	33	32 / 33	1.00E-02	1.19E-01	3.95E-02	3.27E-02
7440020	Nickel, acid soluble	21	21 / 21	7.10E-01	5.12E+00	3.10E+00	1.06E+00
7440020	Nickel	57	56 / 57	1.50E-01	7.19E+00	2.88E+00	1.72E+00
7440020	Nickel, dissolved	57	57 / 57	4.91E-01	3.59E+00	1.74E+00	8.32E-01
39765805	Trans nonachlor	38	25 / 38	7.30E-08	7.97E-04	1.18E-04	1.97E-04
39765805	Trans nonachlor, dissolved	38	16 / 38	1.15E-06	1.25E-04	2.60E-05	3.45E-05

Table A5-2. Descriptive Statistics for Chemicals in Water (sorted by chemical name)

CAS No.	CHEMNAME	Count	Det Freq	Min (ppm)	Max (ppm)	Avg (ppm)	Std Dev
39765805	Trans nonachlor, particulate	38	22 / 38	7.30E-08	7.70E-04	9.66E-05	1.77E-04
7439921	Lead, acid soluble	21	21 / 21	2.50E-01	7.78E+00	3.44E+00	1.52E+00
1336363	PCBS, total	38	38 / 38	2.24E-04	1.72E-02	5.49E-03	3.33E-03
1336363	PCBS, total, dissolved	38	36 / 38	2.11E-04	4.43E-03	1.78E-03	1.02E-03
1336363	PCBS, total, particulate	38	38 / 38	1.26E-05	1.41E-02	3.73E-03	2.71E-03
72559	p,p'DDE	38	38 / 38	7.90E-06	1.45E-03	2.44E-04	2.78E-04
72559	p,p'DDE, dissolved	38	36 / 38	7.90E-06	2.18E-04	8.83E-05	4.96E-05
72559	p,p'DDE, particulate	38	34 / 38	6.00E-08	1.35E-03	1.61E-04	2.53E-04
50293	p,p'DDT	38	27 / 38	6.00E-08	6.49E-04	1.06E-04	1.66E-04
50293	p,p'DDT. Dissolved	38	7 / 38	3.32E-06	2.04E-04	1.69E-05	3.78E-05
50293	p,p'DDT. Particulate	38	26 / 38	6.00E-08	5.17E-04	9.23E-05	1.38E-04
7440666	Zinc	57	56 / 57	1.20E-01	3.18E+01	1.07E+01	8.18E+00
7440666	Zinc, dissolved	57	57 / 57	1.10E-01	1.70E+01	3.39E+00	3.85E+00
7440666	Zinc, acid soluble	21	21 / 21	1.08E+00	3.18E+01	1.40E+01	8.89E+00

This table includes analytes that were omitted from the count of total analytes reported in Sections 5.2 and 6.2.5–6.2.8 (to avoid redundancy); therefore, the number of analytes in this table will differ from those reported in the aforementioned sections. Blanks in the *Det Frequency* column indicate the chemical was not detected in any of the samples. Averages and standard deviations were calculated with non-detects assigned values provided in the concentration field of the NOAA (2000) database. The averages and standard deviations do not include records where negative concentrations were assigned as missing data values to indicate detection limits that were unknown. CHEMNAME refers to the name code in the database; Det Freq, detection frequency (number of detects/number of samples); Min, minimum concentration; Max, maximum concentration; Mean, arithmetic mean; Std Dev, standard deviation of the mean; (a)E(b) refers to [a$\times 10^{b}$]

Table A5-3. Descriptive Statistics for Chemicals in Fish Tissue (sorted by chemical name)

CAS No.	CHEMNAME	Count	Det Freq	Min (ppm)	Max (ppm)	Mean (ppm)	Std Dev
83329	Acenaphthene	29	12 / 29	3.00E-04	2.83E-02	3.39E-03	5.37E-03
208968	Acenaphthylene	29	12 / 29	3.50E-04	5.00E-03	1.14E-03	9.94E-04
309002	Aldrin	32	8 / 32	1.00E-04	2.31E-03	6.67E-04	4.84E-04
120127	Anthracene	29	12 / 29	3.00E-04	1.23E-02	2.92E-03	2.66E-03
7440360	Antimony	11		2.00E-02	3.00E-02	2.55E-02	5.22E-03
11096825	Aroclor 1260	3	3 / 3	1.80E-01	4.50E-01	2.85E-01	1.45E-01
7440382	Arsenic	16	10 / 16	2.50E-02	2.66E-01	1.05E-01	9.17E-02
111444	Bis(2chloroethyl)ether	18		1.00E-03	7.00E-03	2.67E-03	1.46E-03
39638329	Bis(2chloroisopropyl) ether	18		4.00E-03	2.00E-02	8.72E-03	3.91E-03
117817	Bis(2ethylhexyl) phthalate	18	16 / 18	9.00E-03	6.40E-01	1.69E-01	1.44E-01
56553	Benz(a)anthracene	29	11 / 29	2.00E-04	5.00E-03	2.06E-03	2.19E-03
53703	Dibenz(a,h)anthracene	29	11 / 29	1.00E-05	2.00E-03	1.02E-03	8.62E-04
50328	Benzo(a)pyrene	29	11 / 29	7.00E-05	2.00E-03	9.28E-04	8.23E-04
205992	Benzo(b)fluoranthene	29	11 / 29	4.00E-05	3.00E-03	1.27E-03	1.29E-03
111911	Bis(2chloroethoxy)methane	18		5.00E-04	2.00E-03	1.47E-03	7.00E-04
192972	Benzo(e)pyrene	11	11 / 11	1.10E-04	6.40E-04	3.65E-04	1.90E-04
7440417	Beryllium	11		2.00E-02	3.00E-02	2.55E-02	5.22E-03
191242	Benzo(g,h,i)perylene	29	11 / 29	7.00E-05	5.00E-03	1.95E-03	2.26E-03
92524	Biphenyl	11	11 / 11	6.90E-04	1.06E-01	1.19E-02	3.14E-02
207089	Benzo(k)fluoranthene	29	11 / 29	6.00E-05	3.00E-03	1.23E-03	1.32E-03
101553	4Bromophenyl phenyl ether	18		6.00E-04	5.00E-03	3.08E-03	2.21E-03
118796	2,4,6Tribromophenol	18		6.00E-04	4.00E-03	2.53E-03	1.69E-03
85687	Butylbenzyl phthalate	18		1.00E-03	2.00E-01	1.12E-01	1.02E-01
92875	Benzidine	18		2.00E-03	6.00E-03	4.44E-03	1.92E-03
7440439	Cadmium	16	15 / 16	3.00E-03	2.00E-01	3.81E-02	6.67E-02
5103742	Transchlordane	12	10 / 12	3.90E-02	2.30E-01	1.38E-01	6.36E-02
5103719	Cischlordane	12	9 / 12	9.00E-02	2.30E-01	1.59E-01	5.63E-02
27304138	Oxychlordane	23	12 / 23	1.09E-03	1.00E-02	4.94E-03	3.03E-03
5103719	Chlordane alpha	29	29 / 29	2.00E-03	3.40E-01	5.65E-02	7.28E-02
5566347	Chlordane gamma	29	29 / 29	5.00E-04	9.00E-02	2.85E-02	2.69E-02
57749	Chlordane	3	3 / 3	1.50E-01	3.27E-01	2.26E-01	9.10E-02
	Chromium, total	16	10 / 16	4.00E-02	5.00E-01	1.62E-01	1.57E-01
218019	Chrysene	29	11 / 29	2.60E-04	5.37E-03	2.71E-03	2.19E-03
319846	Hexachlorocyclohexanealpha	32	13 / 32	9.00E-05	8.00E-03	1.05E-03	1.40E-03

Table A5-3. Descriptive Statistics for Chemicals in Fish Tissue (sorted by chemical name)

CAS No.	CHEMNAME	Count	Det Freq	Min (ppm)	Max (ppm)	Mean (ppm)	Std Dev
319857	Hexachlorocyclohexanebeta	29	6 / 29	2.00E-05	3.00E-03	9.78E-04	8.39E-04
319868	Hexachlorocyclohexanedelta	29	1 / 29	1.60E-04	2.00E-03	7.15E-04	4.25E-04
58899	Hexachlorocyclohexanegamma (Lindane)	32	12 / 32	1.60E-04	2.58E-03	7.68E-04	5.61E-04
59507	4Chloro3methylphenol	18		2.00E-03	2.00E-02	8.28E-03	4.65E-03
95501	1,2Dichlorobenzene	18		3.00E-04	2.00E-03	1.28E-03	8.36E-04
120821	1,2,4Trichlorobenzene	18		3.00E-04	2.00E-03	1.29E-03	8.26E-04
541731	1,3Dichlorobenzene	18		3.00E-04	2.00E-03	1.28E-03	8.36E-04
106467	1,4Dichlorobenzene	18		3.00E-04	2.00E-03	1.28E-03	8.36E-04
118741	Hexachlorobenzene (HCB)	32	13 / 32	2.50E-04	4.98E-03	2.11E-03	1.62E-03
87683	Hexachlorobutadiene	18		6.00E-04	4.00E-03	2.59E-03	1.65E-03
91941	3,3'Dichlorobenzidine	18		2.00E-03	2.00E-02	1.21E-02	9.09E-03
77474	Hexachlorocyclopentadiene	18		9.00E-04	1.00E-02	6.03E-03	4.58E-03
67721	Hexachloroethane	18		2.00E-03	1.00E-02	6.67E-03	3.90E-03
91587	2Chloronaphthalene	18		2.00E-04	1.00E-03	6.61E-04	3.93E-04
95578	2Chlorophenol	18		6.00E-04	7.00E-03	3.67E-03	2.13E-03
120832	2,4Dichlorophenol	18		4.00E-04	9.00E-03	5.67E-03	3.99E-03
87865	Pentachlorophenol	18		4.00E-03	9.00E-03	7.22E-03	2.34E-03
7440508	Copper	5	5 / 5	2.70E-01	7.50E-01	4.66E-01	2.55E-01
7005723	4Chlorophenyl phenyl ether	18		4.00E-04	2.00E-03	1.33E-03	7.82E-04
1861321	Dacthal	3	1 / 3	1.00E-03	1.00E-03	1.00E-03	0.00E+00
84662	Diethyl phthalate	18	8 / 18	1.00E-03	1.40E-02	4.00E-03	3.79E-03
132650	Dibenzothiophene	11	11 / 11	3.10E-04	1.53E-02	2.41E-03	4.32E-03
60571	Dieldrin	44	41 / 44	2.50E-04	5.20E-02	1.37E-02	1.35E-02
84742	Dinbutyl phthalate	18	17 / 18	5.00E-03	1.60E-01	6.12E-02	3.55E-02
131113	Dimethyl phthalate	18		2.00E-04	2.00E-03	1.24E-03	8.81E-04
534521	4,6dinitro2methylphenol	18		4.00E-03	1.00E-02	7.83E-03	2.83E-03
51285	2,4dinitrophenol	10		9.00E-03	9.00E-03	9.00E-03	2.40E-10
959988	Endosulfanalpha	21		5.00E-04	1.00E-03	6.29E-04	1.90E-04
33213659	Endosulfanbeta	29	2 / 29	1.50E-04	1.00E-03	4.47E-04	1.87E-04
1031078	Endosulfan sulfate	18	1 / 18	8.00E-04	4.00E-03	1.09E-03	7.33E-04
72208	Endrin	32	2 / 32	1.80E-04	2.00E-03	6.67E-04	4.05E-04
7421934	Endrin aldehyde	18		7.00E-04	1.00E-03	8.83E-04	1.50E-04
206440	Fluoranthene	29	14 / 29	4.00E-04	3.06E-02	4.84E-03	7.08E-03
86737	Fluorene	29	13 / 29	3.00E-04	6.01E-02	5.21E-03	1.12E-02

Table A5-3. Descriptive Statistics for Chemicals in Fish Tissue (sorted by chemical name)

CAS No.	CHEMNAME	Count	Det Freq	Min (ppm)	Max (ppm)	Mean (ppm)	Std Dev
1024573	Heptachlor epoxide	32	26 / 32	5.00E-04	1.70E-02	4.08E-03	4.34E-03
76448	Heptachlor (pesticide)	32	12 / 32	5.00E-05	6.10E-03	7.52E-04	1.25E-03
193395	Indeno(1,2,3c,d)pyrene	29	11 / 29	4.00E-05	2.00E+00	2.71E-01	4.90E-01
78591	Isophorone	18	1 / 18	4.00E-04	1.90E+00	1.07E-01	4.48E-01
7439921	Lead	16	16 / 16	2.50E-02	4.20E+00	4.49E-01	1.04E+00
7439965	Manganese	2	2 / 2	5.50E-01	6.00E-01	5.75E-01	3.54E-02
2245387	1,6,7Trimethylnaphthalene	11	11 / 11	8.20E-04	2.09E-01	2.68E-02	6.10E-02
7439976	Mercury	16	16 / 16	2.49E-02	1.59E-01	6.58E-02	3.30E-02
90120	1Methylnaphthalene	11	11 / 11	2.29E-03	1.84E-01	2.79E-02	5.36E-02
91576	2Methylnaphthalene	11	11 / 11	3.64E-03	2.72E-01	4.17E-02	7.96E-02
72435	Methoxychlor	21		4.00E-04	2.00E-03	1.28E-03	7.39E-04
581420	2,6Dimethylnaphthalene	11	11 / 11	1.10E-03	3.82E-01	4.45E-02	1.13E-01
832699	1Methylphenanthrene	11	11 / 11	2.50E-04	1.34E-02	2.68E-03	3.84E-03
2385855	Mirex (pesticide = dechlorane)	14	11 / 14	8.00E-05	1.00E-03	5.34E-04	3.64E-04
105679	2,4Dimethylphenol	18		7.00E-04	8.00E-03	2.75E-03	1.75E-03
91203	Naphthalene	29	25 / 29	1.00E-04	1.60E-01	2.04E-02	3.20E-02
98953	Nitrobenzene	18		1.00E-03	8.00E-03	5.50E-03	3.20E-03
7440020	Nickel	13	6 / 13	3.00E-02	7.16E-02	4.72E-02	1.35E-02
62759	Nnitrosodimethylamine	10		1.00E-02	1.00E-02	1.00E-02	1.96E-10
621647	NnitrosodiNpropylamine	18		4.00E-03	3.00E-02	1.90E-02	1.27E-02
86306	Nnitrosodiphenylamine	18		5.00E-04	1.00E-02	5.83E-03	4.80E-03
117840	DiNoctyl phthalate	18	16 / 18	7.00E-03	6.70E+00	1.65E+00	2.07E+00
39765805	Trans nonachlor	23	21 / 23	1.07E-02	3.70E-01	9.05E-02	8.84E-02
5103731	cisNonachlor	23	13 / 23	4.44E-03	8.20E-02	2.17E-02	1.99E-02
88755	2Nitrophenol	18		1.00E-03	6.00E-03	3.17E-03	1.54E-03
100027	4Nitrophenol	18		3.00E-03	2.00E-02	1.39E-02	8.01E-03
121142	2,4Dinitrotoluene	18		1.00E-03	8.00E-03	5.28E-03	3.27E-03
606202	2,6Dinitrotoluene	18		1.00E-03	7.00E-03	4.39E-03	2.33E-03
3268879	Octachlorodibenzopdioxin	18	18 / 18	6.50E-07	5.71E-05	1.37E-05	1.88E-05
39001020	Octachlorodibenzofuran	18	18 / 18	1.00E-07	9.22E-05	1.49E-05	2.50E-05
53190	o,p'DDD	11	11 / 11	2.37E-03	1.43E-02	7.01E-03	4.65E-03
3424826	o,p'DDE	11	11 / 11	9.00E-05	1.27E-03	5.52E-04	4.63E-04
789026	o,p'DDT	11	10 / 11	8.00E-05	6.90E-03	2.33E-03	2.13E-03
1336363	PCBS, total	44	43 / 44	4.07E-02	4.60E+00	7.98E-01	9.63E-01

Table A5-3. Descriptive Statistics for Chemicals in Fish Tissue (sorted by chemical name)

CAS No.	CHEMNAME	Count	Det Freq	Min (ppm)	Max (ppm)	Mean (ppm)	Std Dev
41903575	TCDD, total	18	18 / 18	5.00E-08	2.80E-06	7.50E-07	9.85E-07
36088229	PCDD, total	18	18 / 18	5.00E-08	3.90E-06	6.47E-07	9.36E-07
34465468	H6CDD, total	18	18 / 18	3.00E-07	2.34E-05	3.29E-06	5.42E-06
37871004	H7CDD, total	18	18 / 18	1.00E-07	7.30E-06	1.89E-06	1.97E-06
35822469	H7CDD1234678	18	15 / 18	1.00E-07	7.30E-06	1.89E-06	1.97E-06
39227286	H6CDD123478	18	16 / 18	1.00E-07	5.70E-06	7.97E-07	1.28E-06
57653857	H6CDD123678	18	16 / 18	5.00E-08	7.40E-06	1.42E-06	1.93E-06
40321764	PCDD12378	18	16 / 18	5.00E-08	3.90E-06	6.47E-07	9.36E-07
19408743	H6CDD123789	18	17 / 18	5.00E-08	1.03E-05	1.08E-06	2.38E-06
1746016	TCDD2378 (dioxin)	18	18 / 18	5.00E-08	2.80E-06	7.50E-07	9.85E-07
55722275	TCDF, total	18	18 / 18	5.00E-08	4.80E-06	1.01E-06	1.34E-06
30402154	PCDF, total	18	18 / 18	1.00E-07	9.75E-06	2.29E-06	2.92E-06
55684941	H6CDF, total	18	18 / 18	2.50E-07	3.21E-05	5.08E-06	7.96E-06
38998753	H7CDF, total	18	18 / 18	1.00E-07	2.20E-05	3.25E-06	5.84E-06
67562394	H7CDF1234678	18	18 / 18	5.00E-08	1.96E-05	2.42E-06	5.28E-06
70648269	H6CDF123478	18	18 / 18	5.00E-08	1.00E-05	1.59E-06	2.60E-06
55673897	H7CDF1234789	18	18 / 18	5.00E-08	2.55E-06	8.25E-07	9.11E-07
57117449	H6CDF123678	18	18 / 18	5.00E-08	8.10E-06	1.21E-06	1.96E-06
57117416	PCDF12378	18	17 / 18	5.00E-08	5.00E-06	1.09E-06	1.47E-06
72918219	H6CDF123789	18	16 / 18	1.00E-07	9.50E-06	1.47E-06	2.29E-06
60851345	H6CDF234678	18	17 / 18	5.00E-08	5.00E-06	8.08E-07	1.45E-06
57117314	PCDF23478	18	18 / 18	5.00E-08	4.75E-06	1.23E-06	1.79E-06
51207319	TCDF2378	18	18 / 18	5.00E-08	4.80E-06	1.01E-06	1.34E-06
198550	Perylene	11	11 / 11	8.00E-05	4.90E-04	2.05E-04	1.44E-04
85018	Phenanthrene	29	15 / 29	3.00E-04	1.03E-01	1.20E-02	2.18E-02
108952	Phenol	18	1 / 18	1.00E-03	4.00E-02	8.78E-03	8.76E-03
72548	p,p'DDD	44	42 / 44	1.00E-03	4.80E-01	6.25E-02	8.70E-02
72559	p,p'DDE	44	43 / 44	3.70E-03	5.00E-01	9.36E-02	1.11E-01
50293	p,p'DDT	44	30 / 44	5.00E-04	5.10E-02	5.34E-03	1.00E-02
129000	Pyrene	29	14 / 29	3.00E-04	3.30E-02	4.59E-03	6.99E-03
7782492	Selenium	11	11 / 11	8.14E-02	5.04E-01	2.50E-01	1.35E-01
7440224	Silver	13	2 / 13	4.00E-03	2.50E-02	8.08E-03	7.57E-03
7440280	Thallium	11		1.00E-02	2.00E-02	1.18E-02	4.05E-03
	Total chlordane (alpha+cis+oxy+trans)	12	10 / 12	8.00E-02	8.00E-01	4.49E-01	2.16E-01

Table A5-3. Descriptive Statistics for Chemicals in Fish Tissue (sorted by chemical name)

CAS No.	CHEMNAME	Count	Det Freq	Min (ppm)	Max (ppm)	Mean (ppm)	Std Dev
8001352	Toxaphene	3		1.00E-02	1.00E-02	1.00E-02	1.34E-10
7440666	Zinc	16	16 / 16	7.48E-01	2.37E+01	1.07E+01	6.92E+00

This table includes analytes that were omitted from the count of total analytes reported in Sections 5.2 and 6.2.5–6.2.8 (to avoid redundancy); therefore, the number of analytes in this table will differ from those reported in the aforementioned sections. Blanks in the *Det Frequency* column indicate the chemical was not detected in any of the samples. Averages and standard deviations were calculated with non-detects assigned values provided in the concentration field of the NOAA (2000) database. The averages and standard deviations do not include records where negative concentrations were assigned as missing data values to indicate detection limits that were unknown. CHEMNAME refers to the name code in the database; Det Freq, detection frequency (number of detects/number of samples); Min, minimum concentration; Max, maximum concentration; Mean, arithmetic mean; Std Dev, standard deviation of the mean; (a)E(b) refers to [a$\times 10^{b}$]

Table A6-1. Chemicals Considered in the Human Health Screening Assessment of the Tidal Anacostia (sorted by CAS Number)			
CAS No.	**Analytes in NOAA (2000)**	**Analyzed in tidal Anacostia ?**	**Detected in tidal Anacostia ?**
100016	4Nitroaniline	Yes	Yes
100027	4Nitrophenol	Yes	Yes
1002535	Dibutyl tin	Yes	Yes
100414	Ethylbenzene	Yes	Yes
100425	Styrene	Yes	Yes
100516	Benzyl alcohol	Yes	Yes
10061015	cis1,3Dichloropropene	Yes	No
10061026	trans1,3Dichloropropene	Yes	No
101553	4Bromophenyl phenyl ether	Yes	Yes
1024573	Heptachlor epoxide	Yes	Yes
1031078	Endosulfan sulfate	Yes	Yes
105679	2,4Dimethylphenol	Yes	Yes
106445	4Methylphenol	Yes	Yes
106467	1,4Dichlorobenzene	Yes	Yes
106478	4Chloroaniline	Yes	Yes
107062	1,2Dichloroethane	Yes	No
108054	Vinyl acetate	Yes	No
108101	4Methyl2pentanone	Yes	Yes
108601	2,2'Oxybis(1chloropropane)	Yes	No
108883	Toluene	Yes	Yes
108907	Chlorobenzene	Yes	Yes
108952	Phenol	Yes	Yes
110758	2Chloroethylvinyl ether	Yes	No
11096825	Aroclor 1260	Yes	Yes
11097691	Aroclor 1254	Yes	Yes
11104282	Aroclor 1221	Yes	No
11141165	Aroclor 1232	Yes	No
111444	Bis(2chloroethyl)ether	Yes	Yes
111911	Bis(2chloroethoxy)methane	Yes	Yes
115322	Dicofol	Yes	Yes

Table A6-1. Chemicals Considered in the Human Health Screening Assessment of the Tidal Anacostia (sorted by CAS Number)			
CAS No.	**Analytes in NOAA (2000)**	**Analyzed in tidal Anacostia ?**	**Detected in tidal Anacostia ?**
117817	Bis(2ethylhexyl) phthalate	Yes	Yes
117840	DiNoctyl phthalate	Yes	Yes
118741	Hexachlorobenzene (HCB)	Yes	Yes
118796	2,4,6Tribromophenol	Yes	No
120127	Anthracene	Yes	Yes
120821	1,2,4Trichlorobenzene	Yes	Yes
120832	2,4Dichlorophenol	Yes	Yes
121142	2,4Dinitrotoluene	Yes	Yes
124481	Dibromochloromethane	Yes	No
12672296	Aroclor 1248	Yes	No
12674112	Aroclor 1016	Yes	No
127184	Tetrachloroethylene	Yes	No
129000	Pyrene	Yes	Yes
131113	Dimethyl phthalate	Yes	Yes
132649	Dibenzofuran	Yes	Yes
132650	Dibenzothiophene	Yes	Yes
1330207	Xylenes, total	Yes	Yes
1336363	PCBS, total	Yes	Yes
156592	cis1,2Dichlorethene	Yes	No
156605	Trans1,2Dichloroethene	Yes	No
16065831	Chromium III	Yes	Yes
1746016	TCDD2378 (dioxin)	Yes	Yes
1825214	Pentachloroanisole	Yes	Yes
18540299	Chromium VI	Yes	Yes
1861321	Dacthal	Yes	Yes
191242	Benzo(g,h,i)perylene	Yes	Yes
192972	Benzo(e)pyrene	Yes	Yes
193395	Indeno(1,2,3c,d)pyrene	Yes	Yes
19408743	H6CDD123789	Yes	Yes
198550	Perylene	Yes	Yes

Table A6-1. Chemicals Considered in the Human Health Screening Assessment of the Tidal Anacostia (sorted by CAS Number)			
CAS No.	**Analytes in NOAA (2000)**	**Analyzed in tidal Anacostia ?**	**Detected in tidal Anacostia ?**
205992	Benzo(b)fluoranthene	Yes	Yes
206440	Fluoranthene	Yes	Yes
207089	Benzo(k)fluoranthene	Yes	Yes
20763886	Tributyl tin	Yes	Yes
208968	Acenaphthylene	Yes	Yes
218019	Chrysene	Yes	Yes
2245387	2,3,5Trimethylnaphthalene	Yes	Yes
22569728	Arsenic III	Yes	Yes
22967926	Methylmercury	Yes	Yes
2385855	Mirex (pesticide = dechlorane)	Yes	Yes
26601649	Hexachlorobiphenyl	Yes	Yes
27304138	Oxychlordane	Yes	Yes
28652779	Trimethylnaphthalene	Yes	Yes
28804888	Dimethylnaphthalene	Yes	Yes
2921882	Chlorpyrifos	Yes	Yes
309002	Aldrin	Yes	Yes
319846	Hexachlorocyclohexanealpha	Yes	Yes
319857	Hexachlorocyclohexanebeta	Yes	Yes
319868	Hexachlorocyclohexanedelta	Yes	Yes
3268879	Octachlorodibenzopdioxin	Yes	Yes
33213659	Endosulfanbeta	Yes	Yes
3424826	o,p'DDE	Yes	Yes
35822469	H7CDD1234678	Yes	Yes
39001020	Octachlorodibenzofuran	Yes	Yes
39227286	H6CDD123478	Yes	Yes
39638329	Bis(2chloroisopropyl) ether	Yes	Yes
39765805	Trans nonachlor	Yes	Yes
40321764	PCDD12378	Yes	Yes
50293	p,p'DDT	Yes	Yes
50328	Benzo(a)pyrene	Yes	Yes

Table A6-1. Chemicals Considered in the Human Health Screening Assessment of the Tidal Anacostia (sorted by CAS Number)			
CAS No.	**Analytes in NOAA (2000)**	**Analyzed in tidal Anacostia ?**	**Detected in tidal Anacostia ?**
5103719	Cischlordane	Yes	Yes
5103731	cisNonachlor	Yes	Yes
5103742	Transchlordane	Yes	Yes
51207319	TCDF2378	Yes	Yes
51285	2,4Dinitrophenol	Yes	No
53190	o,p'DDD	Yes	Yes
534521	4,6dinitro2methylphenol	Yes	Yes
53469219	Aroclor 1242	Yes	No
53494705	Endrin ketone	Yes	No
53703	Dibenz(a,h)anthracene	Yes	Yes
540590	1,2Dichloroethene	Yes	No
541731	1,3Dichlorobenzene	Yes	Yes
5566347	Chlordane gamma	Yes	Yes
55673897	H7CDF1234789	Yes	Yes
55722275	TCDF, total	Yes	Yes
56235	Carbon tetrachloride	Yes	No
56553	Benz(a)anthracene	Yes	Yes
57117314	PCDF23478	Yes	Yes
57117416	PCDF12378	Yes	Yes
57117449	H6CDF123678	Yes	Yes
57125	Cyanide	Yes	Yes
57653857	H6CDD123678	Yes	Yes
57749	Chlordane	Yes	Yes
581420	2,6Dimethylnaphthalene	Yes	Yes
58899	Hexachlorocyclohexanegamma (Lindane)	Yes	Yes
591786	2Hexanone	Yes	Yes
59507	4Chloro3methylphenol	Yes	Yes
60571	Dieldrin	Yes	Yes
606202	2,6Dinitrotoluene	Yes	Yes
60851345	H6CDF234678	Yes	Yes

Table A6-1. Chemicals Considered in the Human Health Screening Assessment of the Tidal Anacostia (sorted by CAS Number)			
CAS No.	**Analytes in NOAA (2000)**	**Analyzed in tidal Anacostia ?**	**Detected in tidal Anacostia ?**
608935	Pentachlorobenzene	Yes	Yes
621647	NnitrosodiNpropylamine	Yes	Yes
62759	Nnitrosodimethylamine	Yes	No
65850	Benzoic acid	Yes	Yes
67562394	H7CDF1234678	Yes	Yes
67641	Acetone	Yes	Yes
67663	Chloroform	Yes	No
67721	Hexachloroethane	Yes	Yes
7005723	4Chlorophenyl phenyl ether	Yes	Yes
70648269	H6CDF123478	Yes	Yes
71432	Benzene	Yes	Yes
71556	1,1,1Trichloroethane	Yes	No
72208	Endrin	Yes	Yes
72435	Methoxychlor	Yes	No
72548	p,p'DDD	Yes	Yes
72559	p,p'DDE	Yes	Yes
72918219	H6CDF123789	Yes	Yes
7421934	Endrin aldehyde	Yes	No
7429905	Aluminum	Yes	Yes
7439896	Iron	Yes	Yes
7439921	Lead	Yes	Yes
7439965	Manganese	Yes	Yes
7439976	Mercury	Yes	Yes
7439987	Molybdenum	Yes	No
7440020	Nickel	Yes	Yes
7440224	Silver	Yes	Yes
7440246	Strontium	Yes	Yes
7440280	Thallium	Yes	No
7440315	Tin	Yes	Yes
7440360	Antimony	Yes	Yes

Table A6-1. Chemicals Considered in the Human Health Screening Assessment of the Tidal Anacostia (sorted by CAS Number)			
CAS No.	**Analytes in NOAA (2000)**	**Analyzed in tidal Anacostia ?**	**Detected in tidal Anacostia ?**
7440382	Arsenic	Yes	Yes
7440393	Barium	Yes	Yes
7440417	Beryllium	Yes	Yes
7440428	Boron	Yes	Yes
7440439	Cadmium	Yes	Yes
7440473	Chromium, total	Yes	Yes
7440484	Cobalt	Yes	Yes
7440508	Copper	Yes	Yes
7440622	Vanadium	Yes	Yes
7440666	Zinc	Yes	Yes
74839	Bromomethane	Yes	No
74873	Chloromethane	Yes	No
75003	Chloroethane	Yes	No
75014	Vinyl chloride	Yes	No
75092	Methylene chloride	Yes	Yes
75150	Carbon disulfide	Yes	No
75252	Bromoform	Yes	No
75274	Bromodichloromethane	Yes	No
75343	1,1Dichloroethane	Yes	No
75354	1,1Dichloroethene	Yes	No
76448	Heptachlor (pesticide)	Yes	Yes
77474	Hexachlorocyclopentadiene	Yes	Yes
7782492	Selenium	Yes	Yes
78591	Isophorone	Yes	Yes
78875	1,2Dichloropropane	Yes	No
789026	o,p'DDT	Yes	Yes
78933	2Butanone	Yes	Yes
79005	1,1,2Trichloroethane	Yes	No
79016	Trichloroethene	Yes	No
79345	1,1,2,2Tetrachloroethane	Yes	No

Table A6-1. Chemicals Considered in the Human Health Screening Assessment of the Tidal Anacostia (sorted by CAS Number)			
CAS No.	**Analytes in NOAA (2000)**	**Analyzed in tidal Anacostia ?**	**Detected in tidal Anacostia ?**
8001352	Toxaphene	Yes	No
832699	1Methylphenanthrene	Yes	Yes
83329	Acenaphthene	Yes	Yes
84662	Diethyl phthalate	Yes	Yes
84742	Dinbutyl phthalate	Yes	Yes
85018	Phenanthrene	Yes	Yes
85687	Butylbenzyl phthalate	Yes	Yes
86306	Nnitrosodiphenylamine	Yes	Yes
86737	Fluorene	Yes	Yes
86748	Carbazole	Yes	No
87683	Hexachlorobutadiene	Yes	Yes
87865	Pentachlorophenol	Yes	Yes
88062	2,4,6Trichlorophenol	Yes	Yes
88744	2Nitroaniline	Yes	Yes
88755	2Nitrophenol	Yes	Yes
90120	1Methylnaphthalene	Yes	Yes
91203	Naphthalene	Yes	Yes
91576	2Methylnaphthalene	Yes	Yes
91587	2Chloronaphthalene	Yes	Yes
91941	3,3'Dichlorobenzidine	Yes	Yes
92524	Biphenyl	Yes	Yes
92875	Benzidine	Yes	No
95476	Xylene, ortho	Yes	Yes
95487	2Methylphenol	Yes	Yes
95501	1,2Dichlorobenzene	Yes	Yes
95578	2Chlorophenol	Yes	Yes
95943	1,2,4,5Tetrachlorobenzene	Yes	Yes
95954	2,4,5Trichlorophenol	Yes	Yes
959988	Endosulfanalpha	Yes	No
98953	Nitrobenzene	Yes	Yes

Table A6-1. Chemicals Considered in the Human Health Screening Assessment of the Tidal Anacostia (sorted by CAS Number)			
CAS No.	**Analytes in NOAA (2000)**	**Analyzed in tidal Anacostia ?**	**Detected in tidal Anacostia ?**
99092	3Nitroaniline	Yes	Yes
	Dimethylarsenic	Yes	Yes
	Monobutyl tin	Yes	No
	Monomethylarsenic	Yes	Yes
	BHCs, total	Yes	Yes

Table A6-2. Applicable or Relevant and Appropriate Criteria Considered for Fish Tissue Data					
CAS	CHEMNAME	EPA: Risk10-6 (ppm)	EPA: HQ=0.1 (ppm)	FDA Guidance (ppm)	ARAR (ppm)
83329	Acenaphthene		65		65
208968	Acenaphthylene				
309002	Aldrin	0.00063	0.032	0.3	0.00063
120127	Anthracene		320		320
11096825	Aroclor 1260	0.0014	0.022	2	0.0014
7440382	Arsenic	0.0062	0.32	68	0.0062
7440382	Arsenic	0.0062	0.32	68	0.0062
117817	Bis(2ethylhexyl) phthalate	0.77	22		0.77
56553	Benz(a)anthracene	0.015			0.015
53703	Dibenz(a,h)anthracene	0.0015			0.0015
50328	Benzo(a)pyrene	0.0015			0.0015
50328	Benzo(a)pyrene	0.0015			0.0015
205992	Benzo(b)fluoranthene	0.015			0.015
192972	Benzo(e)pyrene				
191242	Benzo(g,h,i)perylene				
92524	Biphenyl		54		54
207089	Benzo(k)fluoranthene	0.15			0.15
207089	Benzo(k)fluoranthene	0.15			0.15
7440439	Cadmium		0.54	3	0.54
7440439	Cadmium		0.54	3	0.54
5103742	Transchlordane	0.0083	0.065	0.3	0.0083
5103719	Cischlordane	0.0083	0.065	0.3	0.0083
27304138	Oxychlordane				
5103719	Chlordane alpha	0.0083	0.065	0.3	0.0083
5566347	Chlordane gamma	0.0083	0.065	0.3	0.0083
5566347	Chlordane gamma	0.0083	0.065	0.3	0.0083
57749	Chlordane	0.0083	0.065	0.3	0.0083
7440473	Chromium, total		5.4	11	5.4
218019	Chrysene	1.5			1.5
319846	Hexachlorocyclohexanealpha	0.0017		0.3	0.0017
319857	Hexachlorocyclohexanebeta	0.006		0.3	0.006
319868	Hexachlorocyclohexanedelta	0.006		0.3	0.006
58899	Hexachlorocyclohexanegamma (Lindane)	0.0083	0.32	0.3	0.0083
118741	Hexachlorobenzene (HCB)	0.0067	0.86		0.0067
7440508	Copper		40		40
1861321	Dacthal		11		11
84662	Diethyl phthalate		860		860
132650	Dibenzothiophene				
60571	Dieldrin	0.00067	0.054	0.3	0.00067
60571	Dieldrin	0.00067	0.054	0.3	0.00067
84742	Dinbutyl phthalate		110		110
84742	Dinbutyl phthalate		110		110
33213659	Endosulfanbeta		6.5		6.5
1031078	Endosulfan sulfate				
72208	Endrin		0.32		0.32
206440	Fluoranthene		43		43
86737	Fluorene		43		43
1024573	Heptachlor epoxide	0.0012	0.014	0.3	0.0012
76448	Heptachlor (pesticide)	0.0024	0.54	0.3	0.0024
193395	Indeno(1,2,3c,d)pyrene	0.015			0.015
78591	Isophorone	11	220		11
7439921	Lead			1.3	1.3
7439965	Manganese		5.4		5.4
7439965	Manganese		5.4		5.4
2245387	1,6,7Trimethylnaphthalene				

CAS	CHEMNAME	EPA: Risk10-6 (ppm)	EPA: HQ=0.1 (ppm)	FDA Guidance (ppm)	ARAR (ppm)
7439976	Mercury		0.11	1	0.11
90120	1Methylnaphthalene				
91576	2Methylnaphthalene				
581420	2,6Dimethylnaphthalene				
832699	1Methylphenanthrene				
2385855	Mirex (pesticide = dechlorane)	0.006	0.22	0.1	0.006
91203	Naphthalene		43		43
7440020	Nickel		22	70	22
117840	DiNoctyl phthalate		22		22
39765805	Trans nonachlor				
5103731	cisNonachlor				
3268879	Octachlorodibenzopdioxin				
39001020	Octachlorodibenzofuran				
39001020	Octachlorodibenzofuran				
53190	o,p'DDD	0.045		5	0.045
3424826	o,p'DDE	0.032		5	0.032
789026	o,p'DDT	0.032	0.54	5	0.032
1336363	PCBS, total	0.0014	0.022	2	0.0014
41903575	TCDD, total				
36088229	PCDD, total				
37871004	H7CDD, total				
35822469	H7CDD1234678				
39227286	H6CDD123478				
57653857	H6CDD123678				
40321764	PCDD12378				
19408743	H6CDD123789				
1746016	TCDD2378 (dioxin)	0.000000069			0.000000069
55722275	TCDF, total				
30402154	PCDF, total				
55684941	H6CDF, total				
38998753	H7CDF, total				
67562394	H7CDF1234678				
70648269	H6CDF123478				
55673897	H7CDF1234789				
57117449	H6CDF123678				
57117416	PCDF12378				
72918219	H6CDF123789				
60851345	H6CDF234678				
57117314	PCDF23478				
51207319	TCDF2378				
198550	Perylene				
85018	Phenanthrene				
108952	Phenol		650		650
72548	p,p'DDD	0.045		5	0.045
72559	p,p'DDE	0.032		5	0.032
50293	p,p'DDT	0.032	0.54	5	0.032
129000	Pyrene		32		32
7782492	Selenium		5.4		5.4
7440224	Silver		5.4		5.4
57749	Total chlordane (alpha+cis+oxy+trans)	0.0083	0.065	0.3	0.0083
7440666	Zinc		320		320

The values shown in the table were derived from U.S. EPA. 1997. The Incidence and Severity of Sediment Contamination in Surface Waters of the United States Vol 1:National Sediment Quality Survey, Table D-1. Office of Science and Technology. EPA 823-R-97-006. Fish tissue concentration data in the NOAA 2000 database were compared to the concentration values shown in the last column of the table.

Table A6-3. Applicable or Relevant and Appropriate Criteria Considered for Water Data						
CAS	**CHEMNAME**	**Fed SWQC[1] (ppm)**	**DC SWQC[2] (ppm)**	**Md SWQC DW[3] (ppm)**	**Md SWQC Fish[4] (ppm)**	**ARAR (ppm)**
309002	Aldrin	0.00013	0.00014		0.0014	0.00014
7440382	Arsenic	0.018	0.14	50	1836	0.14
22569728	Arsenic III					
7440439	Cadmium			5		5
7440473	Chromium, total			100		100
118741	Hexachlorobenzene (HCB)	0.00075	0.00077		0.0077	0.00077
7440508	Copper	1300				1300
16065831	Chromium III					
18540299	Chromium VI					
	Dimethylarsenic					
76448	Heptachlor (pesticide)	0.00021	0.00021		0.0021	0.00021
7439921	Lead			50		15
22967926	Methylmercury					
	Monomethylarsenic					
7440020	Nickel	610	4600	100	4600	4600
39765805	Trans nonachlor					
1336363	PCBS, total	0.00017	0.000045	0.5	0.0017	0.000045
72559	p,p'DDE	0.00059			0.0059	0.00059
50293	p,p'DDT	0.00059			0.0059	0.00059
7440666	Zinc	9100			69000	9100

Surface water concentration data in the NOAA 2000 database were compared to the concentration values shown in the last column of the table.

[1]Values were taken from: U.S. EPA. 1998. National Recommended Water Quality Criteria. December 10. 63(237)FR68354-68364.

[2]Values were taken from: Government of the District of Columbia, Department of Consumer and Regulatory Affairs. 1994. Water Quality Standards. March 4. 41D.C. Reg.1075.

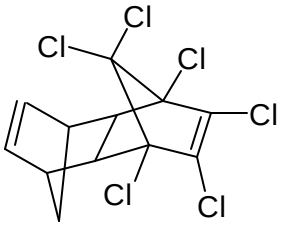
3Values were taken from: Maryland Department of the Environment. 2000. Proposed Water Quality Criteria for Toxic Substances. Available from: http://www.mde.state.md.us/wqstandards/toxics1.html-toxics8.html. June 3. Values were developed to be protective of human health via drinking water pathway.

Values were taken from: Maryland Department of the Environment. 2000. Proposed Water Quality Criteria for Toxic Substances. Available from: http://www.mde.state.md.us/wqstandards/toxics1.html-toxics8.html. June 3. Values were developed to be protective of human health via fish consumption pathway.

APPENDIX B - TOXICITY SUMMARY

Aldrin

CHEMICAL STRUCTURE:



CAS NUMBER: 309-00-2

TOXICOLOGICAL BASIS for RBC (U.S. EPA, 1999): Cancer effects.

MEDIA in which RBC was EXCEEDED: Fish

ORAL TOXICITY (U.S. EPA, 2000a)

RfD	0.00003 mg/kg/day (IRIS; last revised 3/1/88)
Critical Effect	Liver lesions characteristic of chlorinated insecticide poisoning were observed at dose levels of 0.5 ppm and greater. These lesions were characterized by enlarged centrilobular hepatic cells, with increased cytoplasmic oxyphilia, and peripheral migration of basophilic granules.
NOAEL	None.
LOAEL	0.025 mg/kg/day estimated from dietary exposure to 0.5 ppm in rats for 2 years (The composite UF of 1000 encompasses the uncertainty of extrapolation from animals to humans, the uncertainty in the range of human sensitivities, and an additional uncertainty because the RfD is based on a LOAEL rather than a NOAEL.)
Human Data	No data.
Immunotoxicity	No data.
Neurotoxicity	No data.
Reproductive Toxicity	No data.
Developmental Toxicity	No data.
Other Systemic Toxicity	Kidney lesions occurred at the highest dose levels in the critical study; survival was markedly decreased at dose levels of 50 ppm and greater.

Aldrin (continued)

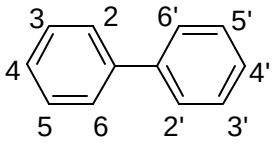
CARCINOGENICITY (U.S. EPA, 2000a)

Weight-of-evidence	B2; probable human carcinogen
Slope Factor	17 per (mg/kg)/day (Drinking Water Unit Risk -- 4.9E-4 per (ug/L))
Human Data	Available studies concerning human carcinogenicity were inadequate.
Animal Data	Orally administered aldrin produced significant increases in tumor responses in three different strains of mice in both males and females. Tumor induction has been observed for structurally related chemicals, including dieldrin, a metabolite.

Aroclor 1260

(Based on data in IRIS for Total Polychlorinated Biphenyls)

CHEMICAL STRUCTURE:



Aroclor 1260 is a mixture of 9.2% penta-, 46.9% hexa-, 36.9% hepta-, and 6.3% octachlorobiphenyl. Chlorine atoms can exist in any of the 10 positions designated.

CAS NUMBER:	11096-82-5
TOXICOLOGICAL BASIS for RBC (U.S. EPA, 1999):	Cancer effects.
MEDIA in which RBC was EXCEEDED:	Fish, Sediment

ORAL TOXICITY (U.S. EPA, 1997a, 2000a)

RfD	None.
Critical Effect	No data.
NOAEL	No data.
LOAEL	No data.
Human Data	No data.
Immunotoxicity	No data.
Neurotoxicity	No data.
Reproductive Toxicity	No data.
Developmental Toxicity	No data.
Other Systemic Toxicity	No data.

Aroclor 1260 (continued)

CARCINOGENICITY (U.S. EPA, 2000a)

Weight-of-evidence	B2; probable human carcinogen (last revised 6/1/97)
Slope Factor	For high risk sub-populations, the following slope factors for polychlorinated biphenyls were provided in IRIS: upper-bound slope factor - 2.0 per (mg/kg)/day; central-estimate slope factor - 1.0 per (mg/kg)/day. Highly exposed populations include some nursing infants and consumers of game fish, game animals, or products of animals contaminated through the food chain. The criteria for using slope factors for high risk populations include food chain exposure and sediment or soil ingestion. The reported slope factors were based on incidences of liver hepatocellular adenomas, carcinomas, cholangiomas, or cholangiocarcinomas in female Sprague-Dawley rats after dietary exposures.
Human Data	Inadequate for quantifying risk of cancer in humans after PCB exposure.
Animal Data	Increased incidences of liver adenomas and carcinomas were observed in male and female rats and thyroid adenomas or carcinomas were increased in male rats after chronic dietary exposure to Aroclor 1260.

Arsenic

CHEMICAL STRUCTURE (Bodek et al. 1988):

In nature, arsenic is associated with sulfide ores. Arsenic occurs in the environment as various inorganic and methylated acids of arsenic, exhibiting the following oxidation states: -3, 0, +3, and +5.

CAS NUMBER:	7440-38-2
TOXICOLOGICAL BASIS for RBC (U.S. EPA, 1999):	Cancer effects.
MEDIA in which RBC was EXCEEDED:	Fish, Sediment, Surface Water

ORAL TOXICITY (U.S. EPA, 2000a)

RfD	0.0003 mg/kg/day (IRIS; last revised 2/1/93)
Critical Effect	Hyperpigmentation, keratosis, and possible vascular complications.
NOAEL	0.0008 mg/kg/day based on an epidemiological study in humans (using exposure level in water was 0.009 mg/L, assumed water consumption rate of 4.5 L/day, and assumed body weight of 55 kg) (A UF of 3 is to account for both the lack of data to preclude reproductive toxicity as a critical effect and to account for some uncertainty in whether the NOAEL of the critical study accounts for all sensitive individuals).
LOAEL	0.014 mg/kg/day (using an exposure level in water of 0.17 mg/L, assumed water consumption rate of 4.5 L/day, and assumed body weight of 55 kg).
Human Data	An increased incidence of blackfoot disease that increases with age and dose was observed in humans exposed to arsenic in the drinking water. Since the high-dose group shows a clear increase in skin lesions over the low dose group, it is therefore designated a LOAEL. There is some question whether the low dose is a NOAEL or a LOAEL since there is no way of knowing what the incidence of skin lesions would be in a group where the exposure to arsenic is zero. Several other epidemiological studies found dose-related increased incidences of skin lesions.
Immunotoxicity	No data.

Arsenic (continued)

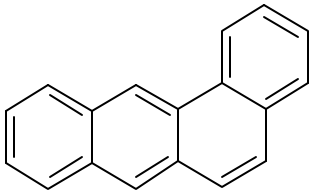
Neurotoxicity	In an epidemiological study in humans, a slight, but not statistically significant, increase in the percent of exposed individuals that have abnormal nerve conduction in the exposed population compared to control group (8/67 vs. 13/83, or 12% vs. 16%. The investigators excluded all individuals older than 47 from the nerve conduction portion of the study. These are the individuals most likely to have the longest exposure to arsenic. IRIS contends that the finding may be biologically important since it occurs in other studies at higher exposure levels. In another study in humans, abnormal electromyographic findings with increasing dose of arsenic were observed, although the sample size was extremely small.
Reproductive Toxicity	No data.
Developmental Toxicity	No data.
Other Systemic Toxicity	No data.

CARCINOGENICITY (U.S. EPA, 2000a)

Weight-of-evidence	A; human carcinogen. Based on sufficient evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic.
Slope Factor	The oral slope factor is 1.5 per (mg/kg)/day (IRIS; last revised 4/10/98); the drinking water unit risk is 0.00005 per (ug/L).
Human Data	Studies of smelter worker populations, pesticide manufacturing workers, a residential population residing near a pesticide manufacturing plant, and case reports of arsenical pesticide applicators have all indicated an association between arsenic exposure and lung cancer. Increased incidence of skin cancers in humans has been associated with exposure in the drinking water, and with the therapeutic oral use of Fowler's solution (potassium arsenite). Cancers of the liver, lung, and bladder were also associated with drinking water exposures in humans.
Animal Data	Inadequate Data. There has not been consistent demonstration of carcinogenicity in test animals for various chemical forms of arsenic administered by different routes to several species.

Benz(a)anthracene

CHEMICAL STRUCTURE:



CAS NUMBER:	56-55-3
TOXICOLOGICAL BASIS for RBC (U.S. EPA, 1999):	Cancer effects.
MEDIA in which RBC was EXCEEDED:	Sediment

ORAL TOXICITY (U.S. EPA, 1997a, 2000a)

RfD	None.
Critical Effect	No data.
NOAEL	No data.
LOAEL	No data.
Human Data	No data.
Immunotoxicity	No data.
Neurotoxicity	No data.
Reproductive Toxicity	No data.
Developmental Toxicity	No data.
Other Systemic Toxicity	No data.

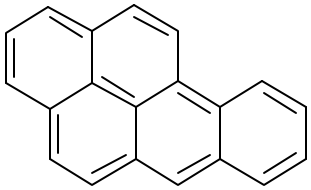
Benz(a)anthracene (continued)

CARCINOGENICITY (U.S. EPA, 2000a)

Weight-of-evidence	B2; probable human carcinogen (IRIS; last revised 3/1/94). Based on no human data and sufficient data from animal bioassays.
Slope Factor	No quantitative estimate of oral carcinogenic risk was available on IRIS for benz(a)anthracene. However, the oral slope factor used to derive screening RBCs for benz(a)anthracene is 0.73 per mg/kg/day, and is an EPA-NCEA provisional value based on a relative potency of 0.1 compared to benzo(a)pyrene (U.S. EPA, 1993). The oral slope factor for benzo(a)pyrene is 7.3 per (mg/kg)/day; (drinking water unit risk is 0.00021 per (ug/L)) (IRIS; last revised 11/1/94).
Human Data	No data.
Animal Data	Benz[a]anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous or intramuscular injection, and topical application. Benz[a]anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture.

Benzo(a)pyrene

CHEMICAL STRUCTURE:



CAS NUMBER:	50-32-8
TOXICOLOGICAL BASIS for RBC (U.S. EPA, 1999):	Cancer effects.
MEDIA in which RBC was EXCEEDED:	Sediment

ORAL TOXICITY (U.S. EPA, 1997a, 2000a)

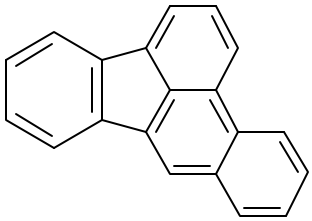
RfD	None.
Critical Effect	No data.
NOAEL	No data.
LOAEL	No data.
Human Data	No data.
Immunotoxicity	No data.
Neurotoxicity	No data.
Reproductive Toxicity	No data.
Developmental Toxicity	No data.
Other Systemic Toxicity	No data.

CARCINOGENICITY (U.S. EPA, 2000a)

Weight-of-evidence	B2; probable human carcinogen. Human data specifically linking benzo[a]pyrene (BAP) to a carcinogenic effect are lacking. There are, however, multiple animal studies in many species demonstrating BAP to be carcinogenic following administration by numerous routes. BAP has produced positive results in numerous genotoxicity assays.
Slope Factor	7.3 per (mg/kg)/day (IRIS; last revised 11/1/94); drinking water unit risk 0.00021 per (ug/L). The oral slope factor estimate was based on a geometric mean of four slope factors obtained by differing modeling procedures. The range of oral slope factors calculated was: 4.5 to 11.7 per (mg/kg)/day. The oral slope factor was derived from the combination of multiple data sets from two different reports using more than one sex and species.
Human Data	Inadequate. Lung cancer has been shown to be induced in humans by various mixtures of polycyclic aromatic hydrocarbons known to contain BAP including cigarette smoke, roofing tar and coke oven emissions. It is not possible, however, to conclude from this information that BAP is the responsible agent.
Animal Data	Repeated BAP administration has been associated with increased incidences of total tumors and of tumors at the site of exposure. BAP administered in the diet or by gavage to mice, rats and hamsters has produced increased incidences of stomach tumors. Distant site tumors have also been observed after BAP administration by various routes. Intratracheal instillation and inhalation studies in guinea pigs, hamsters and rats have resulted in elevated incidences of respiratory tract and upper digestive tract tumors. Intraperitoneal BAP injections have caused increases in the number of injection site tumors in mice and rats. Subcutaneous BAP injections have caused increases in the number of injection site tumors in mice, rats, guinea pigs, hamsters and some primates. BAP is commonly used as a positive control in many dermal application bioassays and has been shown to cause skin tumors in mice, rats, rabbits and guinea pigs. BAP is both an initiator and a complete carcinogen in mouse skin. Increased incidences of distant site tumors have also been reported in animals as a consequence of dermal BAP exposure. BAP has also been reported to be carcinogenic in animals when administered by the following routes: i.v.; transplacentally; implantation in the stomach wall, lung, renal parenchyma and brain; injection into the renal pelvis; and vaginal painting

Benzo(b)fluoranthene

CHEMICAL STRUCTURE:



CAS NUMBER:	205-99-2
TOXICOLOGICAL BASIS for RBC (U.S. EPA, 1999):	Cancer effects.
MEDIA in which RBC was EXCEEDED:	Sediment

ORAL TOXICITY (U.S. EPA, 1997a, 2000a)

RfD	None.
Critical Effect	No data.
NOAEL	No data.
LOAEL	No data.
Human Data	No data.
Immunotoxicity	No data.
Neurotoxicity	No data.
Reproductive Toxicity	No data.
Developmental Toxicity	No data.
Other Systemic Toxicity	No data.

Benzo(b)fluoranthene (continued)

CARCINOGENICITY (U.S. EPA, 2000a)

Weight-of-evidence	B2; probable human carcinogen (IRIS; last revised 3/1/94). Based on no human data and sufficient data from animal bioassays. Benzo[b]fluoranthene produced tumors in mice after lung implantation, intraperitoneal (i.p.) or subcutaneous (s.c.) injection, and skin painting.
Slope Factor	No quantitative estimate of carcinogenic risk was available on IRIS based on carcinogenicity data for benzo(b)fluoranthene. However, the oral slope factor used to derive screening RBCs for benzo(b)fluoranthene is 0.73 per mg/kg/day, and is an EPA-NCEA provisional value based on a relative potency of 0.1 compared to benzo(a)pyrene (U.S. EPA, 1993). The oral slope factor for benzo(a)pyrene is 7.3 per (mg/kg)/day; (drinking water unit risk is 0.00021 per (ug/L)) (IRIS; last revised 11/1/94).
Human Data	None. Although there are no human data that specifically link exposure to benzo[b]fluoranthene to human cancers, benzo[b]fluoranthene is a component of mixtures that have been associated with human cancer. These include coal tar, soots, coke oven emissions and cigarette smoke.
Animal Data	In a lifetime lung implant study of benzo[b]fluoranthene exposure in 3-month-old female Osborne-Mendel rats, the incidences of epidermoid carcinomas and pleomorphic sarcomas in the lung and thorax (combined) showed a statistically significant dose-response relationship. A statistically significant increase in the incidence of liver adenomas and hepatomas (combined) occurred in mice 52 weeks after a single ip injection of benzo[b]fluoranthene. Injection site sarcomas occurred in 18/24 mice that survived three s.c. injections of benzo[b]fluoranthene over a period of 2 months. Benzo[b]fluoranthene has yielded positive results for complete carcinogenic activity and initiating activity in mouse skin-painting assays. Multiple animal studies in many species demonstrate that benzo(a)pyrene is carcinogenic in animals following administration by numerous routes. Benzo(a)pyrene has produced positive results in numerous genotoxicity assays.

Cadmium

CHEMICAL STRUCTURE:

Cd^{2+}

Cadmium is commonly associated with zinc in carbonate and sulfide ores and is also a byproduct of the refining of other metals. In the environment, cadmium exists as a free ion in freshwater(pH 6-8). However, once it enters salt water, it readily complexes with Cl^-.

CAS Number:	7440-43-9
TOXICOLOGICAL BASIS for RBC (U.S. EPA, 1999):	Non-cancer effects.
MEDIA in which RBC was EXCEEDED:	Fish.

ORAL TOXICITY (U.S. EPA, 2000a)

RfD	0.0005 mg/kg/day (water); 0.001 mg/kg/day (food) (IRIS; last revised 2/1/94)
Critical Effect	The highest renal cadmium concentration in humans not associated with significant proteinuria (200 ug cadmium (Cd)/gm wet human renal cortex).
NOAEL	0.005 mg/kg/day (water); 0.01 mg/kg/day (food). An uncertainty factor of 10 is used to account for intrahuman variability to the toxicity of this chemical in the absence of specific data on sensitive individuals. The choice of NOAEL does not reflect the information from any single study. Rather, it reflects the data obtained from many studies on the toxicity of cadmium in both humans and animals. These data also permit calculation of pharmacokinetic parameters of cadmium absorption, distribution, metabolism and elimination. A concentration of 200 ug cadmium (Cd)/gm wet human renal cortex is the highest renal level not associated with significant proteinuria, based on data presented in the 1985 Drinking Water Criteria Document on Cadmium. A toxicokinetic model is available to determine the level of chronic human oral exposure (NOAEL) which results in 200 ug Cd/gm wet human renal cortex; the model assumes that 0.01% day of the Cd body burden is eliminated per day. Assuming 2.5% absorption of Cd from food or 5% from water, the toxicokinetic model predicts that the NOAEL for chronic Cd exposure is 0.005 and 0.01 mg Cd/kg/day from water and food, respectively (i.e., levels which would result in 200 ug Cd/gm wet weight human renal cortex). Thus, based on an estimated NOAEL of 0.005 mg Cd/kg/day for Cd in drinking water and an UF of 10, an RfD of 0.0005 mg Cd/kg/day (water) was calculated; an equivalent RfD for Cd in food is 0.001 mg Cd/kg/day.
LOAEL	None report in IRIS.
Human Data	No data beyond that presented for the critical effect.
Immunotoxicity	No data.
Neurotoxicity	No data.

Cadmium (continued)

Reproductive Toxicity	No data.
Developmental Toxicity	No data.
Other Systemic Toxicity	No data.

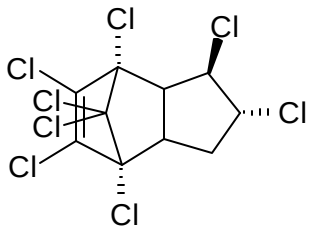
CARCINOGENICITY (U.S. EPA, 2000a)

Weight-of-evidence	B1; probable human carcinogen (IRIS; last revised 6/1/92). Based on limited evidence from occupational epidemiologic studies of cadmium that is consistent across investigators and study populations. There is sufficient evidence of carcinogenicity in rats and mice by inhalation and intramuscular and subcutaneous injection.
Slope Factor	No oral slope factor is available. There are no positive studies of orally ingested cadmium suitable for quantitation.
Human Data	No oral carcinogenicity data in humans was reported in IRIS.
Animal Data	Seven studies in rats and mice wherein cadmium salts (acetate, sulfate, chloride) were administered orally have shown no evidence of carcinogenic response.

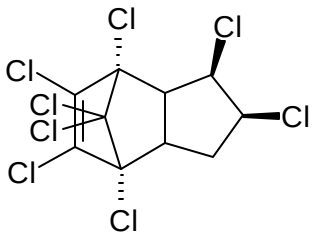
Chlordane

(The toxicology information provided below is based on data in IRIS for Technical Grade Chlordane, a mixture of chlordane isomers; no evaluations were available on IRIS (U.S. EPA, 2000a) or in the HEAST (U.S. EPA, 1997a) concerning the toxicity of individual chlordane isomers)

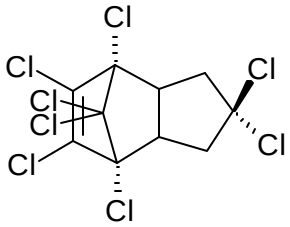
CHEMICAL STRUCTUREs:



beta-Chlordane
CAS 5103-71-9



alpha-Chlordane
CAS 5103-71-9



gamma-Chlordane
CAS 5566-34-7

CAS NUMBERs:	57-74-9 (technical) 5103-71-9 (alpha, cis) 5103-74-2 (beta, trans) 5566-34-7 (gamma, trans)
TOXICOLOGICAL BASIS for RBC (U.S. EPA, 1999) or ARAR (U.S. EPA, 1997b):	Cancer effects
MEDIA in which RBC was EXCEEDED:	Fish

ORAL TOXICITY (U.S. EPA, 2000a)

RfD	0.0005 mg/kg/day (IRIS; last revised 2/7/98)
Critical Effect	Hepatic necrosis in a 2-year oral exposure assay in mice.
NOAEL	0.15 mg/kg-day. The following uncertainty factors are applied to the NOAEL derived from the principal study: 10 for consideration of intraspecies variation, 10 for consideration of interspecies extrapolation, and 3 for lack of any reproductive studies.
LOAEL	0.75 mg/kg-day
Human Data	Available occupational studies, although limited, give no indication that the liver is a target organ in humans as a consequence of chronic exposure to low levels of chlordane. Recent epidemiological findings indicate that neurotoxicity may be a relevant human toxicological endpoint as a consequence of chronic as well as acute chlordane exposure. Neurotoxicity and possibly hematotoxicity are the principal endpoints of acute chlordane toxicity in both experimentally poisoned animals and accidentally poisoned humans, with tremors and convulsions being common interspecies symptoms.

Chlordane (continued)

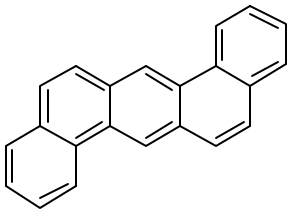
Immunotoxicity	Several investigations in laboratory animals have assessed the effects of chlordane on the immunological system of offspring exposed during gestation and found that chlordane may affect cell-mediated immunity.
Neurotoxicity	Neurotoxicity endpoints are the principal endpoints of acute chlordane toxicity in both experimentally poisoned animals and accidentally poisoned humans, with tremors and convulsions being common interspecies symptoms. Adults (109 women and 97 men) who had been exposed to uncertain levels of chlordane via both air and oral routes were examined. Significant ($p < 0.05$) differences were observed with a battery of neurophysiological and neuropsychological function tests. Also, profiles of mood states (including tension, depression, anger, vigor, fatigue, and confusion) all were affected significantly ($p < 0.0005$), as compared to a referent population. These results indicate that neurological effects are a relevant endpoint in humans exposed to chlordane.
Reproductive Toxicity	No multi-generational reproductive studies, by any route, exist for technical chlordane.
Developmental Toxicity	Behavioral changes were observed in pups of mice exposed orally by gavage on gestation days 12-19. Several investigations in laboratory animals have assessed the effects of chlordane on the immunological system of offspring exposed during gestation and found that chlordane may affect cell-mediated immunity.
Other Systemic Toxicity	Case studies of aplastic anemia are associated with acute exposure to chlordane implicating this pesticide in bone marrow toxicity. Bone marrow hematopoietic activity in mice, as measured by the ability of bone marrow cells to undergo clonal expansion in response to stimulating factors, and spleen colony forming units (after irradiation) both showed a significant dose-related depression.

CARCINOGENICITY (U.S. EPA, 2000a)

Weight-of-evidence	B2; probable human carcinogen, based on (1) human epidemiology studies showing non-Hodgkin's lymphoma in farmers exposed to chlordane and case reports of aplastic anemia (chlordane associated with home use are inadequate to demonstrate carcinogenicity); (2) animal studies in which benign and malignant liver tumors were induced in both sexes of four strains of mice and occurred with an elevated, but not statistically significant, incidence in a fifth strain (liver toxicity but no tumors was observed in rats of two strains); and (3) structural similarity to other rodent liver carcinogens.
Slope Factor	0.35 per mg/(kg-day) (IRIS; last revised 2/7/98); drinking water unit risk 0.00001 per (ug/L).
Human Data	Inadequate to quantify a oral carcinogenicity dose-response.
Animal Data	Available data were sufficient to derive an oral slope factor. Chlordane treatment has induced benign or malignant liver tumors in each of five strains of mice in which bioassays have been reported.

Dibenz(a,h)anthracene

CHEMICAL STRUCTURE:



CAS NUMBER:	53-70-3
TOXICOLOGICAL BASIS for RBC (U.S. EPA, 1999):	Cancer effects.
MEDIA in which RBC was EXCEEDED:	Sediment

ORAL TOXICITY (U.S. EPA, 1997a, 2000a)

RfD	None.
Critical Effect	No data.
NOAEL	No data.
LOAEL	No data.
Human Data	No data.
Immunotoxicity	No data.
Neurotoxicity	No data.
Reproductive Toxicity	No data.
Developmental Toxicity	No data.
Other Systemic Toxicity	No data.

Dibenz(a,h)anthracene (continued)

CARCINOGENICITY (U.S. EPA, 2000a)

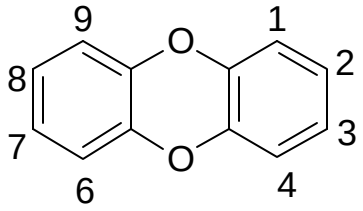
Weight-of-evidence	B2; probable human carcinogen (IRIS; last revised on 3/1/94). Based on no human data and sufficient data from animal bioassays. Dibenz[a,h]anthracene produced carcinomas in mice following oral or dermal exposure and injection site tumors in several species following subcutaneous or intramuscular administration. Dibenz[a,h]anthracene has induced DNA damage and gene mutations in bacteria as well as gene mutations and transformation in several types of mammalian cell cultures.
Slope Factor	No quantitative estimate of carcinogenic risk was available on IRIS based on carcinogenicity data for dibenz(a,h,)anthracene. However, the oral slope factor used to derive screening RBCs for dibenz(a,h)anthracene is 7.3 per mg/kg/day, and is an EPA-NCEA provisional value based on a relative potency of 1 compared to benzo(a)pyrene (U.S. EPA, 1993). The oral slope factor for benzo(a)pyrene is 7.3 per (mg/kg)/day; (drinking water unit risk is 0.00021 per (ug/L)) (IRIS; last revised 11/1/94).
Human Data	None. Although there are no human data that specifically link exposure to dibenz[a,h]anthracene with human cancers, dibenz[a]anthracene is a component of mixtures that have been associated with human cancer. These include coal tar, soots, coke oven emissions and cigarette smoke.
Animal Data	Dibenz[a,h]anthracene produced carcinomas in mice following oral or dermal exposure and injection site tumors in several species following subcutaneous or intramuscular administration. Dibenz[a,h]anthracene has induced DNA damage and gene mutations in bacteria as well as gene mutations and transformation in several types of mammalian cell cultures. Multiple animal studies in many species demonstrate that benzo(a)pyrene is carcinogenic in animals following administration by numerous routes. Benzo(a)pyrene has produced positive results in numerous genotoxicity assays.

Dibenzo-p-Dioxins and Dibenzofurans

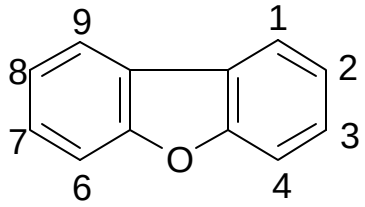
(HxCDD, PxCDD, TxCDD, HxCDF, PxCDF, and TxCDF)

CHEMICAL STRUCTURE:

Dibenzo-p-dioxins (CDDs):



Dibenzofurans (CDFs):



Individual CDD and CDF molecules are specified according to the number and position of chlorine atoms in the molecule. For instance, 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) has one chlorine at each of the 2, 3, 7, and 8 positions. CDDs and CDFs with chlorine substitutions in at least the 2, 3, 7, and 8 positions are thought to have dioxin-like toxicity, and are evaluated in risk assessment in terms of 2,3,7,8-TCDD equivalent concentrations.

CAS NUMBER (2,3,7,8-TCDD):	1746-01-6
TOXICOLOGICAL BASIS for RBC (U.S. EPA, 1999):	Cancer effects.
MEDIA in which RBC was EXCEEDED:	Fish

ORAL TOXICITY (U.S. EPA, 1997a, 2000a)

RfD	None.
Critical Effect	No data.
NOAEL	No data.
LOAEL	No data.
Human Data	No data.
Immunotoxicity	No data.
Neurotoxicity	No data.
Reproductive Toxicity	No data.
Developmental Toxicity	No data.
Other Systemic Toxicity	No data.

CARCINOGENICITY (U.S. EPA, 1997a; no data available on IRIS for 2,3,7,8-TCDD)

Weight-of-evidence	B2 (HEAST; basis was not reported); oral unit risk 4.5 ug/L.
Slope Factor	An oral slope factor of 150,000 per mg/kg/day was reported in HEAST for 2,3,7,8-TCDD, but details concerning the critical study and other relevant data were not reported (U.S. EPA, 1997a). No quantitative estimate of carcinogenic risk for 2,3,7,8-TCDD was available on IRIS. 2,3,7,8-TCDD is thought to be the most potent toxin among the 30 or so dioxin-like compounds. Dioxin-like compounds are often found in complex mixtures, thus a toxicity equivalency procedure was developed by the U.S. EPA to describe the cumulative toxicity of these mixtures (U.S. EPA, 2000b). Toxicity equivalency factors (TEFs) were developed for dioxin-like chemicals based on their toxicity relative to 2,3,7,8-TCDD. For risk assessment of dioxin mixtures, a potency-adjusted concentration of each compound is calculated by multiplying its concentration by its TEF (referred to as its toxic equivalency (TEQ) concentration), and the individual TEQs are summed to provide an estimated total 2,3,7,8-TCDD equivalent exposure point concentration (U.S. EPA, 1989, 2000b). The U.S. EPA (1989) provides more detailed guidance for applying the TEFs. TEFs for dioxin-like COPCs were provided in U.S. EPA (2000b), and are presented below in Table B1. For the screening human health risk assessment, individual RBCs of dioxin-like compounds were determined by dividing the RBC for 2,3,7,8-TCDD by the TEF for the compound, and then comparing against the unadjusted maximum concentration of the compound in the medium. This procedure is mathematically equivalent to first multiplying the maximum concentration for the individual compound by the corresponding TEF and then comparing to the unadjusted RBC for 2,3,7,8-TCDD. An exception to the rule of screening dioxin-like chemicals using the TEF approach was 1,2,3,7,8,9-H6CDD, which has its own oral slope factor of 6200 per mg/kg/day reported in IRIS (last revised on 3/1/91) (U.S. EPA, 2000a). The individual RBC reported in U.S. EPA (1993) for 1,2,3,7,8,9-H6CDD (CAS No.19408-74-3) was used instead of applying the TEF for this chemical from U.S. EPA (1989).
Human Data	No human data were reported in HEAST (U.S. EPA, 1997a) or IRIS (U.S. EPA, 2000a).
Animal Data	The oral slope factor for 2,3,7,8-TCDD was derived based on liver tumors in rats after chronic dietary exposure. No other data were reported in IRIS or HEAST.

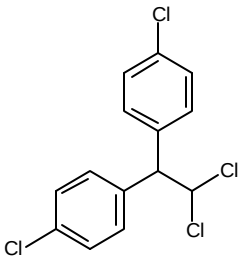
Dibenzo-p-Dioxins and Dibenzofurans (continued)

Table B1. TEF values for the dioxin-like compounds that were COPCs in fish in the screening level human health risk assessment (U.S. EPA, 2000b).

Compound	CAS Number	TEF	
	Dibenzo-p-dioxins		
2,3,7,8-TCDD	1746-01-6	1	
1,2,3,7,8-PCDD	40321-76-4	0.5	
1,2,3,4,7,8-H6CDD	39227-28-6	0.1	
1,2,3,6,7,8-H6CDD	57653-85-7	0.1	
1,2,3,7,8,9-H6CDD	19408-74-3	0.1	(not used in the COPC screening)
1,2,3,4,6,7,8-H7CDD	35822-46-9	0.01	
Octachlorodibenzo-p-dioxin	3268-87-9	0.001	
	Dibenzofurans		
2,3,7,8-TCDF	51207-31-9	0.1	
1,2,3,7,8-PCDF	57117-41-6	0.05	
2,3,4,7,8-PCDF	57117-31-4	0.5	
1,2,3,4,7,8-H6CDF	70648-26-9	0.1	
1,2,3,6,7,8-H6CDF	57117-44-9	0.1	
1,2,3,7,8,9-H6CDF	72918-21-9	0.1	
2,3,4,6,7,8-H6CDF	60851-34-5	0.1	
1,2,3,4,6,7,8-H7CDF	67562-39-4	0.01	
1,2,3,4,7,8,9-H7CDF	55673-89-7	0.01	
Octachlorodibenzofuran	390001-02-0	0.001	

Dichlorodiphenyldichloroethane *(p,p'*-DDD)

CHEMICAL STRUCTURE:



CAS NUMBER:	72-54-8
TOXICOLOGICAL BASIS for RBC (U.S. EPA, 1999):	Cancer effects.
MEDIA in which RBC was EXCEEDED:	Fish

ORAL TOXICITY (U.S. EPA, 1997a, 2000a)

RfD	None.
Critical Effect	No data.
NOAEL	No data.
LOAEL	No data.
Human Data	No data.
Immunotoxicity	No data.
Neurotoxicity	No data.
Reproductive Toxicity	No data.
Developmental Toxicity	No data.
Other Systemic Toxicity	No data.

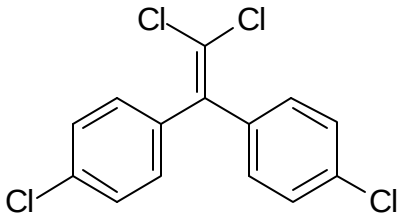
Dichlorodiphenyldichloroethane (p,p'-DDD) (continued)

CARCINOGENICITY (U.S. EPA, 2000a)

Weight-of-evidence	B2; probable human carcinogen. Based on an increased incidence of lung tumors in male and female mice, liver tumors in male mice and thyroid tumors in male rats. DDD is structurally similar to, and is a known metabolite of DDT, a probable human carcinogen.
Slope Factor	0.24 /mg/kg/day (IRIS; last revised 8/22/88); drinking water unit risk 0.0000069 /ug/L.
Human Data	None. Human epidemiological data are not available for DDD. Evidence for the carcinogenicity in humans of DDT, a structural analog, is based on autopsy studies relating tissue levels of DDT to cancer incidence. These studies have yielded conflicting results.
Animal Data	The oral slope factor was derived based on liver tumors in mice observed after chronic dietary exposure. Increased incidence of thyroid tumors (follicular cell adenomas and carcinomas) were observed in male rats fed DDD in the diet for 103 weeks suggesting a possible carcinogenic effect, but the incidence did not appear to be dose-related. DDD is structurally similar to, and is a metabolite of, DDT, a probable human carcinogen, in rats, mice, and humans. Positive effects were found with DDD in mammalian cytogenetic assays and a host-mediated assay.

Dichlorodiphenyldichloroethylene (*p,p'*-DDE)

CHEMICAL STRUCTURE:



CAS NUMBER:	72-55-9
TOXICOLOGICAL BASIS for RBC (U.S. EPA, 1999):	Cancer effects.
MEDIA in which RBC was EXCEEDED:	Fish
MEDIA in which ARAR (U.S. EPA, 1998) was EXCEEDED:	Surface Water

ORAL TOXICITY (U.S. EPA, 1997a, 2000a)

RfD	None.
Critical Effect	No data.
NOAEL	No data.
LOAEL	No data.
Human Data	No data.
Immunotoxicity	No data.
Neurotoxicity	No data.
Reproductive Toxicity	No data.
Developmental Toxicity	No data.
Other Systemic Toxicity	No data.

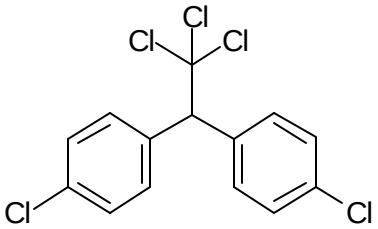
Dichlorodiphenyldichloroethylene (p,p'-DDE) (continued)

CARCINOGENICITY (U.S. EPA, 2000a)

Weight-of-evidence	B2; probable human carcinogen. Based on increased incidence of liver tumors including carcinomas in two strains of mice and in hamsters and thyroid tumors in female rats exposed in the diet.
Slope Factor	3.4E-1/mg/kg/day (IRIS; last revised on 8/22/88); drinking water unit risk -- 9.7E-6/ug/L.
Human Data	None. Human epidemiological data are not available for DDE. Evidence for the human carcinogenicity of DDT, a structural analog, is based on autopsy studies relating tissue levels of DDT to cancer incidence. These studies have yielded conflicting results.
Animal Data	The oral slope factor for *p,p'*-DDE was derived from dose-response data on the incidence of hepatocellular carcinomas in one strain of mice, hepatomas in another mouse strain, and hepatomas in hamsters after chronic dietary exposures. The oral quantitative estimate is a geometric mean of six slope factors computed from incidence data by sex from the three studies. Dietary exposure in female rats induced a significant dose-dependent trend in the incidence of thyroid tumors, but the Fisher exact test was not significant. DDE was mutagenic in mouse lymphoma (L5178Y) cells and chinese hamster (V79) cells, but not in Salmonella.

Dichlorodiphenyltrichloroethane (*p,p'*-DDT)

CHEMICAL STRUCTURE:



CAS NUMBER:	50-29-3
TOXICOLOGICAL BASIS for RBC (U.S. EPA, 1999):	Cancer effects.
MEDIA in which RBC was EXCEEDED:	Fish
MEDIA in which ARAR (U.S. EPA, 1998) was EXCEEDED:	Surface Water

ORAL TOXICITY (U.S. EPA, 2000a)

RfD	0.0005 mg/kg/day (IRIS; last revised on 2/1/96)
Critical Effect	Liver lesions in a 27-week rat feeding study. Weanling rats (25/sex/group) were fed commercial DDT (81% P,P isomer and 19% O,P isomer) at levels of 0, 1, 5, 10 or 50 ppm for 15-27 weeks. Increasing hepatocellular hypertrophy, especially centrilobularly, increased cytoplasmic oxyphilia, and peripheral basophilic cytoplasmic granules (based on H and E paraffin sections) were observed at dose levels of 5 ppm and above. The effect was minimal at 5 ppm (LOAEL) and more pronounced at higher doses. DDT fed to rats for 2 years caused liver lesions at all dose levels (10-800 ppm of diet). DDT-induced liver effects were observed in mice, hamsters and dogs as well.
NOAEL	0.05 mg/kg/day (1 ppm in the diet). A factor of 10 each was applied for the uncertainty of interspecies conversion and to protect sensitive human subpopulations. An uncertainty factor for subchronic to chronic conversion was not included because of a corroborating chronic study in the data base.
LOAEL	5 ppm in the diet
Human Data	No data reported in IRIS.
Immunotoxicity	No data reported in IRIS.
Neurotoxicity	No data reported in IRIS.
Reproductive Toxicity	In one 3-generation rat reproduction study, offspring mortality increased at all dose levels, the lowest of which corresponds to about 0.2 mg/kg bw/day. Three other reproduction studies (rat and mouse) show no reproductive effects at much higher dose levels.

Dichlorodiphenyltrichloroethane (p,p'-DDT) (continued)

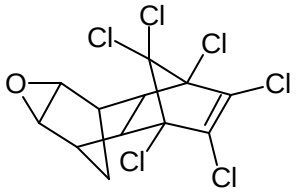
Developmental Toxicity	In the critical study, weanling rats (25/sex/group) were fed commercial DDT (81% p,p isomer and 19% o,p isomer) at levels of 0, 1, 5, 10 or 50 ppm for 15-27 weeks. No interference with growth was noted at any level.
Other Systemic Toxicity	No other effects were observed in the critical study.

CARCINOGENICITY (U.S. EPA, 2000a)

Weight-of-evidence	B2; probable human carcinogen. Based on the observation of tumors (generally of the liver) in seven studies in various mouse strains and three studies in rats. DDT is structurally similar to other probable carcinogens, such as DDD and DDE.
Slope Factor	0.34 per mg/kg/day (IRIS; last revised on 5/1/91); drinking water unit risk - 0.0000097 per (ug/L). Ten sex-specific slope factors were derived from six studies based on dose-response data for either benign or malignant liver tumors in rats or mice after dietary exposures; all 10 slope factors fell within a 13-fold range. A geometric mean of the 10 slope factors was used for the overall slope factor of 3.4E-1. The slope factor derived from the mouse data alone was 4.8E-1 while that derived from the rat data alone was 1.5E-1. There was no apparent difference in slope factor as a function of sex of the animals. The geometric mean of the slope factors from the mouse and rat data combined was identical for the same tumor site as that for DDE [3.4E-1 per (mg/kg)/day], a structural analog.
Human Data	The existing epidemiological data are inadequate to quantify a dose-response relationship. Autopsy studies relating tissue levels of DDT to cancer incidence have yielded conflicting results. Studies of occupationally exposed workers and volunteers have been of insufficient duration to be useful in assessment of the carcinogenicity of DDT to humans.
Animal Data	Twenty-five animal carcinogenicity assays have been reviewed for DDT. Nine feeding studies, including two multigenerational studies, have been conducted in the following mouse strains: BALB/C, CF-1, A strain, Swiss/Bombay and (C57B1)x(C3HxAkR). Only one of these studies, conducted for 78 weeks, showed no indication of DDT tumorigenicity. Both hepatocellular adenomas and carcinomas were observed in six mouse liver tumor studies. Both benign and malignant lung tumors were observed in two studies wherein mice were exposed both in utero and throughout their lifetime. Doses producing increased tumor incidence ranged from 0.15-37.5 mg/kg/day. Three studies using Wistar, MRC Porton and Osborne-Mendel rats and doses from 25-40 mg/kg/day produced increased incidence of benign liver tumors. Another study wherein Osborne-Mendel rats were exposed in this dietary dose range for 78 weeks was negative as were three additional assays in which lower doses were given. Tests of DDT in hamsters have not resulted in increased tumor incidence. Unlike mice and humans, hamsters accumulate DDT in tissue but do not metabolize it to DDD or DDE. Studies of DDT in dogs and monkeys have not shown a carcinogenic effect. However, the length of these studies (approximately 30% of the animals' lifetimes) was insufficient to assess the carcinogenicity of DDT. DDT has been shown to produce hepatomas in trout.

Dieldrin

CHEMICAL STRUCTURE:



CAS NUMBER: 60-57-1

TOXICOLOGICAL BASIS for RBC (U.S. EPA, 1999): Cancer effects.

MEDIA in which RBC was EXCEEDED: Fish

ORAL TOXICITY (U.S. EPA, 2000a)

RfD	0.00005 mg/kg/day (IRIS; last revised 9/1/90)
Critical Effect	Liver lesions in a 2-year rat feeding study. At the end of 2 years, females fed 1.0 and 10.0 ppm (0.05 and 0.5 mg/kg/day) had increased liver weights and liver-to-body weight ratios ($p<0.05$). Histopathological examinations revealed liver parenchymal cell changes including focal proliferation and focal hyperplasia.
NOAEL	0.005 mg/kg/day (0.1 ppm in the diet). The UF of 100 allows for uncertainty in the extrapolation of dose levels from laboratory animals to humans and uncertainty in the threshold for sensitive humans.
LOAEL	0.05 mg/kg/day (1 ppm in the diet)
Human Data	No data.
Immunotoxicity	No data.
Neurotoxicity	In the principle study in rats, at 10.0 ppm (0.5 mg/kg/day) all animals became irritable and exhibited tremors and occasional convulsions. Convulsions were also reported in dogs at 0.5 mg/kg/day in a 2-year feeding study.
Reproductive Toxicity	No data.
Developmental Toxicity	The results from a mouse developmental toxicity study were presented only in the following summary form in IRIS: teratogenic NOEL=6.0 mg/kg/day, gestational days 7-16); maternal LEL=6.0 mg/kg/day, decrease in maternal weight gain); fetotoxic LEL=6.0 mg/kg/day, decreased numbers of caudal ossification centers and increases in supernumerary ribs).

Dieldrin (continued)

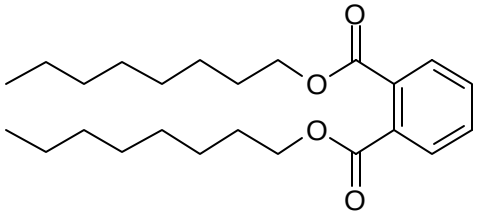
Other Systemic Toxicity	In the principle study, body weight, food intake, and general health remained unaffected throughout the 2-year feeding exposure period, although at 10.0 ppm (0.5 mg/kg/day) all rats became irritable and exhibited tremors and occasional convulsions. No effects were seen in various hematological and clinical chemistry parameters. Hepatomegaly and liver histopathologies were seen in rats in two chronic oral assays. Increased liver weight and liver/body weight ratios, increased plasma alkaline phosphatase, decreased serum protein concentration, weight loss, and convulsions were seen in dogs in two 2-year feeding studies.

CARCINOGENICITY (U.S. EPA, 2000a)

Weight-of-evidence	B2; probable human carcinogen. Dieldrin is carcinogenic in seven strains of mice when administered orally. Dieldrin is structurally related to compounds (aldrin, chlordane, heptachlor, heptachlor epoxide, and chlorendic acid) which produce tumors in rodents.
Slope Factor	16 per (mg/kg)/day (IRIS; last revised 7/1/93); drinking water unit risk 0.00046 per (ug/L).
Human Data	Available data were inadequate to quantify an oral carcinogenicity dose-response. Two studies of workers exposed to aldrin and to dieldrin reported no increased incidence of cancer.
Animal Data	Dieldrin has been shown to be carcinogenic in various strains of mice of both sexes. At different dose levels the effects range from benign liver tumors, to hepatocarcinomas with transplantation confirmation, to pulmonary metastases. The slope factor is the geometric mean of 13 slope factors calculated from liver carcinoma data in both sexes of several strains of mice. Inspection of the data indicated no strain or sex specificity of carcinogenic response. Seven studies with four strains of rats fed 0.1 to 285 ppm dieldrin varying in duration of exposure from 80 weeks to 31 months did not produce positive results for carcinogenicity

Di-n-octyl phthalate

CHEMICAL STRUCTURE:



CAS NUMBER: 117-84-0

TOXICOLOGICAL BASIS for RBC (U.S. EPA, 1999): Non-cancer effects.

MEDIA in which RBC or ARAR was EXCEEDED: Fish

ORAL TOXICITY (U.S. EPA,1997a)

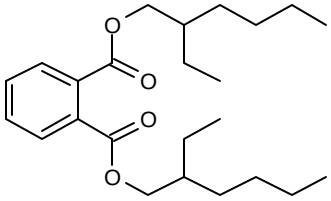
RfD	0.02 mg/kg/day (HEAST; U.S. EPA, 1997a).
Critical Effect	Increased kidney and liver weights and increased levels of liver enzymes SGOT and SGPT in serum were critical effects in rats fed diets containing di-n-octyl phthalate for 7 to 12 months.
NOAEL	Not reported in HEAST.
LOAEL	175 mg/kg/day. An uncertainty factor of 1000 was reported applied, but the basis for the uncertainty factor was not provided.
Human Data	No data.
Immunotoxicity	No data.
Neurotoxicity	No data.
Reproductive Toxicity	No data.
Developmental Toxicity	No data.
Other Systemic Toxicity	No data.

CARCINOGENICITY (U.S. EPA, 1997a, 2000a)

Weight-of-evidence	No data.
Slope Factor	No data.
Human Data	No data.
Animal Data	No data.

bis(2-Ethylhexyl) phthalate

CHEMICAL STRUCTURE:



CAS NUMBER: 117-81-7

TOXICOLOGICAL BASIS for RBC (U.S. EPA, 1999): Cancer effects.

MEDIA in which RBC was EXCEEDED: Fish

ORAL TOXICITY (U.S. EPA, 2000a)

RfD	0.02 mg/kg/day (IRIS; last revised on 5/1/91)
Critical Effect	Increased relative liver weight.
NOAEL	None.
LOAEL	0.04% of diet (19 mg/kg bw/day) in a guinea pigs subchronic-to-chronic oral bioassay (Factors of 10 each were used for interspecies variation and for protection of sensitive human subpopulations. An additional factor of 10 was used since the guinea pig exposure was longer than subchronic but less than lifetime, and because, while the RfD is set on a LOAEL, the effect observed was considered to be minimally adverse.)
Human Data	No data.
Immunotoxicity	No data.
Neurotoxicity	No data.
Reproductive Toxicity	No data.
Developmental Toxicity	In a 2-year dietary exposure study in rats, no effect of treatment on either parental or F1 group was seen with respect to mortality, life expectancy, hematology, or histopathology of organs. Both parental and F1 rats high exposure groups were retarded in growth and had increased kidney and liver weights.
Other Systemic Toxicity	No treatment-related effects were observed on mortality, body weight, kidney weight, or gross pathology and histopathology of kidney, liver, lung, spleen, or testes in the guinea pig subchronic-to-chronic oral bioassay. In a 2-year dietary exposure study in rats, no effect of treatment on either parental or F1 group was seen with respect to mortality, life expectancy, hematology, or histopathology of organs. Both parental and F1 rats high exposure groups were retarded in growth and had increased kidney and liver weights.

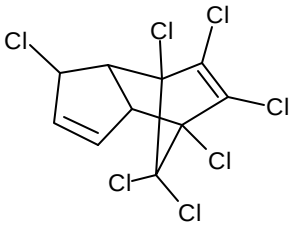
bis(2-Ethylhexyl) phthalate (continued)

CARCINOGENICITY (U.S. EPA, 2000a)

Weight-of-evidence	B2; probable human carcinogen. Based on the finding that orally administered DEHP produced significant dose-related increases in liver tumor responses in rats and mice of both sexes.
Slope Factor	Oral slope factor: 0.014 per mg/kg/day (IRIS; last revised 2/1/93); drinking water unit risk 4.0E-7 per (ug/L)
Human Data	Inadequate for quantifying cancer risk in humans.
Animal Data	A statistically significant increase in the incidence of hepatocellular carcinomas and combined incidence of carcinomas and adenoma were observed in female rats and both sexes of mice in a 2-year dietary exposure assay. The combined incidence of neoplastic nodules and hepatocellular carcinomas was statistically significantly increased in the high-dose male rats. A positive dose response trend was also noted.

Heptachlor (pesticide)

CHEMICAL STRUCTURE:



CAS NUMBER:	76-44-8
TOXICOLOGICAL BASIS for RBC (U.S. EPA, 1999):	Cancer effects.
MEDIA in which RBC was EXCEEDED:	Fish
MEDIA in which ARAR (GDC, 1994) was EXCEEDED:	Surface Water

ORAL TOXICITY (U.S. EPA, 2000a)

RfD	0.0005 mg/kg/day (IRIS; last revised 3/1/91)
Critical Effect	Liver weight increases in male rats in a 2-year feeding study.
NOAEL	0.15 mg/kg/day (3 ppm in diet) (Reported in IRIS as a NOEL). Based on a chronic exposure study, an uncertainty factor of 100 was used to account for inter- and intraspecies differences. An additional factor of 3 was considered appropriate because of the lack of chronic toxicity data in a second species, for a total uncertainty factor of 300. The serious deficiencies in the toxicologic data base would normally warrant a 10-fold factor for this area of uncertainty. However, toxicity data for other cyclodiene insecticides (aldrin, dieldrin, chlordane, and heptachlor epoxide) suggest that dogs and rats do not differ greatly in sensitivity to the effects of this class of compounds. Furthermore, liver toxicity has been fairly well established as the most sensitive endpoint for this class of compounds, which reduces the uncertainty attributable to the lack of information on other toxic effects.
LOAEL	0.25 mg/kg/day (5 ppm in diet) (Reported in IRIS as an LEL).
Human Data	No data.
Immunotoxicity	No data.
Neurotoxicity	There were several case reports involving central nervous system effects and neuroblastomas in children with pre- or postnatal exposure to chlordane and heptachlor.

Reproductive Toxicity	No detailed study descriptions were provided in IRIS; the following data were presented in summary form only. The results of a feeding 1-generation reproduction in rats are as follows: NOEL=5 ppm (0.25 mg/kg/day); LEL=7 ppm (0.35 mg/kg/day) (increased pup death). The results of a 3-generation reproduction study in rats are as follows: NOEL=10 ppm (0.5 mg/kg/day) (no adverse effects).

Heptachlor (continued)

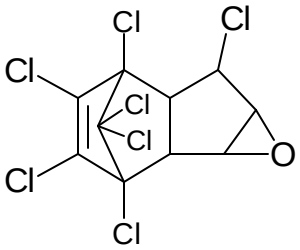
Developmental Toxicity	No data.
Other Systemic Toxicity	There were several case reports involving blood dyscrasias in children with pre- or postnatal exposure to chlordane and heptachlor. The following summary of results was reported in IRIS for an 8-month feeding study in rats: NOEL=none; LEL=5 ppm (0.25 mg/kg/day) (swelling of cells).

CARCINOGENICITY (U.S. EPA, 2000a)

Weight-of-evidence	B2; probable human carcinogen. Sufficient evidence of carcinogenicity in animals exist from studies in which benign and malignant liver tumors were induced in three strains of mice of both sexes. Several structurally related compounds are liver carcinogens.
Slope Factor	4.5 per (mg/kg)/day (IRIS; last revised 7/1/93); drinking water unit risk -- 0.00013 per (ug/L)
Human Data	Data from 11 case studies and 3 epidemiological studies were inadequate to quantify an oral carcinogenicity dose-response.
Animal Data	The oral slope factor was derived based on the dose-response data of hepatocellular carcinomas in two feeding studies in mice. No indication of treatment-related increase of tumors has been reported in chronic studies with rats.

Heptachlor epoxide

CHEMICAL STRUCTURE:



CAS NUMBER: 1024-57-3

TOXICOLOGICAL BASIS for RBC (U.S. EPA, 1999): Cancer effects.

MEDIA in which RBC was EXCEEDED: Fish

ORAL TOXICITY (U.S. EPA, 2000a)

RfD	0.000013 mg/kg/day (IRIS; last revised 3/1/91)
Critical Effect	Increased liver-to-body weight ratio in male and female dogs in a 60-day feeding study
NOAEL	None. (Reported as a NOEL in IRIS)
LOAEL	0.0125 mg/kg/day (0.5 ppm in the diet) (Reported as an LEL in IRIS). An uncertainty factor of 1000 was used to account for inter- and intraspecies differences and to account for the fact that a NOEL was not attained.
Human Data	No data.
Immunotoxicity	No data.
Neurotoxicity	No data.
Reproductive Toxicity	No detailed study descriptions were provided in IRIS; the following data were presented in summary form only. The results of a 2-generation reproduction in dogs are as follows: NOEL=1 ppm (0.025 mg/kg/day); LEL=3 ppm (0.075 mg/kg/day) (liver lesions in pups); Reproductive NOEL=5 ppm (0.125 mg/kg/day); reproductive LEL=7 ppm (0.175 mg/kg/day) (pup survival). The results of a 3-generation reproduction in rats are as follows: NOEL=5 ppm (0.25 mg/kg/day); LEL=10 ppm (0.5 mg/kg/day) (pup mortality).
Developmental Toxicity	No data.
Other Systemic Toxicity	Results of a 2-year feeding study in rats were summarized in IRIS as follows: LEL=0.5 ppm (0.025 mg/kg/day) (females - vacuolar changes in central hepatic lobule); NOEL not established.

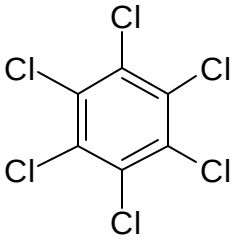
Heptachlor epoxide (continued)

CARCINOGENICITY (U.S. EPA, 2000a)

Weight-of-evidence	B2; probable human carcinogen. Sufficient evidence exists of the carcinogenicity of heptachlor epoxide in animals from rodent studies in which liver carcinomas were induced in two strains of mice of both sexes and in CFN female rats. Several structurally related compounds are liver carcinogens.
Slope Factor	9.1 per (mg/kg)/day (IRIS; last revised 7/1/93); drinking water unit risk 0.00026 per (ug/L).
Human Data	Inadequate. There are no published epidemiologic evaluations of heptachlor epoxide.
Animal Data	Four long-term cancer bioassays of heptachlor epoxide have been reported. The major finding in mice has been an increased incidence of liver carcinomas. The oral slope factor was derived based on the dose-response data of hepatocellular carcinomas in two feeding studies in mice. Analyses of bioassay data with rats reported a significant increase of hepatic carcinomas above the controls in the female rats and a significant increase of hepatic nodules in the males over the controls.

Hexachlorobenzene

CHEMICAL STRUCTURE:



CAS NUMBER: 118-74-1

TOXICOLOGICAL BASIS for RBC (U.S. EPA, 1999): Cancer effects.

MEDIA in which RBC was EXCEEDED: Fish

ORAL TOXICITY (U.S. EPA, 2000a)

RfD	0.0008 mg/kg/day (IRIS; last revised 4/1/91)
Critical Effect	The 8.0-ppm F1 groups were reported to have an increase ($p<0.05$) in hepatic centrilobular basophilic chromogenesis. At 40 ppm, the F1 groups showed increases ($p<0.05$) in pup mortality, hepatic centrilobular basophilic chromogenesis, and severe chronic nephrosis (males only).
NOAEL	0.08 mg/kg/day (1.6 ppm in diet). An uncertainty factor of 100 was applied; 10 for interspecies and 10 for intraspecies variability.
LOAEL	0.29 mg/kg/day (8.0 ppm in diet)
Human Data	The toxicity of long-term dietary exposure of humans to hexachlorobenzene was demonstrated by the epidemic of porphyria cutanea tarda (PCT) in Turkish citizens who accidentally consumed bread made from grain treated with hexachlorobenzene. In children less than 1 year of age, pink sore disease was observed along with 95% mortality. In addition to the PCT-associated symptoms of skin lesions, hypertrichosis, and hyperpigmentation, the exposure caused neurotoxicity and liver damage. Follow-up studies reported PCT symptoms, reduced growth and arthritic changes in the appendages of children who were directly or indirectly (i.e., through breast milk) exposed. These human data cannot be used for quantitative risk assessment purposes because accurate exposure data (dose and duration) are lacking.
Immunotoxicity	No data.
Neurotoxicity	No data.
Reproductive Toxicity	An extensive number of animal research studies have been conducted on hexachlorobenzene including reproductive studies, but they were not summarized in IRIS.

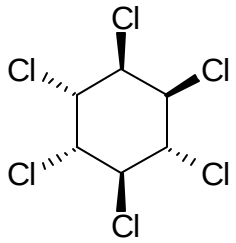
Developmental Toxicity	The derivation of the oral RfD is based on a 130-week, multigeneration rat study in which the males and females in the F0 generation were fed diets containing hexachlorobenzene (analytical grade) for 90 days prior to mating and until 21 days after parturition (at weaning). The F1 animals were exposed to hexachlorobenzene and metabolites in utero, from maternal nursing and from their diets for the remainder of their lifetime (130 weeks). Increased mortality, liver, and renal effects were observed in F1 animals, although IRIS did not report when these effects were observed with respect to exposure. An extensive number of animal research studies have been conducted on hexachlorobenzene including other developmental studies, but they were not summarized in IRIS.
Other Systemic Toxicity	Splenic, renal, and liver effects were observed in a subchronic dietary exposure study in rats.

CARCINOGENICITY (U.S. EPA, 2000a)

Weight-of-evidence	B2; probable human carcinogen. Based on observations of tumors in the liver, thyroid and kidney in three rodent species after oral exposure.
Slope Factor	1.6 per (mg/kg)/day (IRIS; last revised 11/1/96); drinking water unit risk 0.000046 per (ug/L)
Human Data	Inadequate. The reported epidemiological studies of hexachlorobenzene have not been designed to measure increases in cancer incidence as an endpoint and are inadequate in this context.
Animal Data	Hemangiohepatomas, hepatocellular carcinomas and bile duct tumors were significantly increased in treated female rats in a 2-year dietary oral carcinogenicity study; treated males and females had increased incidences of renal cell adenomas and hemangiohepatomas. In a life-time exposure assay in golden hamsters, a significant dose-related increase in the incidence of hepatomas and liver hemangioendotheliomas was observed in males and in females. Treatment-related occurrences of liver tumors were also seen in other oral cancer assays in mice and rats.

alpha-Hexachlorocyclohexane

CHEMICAL STRUCTURE:



CAS NUMBER:	319-84-6
TOXICOLOGICAL BASIS for RBC (U.S. EPA, 1999):	Cancer effects.
MEDIA in which RBC was EXCEEDED:	Fish

ORAL TOXICITY (U.S. EPA, 1997a, 2000a)

RfD	None.
Critical Effect	No data.
NOAEL	No data.
LOAEL	No data.
Human Data	No data.
Immunotoxicity	No data.
Neurotoxicity	No data.
Reproductive Toxicity	No data.
Developmental Toxicity	No data.
Other Systemic Toxicity	No data.

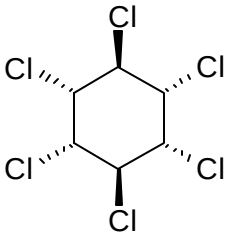
alpha-Hexachlorocyclohexane (continued)

CARCINOGENICITY (U.S. EPA, 2000a)

Weight-of-evidence	B2; probable human carcinogen. Based on increased incidence of liver tumors in five mouse strains and in Wistar rats after dietary exposure to alpha-HCH.
Slope Factor	6.3 per (mg/kg)/day (IRIS; last revised 7/1/93); drinking water unit risk 0.00018 per (ug/L)
Human Data	Available data were inadequate to quantify oral carcinogenicity dose-response.
Animal Data	Dietary alpha-HCH has been shown to cause increased incidences of liver tumors in five mouse strains and in Wistar rats.

gamma-Hexachlorocyclohexane (Lindane)

CHEMICAL STRUCTURE:



CAS NUMBER: 58-89-9

TOXICOLOGICAL BASIS for RBC (U.S. EPA, 1999): Cancer effects.

MEDIA in which RBC was EXCEEDED: Fish

ORAL TOXICITY (U.S. EPA, 2000a)

RfD	0.0003 mg/kg/day (IRIS; last revised 3/1/88)
Critical Effect	Rats receiving 20 and 100 ppm lindane were observed to have greater-than-control incidence of the following: liver hypertrophy, kidney tubular degeneration, hyaline droplets, tubular distension, interstitial nephritis, and basophilic tubules. These effects were mild or rare in animals receiving 4 ppm.
NOAEL	0.33 mg/kg/day (females) (4 ppm in diet). An uncertainty factor of 1000 was used: a factor of 10 each was employed for use of a subchronic vs. a lifetime assay, to account for interspecies variation, and to protect sensitive human subpopulations.
LOAEL	1.55 mg/kg/day (males) (20 ppm in diet)
Human Data	No data.
Immunotoxicity	No data.
Neurotoxicity	No data.
Reproductive Toxicity	Data on reproductive effects of lindane are inconclusive.
Developmental Toxicity	No data.
Other Systemic Toxicity	Liver effects were also observed in a second oral study in rats. No treatment-related effects were noted on mortality, hematology, clinical chemistry, or urinalysis in the principle study.

gamma-Hexachlorocyclohexane *(Lindane)* ***(continued)***

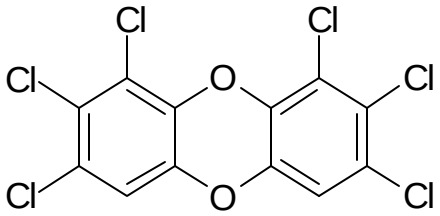
CARCINOGENICITY (U.S. EPA, 1997a; no data available on IRIS)

Weight-of-evidence	B2 or C (unspecified in HEAST).
Slope Factor	1.3 per mg/kg/day (HEAST); oral unit risk 0.000037 ug/L.
Human Data	No data.
Animal Data	Liver tumors were observed in mice in a 2-year dietary exposure assay. No other information was reported in HEAST or IRIS.

1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin

(Synonym of Hexachlorodibenzo-p-dioxin, mixture (HxCDD))

CHEMICAL STRUCTURE:



CAS NUMBER:	19408-74-3
TOXICOLOGICAL BASIS for RBC (U.S. EPA, 1999):	Cancer effects.
MEDIA in which RBC was EXCEEDED:	Fish

ORAL TOXICITY (U.S. EPA, 1997a, 2000a)

RfD	None.
Critical Effect	No data.
NOAEL	No data.
LOAEL	No data.
Human Data	No data.
Immunotoxicity	No data.
Neurotoxicity	No data.
Reproductive Toxicity	No data.
Developmental Toxicity	No data.
Other Systemic Toxicity	No data.

1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (continued)

CARCINOGENICITY (U.S. EPA, 2000)

Weight-of-evidence	B2; probable human carcinogen. Based on hepatic tumors in mice and rats exposed by gavage.
Slope Factor	6200 per (mg/kg)/day (IRIS; last revised 3/1/91); drinking water unit risk 0.18 per (ug/L).
Human Data	None. There are no published epidemiologic evaluations of hexachloro-dibenzo-p-dioxin.
Animal Data	The oral slope factor was derived based on the dose-response data of liver tumors (neoplastic nodules, adenomas, and carcinomas) in 2-year gavage studies in mice and rats. No carcinogenic response related to treatment was observed in a mouse skin-painting study.

Lead

CHEMICAL STRUCTURE:	Pb
CAS NUMBER:	7439-92-1
TOXICOLOGICAL BASIS for ARAR (U.S. EPA, 1997b):	FDA Guidance Value
MEDIA in which ARAR was EXCEEDED:	Fish

ORAL TOXICITY (U.S. EPA, 2000a)

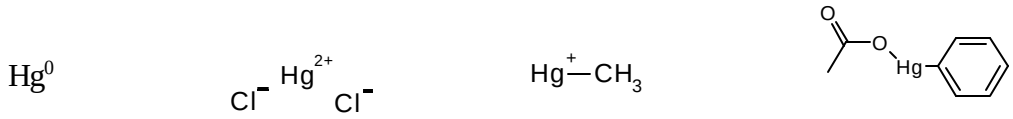
RfD	By comparison to most other environmental toxicants, the degree of uncertainty about the health effects of lead is quite low. It appears that some of these effects, particularly changes in the levels of certain blood enzymes and in aspects of children's neurobehavioral development, may occur at blood lead levels so low as to be essentially without a threshold. The Agency's RfD Work Group discussed inorganic lead (and lead compounds) at two meetings (07/08/1985 and 07/22/1985) and considered it inappropriate to develop an RfD for inorganic lead. For additional information, interested parties are referred to the 1986 Air Quality Criteria for Lead (EPA-600/8-83/028a-dF) and its 1990 Supplement (EPA/600/8-89/049F). (Last update: 02/01/1991). More current information related to performing lead risk assessments is available at the web page developed by the EPA Technical Review Workgroup for Lead: http://www.epa.gov/superfund/programs/lead/index.htm.
Critical Effect	No data.
NOAEL	No data.
LOAEL	No data.
Human Data	No data.
Immunotoxicity	No data.
Neurotoxicity	No data.
Reproductive Toxicity	No data.
Developmental Toxicity	No data.
Other Systemic Toxicity	No data.

CARCINOGENICITY (U.S. EPA, 2000a)

Weight-of-evidence	Classification -- B2; probable human carcinogen. Based on sufficient animal evidence. (Last update: 11/01/1993).
Slope Factor	Not available. Quantifying lead's cancer risk involves many uncertainties, some of which may be unique to lead. Age, health, nutritional state, body burden, and exposure duration influence the absorption, release, and excretion of lead. In addition, current knowledge of lead pharmacokinetics indicates that an estimate derived by standard procedures would not truly describe the potential risk. Thus, the Carcinogen Assessment Group recommends that a numerical estimate not be used.
Human Data	Human evidence is inadequate. All of the available epidemiological studies lacked quantitative exposure information, as well as information on the possible contribution from smoking. All studies also included exposures to other metals such as arsenic, cadmium, and zinc for which no adjustment was done. The cancer excesses observed in the lung and stomach were relatively small (<200). There was no consistency of site among the various studies, and no study showed any dose-response relationship. Thus, the available human evidence is considered to be inadequate to refute or demonstrate any potential carcinogenicity for humans from lead exposure.
Animal Data	Sufficient. The carcinogenic potential of lead salts (primarily phosphates and acetates) administered via the oral route or by injection has been demonstrated in rats and mice by more than 10 investigators. The most characteristic cancer response is bilateral renal carcinoma. Rats given lead acetate or subacetate orally have developed gliomas, and lead subacetate also produced lung adenomas in mice after i.p. adminstration. Most of these investigations found a carcinogenic response only at the highest dose. The lead compounds tested in animals are almost all soluble salts. Metallic lead, lead oxide and lead tetralkyls have not been tested adequately. Studies of inhalation exposure have not been located in the literature.Animal assays provide reproducible results in several laboratories, in multiple rat strains with some evidence of multiple tumor sites. Short term studies show that lead affects gene expression.

Mercury

CHEMICAL STRUCTUREs:



elemental mercury | mercuric chloride | methyl mercury | phenylmercuric acetate

CAS NUMBERs:

7439-97-6 (elemental)
7487-94-7 (mercuric chloride)
22967-92-6 (methyl mercury)
62-38-4 (phenylmercuric acetate)

TOXICOLOGICAL BASIS for ARAR (U.S. EPA, 1997b): Non-cancer effects.

MEDIA in which ARAR was EXCEEDED: Fish

ORAL TOXICITY (U.S. EPA, 1997a, 2000a)

RfD	Elemental mercury: None. Mercuric chloride: 0.0003 mg/kg-day (This RfD is based on the back calculations from a Drinking Water Equivalent Level (DWEL), recommended to and subsequently adopted by the Agency, of 0.010 mg/L: (RfD = 0.010 mg/L x 2 L/day/70 kg bw = 0.0003 mg/kg bw/day). The LOAEL exposure levels were obtained in the three studies selected as the basis of the recommended DWEL). Methyl mercury: An RfD of 0.0001mg/kg-day based on a NOAEL of for developmental neurological abnormalities in human infants is reported on IRIS for methylmercury (last updated on 05/01/1995). Phenylmercuric acetate: An RfD of 0.00008 based on a NOAEL of 0.0084 mg/kg/day for renal damage in a chronic rat study (last updated 11/01/1996).
Critical Effect	Mercuric chloride: autoimmune effects in Brown Norway rats after subchronic feeding and subcutaneous exposures. Methyl mercury: developmental neurological abnormalities in human infants. Phenylmercuric acetate: renal damage.

Mercury (continued)

NOAEL	Mercuric chloride: None. Methyl mercury: None. Phenylmercuric acetate: 0.0084 mg/kg-day estimated using the following conversion: food consumption 5% bw/day, molecular weight phenyl mercuric acetate/mercury is 337/201; thus, 0.1 mg/kg of diet (ppm) x 0.05 kg of diet/kg bw/day x 337/201 = 0.0084 mg/kg bw/day. (An ADI of 0.08 ug/kg/day or 6 ug/kg/day for a 70-kg person was derived by dividing the NOEL by an uncertainty factor of 100 to account for species extrapolation and differences in human sensitivity).
LOAEL	Mercuric chloride: 0.226, 0.317, and 0.633 mg/kg-day (an uncertainty factor of 1000 was applied to the animal studies using Brown Norway rats as recommended in U.S. EPA (1987). An uncertainty factor was applied for LOAEL to NOAEL conversion: 10 for use of subchronic studies and a combined 10 for both animal to human and sensitive human populations.) Methyl mercury: Benchmark maternal dose of 1.1 ug/kg-day based estimated from measured maternal body burden (An uncertainty factor of 3 is applied for variability in the human population, in particular the variation in the biological half-life of MeHg and the variation that occurs in the hair:blood ratio for Hg. In addition, a factor of 3 is applied for lack of a two-generation reproductive study and lack of data for the effect of exposure duration on sequelae of the developmental neurotoxicity effects and on adult paresthesia. The total UF is 10.). Phenylmercuric acetate: 0.5 ppm mercury in the diet, or 0.042 mg/kg/day phenyl mercuric acetate for renal damage.

Human Data	Mercuric chloride: Renal biopsies were performed in 2 (out of 4) workers with nephrotic syndrome who had been occupationally exposed to mercuric oxide, mercuric acetate and probably mercury vapors. Investigators reported that the nephrotic syndrome observed in 3 of the 4 workers may have been an idiosyncratic reaction since many other workers in a factory survey had similarly high levels of urine mercury without developing proteinuria. Methyl mercury: In 1971-1972 many citizens in rural Iraq were exposed to MeHg-treated seed grain that was mistakenly used in home-baked bread. Latent toxicity was observed in many adults and children who had consumed bread over a 2- to 3-month period. Infants born to mothers who ate contaminated bread during gestation were the most sensitive group. Often infants exhibited neurologic abnormalities while their mothers showed no signs of toxicity. Among the signs noted in the infants exposed during fetal development were cerebral palsy, altered muscle tone and deep tendon reflexes as well as delayed developmental milestones, i.e., walking by 18 months and talking by 24 months. The neurologic signs noted in adults included paresthesia, ataxia, reduced visual fields and hearing impairment. In a report of neurologic abnormalities in four communities of Cree Indians in northern Quebec, a group of 247 children first exhibited clinical signs consistent with MeHg exposure between 12 and 30 months of age. The average indices of exposure were the same for boys and girls at 6 ug/g; only 6% had exposure above 20 ug/g. The prevalence of multiple abnormal neurologic findings was about 4% for children of both sexes. The most frequently observed abnormality was delayed deep tendon reflexes; this was seen in 11.4% of the boys and 12.2% of the girls. These investigators found that when there was a positive association between maternal Hg exposure and abnormal neurologic signs in boys, the incidence rate was 7.2%. Persistence of the Babinski reflex and incoordination due to delayed motor development were seen with equal frequency for both sexes. Other supporting human data are reported in IRIS. Phenylmercuric acetate: No data.
Immunotoxicity	Mercuric chloride: The most sensitive adverse effect for mercury risk assessment is formation of mercuric-mercury-induced autoimmune glomerulonephritis. The production and deposition of IgG antibodies to the glomerular basement membrane can be considered the first step in the formation of this mercuric-mercury-induced autoimmune glomerulonephritis. The Brown Norway rat should be used for mercury risk assessment. The Brown Norway rat is a good test species for the study of Hg2+-induced autoimmune glomerulonephritis. The Brown Norway rat is not unique in this regard (this effect has also been observed in rabbits). Methyl mercury: No data. Phenylmercuric acetate: No data.

Mercury (continued)

Neurotoxicity	Mercuric chloride: No data. Methyl mercury: An epidemiologic report of MeHg poisoning involved 628 human cases that occurred in Minamata Japan between 1953 and 1960. The overall prevalence rate for the Minamata region for neurologic and mental disorders was 59%. Among this group 78 deaths occurred and hair concentrations of Hg ranged from 50-700 ug/g. The most common clinical signs observed in adults were paresthesia, ataxia, sensory disturbances, tremors, impairment of hearing and difficulty in walking. This particular group of neurologic signs has become known as "Minimata disease." Examination of the brains of severely affected patients that died revealed marked atrophy of the brain (55% normal volume and weight) with cystic cavities and spongy foci. Microscopically, entire regions were devoid of neurons, granular cells in the cerebellum, golgi cells and Purkinje cells. A large database of supporting animal data is reported in IRIS. Phenylmercuric acetate: No data.
Reproductive Toxicity	Mercuric chloride: In male mice administered a single i.p. dose of 1 mg/kg HgCl2, fertility decreased between days 28 and 49 post treatment with no obvious histological effects noted in the sperm. Methyl mercury: No clear reproductive performance effects were reported in IRIS in animal studies. Phenylmercuric acetate: No data.
Developmental Toxicity	Mercuric chloride: No data. Methyl mercury: The initial epidemiologic report of MeHg poisoning involved 628 human cases that occurred in Minamata Japan between 1953 and 1960. Extensive investigations of congenital Minamata disease were undertaken and 20 cases that occurred over a 4-year period were documented. In all instances the congenital cases showed a higher incidence of symptoms than did their mothers. Severe disturbances of nervous function were described and the affected offspring were very late in reaching developmental milestones. Developmental studies in animals also indicated neurological involvement. Phenylmercuric acetate: No data.
Other Systemic Toxicity	Mercuric chloride: In animal studies, nephropathy, proteinurea, altered kidney weights have been reported. Hyperparathyroidism, mineralization of various tissues and fibrous osteodystrophy were observed and considered secondary to the renal impairment. Methyl mercury: chronic nephropathy in animal studies Phenylmercuric acetate: No data.

CARCINOGENICITY (U.S. EPA, 2000a)

Weight-of-evidence	Elemental mercury: Classification -- D; not classifiable as to human carcinogenicity based on inadequate human and animal data (last updated 05/01/1995). Epidemiologic studies failed to show a correlation between exposure to elemental mercury vapor and carcinogenicity; the findings in these studies were confounded by possible or known concurrent exposures to other chemicals, including human carcinogens, as well as lifestyle factors (e.g., smoking). Findings from genotoxicity tests are severely limited and provide equivocal evidence that mercury adversely affects the number or structure of chromosomes in human somatic cells. Mercuric chloride: Classification -- C; possible human carcinogen based on the absence of data in humans and limited evidence of carcinogenicity in rats and mice (last updated on 06/01/1995). Methyl mercury: Classification -- C; possible human carcinogen based on inadequate data in humans and limited evidence of carcinogenicity in animals (last updated on 05/01/1995). Phenylmercuric chloride: No data.
Slope Factor	Elemental mercury: None. Mercuric chloride: None. Methyl mercury: None.
Human Data	Elemental mercury: Inadequate. A number of epidemiological studies were conducted that examined mortality among elemental mercury vapor-exposed workers. Conflicting data regarding a correlation between mercury exposure and an increased incidence of cancer mortalities have been obtained. All of the studies have limitations that complicate interpretation of their results for associations between mercury exposure and induction of cancer; increased cancer rates were attributable to other concurrent exposures or lifestyle factors. Mercuric chloride: No data. Methyl mercury: Inadequate. Three studies were identified that examined the relationship between methylmercury exposure and cancer. No persuasive evidence of increased carcinogenicity attributable to methylmercury exposure was observed in any of the studies. Interpretation of these studies, however, was limited by poor study design and incomplete descriptions of methodology and/or results.

Mercury (continued)

Animal Data

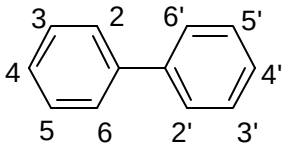
Elemental mercury: Inadequate. One study was available that evaluated carcinogenicity of elemental mercury in rats after intraperitoneal injection.

Mercuric chloride: Focal papillary hyperplasia and squamous cell papillomas in the forestomach as well as thyroid follicular cell adenomas and carcinomas were observed in male rats gavaged with mercuric chloride for 2 years. The relevance of the forestomach papillomas to assessment of cancer in humans is questionable because no evidence indicated that the papillomas progressed to malignancy. The relevance of the increase in thyroid tumors has also been questioned because these tumors are generally considered to be secondary to hyperplasia; this effect was not observed in the high-dose males. It should also be noted that the authors considered the doses used in the study to exceed the MTD for male rats. In the same study, evidence for increases in squamous cell papillomas in the forestomach of female rats was equivocal. In a second study, equivocal evidence for renal adenomas and adenocarcinomas was observed in male mice; there was a significant positive trend. This tumor type is rare in mice, and the increase in incidence was statistically significant when compared with historic controls. Two other nonpositive lifetime rodent studies were considered inadequate. Mercuric chloride showed mixed results in a number of genotoxicity assays.

Methyl mercury: Limited. Three dietary studies in two strains of mice indicate that methylmercury is carcinogenic. Interpretation of two of the positive studies was complicated by observation of tumors only at doses that exceeded the MTD. A fourth dietary study in mice and four dietary studies in rats failed to indicate carcinogenicity associated with methylmercury exposure. Interpretation of four of the nonpositive studies was limited because of deficiencies in study design or failure to achieve an MTD.

PCBs (Total)

CHEMICAL STRUCTURE:



PCBs are a group of compounds which contain chlorine atoms attached to different positions on a biphenyl molecule. Although 209 different congeners can potentially exist, recent studies indicate that the commercial PCBs contained 132 different compounds.

CAS NUMBER:	1336-36-3
TOXICOLOGICAL BASIS for RBC (U.S. EPA, 1999):	Cancer effects.
MEDIA in which RBC was EXCEEDED:	Fish, Sediment
MEDIA in which ARAR (GDC, 1994) was EXCEEDED:	Surface Water

ORAL TOXICITY (U.S. EPA, 1997a, 2000a)

RfD	None.
Critical Effect	No data.
NOAEL	No data.
LOAEL	No data.
Human Data	No data.
Immunotoxicity	No data.
Neurotoxicity	No data.
Reproductive Toxicity	No data.
Developmental Toxicity	No data.
Other Systemic Toxicity	No data.

PCBs (Total) (continued)

CARCINOGENICITY (U.S. EPA, 2000a)

Weight-of-evidence	B2; probable human carcinogen (last revised 6/1/97). Basis -- A 1996 study found liver tumors in female rats exposed to Aroclors 1260, 1254, 1242, and 1016, and in male rats exposed to 1260. These mixtures contain overlapping groups of congeners that, together, span the range of congeners most often found in environmental mixtures. Earlier studies found high, statistically significant incidences of liver tumors in rats ingesting Aroclor 1260 or Clophen A 60. Mechanistic studies are beginning to identify several congeners that have dioxin-like activity and may promote tumors by different modes of action. PCBs are absorbed through ingestion, inhalation, and dermal exposure, after which they are transported similarly through the circulation. This provides a reasonable basis for expecting similar internal effects from different routes of environmental exposure. Information on relative absorption rates suggests that differences in toxicity across exposure routes are small. The human studies are being updated; currently available evidence is inadequate, but suggestive.
Slope Factor	For high risk sub-populations, the following slope factors for polychlorinated biphenyls were provided in IRIS: upper-bound slope factor - 2.0 per (mg/kg)/day; central-estimate slope factor - 1.0 per (mg/kg)/day. Highly exposed populations include some nursing infants and consumers of game fish, game animals, or products of animals contaminated through the food chain. The criteria for using slope factors for high risk populations include food chain exposure and sediment or soil ingestion. The slope factors were based on reported incidences of liver hepatocellular adenomas, carcinomas, cholangiomas, or cholangiocarcinomas in female Sprague-Dawley rats after dietary exposures.
Human Data	Inadequate for quantifying risk of cancer in humans after PCB exposure.
Animal Data	Increased incidences of liver adenomas and carcinomas and/or thyroid adenomas or carcinomas in rats after chronic dietary exposure to Aroclor 1260 and Aroclor 1254.

Appendix B REFERENCES

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APPENDIX C - RAGS D TABLES

TABLE C-2.2
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
TIDAL ANACOSTIA RIVER

Scenario Timeframe:	**Current**
Medium:	**Various**
Exposure Medium:	**Fish Tissue**
Exposure Point:	**N/A**

CAS Number	Chemical	Minimum Concentration[1]	Minimum Qualifier[2]	Maximum Concentration[1]	Maximum Qualifier[2]	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits[3]	Concentration Used for Screening[4]	Background Value[5]	Screening Toxicity Value[6]	Potential ARAR/ TBC Value	Potential ARAR/ TBC Source[7]	COPC Flag	Rationale for Contaminant Deletion or Selection[8]
83329	Acenaphthene	6.30E-04	J	2.83E-02		PPM	LA	12 / 29	0.0003 - 0.002	2.83E-02	N/A	8.11E+00 N	6.50E+01	2	YES	IEI
208968	Acenaphthylene	3.50E-04	J	5.00E-03		PPM	LA	12 / 29	0.0004 - 0.0009	5.00E-03	N/A				YES	IEI
309002	Aldrin	2.90E-04		2.31E-03		PPM	LA	8 / 32	0.0001 - 0.001	2.31E-03	N/A	1.86E-04 C	6.30E-04	1	YES	ATL
120127	Anthracene	8.00E-04		1.23E-02		PPM	LA	12 / 29	0.0003 - 0.004	1.23E-02	N/A	4.06E+01 N	3.20E+02	2	YES	IEI
11096825	Aroclor 1260	1.80E-01		4.50E-01		PPM	16330	3 / 3		4.50E-01	N/A	1.58E-03 C	1.40E-03	1	YES	ATL
7440382	Arsenic	2.50E-02		2.66E-01		PPM	LA	10 / 16	0.029 - 0.05	2.66E-01	N/A	2.10E-03 C	6.20E-03	1	YES	ATL
117817	Bis(2ethylhexyl) phthalate	5.80E-02		6.40E-01		PPM	3	16 / 18	0.009 - 0.009	6.40E-01	N/A	2.25E-01 C	7.70E-01	1	YES	ATL
56553	Benz(a)anthracene	2.00E-04	J	1.35E-03		PPM	LA	11 / 29	0.0004 - 0.005	1.35E-03	N/A	4.32E-03 C	1.50E-02	1	YES	IEI
53703	Dibenz(a,h)anthracene	1.00E-05	J	1.20E-04	J	PPM	LA	11 / 29	0.001 - 0.002	1.20E-04	N/A	4.32E-04 C	1.50E-03	1	YES	IEI
50328	Benzo(a)pyrene	7.00E-05	J	2.60E-04	J	PPM	KM	11 / 29	0.0006 - 0.002	2.60E-04	N/A	4.32E-04 C	1.50E-03	1	YES	IEI
205992	Benzo(b)fluoranthene	4.00E-05	J	4.90E-04	J	PPM	KM	11 / 29	0.0005 - 0.003	4.90E-04	N/A	4.32E-03 C	1.50E-02	1	YES	IEI
192972	Benzo(e)pyrene	1.10E-04	J	6.40E-04		PPM	UA	11 / 11		6.40E-04	N/A				YES	IEI
191242	Benzo(g,h,i)perylene	7.00E-05	J	3.10E-04	J	PPM	LA	11 / 29	0.0005 - 0.005	3.10E-04	N/A				YES	IEI
92524	Biphenyl	6.90E-04	J	1.06E-01		PPM	LA	11 / 11		1.06E-01	N/A	6.76E+00 N	5.40E+01	2	YES	IEI
207089	Benzo(k)fluoranthene	6.00E-05	J	1.60E-04	J	PPM	LA	11 / 29	0.0005 - 0.003	1.60E-04	N/A	4.32E-02 C	1.50E-01	1	YES	IEI
7440439	Cadmium	3.02E-03		2.00E-01		PPM	16330	15 / 16	0.003 - 0.003	2.00E-01	N/A	1.35E-01 N	5.40E-01	2	YES	ATL
5103742	Transchlordane	3.90E-02		2.30E-01		PPM	LA	10 / 12		2.30E-01	N/A		8.30E-03	1	YES	ASL
5103719	Cischlordane	2.00E-03		3.40E-01		PPM	4	38 / 41		2.30E-01	N/A		8.30E-03	1	YES	ASL
27304138	Oxychlordane	1.09E-03		1.00E-02		PPM	BRA	12 / 23		1.00E-02	N/A				YES	IEI
5566347	Chlordane gamma	5.00E-04		9.00E-02		PPM	3	29 / 29		9.00E-02	N/A		8.30E-03	1	YES	ASL
7440473	Chromium, total	4.71E-02		5.00E-01		PPM	16330	10 / 16	0.04 - 0.5	5.00E-01	N/A		5.40E+00	2	YES	IEI
218019	Chrysene	2.60E-04	J	5.37E-03		PPM	LA	11 / 29	0.0004 - 0.005	5.37E-03	N/A	4.32E-01 C	1.50E+00	1	YES	IEI
319846	Hexachlorocyclohexanealpha	1.10E-04		8.00E-03		PPM	16330	13 / 32	0.00009 - 0.002	8.00E-03	N/A	5.01E-04 C	1.70E-03	1	YES	ATL
319857	Hexachlorocyclohexanebeta	2.00E-05	J	5.00E-04		PPM	LA	6 / 29	0.00003 - 0.003	5.00E-04	N/A	1.75E-03 C	6.00E-03	1	YES	IEI
319868	Hexachlorocyclohexanedelta	4.90E-04		4.90E-04		PPM	LA	1 / 29	0.00016 - 0.002	4.90E-04	N/A		6.00E-03	1	YES	IEI
58899	Hexachlorocyclohexanegamma (Lindane)	1.60E-04		2.58E-03		PPM	LA	12 / 32	0.0003 - 0.002	2.58E-03	N/A	2.43E-03 C	8.30E-03	1	YES	ATL
118741	Hexachlorobenzene (HCB)	2.50E-04		4.98E-03		PPM	LA	13 / 32	0.0005 - 0.004	4.98E-03	N/A	1.97E-03 C	6.70E-03	1	YES	ATL
7440508	Copper	2.70E-01		7.50E-01		PPM	16330	5 / 5		7.50E-01	N/A	5.41E+00 N	4.00E+01	2	YES	IEI
1861321	Dacthal	1.00E-03		1.00E-03		PPM	16330	1 / 3	0.001 - 0.001	1.00E-03	N/A	1.35E+00 N	1.10E+01	2	YES	IEI
84662	Diethyl phthalate	4.00E-03		1.40E-02		PPM	4	8 / 18	0.001 - 0.002	1.40E-02	N/A	1.08E+02 N	8.60E+02	2	YES	IEI
132650	Dibenzothiophene	3.10E-04	J	1.53E-02		PPM	LA	11 / 11		1.53E-02	N/A				YES	IEI
60571	Dieldrin	2.50E-04		5.20E-02		PPM	LA	41 / 44		5.20E-02	N/A	1.97E-04 C	6.70E-04	1	YES	ATL
84742	Dinbutyl phthalate	2.50E-02		1.60E-01		PPM	3	17 / 18	0.005 - 0.005	1.60E-01	N/A	1.35E+01 N	1.10E+02	2	YES	IEI
33213659	Endosulfanbeta	3.40E-04		4.10E-04		PPM	KM	2 / 29	0.00015 - 0.001	4.10E-04	N/A		6.50E+00	2	YES	IEI

TABLE C-2.2
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
TIDAL ANACOSTIA RIVER

Scenario Timeframe:	**Current**
Medium:	**Various**
Exposure Medium:	**Fish Tissue**
Exposure Point:	**N/A**

CAS Number	Chemical	Minimum Concentration[1]	Minimum Qualifier[2]	Maximum Concentration[1]	Maximum Qualifier[2]	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits[3]	Concentration Used for Screening[4]	Background Value[5]	Screening Toxicity Value[6]	Potential ARAR/ TBC Value	Potential ARAR/ TBC Source[7]	COPC Flag	Rationale for Contaminant Deletion or Selection[8]
1031078	Endosulfan sulfate	4.00E-03		4.00E-03		PPM	3	1 / 18	0.0008 - 0.001	4.00E-03	N/A				YES	IEI
72208	Endrin	9.90E-04		1.12E-03		PPM	LA	2 / 32	0.00018 - 0.002	1.12E-03	N/A	4.06E-02 N	3.20E-01	2	YES	IEI
206440	Fluoranthene	5.00E-04	J	3.06E-02		PPM	UA	14 / 29	0.0004 - 0.002	3.06E-02	N/A	5.41E+00 N	4.30E+01	2	YES	IEI
86737	Fluorene	8.90E-04	J	6.01E-02		PPM	LA	13 / 29	0.0003 - 0.002	6.01E-02	N/A	5.41E+00 N	4.30E+01	2	YES	IEI
1024573	Heptachlor epoxide	5.90E-04		1.70E-02		PPM	4	26 / 32	0.0005 - 0.001	1.70E-02	N/A	3.47E-04 C	1.20E-03	1	YES	ATL
76448	Heptachlor (pesticide)	5.00E-05	J	6.10E-03		PPM	3	12 / 32	0.00012 - 0.001	6.10E-03	N/A	7.01E-04 C	2.40E-03	1	YES	ATL
193395	Indeno(1,2,3c,d)pyrene	4.00E-05	J	2.00E-04	J	PPM	LA	11 / 29	0.005 - 2	2.00E-04	N/A	4.32E-03 C	1.50E-02	1	YES	IEI
78591	Isophorone	1.90E+00		1.90E+00		PPM	4	1 / 18	0.0004 - 0.005	1.90E+00	N/A	3.32E+00 C	1.10E+01	1	YES	IEI
7439921	Lead	2.50E-02		4.20E+00		PPM	16330	16 / 16		4.20E+00	N/A		1.30E+00	3	YES	ASL
7439965	Manganese	5.50E-01		6.00E-01		PPM	ANA82	2 / 2		6.00E-01	N/A	1.89E+01 N	5.40E+00	2	YES	IEI
2245387	1,6,7Trimethylnaphthalene	8.20E-04	J	2.09E-01		PPM	LA	11 / 11		2.09E-01	N/A				YES	IEI
7439976	Mercury	2.49E-02		1.59E-01		PPM	16330	16 / 16		1.59E-01	N/A	1.35E-02 N	1.10E-01	2	YES	ATL
90120	1Methylnaphthalene	2.29E-03		1.84E-01		PPM	LA	11 / 11		1.84E-01	N/A				YES	IEI
91576	2Methylnaphthalene	3.64E-03		2.72E-01		PPM	LA	11 / 11		2.72E-01	N/A	2.70E+00 N			YES	IEI
581420	2,6Dimethylnaphthalene	1.10E-03	J	3.82E-01		PPM	LA	11 / 11		3.82E-01	N/A				YES	IEI
832699	1Methylphenanthrene	2.50E-04	J	1.34E-02		PPM	LA	11 / 11		1.34E-02	N/A				YES	IEI
2385855	Mirex (pesticide = dechlorane)	8.00E-05		8.80E-04		PPM	UA	11 / 14	0.001 - 0.001	8.80E-04	N/A	2.70E-02 N	6.00E-03	1	YES	IEI
91203	Naphthalene	4.80E-03		1.60E-01		PPM	3	25 / 29	0.0001 - 0.0001	1.60E-01	N/A	2.70E+00 N	4.30E+01	2	YES	IEI
7440020	Nickel	3.40E-02		7.16E-02		PPM	LA	6 / 13	0.03 - 0.05	7.16E-02	N/A	2.70E+00 N	2.20E+01	2	YES	IEI
117840	DiNoctyl phthalate	3.90E-02		6.70E+00		PPM	4	16 / 18	0.007 - 0.03	6.70E+00	N/A	2.70E+00 N	2.20E+01	2	YES	ATL
39765805	Trans nonachlor	1.07E-02		3.70E-01		PPM	LA	21 / 23		3.70E-01	N/A				YES	IEI
5103731	cisNonachlor	4.44E-03		8.20E-02		PPM	LA	13 / 23		8.20E-02	N/A				YES	IEI
3268879	Octachlorodibenzopdioxin	6.50E-07		5.71E-05		PPM	4	18 / 18		5.71E-05	N/A	2.10E-05 C			YES	ATL
39001020	Octachlorodibenzofuran	1.00E-07		9.22E-05		PPM	3	18 / 18		9.22E-05	N/A	2.10E-05 C			YES	ATL
53190	o,p'DDD	2.37E-03		1.43E-02		PPM	UA	11 / 11		1.43E-02	N/A		4.50E-02	1	YES	IEI
3424826	o,p'DDE	9.00E-05	J	1.27E-03		PPM	LA	11 / 11		1.27E-03	N/A		3.20E-02	1	YES	IEI
789026	o,p'DDT	6.20E-04		6.90E-03		PPM	LA	10 / 11	0.00008 - 0.00008	6.90E-03	N/A		3.20E-02	1	YES	IEI
1336363	PCBS, total	4.07E-02		4.60E+00		PPM	LA	43 / 44		4.60E+00	N/A	1.578E-02 C	1.40E-03	1	YES	ATL
35822469	H7CDD1234678	1.00E-07		6.20E-06		PPM	4	15 / 18	0.0000002 - 0.0000073	6.20E-06	N/A	2.10E-06 C			YES	ATL
39227286	H6CDD123478	1.00E-07		5.70E-06		PPM	3	16 / 18	0.0000001 - 0.00000085	5.70E-06	N/A	2.10E-07 C			YES	ATL
57653857	H6CDD123678	5.00E-08		7.40E-06		PPM	3	16 / 18	0.00000015 - 0.00000075	7.40E-06	N/A	2.10E-07 C			YES	ATL
40321764	PCDD12378	5.00E-08		3.90E-06		PPM	4	16 / 18	0.0000002 - 0.0000016	3.90E-06	N/A	4.20E-07 C			YES	ATL
19408743	H6CDD123789	5.00E-08		1.03E-05		PPM	3	17 / 18	0.00000085 - 0.00000085	1.03E-05	N/A	2.09E-07 C			YES	ATL
1746016	TCDD2378 (dioxin)	5.00E-08		2.80E-06		PPM	3	18 / 18		2.80E-06	N/A	2.10E-08 C	6.90E-08	1	YES	ATL

TABLE C-2.2
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
TIDAL ANACOSTIA RIVER

Scenario Timeframe:	**Current**
Medium:	**Various**
Exposure Medium:	**Fish Tissue**
Exposure Point:	**N/A**

CAS Number	Chemical	Minimum Concentration[1]	Minimum Qualifier[2]	Maximum Concentration[1]	Maximum Qualifier[2]	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits[3]	Concentration Used for Screening[4]	Background Value[5]	Screening Toxicity Value[6]	Potential ARAR/ TBC Value	Potential ARAR/ TBC Source[7]	COPC Flag	Rationale for Contaminant Deletion or Selection[8]
67562394	H7CDF1234678	5.00E-08		1.96E-05		PPM	3	18 / 18		1.96E-05	N/A	2.10E-06 C			YES	ATL
70648269	H6CDF123478	5.00E-08		1.00E-05		PPM	3	18 / 18		1.00E-05	N/A	2.10E-07 C			YES	ATL
55673897	H7CDF1234789	5.00E-08		2.55E-06		PPM	4	18 / 18		2.55E-06	N/A	2.10E-06 C			YES	ATL
57117449	H6CDF123678	5.00E-08		8.10E-06		PPM	3	18 / 18		8.10E-06	N/A	2.10E-07 C			YES	ATL
57117416	PCDF12378	5.00E-08		5.00E-06		PPM	3	17 / 18	0.0000007 - 0.0000007	5.00E-06	N/A	4.20E-06 C			YES	ATL
72918219	H6CDF123789	1.00E-07		9.50E-06		PPM	3	16 / 18	0.00000015 - 0.00000025	9.50E-06	N/A	2.10E-07 C			YES	ATL
60851345	H6CDF234678	5.00E-08		5.00E-06		PPM	3	17 / 18	0.0000045 - 0.0000045	5.00E-06	N/A	2.10E-07 C			YES	ATL
57117314	PCDF23478	5.00E-08		4.75E-06		PPM	3	18 / 18		4.75E-06	N/A	4.20E-07 C			YES	ATL
51207319	TCDF2378	5.00E-08		4.80E-06		PPM	3	18 / 18		4.80E-06	N/A	2.10E-07 C			YES	ATL
198550	Perylene	8.00E-05	J	4.90E-04	J	PPM	LA	11 / 11		4.90E-04	N/A				YES	IEI
85018	Phenanthrene	1.35E-03		1.03E-01		PPM	LA	15 / 29	0.0003 - 0.004	1.03E-01	N/A				YES	IEI
108952	Phenol	4.00E-02		4.00E-02		PPM	4	1 / 18	0.001 - 0.01	4.00E-02	N/A	8.11E+01 N	6.50E+02	2	YES	IEI
72548	p,p'DDD	1.00E-03		4.80E-01		PPM	LA	42 / 44		4.80E-01	N/A	1.31E-02 C	4.50E-02	1	YES	ATL
72559	p,p'DDE	3.70E-03		5.00E-01		PPM	LA	43 / 44		5.00E-01	N/A	9.28E-03 C	3.20E-02	1	YES	ATL
50293	p,p'DDT	5.00E-04		5.10E-02		PPM	LA	30 / 44	0.001 - 0.001	5.10E-02	N/A	9.28E-03 C	3.20E-02	1	YES	ATL
129000	Pyrene	4.90E-04	J	3.30E-02		PPM	4	14 / 29	0.0003 - 0.003	3.30E-02	N/A	4.06E+00 N	3.20E+01	2	YES	IEI
7782492	Selenium	8.14E-02		5.04E-01		PPM	LA	11 / 11		5.04E-01	N/A	6.76E-01 N	5.40E+00	2	YES	IEI
7440224	Silver	2.50E-02		2.50E-02		PPM	ANA82	2 / 13	0.004 - 0.007	2.50E-02	N/A	6.76E-01 N	5.40E+00	2	YES	IEI
57749	Total chlordane (alpha+cis+oxy+trans)	8.00E-02		8.00E-01		PPM	LA	10 / 12		8.00E-01	N/A	9.01E-03 C	8.30E-03	1	YES	ATL
7440666	Zinc	7.48E-01		2.37E+01		PPM	16330	16 / 16		2.37E+01	N/A	4.06E+01 N	3.20E+02	2	YES	IEI

(1) Minimum/maximum detected concentration.
(2) J = estimated concentration
(3) Blank indicates detection limits were not available
(4) Maximum concentration used as screening value.
(5) N/A - Information on background concentrations was not available.
(6) U.S. EPA. 1999. Risk-Based Concentration Tables. Memorandum from Jennifer Hubbard, Region III U.S. EPA to RBC Table Users. (Cancer benchmark value = 1E-06, HQ = 0.1)
(7) U.S. EPA. 1997. The Incidence and Severity of Sediment Contamination in Surface Waters of the United States. Vol 1: National Sediment Quality Survey. Office of Science and Technology. EPA 823-

value = 1E-06

Definitions:
N/A = Not Available
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
C = Carcinogenic
N = Non-Carcinogenic

TABLE C-2.2
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
TIDAL ANACOSTIA RIVER

	Scenario Timeframe:	**Current**
	Medium:	**Various**
	Exposure Medium:	**Fish Tissue**
	Exposure Point:	**N/A**

CAS Number	Chemical	Minimum Concentration[1]	Minimum Qualifier[2]	Maximum Concentration[1]	Maximum Qualifier[2]	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits[3]	Concentration Used for Screening[4]	Background Value[5]	Screening Toxicity Value[6]	Potential ARAR/ TBC Value	Potential ARAR/ TBC Source[7]	COPC Flag	Rationale for Contaminant Deletion or Selection[8]
	2 - Noncancer based; HQ = 0.1															
	3 - FDA guidance/action/tolerance level															
(8)	Rationale Codes:	Above Toxicity Level (ATL)														
		Above Screening Levels (ASL)														
		Insufficient Exposure Information (IEI)														
		Insufficient Toxicity Information (ITI)														

White Paper on PCB and PAH Contaminated Sediment in the Anacostia River

DRAFT FINAL

February 23, 2009

Executive Summary

This paper evaluates sediment contamination in the Anacostia River and proposed a means of identifying and capping hotspots to reduce risk to aquatic receptors including fish and humans who may eat those fish. It has been recognized for many years that water quality and sediment quality in the Anacostia River are highly degraded due to point source, non-point source pollution, and refuse. The problem has been made particularly troublesome because the lower reaches of the Anacostia River are tidally influenced and the slow moving water causes contaminants to settle out of the water column into bottom sediments and prevents flushing that might otherwise remove some of the contamination. Contaminated sediment can affect burrowing organisms that live within the sediment, fish that feed on those organisms, and people who consume those fish. The degree of contamination prompted public health agencies to establish advisories prohibiting fish consumption from the river. Efforts have been initiated to control many of the sources, but sediment acts as a repository for contaminants, most notably PCBs and PAHs. PCBs have been measured in sediments at concentrations between 2 µg/kg and 12,000 µg/kg, with a mean concentration of 579 µg/kg. The mean concentration exceeds a probable effects threshold for ecological resources by a factor of 2. PAHs range from 100 µg/kg to 211,300 µg/kg, with a mean concentration of 16,619 µg/kg. The mean PAH concentration exceeds TELs by about a factor of 10.

Geospatial analysis was used to identify and map sediment hotspots with concentrations exceeding the mean plus two standard deviations, which were 879 µg/kg for PCBs and 35,440 µg/kg for PAHs. Risk to ecological and human receptors associated with the sediment hotspots could be reduced by capping the hotspots with a remedial action known as sand capping. This involves placing a layer of sand or gravel over contaminated sediments, which breaks the exposure pathway between the underlying contaminated sediments and the receptors (burrowing organisms and fish) that live or feed in the surficial sediment. The combined area of the PAH and PCB hotspots is approximately 59 acres out of the study area of 628 acres or about 9 percent. Risk reduction for ecological receptors, particularly fish, based on the reduction in mean PCB and PAH concentrations are 24 and 19 percent, respectively. The reduction in the maximum concentrations are 88 and 82 percent for PCBs and PAHs. Although a formal risk assessment was not within the scope of this paper, similar reductions in risk levels for humans consuming fish from the Anacostia River are anticipated, at least for the portion of diet that is associated with fish from the river. Source control efforts at several of the larger facilities along the Anacostia River that have historically led to sediment contamination have reduced chance of recontamination of a sediment cap. However, there will likely be some recontamination of capped areas from various non-point and point sources. Additional sediment sampling will likely be required to design and implement a remedy of the type described here and monitoring will be required to document the effectiveness of the remedy. A capping remedy is likely to be most effective if combined with ongoing source control efforts focused on point source and non-point source controls so that the potential for recontamination of capped areas and other areas within the river can be minimized.

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1.0 Introduction

The Anacostia River and its watershed are a very important resource to the people living in Washington DC, Maryland, and surrounding communities (Figure 1). However, for at least three decades, it has been recognized that this resource is at risk. Water and sediment quality in the Anacostia River have been degraded by nutrient loading, toxic chemicals, and trash, resulting in adverse effects to human health and the environment.

Assessment and cleanup of the Anacostia watershed and river is challenging because of its size (176 square miles), the numerous contaminant sources, and the complexity of tidal flow. Some of the major environmental problems include nonpoint source runoff, storm water pollution, contaminated sediment, and loss of natural habitat for fish. To address these serious issues, numerous stakeholder groups have been assembled over the years to study the river system and devise approaches for cleaning up the river.

One such stakeholder group is the Anacostia Watershed Toxics Alliance (AWTA). AWTA is a voluntary coalition of over 25 groups, agencies, and institutions, convened by the EPA in 1999 to investigate toxic substances that present an unacceptable risk to human health and the environment, and develop and implement a comprehensive contaminated sediment management strategy. A major impetus for the group's creation was the listing of the Washington Naval Shipyard on the National Priorities List in conjunction with several other sites in other remedial programs. The goal was to comprehensively assess contaminated sediments in the river as part of the remedial investigation process.

AWTA developed a three phase approach for addressing sediment contamination. Phase 1 used existing data and information to perform initial human health and ecological risk assessments, and identified the major gaps in knowledge required to formulate decisions about remedies. This phase was completed during the first year and the Phase 1 Report titled *Interpretive Summary of Existing Data* was published in June 2000. Phase 2 studies were conducted to fill in significant data gaps, and an overall conceptual model of the river (including hydrodynamic models and sediment transport analysis) was developed. With this fundamental understanding of river dynamics, and existing contamination, potential remedies to address risks were identified. The information was presented in a document entitled *Charting a Course Toward Restoration: A Toxic Chemical Management Strategy for the Anacostia River* (AWTA 2000). Phase 3 is the ongoing implementation phase with the objective of designing and conducting reasonable remedial actions, developing effective monitoring strategies focused on contamination issues, and documenting restoration success.

In addition to articulating the Anacostia Watershed Toxics Alliance's (AWTA) preliminary position on how to address these contaminated areas, this paper is intended to communicate: 1) the approximate location of the contaminated sediment hotspots; 2) potential contributing sources; 3) an initial scope of a potential remedial action; and 4) estimated remediation costs. This paper derives the bulk of its information from the Anacostia Watershed Toxics Alliance (AWTA) Contaminants Management Plan and Conceptual Model, the final 18-month Anacostia capping study (Horne, 2007), and subsequent spatial analyses performed by NOAA using the GIS-based Anacostia

Watershed Database and Mapping Project. The approach used to identify the hotspots incorporates information and integrates an understanding of the river system (i.e., hydrodynamics, sediment transport, contaminant fate and transport, etc.) as developed through AWTA's conceptual model.

1.1 Indicator Chemicals

A number of toxic chemicals have been identified in sediment samples collected in the Anacostia River, but two chemical groups (indicator chemicals) were selected for detailed study in this paper because of their toxicity and relatively widespread distribution: polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs). DC issued a fish advisory for the Anacostia River in 1989 and the Agency for Toxic Substances and Disease Registry (ATSDR) performed a health consultation demonstrating that PCB levels are elevated to the extent that consumption of fish poses a risk to recreational fisherman (ATSDR, 1991). Contaminated fish may also pose a risk to piscivorous mammals and birds such as osprey. PCBs and PAHs are hydrophobic and lipophilic compounds, indicating that they partition rapidly from water to organic material (e.g., sediment, fat tissue, soil, etc), which can serve as a reservoir where they have the potential to persist for extended periods of time. For instance, although PCBs were banned in 1978, they can persist for many years or even decades, and are still found in abundance in the sediment of the Anacostia River.

PCBs were manufactured for their chemical and thermal stability and used as liquid insulators in electrical equipment. They were widely used in electrical transformers and also as hydraulic fluids. The molecular structure of PCBs consists of two linked six-carbon phenyl rings. Each of the five open carbon molecules in the rings has the potential for a single chlorine atom bond. This produces a theoretical total of 209 potential variations, which are generally termed "congeners." Persistence and stability in the environment, and the toxicological modes of action, are related to the number of chlorine atoms and their relative positions. Many of the products containing PCBs had distinctive patterns in the congeners and sources can sometimes be determined from patterns found in environmental samples. Due to the lipophilic nature of PCBs, they are readily bio-accumulated in the fatty tissues of aquatic organisms and pose the potential for biomagnifications and disruption of food web dynamics. Consequently, PCBs present a risk to wildlife (such as osprey) and humans.

PAHs are commonly found in oils and oil products, and are generated through the combustion of almost any organic material, including coal and wood. The molecular structure of PAHs consists of six-sided benzene rings, linked in a pattern similar to that observed in honeybee combs. The number and pattern of the assembled benzene rings, along with the attachment of other atoms or molecules determines the character and toxicity of these molecules. Patterns in the abundance of the various molecules can be linked to the products used in combustion, thus helping to identify potential sources. PAHs and their metabolites have been linked to excess tumor rates in bottom-feeding fish like the brown bullhead. PAHs can also be directly toxic to and can accumulate in sediment dwelling organisms that are a food source for fish.

1.2 Draft Remedial Strategy

AWTA recognizes that the Anacostia Watershed is an extremely complicated system which has been impacted by a variety of historical and ongoing sources of toxic chemicals. Contaminated sediments are relatively widespread within the river, however, a review of historical sampling data indicated that chemical concentrations are particularly high in certain areas that can be considered "hotspots." This pattern suggests that there may be utility in evaluating a remedial strategy focusing on hotspots. An advantage of such an approach is that it may be possible to substantially reduce sediment concentrations in hotspots at a lower cost than dealing with the entire area of contaminated sediments. This concept is sometimes framed as trying to achieve the greatest "bang for the buck." A number of important issues are raised by this approach and are addressed to varying degrees in this paper:

- Are ongoing sources of contaminants controlled? If not, then remedial actions may be premature and limited financial resources may be wasted. This question is partially answered in section 1.3 but should be included in future, more detailed studies and plans.

- How is the threshold concentration identifying hotspots defined? The concentration can be risk-based or statistically determined as explained later. The latter approach is taken for simplicity in this paper and risk-based concentrations are mentioned as a point of reference.

AWTA recognizes that comprehensive efforts will be required to return sediment and water quality to health. Efforts will likely include point and nonpoint source control, active remediation (capping or dredging) of sediment with highly elevated concentrations, and possibly natural recovery of sediments with moderately elevated concentrations. These terms are explained later in the paper.

1.3 Sources of Contamination

Sources of contamination to the mainstem Anacostia River include releases from individual facilities or waste sites along the river, storm water discharges, combined sewer overflows, nonpoint source runoff, atmospheric deposition, and input from tributaries. The nature of the source (point source vs. nonpoint source) and the transport mechanism within the river have an impact on the distribution of contaminants within the river. For example, contaminated sediments from point sources would likely be located adjacent to the facility although over time the contaminants may move downstream if there is enough energy in the river to transport the sediment. Previous work suggests that the upstream portion of the Anacostia River is generally erosional and the downstream portion, near the confluence with the Potomac River is generally depositional (Hill et al, 2000). The zone in between is likely to be transitional between erosional and depositional depending on the lateral position within the river (inside or outside of a bend.)

EPA has indentified four sites along the Anacostia River that may be point sources of either PCBs, PAHs or both. These sites are describes below.

Pepco Benning Road

The Pepco Benning facility is located at 3400 Benning Road NE, Washington DC. The site is bordered by residential areas to the east, commercial areas to the south, and the Anacostia River to the west. Pepco Energy Incorporated uses the 77 acre site to manage operations and maintain equipment associated with their electrical distribution system. Several releases to the environment have occurred between 1987-2003 resulting from spills of contaminated oil or leaking equipment. Pepco has completed five cleanups of contaminated soil and other materials in order to address these areas and installed Low Impact Development (LIDS) rain gardens in order to reduce runoff from the site. EPA has conducted several environmental investigations in the past at the facility and recently completed sampling of soil and sediments at the site in September 2008 as part of Site Investigation (SI) efforts.

Poplar Point

The 110 acre parcel known as Poplar Point is part of a land transfer from the National Park Service (NPS) to DC. Portions of the site are contaminated from past use by DC, the Architect of the Capitol and the Navy. Past studies have found contamination of soil, sediment, groundwater, and surface water with a wide variety of chemicals including metals, pesticides, petroleum products and solvents. The National Park Service and DDOE is currently coordinating in an effort to develop a plan for determining the nature and extent of the contamination at the site, in order to determine if clean up actions are needed.

Kenilworth Landfill

The Kenilworth landfill is a 50 acre site that is located south of the Watts Branch and east of the Anacostia River. The Kenilworth Landfill was used by DC as a municipal dump from the 1950's to the 1970's. During this period the landfill extended into the Anacostia River and no barriers were constructed to prevent migration of wastes mixed with soil into the water. In the 1970's the National Park Service placed a vegetated cap on the landfill and converted the area into a park. From 1996 to 1997 construction debris was disposed of in an area west of Dean Avenue. NPS removed some of the construction debris, graded, and planted vegetation in this area. NPS completed a Remedial Investigation/Feasibility Study (RI/FS) in 2002 which documented the nature and extent of the contamination and proposed a remedy for cleanup. Sampling results indicated that fill materials had elevated levels of PCBs, PAHs, arsenic, and lead. NPS proposed installing a cap to prevent contact with the soil along with institutional controls and monitoring. Additionally, NPS has installed riprap to prevent erosion of soils originating from the contaminated areas.

Washington Gas and Light Company

Washington Gas and Light Company (Washington Gas) site is comprised of two parcels, the 4.2 acre NPS parcel which was transferred to DC in December 2008, and the 11.4 acre East Station property. The property is located at 1240 12th Street in Southeast Washington situated next to the Anacostia

River. The Washington Navy Yard is located just south of the site. The East Station property is the location of the former manufactured gas plant which operated from 1888 to 1948. Several environmental studies were conducted following the closure of the gas manufacturing plant in 1983. Sampling results from these studies indicated that soil and groundwater on the site were found to be contaminated with waste byproducts of coal tar wastes such as PAHs, volatile organic compounds (VOCs), and metals such as beryllium, arsenic, and lead. Washington Gas initiated treatment of the groundwater using an interceptor trench, recovery wells, and a groundwater treatment system to remediate and prevent migration of site related contaminants. The National Park Service (NPS) completed a Feasibility Study (FS) which proposed excavating and disposing of soils contaminated with coal gas wastes which posed risk to park visitors and onsite workers. EPA reviewed the Feasibility Study (FS) and recommended that contaminated sediments be addressed as a part of the remedy. The NPS ROD specified that Washington Gas would address river sediments as part of the remedy. Washington Gas Light has developed a work plan for a sediment investigation and has submitted the document to EPA, DDOE, and NPS for review and comment.

Pepco Benning Road, Poplar Point, Kenilworth Landfill and Washington Gas Light sites have been investigated and shown to be contaminated with PCBs and/or PAHs. While some of these sites have undergone a remedial action there is a potential for historical contamination to have contributed to the PAH and PCB hot spots. As described above, significant source control efforts at several of the major facilities along the river have been implemented or are planned. Additionally, there are ongoing efforts to implement non-point source controls including LID techniques. Therefore, it is anticipated that ongoing or future recontamination will occur in the future to a lesser degree than has occurred in the past.

1.4 Need for Action

Current monitoring efforts (e.g., permit-based monitoring) are insufficient to characterize ongoing PCB and PAH loadings at a localized scale. The TAM/WASP model incorporated into the conceptual model predicts surface water and sediment concentrations except in hotspot areas where local sources are not well characterized by the model. There is also no long-term monitoring program that assesses the effectiveness of source control actions within the watershed. Natural attenuation of hotspot sediments by deposition of cleaner sediment on top is expected to take 20+ years, and that is only if effective source control actions are taken throughout the watershed. Given the 20+ year recovery process to abate ecological and human health risks, sediment hot spot areas have been identified for potential active remediation to achieve risk reduction more quickly.

2.0 Methodology

2.1 Evaluation of Chemistry Data

The evaluation in this paper focuses on samples collected in the top 10 centimeters (cm) that were analyzed for PCBs or PAHs. Data from 13 studies were obtained and extracted from NOAA's Query Manager database (NOAA, 2008). One study conducted by the Academy of Natural Sciences (ANS) was relatively comprehensive (ANS, 2000), while the other studies tended to focus on a specific geographic area or were intended to answer a limited scientific question. The other studies used in this paper were conducted between 1990 and 2003, using a variety of sampling protocols and analytical methodologies (Table 1). For these reasons, the ANS 2000 data, which were collected synoptically using consistent protocols, were evaluated as a single dataset for some of the evaluations in this paper. Additionally, the larger dataset (ANS plus the other 12 studies) was considered in total, recognizing the limitations and uncertainties that existed when using somewhat dissimilar data. Figure 2 shows the locations of the sediments samples that were used in this paper.

Table 1. Sediment Sampling Studies in the Anacostia River

Study Description	Date	Number of Samples
EMAP- Chesapeake Bay	1990	1
Bolling AFB – SW Corner Landfill	1992	5
Potomac and Anacostia Sediment Study	1992	12
Washington Navy Yard	1995	7
US Fish and Wildlife Service- Mason Neck	1996	3
Washington Gas- East Station Project	1996	8
DC Sediment Core Analysis	1997	6
USACE Federal Navigation Channel	1998	4
GSA SE Federal Center	1999	24
Washington Navy Yard RI	1999	33
Ambient Toxics Chesapeake Bay	2000	6
US Fish and Wildlife Service Bioavailability	2000	4
Academy of Natural Sciences	2000	125
Active Capping Study	2003	77

Total PCBs used in this paper were calculated as either the sum of the aroclors or the sum of the congeners depending on the analytical method used by the original investigators. It should be recognized that these analytical methods are not identical, which may introduce inaccuracy into the analysis. For PAHs, the value used was the sum of the low molecular weight PAHs and the high molecular weight PAHs. These data were imported into ARCGIS for mapping and spatial analysis purposes. Table 2 shows the number of sample points used for each group of chemicals. A polygon

of the river bank was used to clip data points that fell outside of the river corridor. Next, an inverse-distance weighting algorithm was used to interpolate the point data onto a 10 meter (m) by 10 m square grid, within a model domain of 628 acres. Table 3 shows statistics calculated from the samples points for PCBs and PAHs.

Figure 3 shows the distribution of PCBs within the Anacostia River sediments using the ANS 2000 data and all 13 studies. Figure 4 shows the distribution of PAHs within the Anacostia River sediments using the ANS 2000 data and all 13 studies. Spatial statistics from the grids, including minimum, maximum, mean and standard deviation, were then calculated from the grid, as summarized in Table 4.

Table 2. Number of Sediment Samples Used in the Analysis

Contaminant	**All studies (13 surveys)**			**ANS 2000 survey only**		
	All samples	**Excluded***	**Samples used**	**All samples**	**Excluded***	**Samples used**
PCBs	383	88	**295**	133	9	**124**
PAHs	424	110	**314**	134	9	**125**

*Samples falling outside the Anacostia River corridor including samples from the Potomac River were excluded from the analysis

Table 3. Summary Statistics for PCBs and PAHs (Sample Data)

Study	**Number of Samples**	**Minimum**	**Mean**	**Maximum**	**Standard Deviation**
PCBs (1)					
ANS 2000	124	2	181	1,643	171
All Studies	295	ND	579	12,000	1,091
PAHs (1)					
ANS 2000	125	495	11,742	56,330	8,737
All Studies	314	100	16,619	211,300	22,453

(1) Values reported in micrograms per kilogram (µg/kg).

2.2 Preliminary Identification of Areas Potentially Requiring Active Remediation

This section presents a preliminary identification of river locations recommended for focused feasibility studies and potential active remediation. These areas pose the greatest risk to benthic organisms higher trophic level ecological receptors and human health due to their elevated PAH and PCB sediment concentrations. A spatial evaluation of contaminant concentrations was performed using the GIS-based Anacostia Watershed Project.

Table 4. Summary Statistics for PCBs and PAHs (Gridded Data)

Study	Minimum	Mean	Maximum	Standard Deviation
PCBs (1)				
ANS 2000	2	189	1,635	123
All Studies	ND	297	7,496	291
PAHs (1)				
ANS 2000	500	10,720	56,308	6,190
All Studies	357	11,584	200,683	11,928

(1) Values reported in micrograms per kilogram (µg/kg).

The identification of areas contaminated to such a degree that they pose unacceptable risk was initially estimated by comparison of sediment chemistry to benchmarks for protection of ecological resources. For PCBs, the benchmarks applied were the freshwater threshold effect levels and probable effect levels (TELs/PELs; 34 and 277 µg/kg respectively) that are indicative of a low and high probability of risk to the benthic community, respectively. These values draw upon synoptic chemical analyses with observations not only from bioassays with several freshwater species, but also from observations of several benthic community metrics. Because of the broad basis for their derivation, these values are considered more robust than benchmarks derived from single measurement endpoints. For PCBs, guidelines for sediment have yet to be established for the protection of fish based on bioaccumulation in the food web. Values assessed by Paige Doelling-Brown in her food web model were also evaluated geographically (Doelling-Brown, 2001). She estimated bioaccumulation at the average PCB concentration of 286 µg/kg and at half of that value.

PAHs are metabolized by most vertebrates (fish for example), so tissue residues are not good indicators for risk. So for PAHs, two benchmarks were used:

- A freshwater sediment TEL of 1,700 µg/kg, which is protective of the benthic community, and
- A sediment guideline of 2,000 µg/kg, which is a risk threshold for benthic fish.

An initial screening indicates that PAHs in sediments exceed the benchmarks throughout the entire river. Also, PCBs throughout the entire river exceeded the TEL, suggesting the potential for toxicity. Although biological observations throughout the extent of the areas that exceeded benchmarks seem to corroborate these predictions, these evaluations were not helpful for providing priorities. Therefore, additional evaluations were conducted to help determine those areas most likely in need of active remediation. A preliminary spatial evaluation of contaminant data was conducted to identify those areas that indicated the greatest degree of contamination.

As an alternative to using ecologically-based screening values, a statistical approach for defining hotspots was developed to define the threshold for a hotspot. Figure 5 is a histogram of the PCB sample results for the ANS 2000 and complete data sets. Figure 6 is a histogram of the PAH sample results for the ANS 2000 and complete data sets. The value selected for a hotspot threshold was the mean plus two standard deviations. For example, the hot spot threshold for PCBs (all data) was defined as the mean (297 µg/kg) plus two standard deviations (2 x 291 µg/kg), or 879 µg/kg. The hot spot threshold for PAHs (all data) was defined as the mean (11,584 µg/kg) plus two standard deviations (2 x 11,928 µg/kg), or 35,440 µg/kg.

Figure 7 shows the hotspots for PCBs and PAHs, which would be capped under the approach suggested in this paper. Table 5 shows the mean concentration in the sediments before and after placing the hypothetical cap over the hotspots. These were calculated by assuming that the concentration of PCBs and PAHs in the cap material would be zero. Using the ANS 2000 data only, the reduction in mean concentrations for PCBs and PAHs are 10% and 11%, respectively. Using all of the data, the reduction in mean concentrations for PCBs and PAHs increases to 24% and 19%, respectively. The greater effectiveness is at least in part a reflection that several of the studies that supplement the ANS 2000 study were intended to investigate specific source areas. Consequently, the hotspots are better defined using the larger data set. The hotspot capping approach would reduce the maximum concentrations to the capping threshold. For example, using all of the PCB data the original maximum of 7,496 µg/kg would be reduced to 879 µg/kg, an 88 percent reduction. The PAH maximum would be reduced from 200,683 µg/kg to 35,440 µg/kg, an 82 percent reduction.

Table 5. Calculated Reduction in Mean Concentration by Capping Hotspots

Chemical Class	Mean Concentration (before)	Mean Concentration (after capping)	Percent Reduction in Mean
PCBs (ANS 2000)	189	169	10%
PCBs (All Studies)	297	225	24%
PAHs (ANS 2000)	10,720	9,581	11%
PAHs (All Studies)	11,584	9,352	19%

Further sampling should be conducted to characterize these locations at a level suitable for performing a focused FS. Site-specific sediment stability should be evaluated to confirm that capping would provide an effective, long term remedy. For instance, erosional areas are not considered amenable to placement of a standard cap in since it may not provide long-term protection in these areas.

2.3 Remedy Evaluation

Remedial actions for contaminated sediment generally include dredging, capping, natural recovery, or a combination of these approaches. A FS report for a contaminated sediment project typically considers all of these technologies and evaluates them against criteria including short and long-term effectiveness, implementability, permanence, and cost. Estimating the cost of dredging requires knowledge of the depth of contaminated sediments as well as the aerial extent. Additionally, it is important that ongoing sources of contamination have been eliminated or controlled to an acceptable degree. Finally, the dynamics of sediment transport in the system need to be understood to evaluate the type of material (grain size) required for a cap. In the absence of such detailed information, for the purposes of this white paper it is assumed that an aggregate cap (sand or gravel) would be placed over hotspot areas. This approach allows consideration of remedial effectiveness based on area alone. Calculating the decrease in concentrations can be viewed as an approximate surrogate for risk reduction because the majority of chemical exposure related to sediments is associated with surficial sediments. This is true because the inputs for an ecological risk assessment include either a central tendency value, such as the mean concentration, or a reasonable maximum exposure, which is characterized by values near the upper end of the distribution of a data set, such as the 90th percentile.

Unit costs for capping materials taken from the Anacostia River Active Capping Pilot Study are provided in Table 6 (Horne, 2005). As indicated in the subject report, the values in Table 6 do not

include mobilization or placement costs because the cost expended in the pilot study are unlikely to be representative of the cost that would be incurred in a full scale capping project. The last column in Table 6 includes an escalation factor of 34 percent to account for inflation in the time between the original study and 2009 (USACE, 2008).

Table 6. - Capping Technology Costs on a Unit Cost Basis

Cap Type	Cap Material Cost (Horne, 2005)	Cap Material Cost Escalated to 2009 (1)
12" Sand Cap	$9/yd^2	$12/ yd^2
6" Sand Cap	$9/yd^2	$12/ yd^2
Aquablok	$31/yd^2	$41/ yd^2
Coke Breeze	$15/yd^2	$20/ yd^2
Apatite	$42/yd^2	$56/ yd^2

(1) Unit costs were escalated using factors from USACE, 2008

2.4 Risk Reduction Associated with Capping Hot Spots

Capping sediments with the highest concentrations of PCBs and PAHs will reduce the risk to ecological receptors such as fish as well as humans who consume fish. Calculating the amount of risk reduction for either ecological or human receptors is complicated because it depends on hard to measure factors such as the home-range of various species and the fraction of food that a particular human population consumes from the Anacostia River. It is useful to consider the home range of different fish species to bracket the range of possible exposures. If a fish species has a very limited home range with respect to a capped area then the chemical load in specific fish that spend their lives in that area may be quite low. However, there may be other individuals of that same species that spend their lives in adjacent, uncapped areas. (If there is an equal likelihood of individual fish being in either area, the resultant risk for that species can be approximated by the risk associated with the average sediment post-capping concentrations.) On the other end of the spectrum are fish with a large home range. If their home range is larger than the lower Anacostia study area, then the risk reduction to these fish would be proportional to the amount of their life span spent in the study area, weighted by the concentration reduction in the study area. Table 7 shows the estimated reduction in average and maximum risk for ecological and human receptors that might be realized by capping the identified hotspots. The values in Table 7 were calculated that the average risk reduction is equal to the reduction in mean concentration and that the maximum

risk is associated with the maximum sediment concentration before or after capping. The risk reduction for human receptors would be proportional to the assumed amount of fish consumed from the Anacostia River. For example, capping hotspots would offer considerably more risk reduction to someone who regularly consumed fish from the river than to another person who rarely consumed fish from the river.

The hotspot remediation project is a possible first phase of a holistic and integrated management plan designed to rehabilitate the Anacostia Watershed. However, more detailed studies would be required to carry out a capping project. Without preference to a specific regulatory framework it would be necessary to better define the extent of the hotspots by collecting and analyzing sediment samples, prepare a FS for the contaminated sediments, complete a remedial design, and implement remedial actions. Table 8 provides order of magnitude costs for these elements of the project, based on experience with similar projects. The sum of the costs shown here is on the order of $6 to $8 million dollars. This does not include dredging or source control, which are likely to be required in some areas to prevent recontamination.

Table 7. Estimated Risk Reduction for Ecological and Human Receptors by Capping Hotspots

Chemical Class	**Percent Reduction in Average Risk**	**Percent Reduction in Maximum Risk**
PCBs (ANS 2000)	10%	73%
PCBs (All Studies)	24%	88%
PAHs (ANS 2000)	11%	59%
PAHs (All Studies)	19%	82%

Table 8. Order of Magnitude Costs for Capping and Associated Activities.

Work Element	**Order of Magnitude Cost**
Sediment Sampling	$300,000 to $500,000
Feasibility Study	$80,000 to $150,000
Remedial Design	$70,000 to $130,000
Remedial Action (50 to 60 acre sand cap)	$3,000,000 to $5,000,000
Monitoring	$200,000/yr for 10 years
Total	$6 million - $8 million

3.0 Summary and Conclusions

This paper evaluated sediment contamination in the Anacostia River and proposed a means of identifying and capping hotspots to reduce risk to aquatic receptors including fish and humans who may eat those fish. It has been recognized for many years that water quality and sediment quality in the Anacostia River are highly degraded due to point source, non-point source pollution, and refuse. The degree of contamination has resulted in advisories prohibiting fish consumption from the river. Efforts have been initiated to control many of the sources, but sediment acts as a repository for contaminants, most notably PCBs and PAHs. PCBs have been measured in sediments at concentrations between 2 µg/kg and 12,000 µg/kg, with a mean concentration of 579 µg/kg. The mean concentration exceeds a probable effects threshold for ecological resources by a factor of 2. PAHs range from 100 µg/kg to 211,300 µg/kg, with a mean concentration of 16,619 µg/kg. The mean PAH concentration exceeds TELs by about a factor of 10. Geospatial analysis was used to identify hotspots with concentrations exceeding the mean plus two standard deviations, which were 879 µg/kg for PCBs and 35,440 µg/kg for PAHs.

Risk associated with the sediment hotspots could be reduced by capping those areas with a sand cap. The combined area of the PAH and PCB hotspots is approximately 59 acres out of the study area of 628 acres or about 9 percent. Risk reduction based on the reduction in mean PCB and PAH concentrations are 24 and 19 percent, respectively. The reduction in the maximum concentrations are 88 and 82 percent for PCBs and PAHs. Source control efforts at several of the larger facilities along the Anacostia River that have historically led to sediment contamination have reduced chance of recontamination of a sediment cap. However, there will likely be some recontamination of capped areas from various non-point and point sources.

Additionally, future restoration efforts should include restoration of the natural benthic substrate in the hotspot areas, stabilization of the riparian banks with native vegetation, employing LID (Low Impact Development) technologies in developed areas, and the restoration of wetlands. Best Management Practices such as LID techniques, wetland restoration and stream bank stabilization serve a vital function in reducing erosion, and intercepting runoff of urban contaminants, thus preventing the reintroduction of contaminants after the remediation has occurred. Once the hotspot cleanup is completed, natural substrate should be reintroduced to the site to encourage recolonization of indigenous benthic organisms. The final phases of the proposed ATWA strategy would ultimately focus on monitoring the results of the watershed restoration efforts. Monitoring activities would typically involve obtaining post remediation confirmation sampling, collecting water quality data, and conducting riparian habitat assessments and fish and benthic macro-invertebrate surveys to assess the effectiveness of the watershed management efforts.

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Figures

Figure 1 Site Location Map

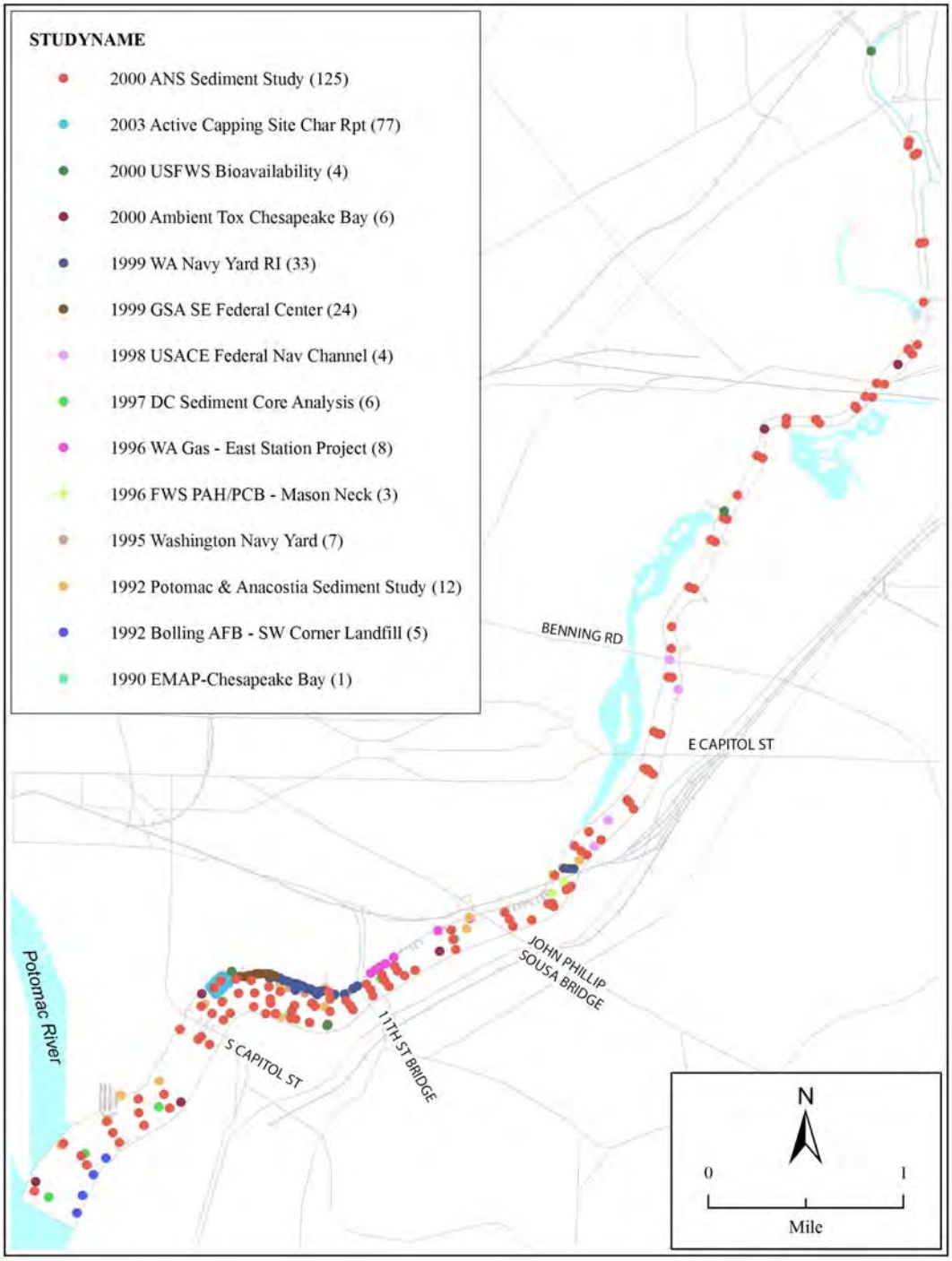


Figure 2 Sample Location Map

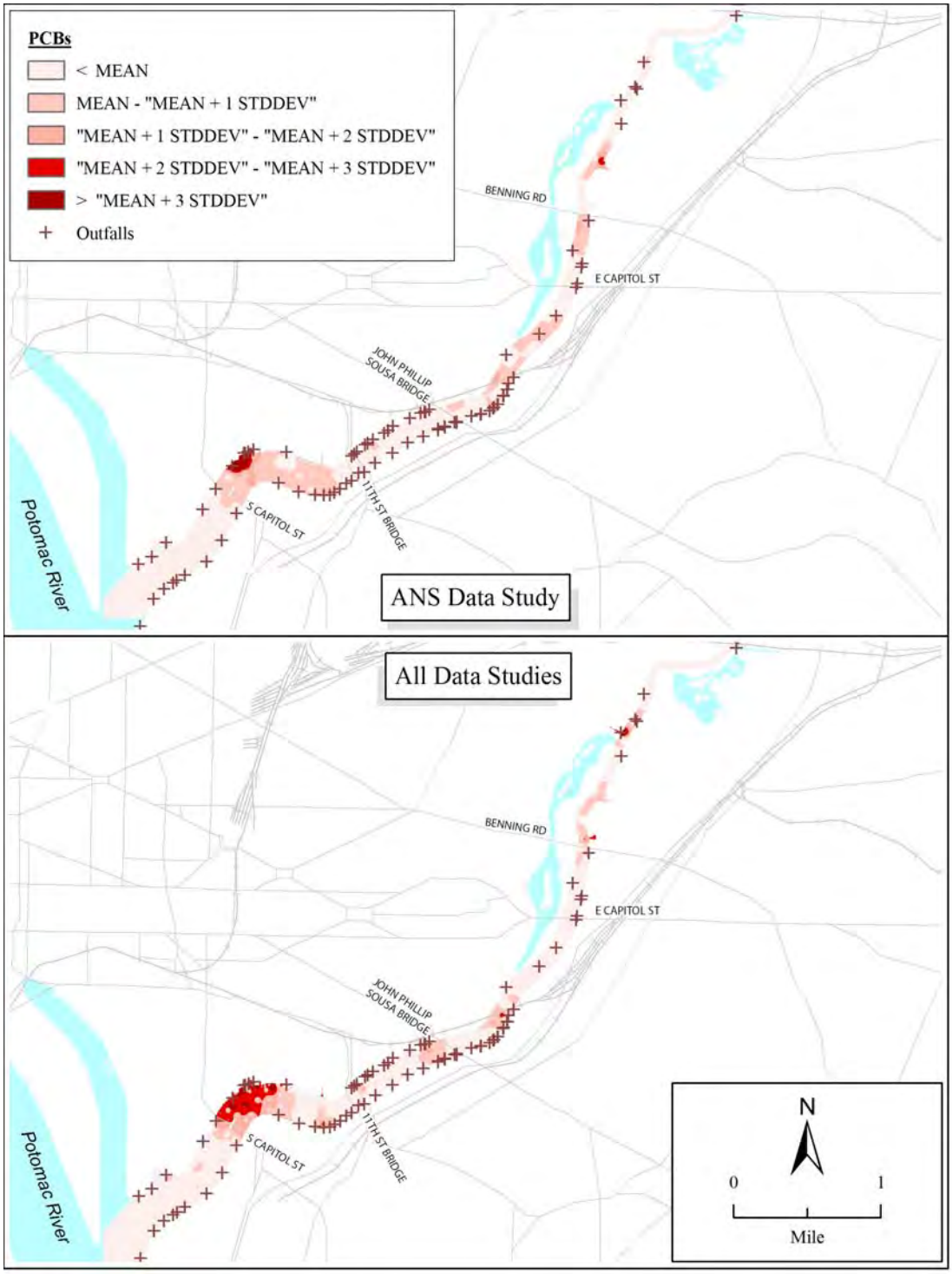


Figure 3 Maps of PCBs in the Anacostia River

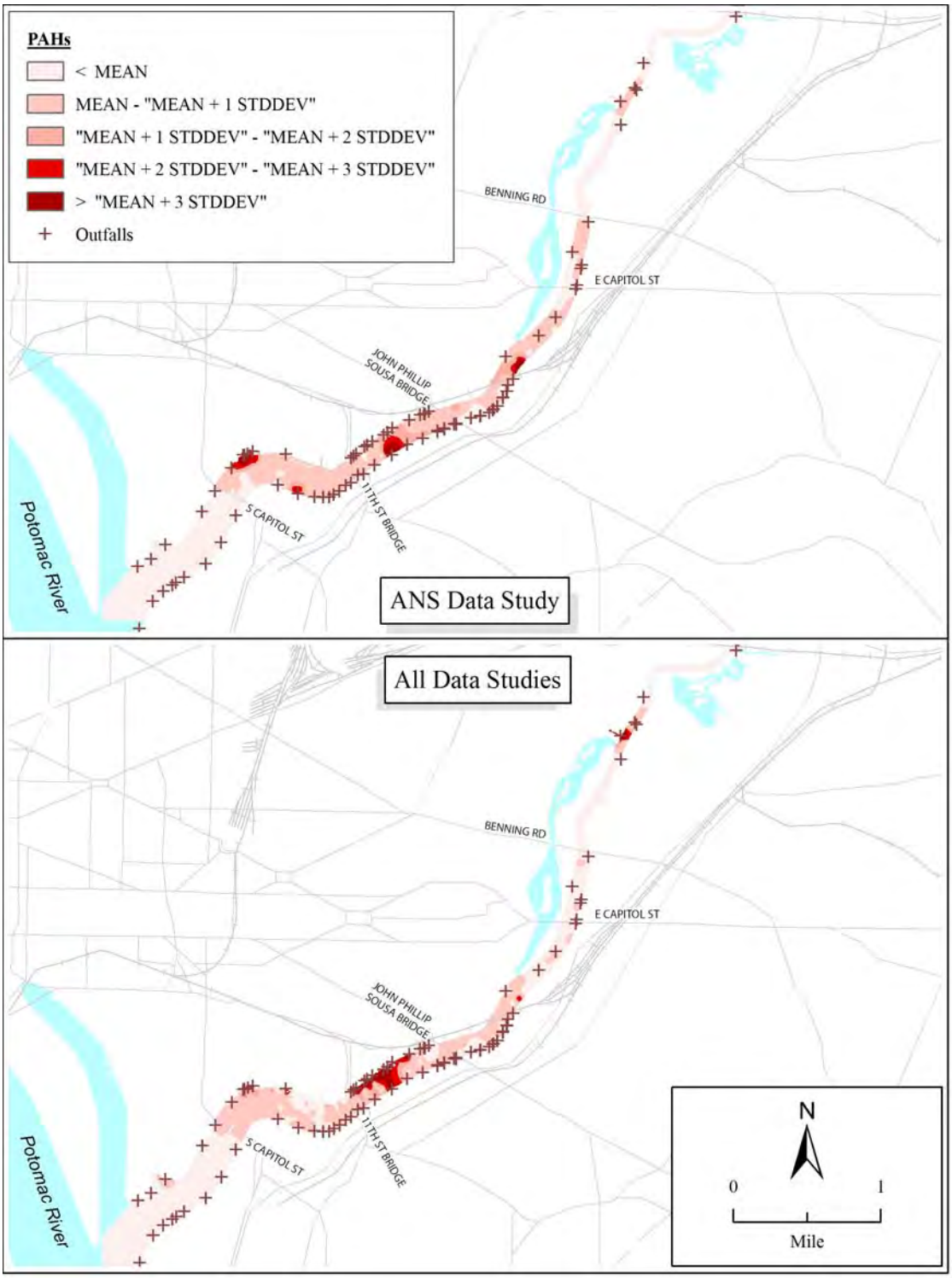
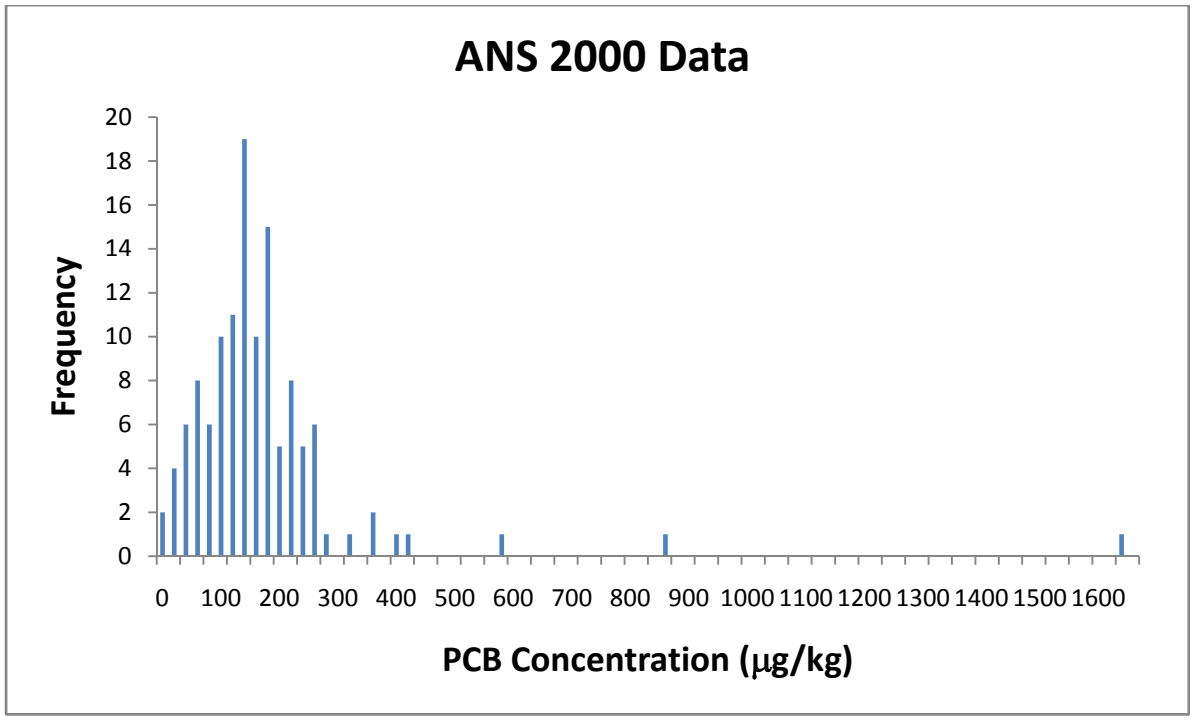


Figure 4 Maps of PAHs in the Anacostia River



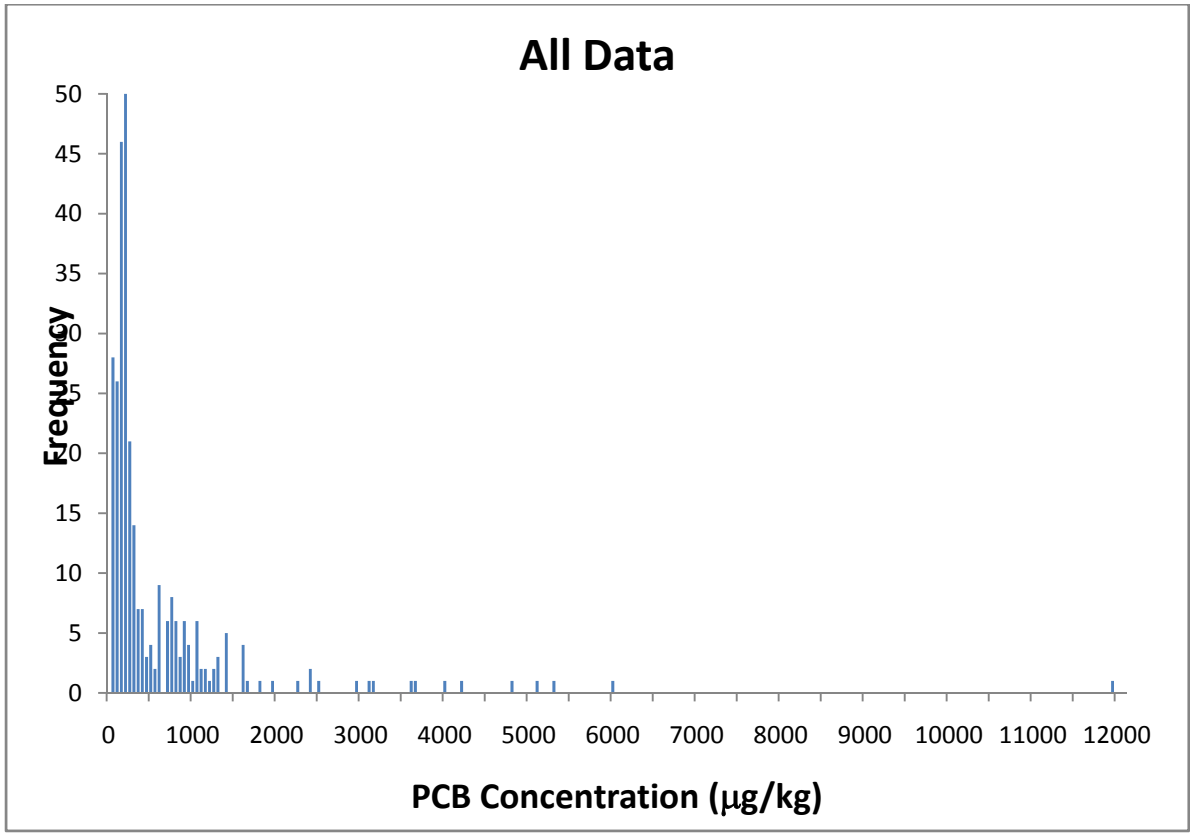
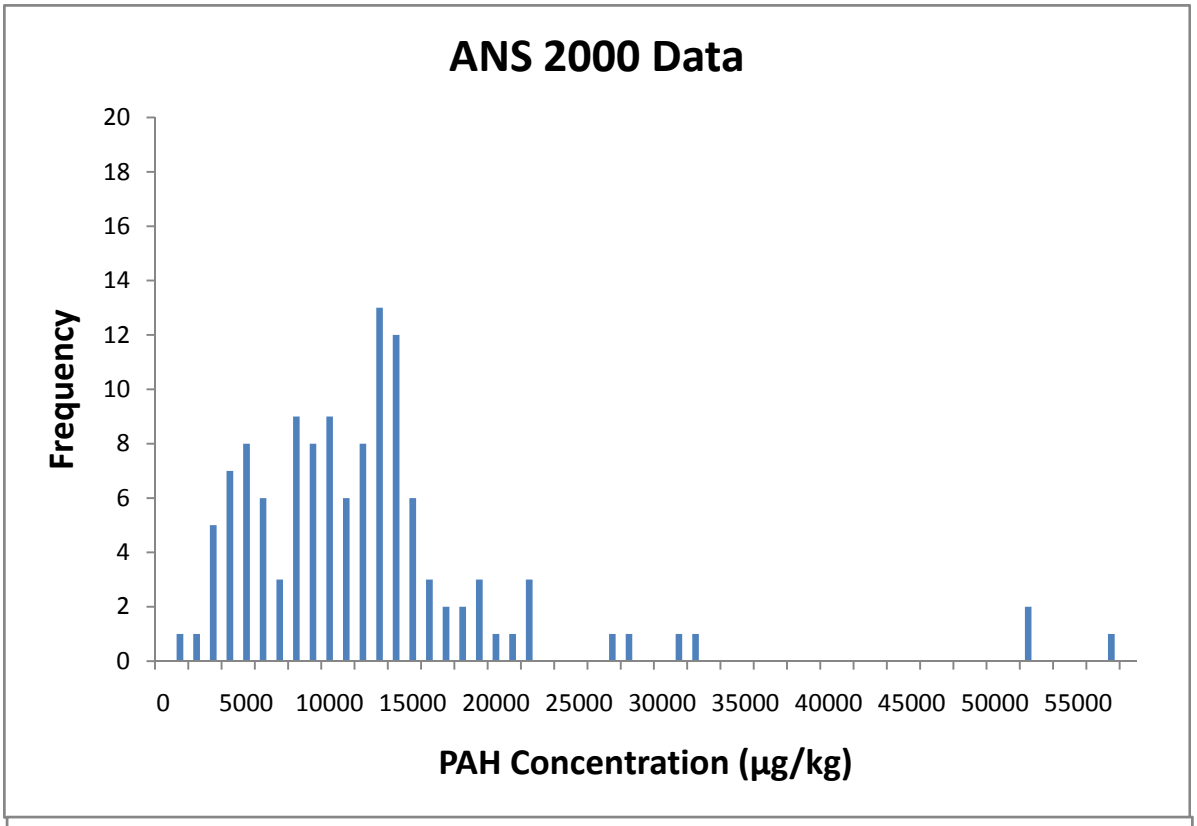


Figure 5 Histograms of PCBs



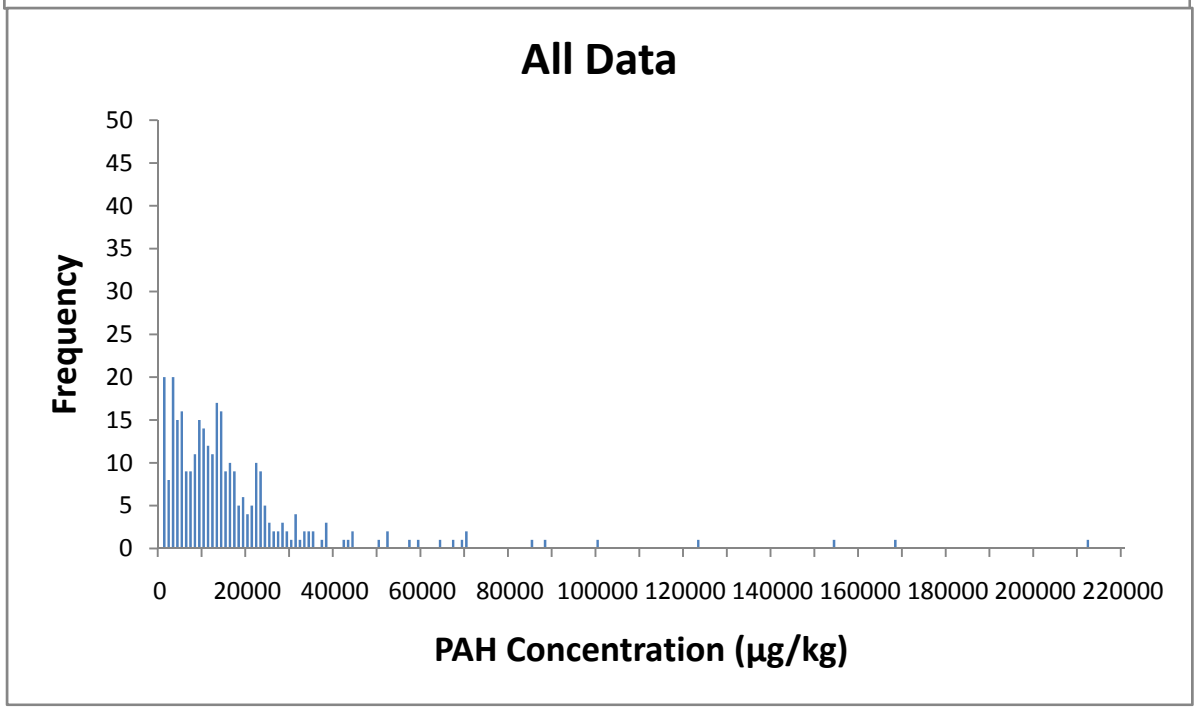


Figure 6 Histogram of PAHs

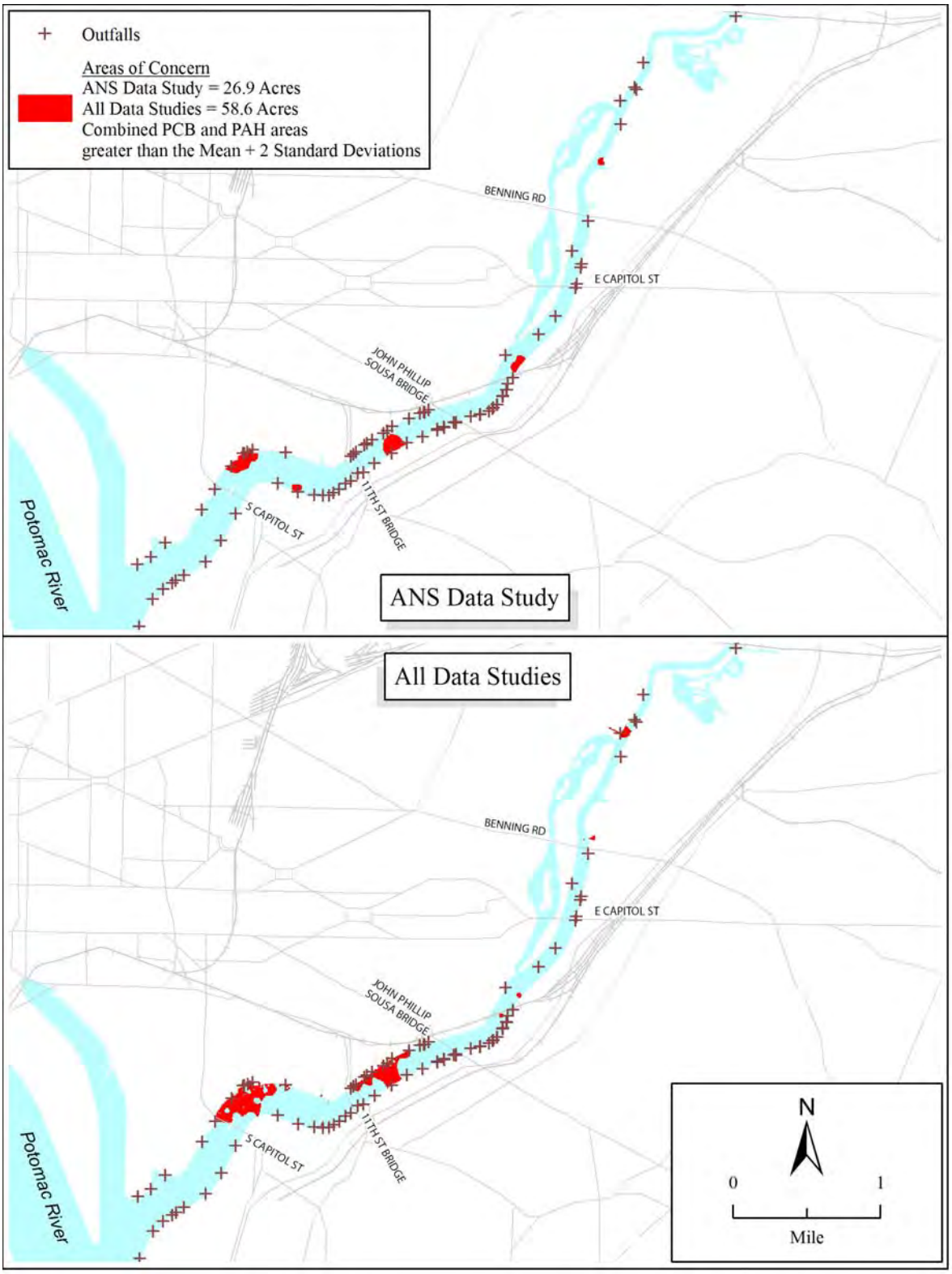


Figure 7 Map of PCB and PAH hotspots in the Anacostia River

Anacostia River White Paper

Simeon Hahn

April 14, 2009

Background

- *NOAA prepared a white paper outlining an approach for sediment cleanup in the Anacostia River*
- *Stakeholders provided comments on the white paper*
- *NOAA reviewed comments and revised the White Paper*

Purpose of the White Paper

- *To develop a tool or framework for evaluating hot spot sediment cleanup in the Anacostia River so that the Anacostia Watershed Restoration Committee can facilitate planning for potential remediation needs.*

White Paper Topics

- *The approximate location of the contaminated sediment Areas of Concern (AOCs);*
- *Potential contributing sources;*
- *Initial scope of a potential remedial action using a sand cap; and*
- *Remediation costs and benefits.*

Contaminant Sources and Indicator Chemicals

- *Sources of contamination to the river include:*
  - *migration from waste sites along the river,*
  - *storm-water discharges,*
  - *combined sewer overflows,*
  - *non point source run-off, atmospheric deposition, and inputs from tributaries.*
- *Polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) have been identified as risk drivers for potential sediment hot spot remediation*

PA
WV
VA
DC
MD
DE
NJ
Atlantic Ocean
Anacostia River Study Area
Duck Pond
Lake Artemesia
Northeast Branch
Sligo Creek
Maryland
Northwest Branch
District of Columbia
Anacostia River
Mc Millan Reservoir
Kenilworth Aquatic Gardens
Kenilworth Landfill
BENNING RD
PEPCO Benning Road
E CAPITOL ST
Washington Gas
Washington Navy Yard
Study Area
S CAPITOL ST
JOHN PHILLIP SOUSA BRIDGE
11TH ST BRIDGE
Potomac River
Anacostia River
Poplar Point
Study Area
Outfalls
State Boundary
N
0
1
Mile

Pepco Benning Road

- *77 acre site*
- *1987–2003: contaminated oil or leaking equipment spills released into the environment*
- *5 cleanups of contaminated soil completed*
- *Low Impact Development (LID) rain gardens installed*
- *Soil and sediment sampling completed in September 2008.*

Poplar Point

- *110 acre parcel*
- *Soil, sediment, groundwater, and surface water contaminated*
- *Metals, pesticides, petroleum products, and solvents found*
- *Currently, establishing nature and extent of contamination to determine cleanup actions.*

Kenilworth Landfill

- *50 acre site*
- *1950's–1970's: used by DC as municipal dump*
- *1970's: closed and vegetated cap emplaced*
- *2002: Remedial Investigation/Feasibility Study (RI/FS) determined elevated levels of PCBs, PAHs, arsenic, and lead*
- *2002 or later: riprap installed to prevent erosion of contaminated soil.*

Washington Gas and Light Company

- *4.2 acre DC parcel and 11.4 acre East Station property*
- *1888-1948: manufactured gas plant*
- *Soil and groundwater contaminated with coal tar wastes such as PAHs, volatile organic compounds, beryllium, arsenic, and lead*
- *FS completed; GW remediation constructed*
- *NPS ROD specified Washington Gas would investigate sediments, and work plan was submitted for sediment investigation.*

Washington Navy Yard

- *Only NPL Site on the Tidal River*
- *Previous removal actions for PCBs in storm drains*
- *Previous investigations focused on Pier area and detected PCBs and other contaminants at levels above screening levels*
- *Current work plan for Ecological Risk Assessment and Background investigation*

Need for Action

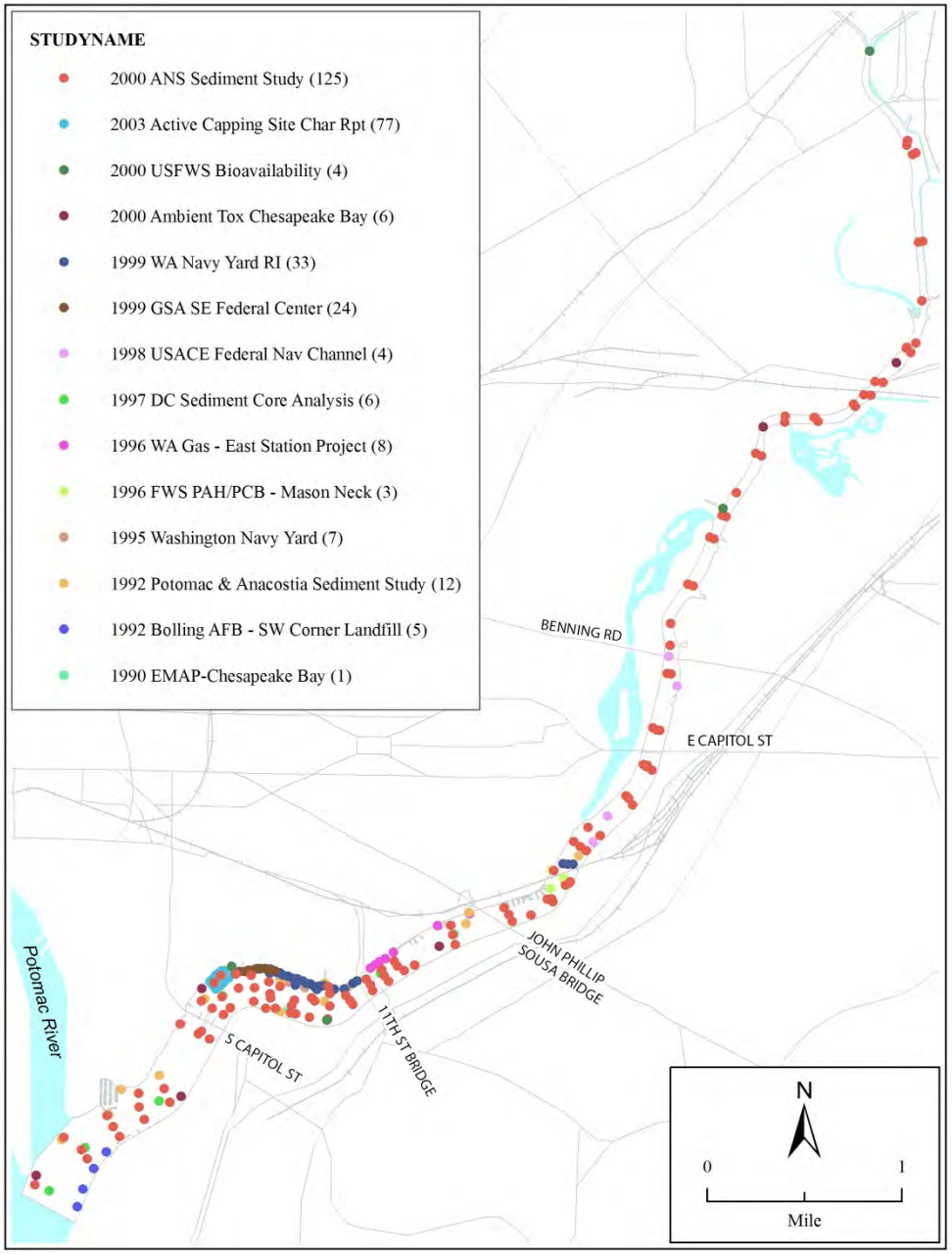
- *Hot spots with high concentrations are present*
- *Low to moderate sediment contamination is wide-spread*
- *Ongoing sources (point and non-point) continue to impact river sediments*
- *Ecological and human health risks persist*

"Strawman" Remedy

- *Sand capping of identified hot spots*
  - *Potentially cost effective*
  - *Ecosystem disturbance is minimal and may provide for benthic community restoration*
  - *Effective if used in combination with source control*

Sources of Data

- *Academy of Natural Sciences*
- *13 other studies, prior to 2003*
- *More recent data were not used because they weren't in the query manager database*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2003 Active Capping Site Char Rpt (77)
2000 USFWS Bioavailability (4)
2000 Ambient Tox Chesapeake Bay (6)
1999 WA Navy Yard RI (33)
1999 GSA SE Federal Center (24)
1998 USACE Federal Nav Channel (4)
1997 DC Sediment Core Analysis (6)
1996 WA Gas - East Station Project (8)
1996 FWS PAH/PCB - Mason Neck (3)
1995 Washington Navy Yard (7)
1992 Potomac & Anacostia Sediment Study (12)
1992 Bolling AFB - SW Corner Landfill (5)
1990 EMAP-Chesapeake Bay (1)
BENNING RD
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JOHN PHILLIP SOUSA BRIDGE
11TH ST BRIDGE
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Potomac River
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Data Sources

Contaminant	All Data (13 Surveys)			ANS 2000 Survey Only		
	All Points	Excluded*	Points Used	All Points	Excluded**	Points Used
PCBs	383	88	295	133	9	124
PAHs	424	110	314	134	9	125

*Points falling outside the river corridor were excluded from the analysis
** This is being checked because these points should fall in the river corridor

Summary Statistics for PCBs and PAHs (Sample Data)

Study	Number of Samples	Minimum	Mean	Maximum	Standard Deviation
PCBs					
ANS 2000	124	2	181	1,643	171
All Studies	295	ND	579	12,000	1,091
PAHs					
ANS 2000	125	495	11,742	56,330	8,737
All Studies	314	100	16,619	211,300	22,453

Values reported in micrograms per kilogram (μg/kg).

Data Analysis

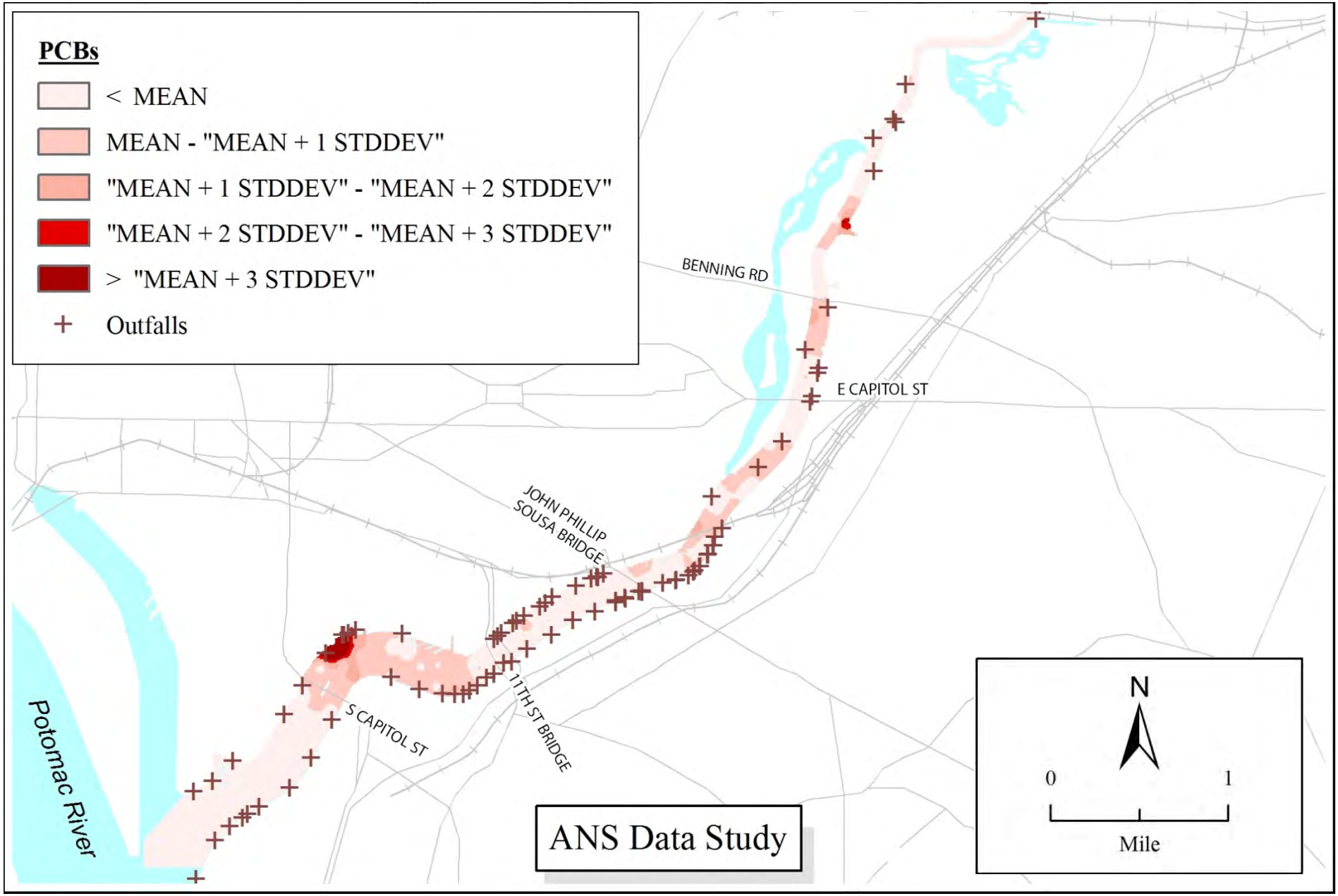
DAMAGE ASSESSMENT, REMEDIATION, and RESTORATION PROGRAM (DARRP)

1. *Created a grid from the selected data points using Inverse Distance Weighted (IDW) method with the following parameters*
   i. *Output cell size = 10 meters*
   ii. *Search Radius = Fixed*
   iii. *Distance = 500 meters*
   iv. *Minimum number of points = 5*
2. *Hotspots were selected from the output grids based on their value being greater than the Mean + 2*Standard Deviation*

Summary Statistics for PCBs and PAHs (Gridded Data)

Study	Minimum	Mean	Maximum	Standard Deviation
PCBs				
ANS 2000	2	189	1,635	123
All Studies	ND	297	7,496	291
PAHs				
ANS 2000	500	10,720	56,308	6,190
All Studies	357	11,584	200,683	11,928

Values reported in micrograms per kilogram (μg/kg).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> "MEAN + 3 STDDEV"
Outfalls
BENNING RD
E CAPITOL ST
JOHN PHILLIP SOUSA BRIDGE
11TH ST BRIDGE
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Potomac River
ANS Data Study
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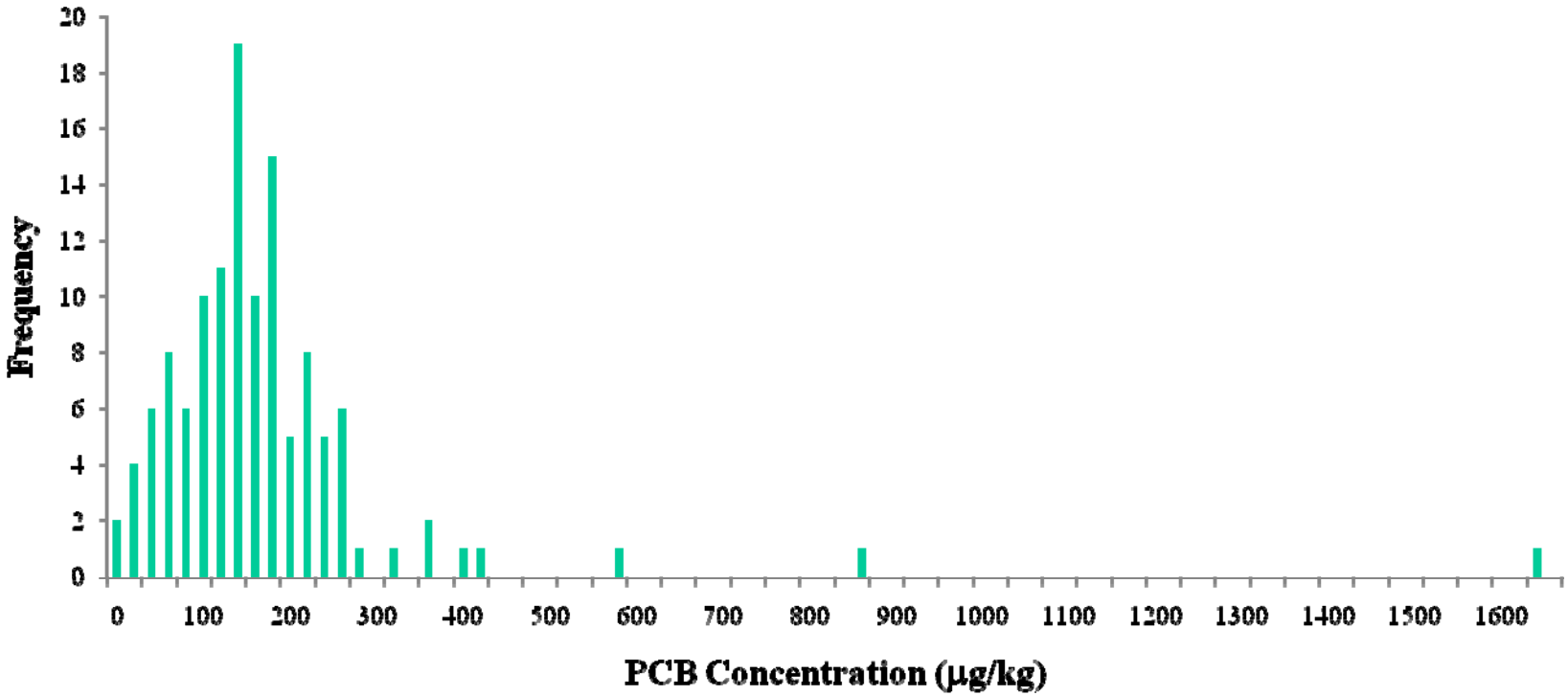
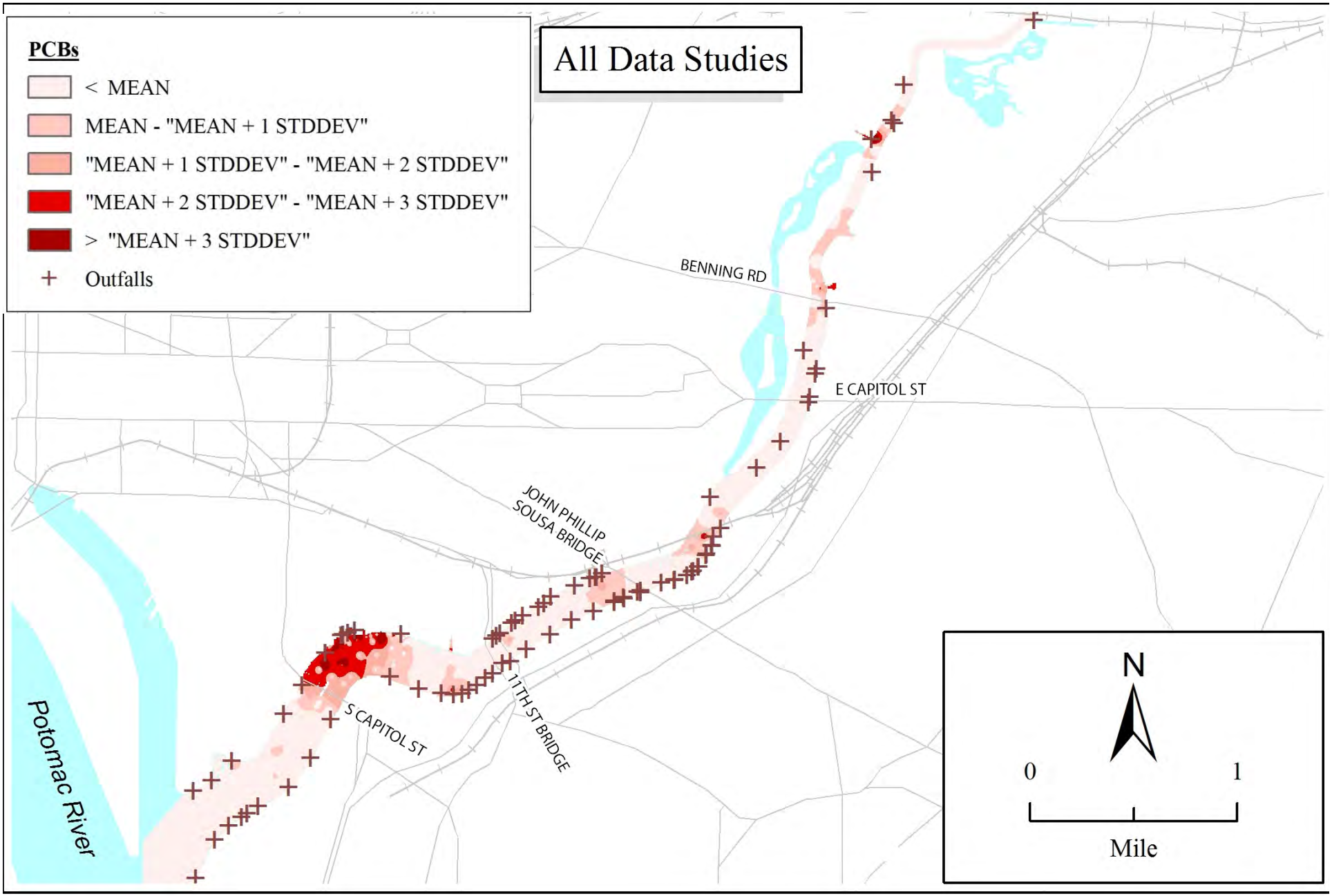
ANS 2000 Data

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PCBs
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"MEAN + 1 STDDEV" - "MEAN + 2 STDDEV"
"MEAN + 2 STDDEV" - "MEAN + 3 STDDEV"
> "MEAN + 3 STDDEV"
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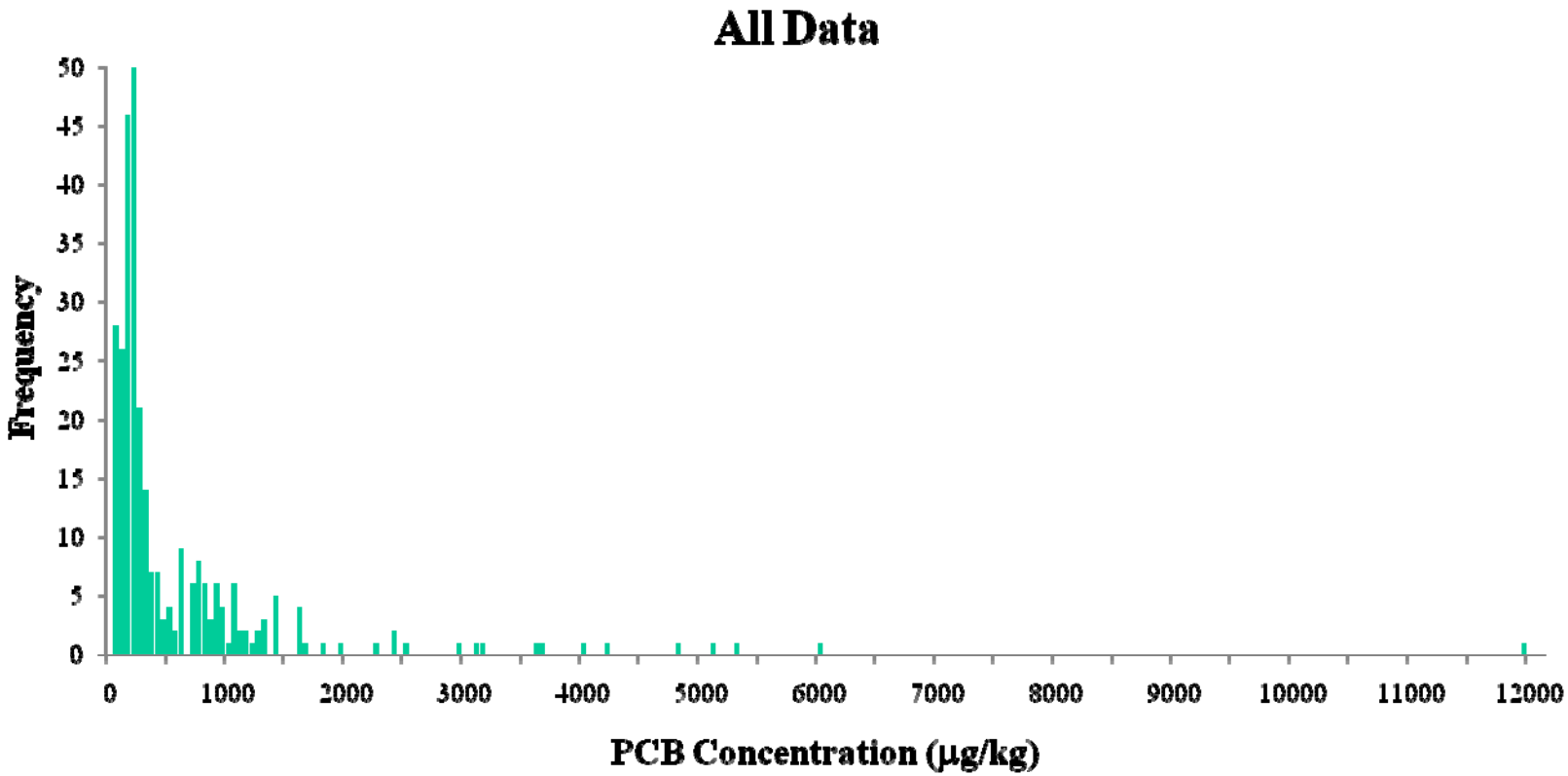
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20
15
10
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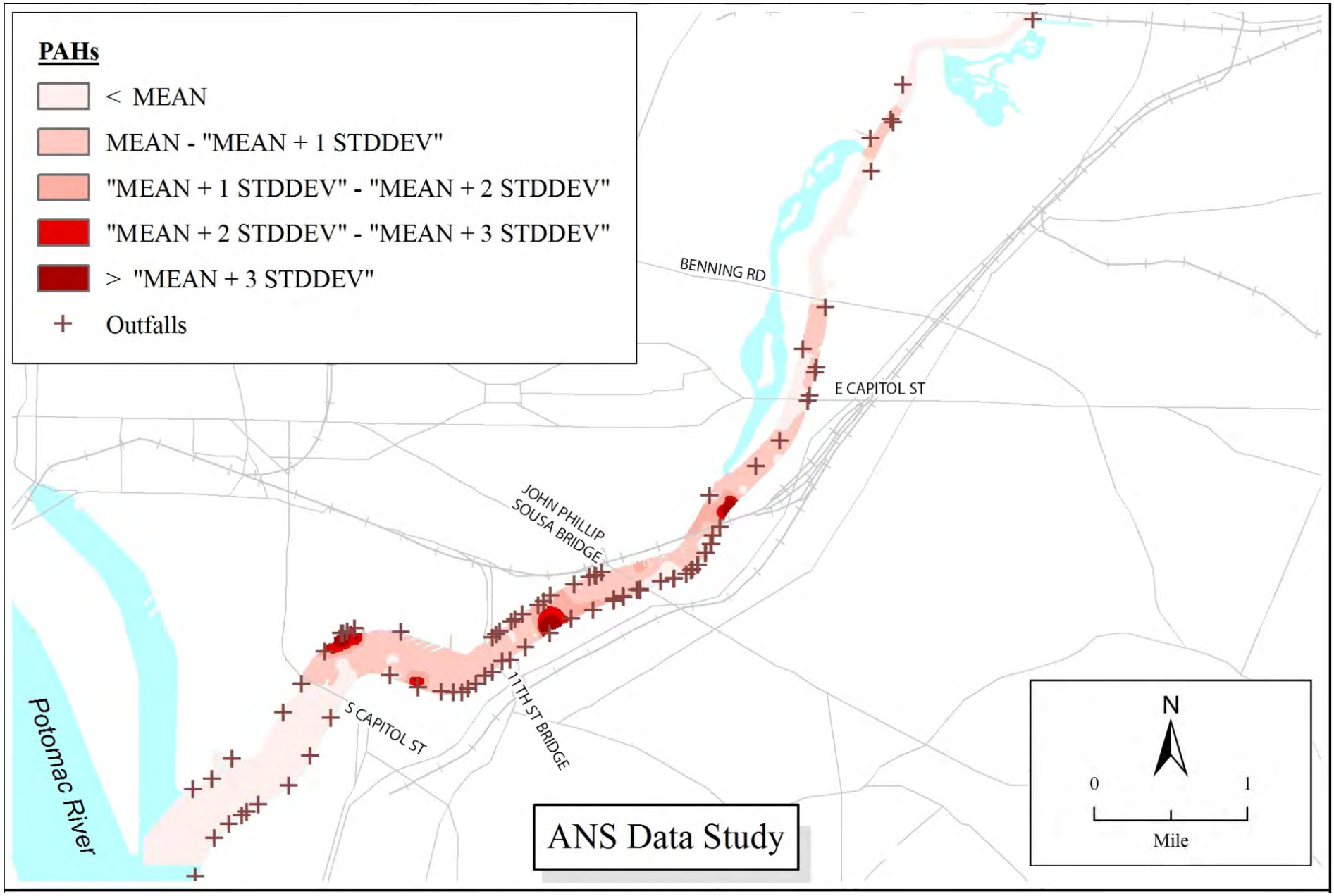
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
PCB Concentration (µg/kg)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> "MEAN + 3 STDDEV"
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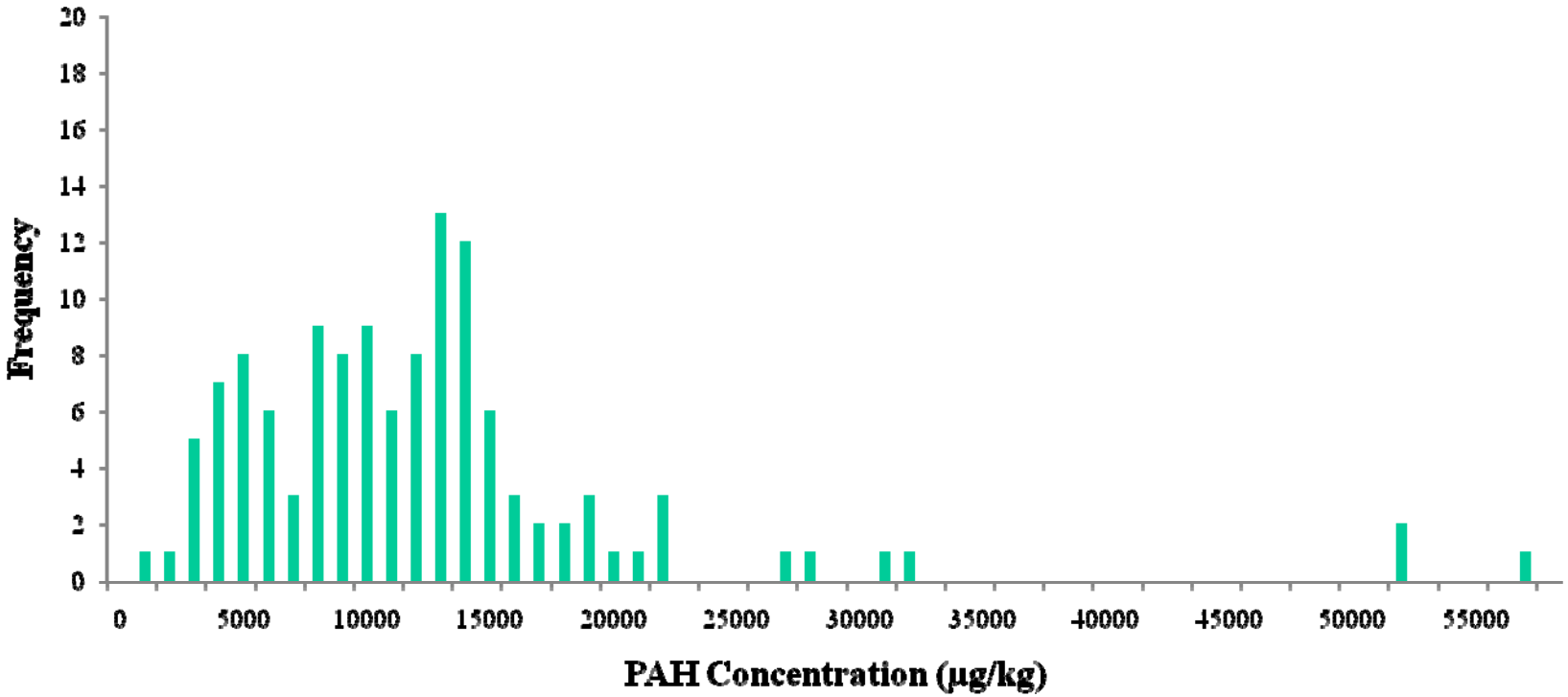
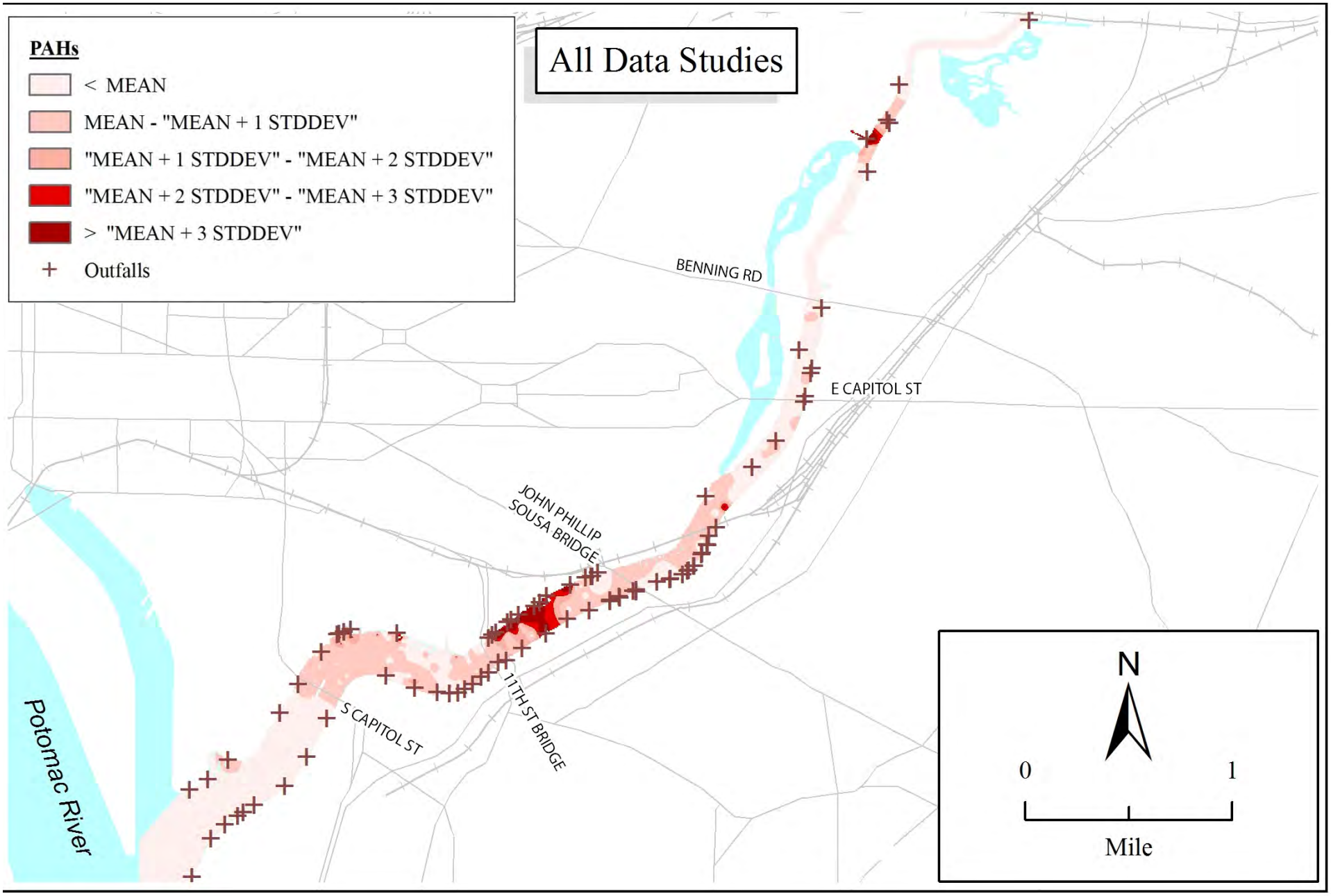
ANS 2000 Data

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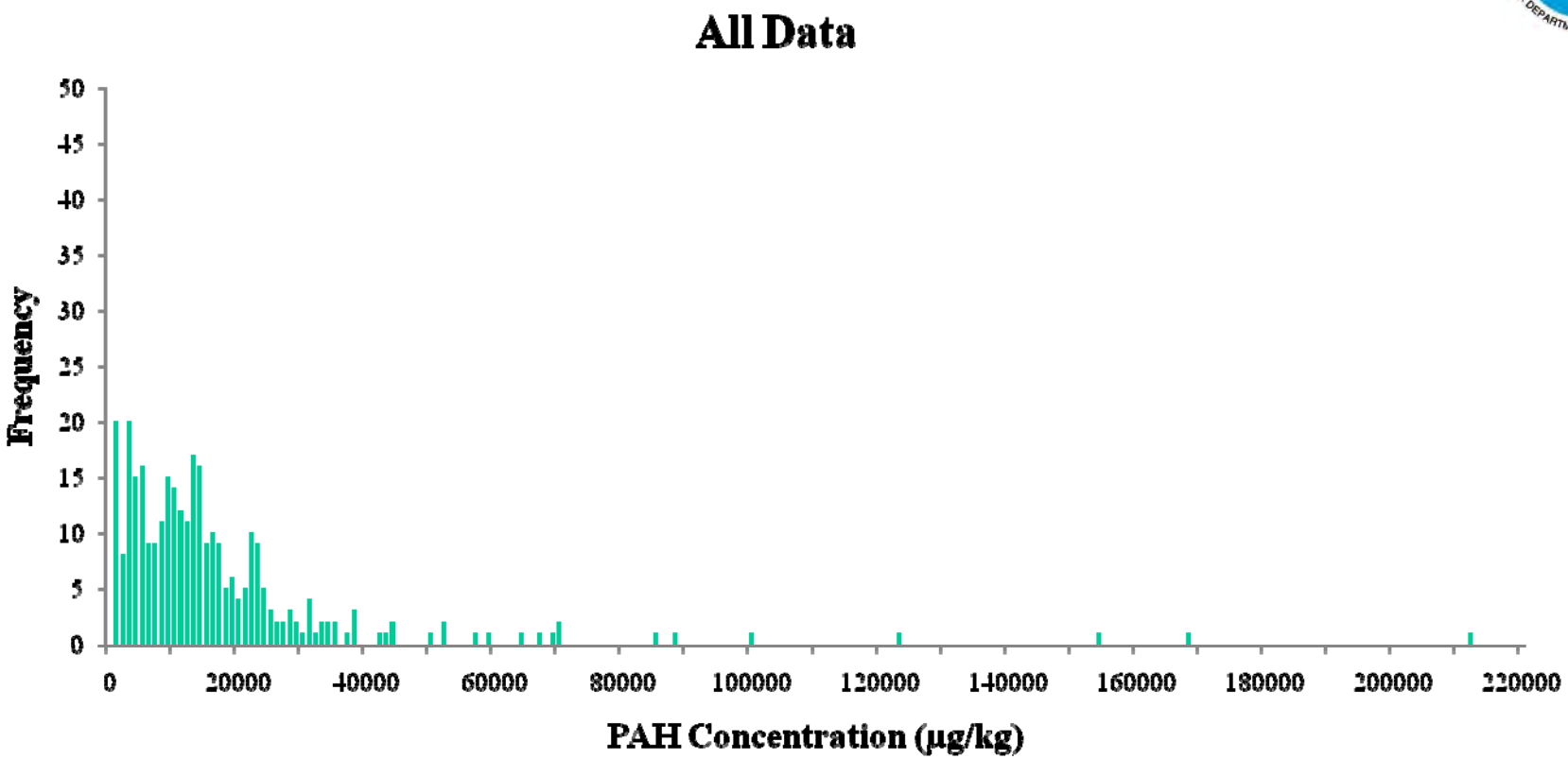
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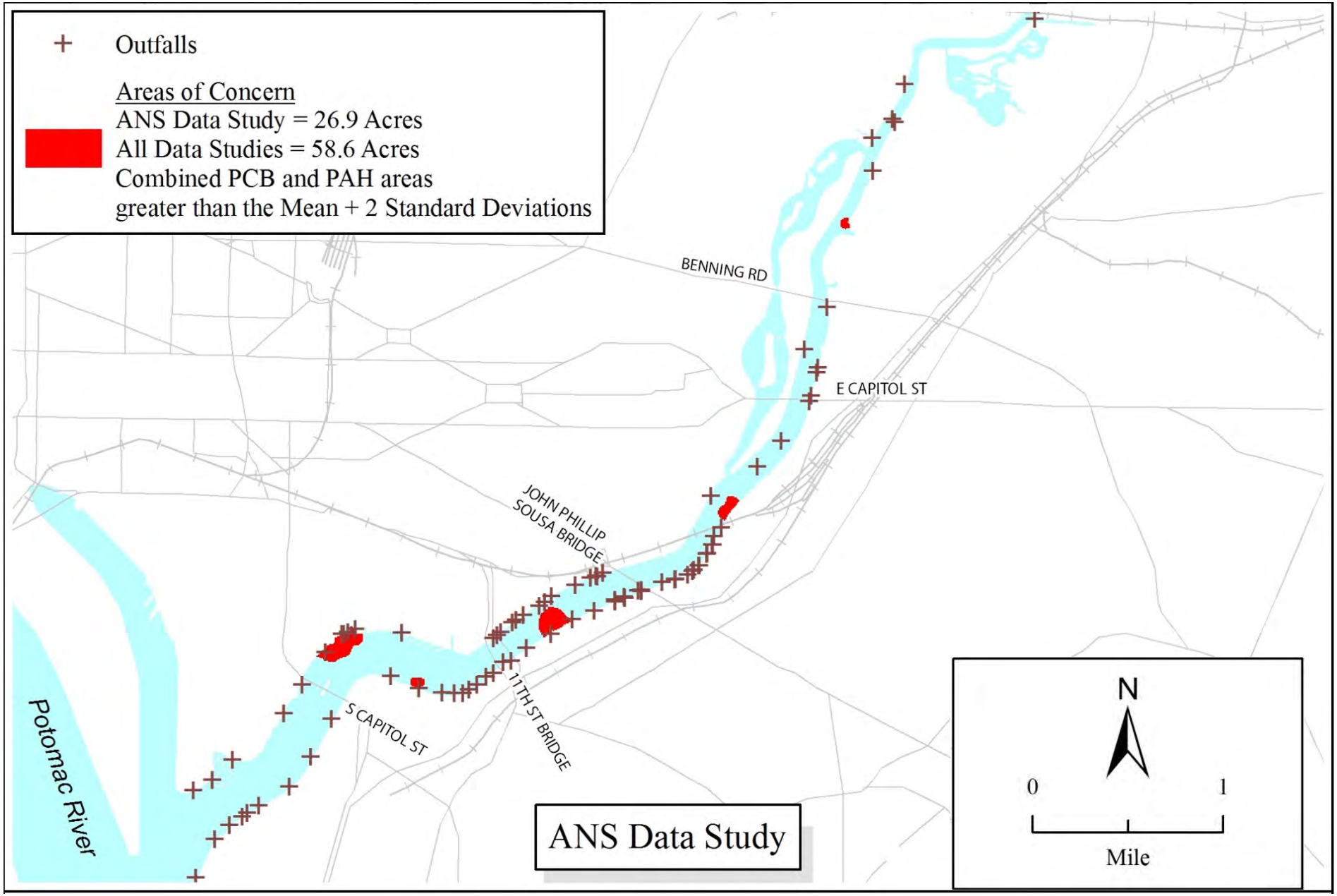
120000
140000
160000
180000
200000
220000
PAH Concentration (µg/kg)


Outfalls
Areas of Concern
ANS Data Study = 26.9 Acres
All Data Studies = 58.6 Acres
Combined PCB and PAH areas
greater than the Mean + 2 Standard Deviations
BENNING RD
E CAPITOL ST
JOHN PHILLIP SOUSA BRIDGE
11TH ST BRIDGE
S CAPITOL ST
Potomac River
ANS Data Study
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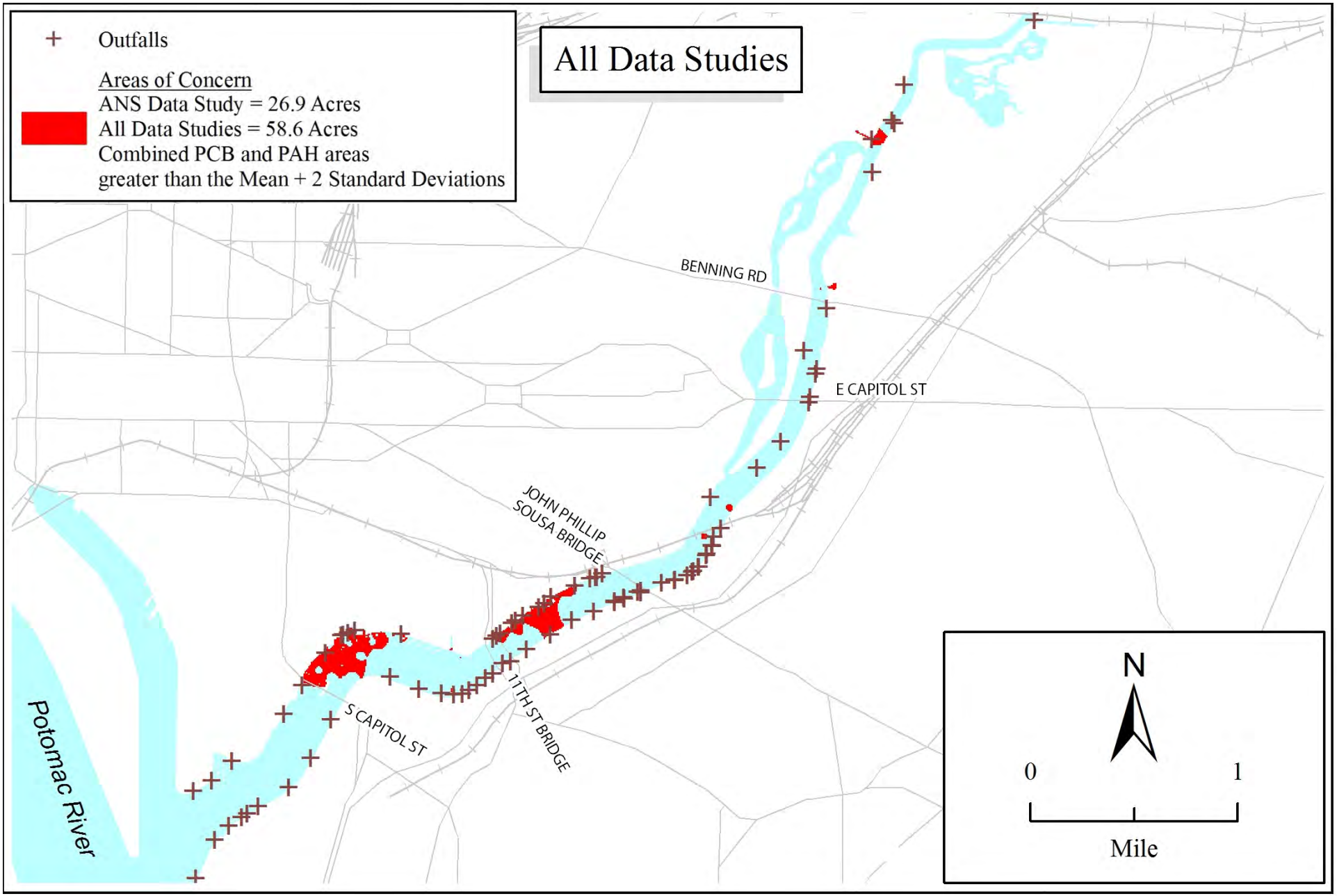
All Data Studies
Outfalls
Areas of Concern
ANS Data Study = 26.9 Acres
All Data Studies = 58.6 Acres
Combined PCB and PAH areas
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11TH ST BRIDGE
S CAPITOL ST
Potomac River
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Reduction in Mean

Contaminant	All Study Area Data Mean (µg/kg)	ANS Data Mean (µg/kg)
PAHs		
Initial value	11,584	10,720
After hot spot removal	9,352	9,581
Reduction in mean:	19%	11%
PCBs		
Initial value	297	189
After hot spot removal	225	169
Reduction in mean:	24%	10%

Order of Magnitude Costs for Capping and Associated Activities

Work Element	Order of Magnitude Cost
Sediment Sampling	$300,000 to $500,000
Feasibility Study	$80,000 to $150,000
Remedial Design	$70,000 to $130,000
Remedial Action (50 to 60 acre sand cap)	$3,000,000 to $5,000,000
Monitoring	$200,000/year for 10 years
Total	$6 million to $8 million

Estimated Risk Reduction for Ecological and Human Receptors by Capping Hotspots

Chemical Class	Percent Reduction in Average Risk	Percent Reduction in Maximum Risk
PCBS (ANS 2000)	10%	73%
PCBs (All Studies)	24%	88%
PAHs (ANS 2000)	11%	59%
PAHs (All Studies)	19%	82%

Limitations on White Paper

- *This White Paper is limited in detail because it is not intended as a Feasibility Study or Remedial Design*
- *Cost information is presented as a general estimate for sand capping*
- *Innovative remedies for point and non-point sources are appropriate for evaluation in a feasibility study*

Comment: Remedial Strategy Too Simple

- *Evaluate existing sediment data, collect and analyze new samples where needed on a site specific basis*
- *Evaluate sources of contamination*
- *Conduct site specific feasibility studies*
- *Develop a remedy that is effective for hotspots and for source control*

Additional Remedial Alternatives

- *Dredging hot spots (with disposal options)*
- *Reactive capping and other in situ treatment*
  - *Limnofix, electrochemistry, dechlorination*
- *Natural recovery*
- *Enhanced natural recovery*

Comment: Remedy Selection

- *Several commenters asked: Why sand capping, why not dredging, why not combined remedy?*
- *Sand capping was selected because it is conceptually simple, doesn't require volume estimates, demonstrated applications, and costs are well-known.*
- *Other alternatives are clearly appropriate for FS and RD*

Comment: Additional Data Needed

- *Several commenters noted more data are required to identify an appropriate remedy and post-remedy to check for recontamination*
- *Response: Agreed and the white paper will state as much*
- *Both site-specific design and comprehensive river-wide monitoring data are desirable*

Comment: Source Control

- *Several commenters noted that neither point source nor non-point source control has been achieved.*
- *Agreed. Hotspot actions (capping or dredging) only make sense to the extent that recontamination doesn't undo the benefit. Timing is an issue at most complex sites with multiple sources and multiple hot spots.*
- *Source control measures have occurred at Washington Gas and the Navy Yard.*
- *Additional source identification is needed*

Comment: Recontamination Potential

- *Many sources of contamination exist, both point and nonpoint source, thus some level of recontamination is likely*
- *The 30-month Active Capping study by Reible, et al (Dec 2007) shows that after 30 months:*
  - *Deposition of fines on sand caps was limited to the extent that the deposition rate was immeasurable*
  - *Discoloration appeared on some caps to a depth of up to 5 inches*

Comment: Regulatory Framework

- *Several commenters noted that the regulatory framework for cleanup is unclear (federal, state, DC)*
- *Agreed, but it is beyond the scope of this paper to resolve this issue.*

White Paper Reviewers

- *Robert Boone, Anacostia Watershed Society*
- *Mary Jean Brady, Washington Gas Company*
- *Paul S. Emmart, Maryland Department of the Environment*
- *Rich Eskin, Maryland Department of Environment*
- *George Harman, Maryland Department of Environment*
- *Scott MacEwen, P.E., CH2M Hill*
- *Harriette L. Phelps, University of D.C.*
- *Fred Pinkney, USDOI: Fish & Wildlife Service*
- *Dennis Powers, USACE, Baltimore District (CENAB-EN-HT)*
- *Angela Sowers and David Robbins, USACE*
- *David Velinsky, Academy of Natural Sciences*

Analysis of Contaminant Concentrations in Fish Tissue Collected from the Waters of the District of Columbia

Publication No. CBFO-C08-03

Alfred E. Pinkney

Prepared for:

The District Department of the Environment
Natural Resources Administration
Water Quality Division

Prepared under supervision of:
Sherry Krest, Program Leader

U.S. Fish and Wildlife Service
Chesapeake Bay Field Office
177 Admiral Cochrane Drive
Annapolis, MD 21401

March, 2009

EXECUTIVE SUMMARY

The Government of the District of Columbia (D.C.) regularly monitors contaminant concentrations in fish tissue in order to protect the health of the public. Currently, there is an advisory warning the public to avoid consuming bottom feeding fish (catfish, carp, and eels), and restrict their intake of other species. The advisory is due to unacceptably high concentrations of polychlorinated biphenyls (PCBs) and other chemicals. The present study summarizes the results of contaminant analyses conducted on fish collected by the District Department of the Environment (DDOE) in November, 2007. Concentrations are compared with those measured in the previous sampling periods (1993-1994 and 2000). Information is provided on various approaches used to set consumption advisories.

The DDOE collected American eel (*Anguilla rostrata*), bluegill (*Lepomis macrochirus*), pumpkinseed (*Lepomis gibbosus*), carp (*Cyprinus carpio*), channel catfish (*Ictalurus punctatus*), blue catfish (*Ictalurus furcatus*), and largemouth bass (*Micropterus salmoides*) from the Anacostia and Potomac Rivers using an electroshocking boat. Four locations were designated: Upper Potomac (above the 14th street bridge), Lower Potomac (below the 14th street bridge), Upper Anacostia (above the CSX Railroad bridge), and Lower Anacostia (below the CSX Railroad bridge). Composite samples were composed of $\geq$ 3 individual fish (except for one blue catfish composite of two fish). The samples were analyzed by the TDI Brooks International (College Station, TX) laboratory for lipid and moisture content, over 40 polynuclear aromatic hydrocarbons (PAHs, including alkylated compounds), 23 organochlorine pesticides, total polychlorinated biphenyls (PCBs, including Aroclor analysis), 119 PCB congeners, and polybrominated diphenyl ethers. Analysis for metals was performed by Laboratory and Environmental Testing, Inc. (Columbia, MO).

The U.S. EPA has developed screening levels which are concentrations above which fish tissue contaminants may pose risks to human consumers. The following chemicals are designated as potential Contaminants of Concern (COCs) because at least one composite sample had a concentration that exceeded one or more of the screening levels used to identify possible risks to human consumers: total PCBs, total DDT, total chlordane, dieldrin, heptachlor epoxide, hexachlorobenzene, total PAHs, and mercury. Median concentrations for at least one species exceeded a screening level for the following contaminants: total PCBs, total chlordane, total DDT, dieldrin, heptachlor epoxide, and total PAHs. This list of contaminants was considered to be the final list of Contaminants of Concern.

The greatest and most consistent exceedence of screening levels was for PCBs, total chlordane, total DDT, and dieldrin. All samples of PCBs exceeded the 0.02 ppm screening level. The highest concentrations were in American eel, where the median concentration was 2.18 ppm. Median concentrations in carp, channel catfish, and blue catfish were all close to 0.80 ppm. Median total PCB concentrations in largemouth bass and sunfish were about 0.258 ppm and 0.144 ppm, respectively. In American eel and carp, median concentrations of four chemicals (total chlordane, total DDT, dieldrin, and heptachlor epoxide) all exceeded screening levels. In

blue catfish three chemicals (total chlordane, total DDT, dieldrin) exceeded screening levels. In channel catfish median concentrations of dieldrin exceeded the screening level. Although total PAHs exceeded the EPA screening level for many species, no fish had concentrations exceeding the state of Delaware's screening value which uses a more refined method, the Toxic Equivalent Quotient (TEQ) approach.

One group of analytes, PBDEs., was measured for the first time in waters of the District of Columbia. PBDEs have no U.S. EPA screening value. Concentrations were well below the advisory threshold (5 ppm) used by the Virginia Department of Health.

Contaminants in blue catfish and smallmouth bass were measured for the first time in this sampling round. Smallmouth bass concentrations were generally less than those in largemouth bass. Blue catfish concentrations were similar to those in channel catfish and carp, despite the fact that several fish were considerably larger.

The most relevant time line for the purposes of the advisory is to evaluate changes between 2000 and 2007 for PCBs and chlordane. Based on median concentrations, the following three conclusions are drawn. First, concentrations of both contaminants in American eel, carp, and largemouth bass increased in both rivers. Second, concentrations of both contaminants in channel catfish decreased in both rivers. Third, concentrations in sunfish in nearly all comparisons, decreased slightly. Concentrations of PCBs and chlordane were generally higher in the Anacostia vs. Potomac with larger differences for chlordane than for PCBs.

Finally, I provide a brief discussion of several approaches to meal recommendations. One approach applies the median concentration for a species into specific threshold categories. Table 10 of the report reproduces the threshold categories for PCBs used by the Virginia Department of Health and many of the Great Lakes states and provides an example of meal recommendations based on each of these procedures.

ACKNOWLEDGMENTS

The assistance and cooperation of Lucretia Brown, Jon Siemien, and Danny Ryan of the District Department of the Environment are appreciated. The map was prepared by Leslie Gerlich. We thank Judy Bischoff and Ken Crabb of the USFWS, Analytical Control Facility for quality assurance and interaction with the laboratories.

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Appendix B Analytical Chemistry Data Reports (Including Methods)

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1.0 INTRODUCTION

1.1 Fish contamination in U.S. Waters

Thirty million Americans fished in U.S. waters in 2006, the year of the most recent national survey (U.S. Department of the Interior and U.S. Department of Commerce, 2006). Freshwater fishing was more popular than saltwater fishing and accounted for 25.4 million Americans who spent a total of $26.3 billion on trips and equipment. As part of the fishing experience, many fishermen choose to consume their catch. Fish are a valuable source of protein and the benefits of consuming fish are considerable (Anderson *et al.* 1993).

The states (D.C., territories and American Indian tribes included in this category) are primarily responsible for evaluating the safety of fish and shellfish obtained by recreational fishermen. The U.S. Food and Drug Administration (U.S. FDA) is responsible for evaluating the safety of commercially-obtained fish. States regularly monitor the chemical concentrations in fish through tissue monitoring programs. They apply risk assessment models to establish the need to place restrictions on consumption to protect the public health. The U.S. Environmental Protection Agency (U.S. EPA 1995, 1996, 2000a, 2000b) has produced a four volume guidance manual to assist the states in these programs. In Volume I of the guidance, U.S. EPA (2000a) developed screening values (SVs) for contaminants commonly measured in tissue monitoring programs. A screening value is defined as a concentration that is of potential health concern. Detection of fish tissue concentrations that exceed a screening value is intended to trigger a more intensive survey and/or an evaluation of human health risk.

There are five major types of advisories that states issue (U.S. EPA 2007):

1. **No consumption advisory for the general population** - issued when chemical contamination in certain species and/or size classes poses risks such that the general population is advised to avoid eating locally caught fish.

2. **No-consumption advisory for sensitive subpopulations** - issued when subpopulations (such as pregnant women and children) are advised to avoid consumption of certain species because chemical contamination poses risks to their health.

3. **Restricted consumption for the general population** - issued when health risks may occur if too much fish is consumed. The public is advised to limit their consumption of certain species because of chemical contamination.

4. **Restricted consumption for sensitive subpopulations** - issued when subpopulations (such as pregnant women and children) are advised to limit consumption of certain species because chemical contamination poses risks to their health.

5. **Commercial fishing ban -** issued when high levels of contaminants are found in fish caught for commercial purposes. Commercial harvest is prohibited.

For many contaminants that bioaccumulate in fish, older and larger fish contain higher concentrations than smaller, younger fish. Restrictions on consumption may be based on specific size classes.

Currently, 48 U.S. states, the District of Columbia, and two territories have consumption advisories (U.S. EPA 2007). Some have state-wide advisories covering certain types of waters (e.g, lakes) while other advisories are water-body specific (e.g., a river or section of a river). The five most common chemicals involved in advisories are: mercury (48 states plus one territory), polychlorinated biphenyls (PCBs: 39 states (plus D.C. and American Samoa), dioxins: 17 states, DDT compounds:16 states, and chlordane: 15 states. These compounds were at least partly responsible for 88% of all advisories in effect in 2006 (U.S. EPA 2007).

1.2 Current advisory for District of Columbia waters

A fish consumption advisory has been in effect since 1989 for the Potomac and Anacostia Rivers in the District of Columbia. In 1994, the advisory was updated, cautioning the public not to eat catfish, carp, and eel. Consumption of largemouth bass (*Micropterus salmoides*) is limited to one half pound per month and consumption of sunfish and species is limited to one half pound per week. This is the current advisory (District Department of the Environment (DDOE 2008a). The advisory states that these restrictions are due to contamination with PCBs and other chemicals. The District of Columbia Government has continued to fund studies monitoring the concentrations of these and other contaminants in fish caught in District waters (Velinsky and Cummins, 1994; 1996; Pinkney *et al.* 2001). These studies have indicated that detectable levels of many chemicals are present in the edible portion of certain fish species, including trace inorganics such as mercury and lead, as well as organic compounds such as polycyclic aromatic hydrocarbons (PAHs), PCBs, DDTs and chlordane (Velinsky and Cummins, 1994; 1996). Results also suggest that concentrations of PCBs and chlordane in fish, particularly bottom feeding species, continue to pose a human health risk. Continued monitoring is critical to evaluate changes in contaminant levels and assess the potential for risk to human and ecological receptors.

1.3 Advisories for Virginia and Maryland waters near the District of Columbia

Information on current advisories for the Potomac and Anacostia Rivers was obtained from the Maryland Department of the Environment (MDE). Information on advisories in Virginia tribuatries of the Potomac River were obtained from the Virginia Department of Health. These advisories are listed in Tables 1a and 1b.

1.4 Objectives

The objective of this project was to determine the concentration of chemical contaminants in fish tissue samples collected by the DDOE from the waters of the District of Columbia from August through November 2007. The data are analyzed and interpreted and risks to human consumption are discussed.

2.0 MATERIALS AND METHODS

2.1 Sampling methods

DDOE collected fish from waters of the District of Columbia in August through November 2007 through standard electro-fishing procedures. Four locations were designated: Upper Potomac (above the 14th street bridge), Lower Potomac (below the 14th street bridge), Upper Anacostia (above the CSX Railroad bridge), and Lower Anacostia (below the CSX Railroad bridge-see Figure 1). Tissue samples were obtained from eight species of fish indigenous to these waters: American eel (*Anguilla rostrata*), bluegill (*Lepomis macrochirus*), pumpkinseed (*L. gibbosus*), carp (*Cyprinus carpio*), channel catfish (*Ictalurus punctatus*), blue catfish (*I. furcatus*), largemouth bass (*Micropterus salmoides*) and smallmouth bass (*M. dolomieu*). To the extent possible, the objective was to collect at least three similarly-sized fish of each species to prepare composite samples. In cases where more than one fish could not be obtained, it was necessary to analyze fish as individuals.

Six composite samples were collected from the Lower Anacostia River, five composites and one individual sample from the Upper Anacostia River, seven composites and four individual samples from the Lower Potomac River, and five composites and four individual samples from the Upper Potomac River. Composite samples were composed of at least two and as many as ten individual fish, and individual samples contained one fish per sample (Table 2). As fish were collected, they were measured to the nearest millimeter, and individual fish were wrapped in aluminum foil, labeled, and placed in plastic bags on ice. At the end of each field day, samples were placed in a locked freezer (-20 EC) at the DDOE. Once all fish collections were completed, USFWS obtained samples from the DDOE following chain of custody procedures (Standard Operating Procedure 102, 103-Appendix A), and were maintained frozen at the USFWS Chesapeake Bay Field Office (CBFO) until processed.

During processing by CBFO, fish were weighed to the nearest gram and measured to the nearest millimeter. Fillets were taken from each of the fish following CBFO SOP 114 (Appendix A) and weights of fillets were recorded to the nearest 0.01 gram. Channel and blue catfish were skin-off fillets, while all others, excluding American eel, were skin-on. For American eel, the skin and viscera were removed, and samples included muscle and bone. Samples (i.e., fillets and composites) were given a unique sample identification number which was coded as follows: bgup01, where the first two letters identified the location (UP=Upper Potomac, LP=Lower

Potomac, UA=Upper Anacostia, LA=Lower Anacostia); the second two identified the species (AE=American eel, BC=blue catfish, BG=bluegill, CA=carp, CC=channel catfish, LB=largemouth bass, PU=pumpkinseed, SB=smallmouth bass), and the last two or three numbers were the sample number. For the sunfish (SF), there were several cases in which both pumpkinseeds and bluegill were collected. Samples were stored in chemically cleaned jars and kept frozen in preparation for shipment. They were then packaged with dry ice and shipped to the contracted laboratory for processing and analysis. A catalog of samples and requested analyses was prepared using the Environmental Contaminants Data Management System (ECDMS) database and accompanied the shipment of samples. Chain of custody procedures (SOP 102) were followed for all transfer of samples and copies are in Appendix A.

2.2 Analytical methods

All analyses were contracted through USFWS Analytical Control Facility (ACF). The samples were analyzed by TDI Brooks International Inc. (College Station, TX) laboratory for lipid and moisture content, over 40 polynuclear aromatic hydrocarbons (PAHs, including alkylated compounds), 23 organochlorine pesticides, total polychlorinated biphenyls (PCBs, including Aroclor analysis), 119 PCB congeners, and 38 polybrominated diphenyl ether (PBDE) congeners (Table 3a). The requested detection limits are given in Table 3a and 3b.

Method summaries are provided in Appendix B. In brief, tissues were homogenized, dried, and extracted using a Dionex ASE200 Accelerated Solvent Extractor. The extraction solvent was dichloromethane. Extracts were processed through silica gel/alumina chromatography columns and High Performance Liquid Chromatography. Extracts were concentrated and analyzed by gas chromatography/mass spectrometry (GC/MS) for PAHs or GC with an electron capture detector (ECD) for organochlorine pesticides and PCBs. Confirmation of pesticides and PCBs was by GC/MS in either full scan or selection ion monitoring mode.

Analysis for metals (and moisture content) was performed by Laboratory and Environmental Testing, Inc. (Columbia, MO). Methods are described in Appendix B and summarized briefly here. Samples were freeze dried and the moisture percentage was determined. Arsenic and selenium were analyzed by hydride generation atomic absorption spectrometry (AAS). Mercury was analyzed by cold vapor AAS. Cadmium and lead were analyzed by graphite furnace AAS. Aluminum, boron barium, beryllium, chromium, copper, iron, magnesium, manganese, molybdenum, nickel, strontium, vanadium, and zinc were analyzed by inductively coupled plasma spectroscopy (ICP). Detection limits are given in Table 3b.

To examine variability within a composite sample, equal portions of fillets from three individual fish within channel catfish sample (UPCC01) were analyzed separately (as samples UPCC101, -102, and -103). The coefficient of variation (CV) was calculated as the standard deviation divided by the mean and multiplied by 100.

2.3 Data Presentation and Analysis

All data are reported as wet weight in parts per million. Summary statistics were prepared for all analytes, including the frequency of detection, minimum, maximum, mean, standard deviation of the mean, and median concentrations. For individual compounds, for the purposes of calculating summary statistics, non-detected samples were reported as one half the sample detection limit. Total DDT was determined as the sum of all six o,p=- and p,p=- DDD, DDE, and DDT isomers. Total chlordane was determined as the sum of alpha and gamma chlordane, cis- and trans-nonachlor, and oxychlordane (U.S. EPA 2000a). For total DDT, PCBs, chlordane, PAHs and PBDEs all non-detected compounds were set equal to zeros to avoid inflating the total.

Several congeners co-elute and are reported as a single concentration. Total PCB concentrations were calculated both as the sum of the Aroclors (avoiding duplicate counting of peaks that overlapped) and as the sum of the congeners. In addition, co-planar PCBs have dioxin-like properties inducing effects through a common mechanism, i.e., binding to an aryl hydrocarbon receptor (Eisler and Belisle 1996). Thus the effects of PCBs were also evaluated using the toxic equivalency factors (TEFs) which relate the potency of the individual PCB congener to that of 2,3,7,8 tetrachlorodibenzo-*p*-dioxin (TCDD), the most potent compound in this class. The TEFs of Van den berg *et al.* (1998) were used. For PAHs, I used the TEFs calculated by Nisbet and LaGoy (1992), which relate various compounds to the toxicity of benzo(a)pyrene.

I identified guidance values by focusing primarily on those developed on a national basis by U.S. EPA and U.S. FDA. All available U.S. FDA advisory and tolerance levels and U.S. EPA (2000a) screening values or water quality criteria (for methylmercury, U.S. EPA 2001) are identified and included in the summary tables. For PBDEs, no federal guidelines were identified. I listed the 5 ppm threshold used by the Virginia Department of Health (VDH; R. Tripathi, personal communication). For the TEF approach, I used the screening values developed by Delaware Department of Natural Resources and Environmental Control and Delaware Department of Health and Social Services (DNREC-DHSS 2005). Contaminants of concern (COCs) were selected by comparing the concentrations with the lower of these four sources of guidance values. All contaminants for which a single composite exceeded any of these screening values were designated as potential COCs. Final COCs included only those contaminants for which a median concentration in at least one species exceeded a guidance value. The discussion of risks and various methods for developing advisories are restricted to these COCs with one exception. I discuss arsenic because of the uncertainty in comparing total arsenic with screening values for inorganic arsenic. The analysis of data for setting advisories (see Discussion section) uses the median concentration as recommended by DNREC-DHSS (2005).

3.0 RESULTS

3.1 Contaminants of concern

The following chemicals were designated as potential COCs because at least one composite sample had a target analyte concentration that exceeded one or more of the guidance values described above: total PCBs, total DDT, total chlordane, dieldrin, heptachlor epoxide, hexachlorobenzene, mercury, and total PAHs (see Table 4a and 4b for summary statistics). I remove hexachlorobenzene and mercury for the final list of COCs because no species had a median concentration that exceeded a screening value.

The following sections describe the results for the COCs. There is also a brief discussion of mercury because it is so frequently a driver for advisories in other jurisdictions (U.S. EPA 2007). Arsenic is discussed because of uncertainty over the concentration of its more toxic inorganic form. The inorganic arsenic concentration in American eel sample (estimated as 10% of total arsenic, U.S. FDA (1993a)) approached but did not exceed the screening value.

3.1.1 Total PCBs (screening value: 0.02 ppm)

Total PCBs were similar (averaging within 15%) when calculated as the sum of the Aroclors or as the sum of the congeners (Table 5). In nearly all cases the Aroclor-based concentration was higher than the congener total. The largest difference both in numeric concentration and as a percentage was for American eel sample LPAE01 from the Lower Potomac. The concentration was 4.00 ppm by Aroclors vs. 2.80 by congeners, a 30% difference. To simplify the reporting of the results and to be conservative with respect to risk, total PCB data are discussed as the values calculated by the Aroclor method.

All samples of all species exceeded the U.S. EPA screening value of 0.02 ppm. The highest total PCB concentrations were detected in American eel (Table 4a; Figure 2, Appendix C), with eel samples exceeding the screening level by factors ranging from 55 to 200. The median concentration of 2.18 ppm also exceeded the U.S. FDA action level of 2.0 ppm. For this species, the highest concentrations were reported in the two Lower Potomac composites. The larger sized composite (length range of 493-530 mm) had a total PCB concentration of 4.00 ppm. The remaining composite from the Lower Potomac (255-290 mm) had a total PCB concentration of 2.28 ppm and that from the Upper Potomac (271-330 mm) had a concentration of 2.18 ppm. The two Anacostia samples had lower total PCB concentrations: 1.49 ppm- (Lower) and 1.10 ppm (Upper).

Median total PCB concentrations were similar in carp (0.844 ppm), channel catfish (0.808 ppm), and blue catfish (0.759 ppm). Carp concentrations were highest in the Upper Anacostia (1.09 ppm) and lowest in the Lower Potomac (0.444 ppm). Channel catfish concentrations were highest in the Lower Potomac composite (1.03 ppm). The median concentration in the

Anacostia samples, however, was higher (0.886 ppm) than that in the Potomac samples (0.503 ppm).

As one would expect, three very large blue catfish (819-952 mm) from the Lower Potomac had much higher total PCB concentrations than the smaller composites made up of fish ranging from 430 to 505 mm. In the large fish, total PCBs ranged from 0.822 ppm to 1.33 ppm, while the smaller composites ranged from 0.605 ppm to 0.695 ppm with a median concentration of 0.641 ppm. Thus similar sized blue catfish were slightly lower in total PCB concentrations compared with carp and channel catfish.

Total PCB concentrations in largemouth bass ranged from 0.182 ppm in the Lower Potomac to 0.465 ppm in the Lower Anacostia. The Lower Potomac sample, however, was a single fish (250 mm) whereas the other composites were in the 310 to 417 mm range. The only smallmouth bass composite (from the Lower Potomac) contained 0.144 ppm total PCBs. The lowest total PCB concentrations were in the sunfish which ranged from 0.0473 ppm in the Lower Anacostia to 0.129 ppm in the Upper Anacostia.

PCBs with dioxin-like properties were detected in all of the composite samples. These concentrations are most easily discussed in parts per billion (ppb) wet weight. The most potent congener (PCB #126), however, was only detected in two samples. A blue catfish sample from the Lower Potomac (LPBC03) had a concentration of 0.148 ppb and a channel catfish sample from the same region (LPCC01) had a concentration of 0.139 ppb (Appendix C). On a TEQ-basis, the highest concentrations were in American eel (0.0327 ppb TEQ; Table 4b). Median total TEQ concentrations were similar in carp, channel catfish, and blue catfish, ranging from (0.0160 to 0.0149 ppb). For all fish species, the minimum, median, and maximum TEQs all exceeded the DNREC-DHSS (2005) screening value of 0.0004 ppb.

The total PCBs concentration in channel catfish sample UPCC01 was 0.503 ppm. Variability in the three channel catfish individuals from this sample was high. Total PCB concentrations ranged from 0.273 ppm to 0.845 ppm, resulting in a coefficient of variation of 55.2%.

3.1.2 Total chlordane (screening value: 0.114 ppm)

At least one sample from all species except sunfish had total chlordane concentrations greater than the screening value of 0.114 ppm. Total chlordane concentrations were greatest in the American eel, ranging from 0.0927 ppm in the Lower Potomac to 0.576 ppm in the Upper Anacostia (Table 4a; Figure 3, Appendix C). The median concentration was 0.382 ppm, about three times the screening value and also greater than the 0.3 ppm FDA action level. All of the eel samples except one from the Lower Potomac had concentrations above the screening level. Median total chlordane concentrations in blue catfish (0.116 ppm) and carp (0.176 ppm) were also above the 0.114 ppm screening level. In blue catfish there was great variability in total chlordane concentrations. Total chlordane concentrations in two of the three large sized blue catfish (from the Lower Potomac) were the two lowest concentrations (0.0708 and 0.0784 ppm)

of all samples for this species. The third large blue catfish, however, had the highest total chlordane concentration for this species (0.189 ppm).

The total chlordane concentration in channel catfish sample UPCC01 was 0.0525 ppm. Variability in the three channel catfish individuals from this sample was low, ranging from 0.0504 to 0.0660 ppm. The coefficient of variation was 13.4%.

3.1.3 DDT compounds (screening value: 0.117 ppm)

Total DDT concentrations were greatest in the American eel, ranging from 0.147 ppm in the Lower Potomac smaller length sample to 0.574 ppm in the Lower Potomac larger sized sample (Table 4; Figure 4, Appendix C). The median concentration was 0.285 ppm, more than twice the screening value of 0.117 ppm, but well below the U.S. FDA action level of 5 ppm. All of the eel samples had concentrations above the screening level. Median total DDT concentrations in blue catfish (0.119 ppm) and carp (0.127 ppm) were also above the screening level. One channel catfish sample (LACC01 from the Lower Anacostia, with a concentration of 0.131 ppm) also exceeded the screening level. Total DDT concentrations in largemouth and smallmouth bass and sunfish were considerably lower, and none approached the screening level.

The total DDT concentration in channel catfish sample UPCC01 was 0.07355 ppm. Variability in the three channel catfish individuals from this sample was moderate, ranging from 0.0539 ppm to 0.0897 ppm. The coefficient of variation for total chlordane was 27.9%.

3.1.4 Dieldrin (screening value: 0.0025 ppm)

Dieldrin concentrations were highest in American eel, with all samples exceeding the screening level. The highest concentration was 0.110 ppm in sample UAAE01, from the Upper Anacostia. The median concentration in American eel was 0.0344 ppm, which exceeded the screening level by nearly a factor of 14 (Table 4a; Figure 5, Appendix C), but was well below the U.S. FDA action level of 0.3 ppm. Carp had the next highest concentration with all samples exceeding the screening value and a median concentration of 0.0208 ppm. Similar concentrations were detected in blue and channel catfish with medians of 0.00819 ppm and 0.00624 ppm, respectively. One largemouth bass (UALB01, from the Upper Anacostia) had a dieldrin concentration of 0.00304 ppm, which exceeded the screening level. One sunfish (UASF01, from the Upper Anacostia) had a concentration of 0.00252 ppm which slightly exceeded the screening value.

The dieldrin concentration in channel catfish sample UPCC01 was 0.00624 ppm. Variability in the three channel catfish individuals from this sample was moderate, ranging from 0.00399 ppm to 0.00866 ppm. The coefficient of variation for total chlordane was 38.0%.

3.1.5 Heptachlor epoxide (screening value: 0.00439 ppm)

Median heptachlor epoxide concentrations were similar in American eel (0.00689 ppm) and carp (0.00692 ppm), both about 50% higher than the screening value of 0.00439 ppm, but well below the U.S. FDA action level of 0.3 ppm. One American eel sample (UAAE01, from the Upper Anacostia) had a concentration of 0.0611 ppm, about an order of magnitude higher than the median. The screening value was not exceeded in samples from any other species (Table 4a).

The heptachlor epoxide concentration in channel catfish sample UPCC01 was 0.00212 ppm. Variability in the three channel catfish individuals from this sample was high, ranging from 0.00105 ppm to 0.00513 ppm. The coefficient of variation was 84.4%.

3.1.6 Total PAHs (screening value: 0.00547 ppm)

In general, the two and three ring PAHs such as naphthalene and anthracene were detected in higher concentrations than the five and six ring compounds such as benzo(a)pyrene and benzo(g,h,i) perylene (Appendix B). All samples except a single sunfish sample exceeded the screening value of 0.00547 ppm (Table 4a; Figure 6, Appendix C). By far, the highest total PAH concentrations, were detected in carp which ranged from 0.0706 ppm in the Lower Potomac sample to 0.384 ppm in the Upper Potomac sample. The median concentration (0.184 ppm) was about 34 times the screening level. Median total PAH concentrations in the other species ranged from 0.0079 ppm in the single smallmouth bass sample (from the Lower Potomac) to 0.0814 ppm in American eel.

Using the TEQ approach, none of the samples for any species exceeded the DNREC-DHSS (2005) screening value of 7 ppb. Median TEQ concentrations ranged from 0.002 ppb in smallmouth bass to 0.129 ppb in carp. The highest TEQ was in a carp sample from the Upper Potomac River at 0.217 ppb (Table 4b, Appendix C).

The total PAH concentration in channel catfish sample UPCC01 was 0.0744 ppm. Variability in the three channel catfish individuals from this sample was moderate, ranging from 0.0628 ppm to 0.114 ppm. The coefficient of variation was 32.1%.

3.1.7 Mercury (screening value: 0.400 ppm, water quality criterion (methylmercury): 0.3 ppm)

A single blue catfish sample (0.350 ppm) from the Upper Anacostia had a concentration that exceeded the U.S. EPA (2001) methylmercury tissue criterion of 0.300 ppm. No other samples from any species exceeded this value (Table 4a, Appendix C). The mercury concentration in channel catfish sample UPCC01 was 0.0860 ppm. Variability in the three channel catfish individuals from this sample was low, ranging from 0.0700 ppm to 0.0990 ppm. The coefficient of variation was 17.3%.

3.1.8 Arsenic (screening value: 0.026 ppm as inorganic arsenic)

Median arsenic concentrations ranged from 0.0500 ppm (both blue and channel catfish) to 0.100 ppm (American eel; Table 6, Appendix C). The maximum concentration in an eel sample was 0.250 ppm. According to U.S. EPA (2000a), the inorganic fraction can be estimated at 10%. Thus the estimated maximum concentration of total arsenic in this eel sample would be 0.025 ppm which approaches but does not exceed the screening value. The Discussion section includes information about the use of a multiplier to estimate the total inorganic arsenic fraction from a total arsenic measurement.

3.2 Other contaminants

The following contaminants, listed as target analytes with U.S. EPA (2000a) screening values, U.S. FDA guidance values, or a Virginia guidance value, were detected in at least one sample: endosulfan I and II, endrin, gamma BHC, mirex, PBDEs, chromium, lead, nickel, and selenium. Summary statistics for the concentration data and comparisons with screening values are in Table 6. As indicated, none of these contaminants were detected at concentrations exceeding a guidance value. Cadmium, which has a screening value, was not detected in any of the fish tissue samples.

3.3 Quality assurance data

Quality assurance procedures included the analysis of blanks, duplicates, and standard reference materials. These data are contained within Appendix B, pages 36-57 of the inorganic report and pages 332-456 of the organic report. The USFWS Quality Assurance staff, of the Analytical Control Facility Shepherdstown, WV, indicated that the data are acceptable, and are available to discuss questions of interpretation.

4.0 DISCUSSION

4.1 Temporal comparisons

Fish consumption advisories have been in effect for D.C. waters since 1989. The primary risk drivers for the advisory have been PCBs and chlordane (Velinsky and Cummins 1996). Since then, restoration and source control measures have been put into place on the rivers and in the surrounding watersheds. To compare these years, it is necessary to examine collection location, filleting procedures, lipid content and fish length which are known to affect contaminant concentrations. In all three sampling years, the rivers have been divided in an identical manner and filleting procedures have been the same. The following species have been collected from at least one river in every sampling period: American eel, carp, channel catfish, largemouth bass, and sunfish. Thus, the analysis is focused on these five species.

To the extent possible, we attempted to match the lengths of the 1993-94 collection in our 2000 effort (Pinkney *et al.* 2001) and replicate the 2000 lengths in 2007. As shown in Table 7, this effort succeeded for carp, channel catfish, sunfish, and largemouth bass. For American eel, the 1993-94 samples were 230-270 mm and 2000 samples were 620 and 760 mm. Those collected in 2007 included a smaller size range (255-330 mm) and one larger sized composite (493-530 mm), both of which were smaller than those obtained in 2000.

Lipid content was substantially higher in the 1993-94 fish (Velinsky and Cummins 1996) compared with the 2000 and 2007 collections, which were within a factor of two in most cases (Table 8). Hebert and Keenleyside (1995) concluded that the ratio approach to lipid normalization (expressing concentrations on a µg/g lipid basis) often leads to erroneous conclusion. They recommended an analysis of covariance (ANCOVA) approach as an alternative. In evaluating the number of samples for each species within each sampling period, I concluded that there were inadequate samples for such a procedure. Thus data are compared on a wet weight basis. Lipid based total PCB concentrations are provided, however, for readers who wish to utilize those data (Table 8).

Recognizing that samples sizes are small and there are some differences in sample size and lipid content through the years, I have not statistically analyzed for differences in concentrations between the three sampling periods. Median concentrations are presented in Table 9, with the highest concentration from each river in bold. For four of the COCs -- PCBs, DDTs, chlordane, and dieldrin – graphs are provided for each species collected in all three sampling periods (Figures 7-10).

Graphs and discussion of trends are not presented for PAHs and mercury. Unlike the organochlorines, PAHs can be rapidly metabolized by fish (Velinsky and Cummins 1996). Environmental monitoring programs, such as the National Oceanic at Atmospheric Administration's National Status and Trends Program generally use invertebrates, which are much less efficient at metabolizing PAHs, to track trends in the bioavailability of this class of compounds (O'Connor 1996). In addition, in 2007, using the DNREC-DHSS (2005) TEQ approach, screening levels were not exceeded for any samples. Mercury is not discussed because, no samples from the four species collected consistently in D.C. waters ever exceeded the lowest available screening level of 0.3 ppm (Velinsky and Cummins 1996, Pinkney *et al.* 2001). In 2007, only a single sample (a blue catfish at 0.350 ppm), exceeded this concentration.

4.1.1 Total PCBs

PCB concentrations in American eel declined from 1993-1994 to 2000 and then increased sharply in 2007, ending higher than 1993-94 (Table 9, Figure 7). The dramatic increase between 2000 and 2007 cannot be attributed to length since the 2000 fish were 620 and 760 mm, whereas the 2007 fish ranged from 255 to 530 mm (Table 7). Lipid fraction appears to be somewhat higher in the 2007 sampling, averaging 18.9% vs. 11.4% in 2000, but there were only two samples collected in 2000 (Table 8).

Median total PCB concentrations in carp showed the same overall pattern as the eel (a decrease followed by an increase) but the increase was less dramatic (Table 9, Figure 7). In contrast, concentrations in channel catfish increased from 1993-94 to 2000 and then declined to less than the 1993-95 concentration in 2007. Largemouth bass concentrations were relatively stable through all three sampling events. Concentrations in sunfish were not obtained from the Potomac in 1993-94 so trends are best examined in the Anacostia, where concentrations declined steadily.

4.1.2 Total chlordane

Total chlordane concentrations in American eel followed a similar pattern as the PCB concentrations, with a decrease followed by an increase (in 2007) to a higher concentration than was reported in 1993-94 (Table 9, Figure 8**).** The same trend occurred in carp. Channel catfish followed a similar pattern as occurred with PCBs. Concentrations increased between 1993-94 and 2000 and then, in 2007, decreased to less than the 1993-94 concentration (Table 9). Total chlordane in largemouth bass decreased from 1993-95 to 2000 and then increased sharply in 2007. Concentrations in sunfish were not obtained from the Potomac in 1993-95 so trends are best examined in the Anacostia, where concentrations decreased sharply between 1993-95 and 2000, then increased but not to the 1993-95 concentration.

4.1.3 Total DDT

Total DDT concentrations in the American eel could be compared for all three periods only in the Potomac River (Table 9, Figure 9). Concentrations were similar in 1993-94 and 2000 and increased sharply in 2007. Total DDT concentrations declined in carp and channel catfish between 2000 and 2007 and stable during these periods for largemouth bass and sunfish.

4.1.4 Dieldrin

In American eel, dieldrin concentrations showed a similar trend as observed for total DDT. Concentrations rose more than fourfold between 2000 and 2007 (Table 9, Figure 10). Concentrations increased in carp, but decreased sharply in channel catfish. Concentrations in largemouth bass and sunfish were stable between 2000 and 2007.

4.1.5 Comparisons of total PCB and total chlordane concentrations by river and species: 2000 vs. 2007

The most relevant time line for the purposes of the advisory is to evaluate changes between 2000 and 2007 for PCBs and chlordane. Based on the median concentrations listed in Table 9, the following three conclusions are drawn. First, concentrations of both contaminants in American eel, carp, and largemouth bass increased in both rivers. Second, concentrations of both

contaminants in channel catfish decreased in both rivers. Third, concentrations in sunfish in nearly all comparisons, decreased slightly.

4.2 Spatial comparisons --PCBs and chlordane in 2007

For all species except American eel, total PCB concentrations were higher in the Anacostia samples compared with those from the Potomac. The median concentrations were greater by factors ranging from 1.4X to 1.8X. In contrast, eels were 1.8 times higher in the Potomac. Excluding the larger Potomac eels, the ratio was still 1.7 times higher in the Potomac (data from Table 9). Median total chlordane concentrations were higher in Anacostia vs. Potomac samples of all species. The ratios of the median concentrations ranged from 1.8 to 3.7.

4.3 Inorganic arsenic

The assumption that inorganic arsenic can account for 10% of total arsenic was tested in Delaware in samples collected in 2002 and 2003. Greene and Crecelius (2005) reported that on average, inorganic arsenic represented only 0.7 to 1.7% of total arsenic. These data are based on coastal species, striped bass (*Morone saxatilis*), summer flounder (*Paralicthys dentatus*), and Atlantic croaker (*Micropogonias undulates*), caught in estuarine waters and may not match the speciation in fish collected in the largely freshwaters of the District of Columbia. Nevertheless, should future total arsenic concentrations approach an advisory threshold, it would be worthwhile to conduct a similar analysis with fish from the Potomac and Anacostia Rivers.

4.4 Approaches used for consumption advisories

A number of different methodologies exist for determination of the risk associated with consumption of contaminated seafood. At the Federal level, standards are set by the U.S. FDA and guidance is provided by the U.S. EPA. Advisories for restriction on fish consumption are developed by the states. Standards set by the FDA are intended for seafood that is sold commercially, and FDA notes that its standard is not necessarily applicable to recreational fisheries, due to differences in consumption rates and variances in the probability of consuming fish from the same water body, as compared to the general public (U.S. FDA 1998). Note that there is no commercial harvesting of seafood within waters of the District of Columbia (DDOE 2008b).

The EPA has developed screening values (SVs) for a number of commonly occurring environmental contaminants (U.S. EPA 2000a). These screening values do not represent a no consumption level, but serve as a warning threshold. Contaminants which occur in concentrations above the SVs are considered contaminants of concern (COCs) and U.S. EPA (2000a) recommends that risk assessments be conducted on these COCs by the local regulatory authorities. Risk assessments are based generally on a set of assumptions summarized in U.S. EPA (2000a), with modifications of some factors to more accurately reflect local conditions.

To assist the D.C. Department of the Environment in consideration of consumption advisories for D.C. waters, I contacted nearby states to identify threshold concentrations of contaminants associated with specific recommendations for numbers of meals. Virginia Department of Health (R. Tripathi, Virginia Department of Health, personal communication) provided their current thresholds. Maryland is currently re-evaluating its procedures and threshold tables are not available (A. Soehl, MDE personal communication). Delaware provided its technical support document (DNREC-DHSS 2005) but stated that it does not release threshold tables (R. Greene, DNREC, personal communication).

In Table 10, I provide the Virginia thresholds along with the PCB thresholds used by many of the Great Lakes (Anderson *et al.*, 1993). Thus, one approach for meal recommendations would be to identify the median concentration for a particular species and determine which meal category would be appropriate. Meal recommendations using both thresholds are given in Table 10.

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TABLES

Table 1a. Fish advisories for Maryland waters near the District of Columbia.

		Recommended number of meals per year			
Species	Water body	General population (8 ounce meal)	Women (6 ounce meal)	Children (3 ounce meal)	Contaminant (Risk driver)
American eel	Anacostia [a]	15	11	8	PCBs
	Potomac [b]	19	15	11	PCBs
Brown bullhead	Anacostia	9	7	avoid	PCBs
Channel catfish	Anacostia	9	7	avoid	PCBs
	Potomac (<18”)	8	6	avoid	PCBs
	Potomac (>18”)	7	avoid	avoid	PCBs
Carp	Potomac	11	8	6	PCBs
Striped bass	Ches Bay tributaries: <28” May 16-Dec 15	25	19		PCBs
	Ches Bay tributaries: >28” April 15-				PCBs
Sunfish	Anacostia River	35	27	21	PCBs
Small and largemouth bass	Statewide default	48	48	24	Methylmercury
White catfish	Potomac (<18”)	17	13	10	PCBs
	Potomac (.18”)	12	avoid	avoid	PCBs
White perch	Potomac	35	26	20	PCBs

[a] Advisories for the Anacostia River are for the main stem and tributaries below MD Route 193
[b] Advisories for the Potomac River from the DC line downriver to the MD 301 Bridge

Table 1b. Fish advisories for Virginia waters near the District of Columbia.[a]

Species	Water body	Recommended meals per month	Contaminant (Risk driver)
American eel	Tributaries between MD/VA line near Route 340 Bridge and I-395 Bridge	No more than two	PCBs
American eel	Tributaries and embayments between I-395 Bridge and Route 301 Bridge	No more than two	PCBs
Bullhead catfish			
Channel catfish (<18”)			
Gizzard shad			
Largemouth bass			
Smallmouth bass			
Sunfish			
Striped bass			
White catfish			
White perch			
Yellow perch			
Carp		Do not eat	
Channel catfish (>18”)			

[a] High risk individuals such as women who are pregnant or may become pregnant, nursing mothers, and young children are advised not to eat any fish contaminated either with polychlorinated biphenyls (PCBs) or mercury from the respective advisory areas.

Table 2. List of samples and preparation of composites.

Location	Species	Length range (mm)	# in composite	Sample ID
Lower Potomac	Sunfish[a]	150-170	10	LPSF01
	Largemouth bass	250	1	LPLB01
	Smallmouth bass	354-374	3	LPSB01
	American eel	493-530	3	LPAE01
	American eel	255-290	4	LPAE02
	Carp	486-512	3	LPCA01
	Channel catfish	384-388	3	LPCC01
	Blue catfish	430-490	5	LPBC01
	Blue catfish	952	1	LPBC02
	Blue catfish	819	1	LPBC03
	Blue catfish	959	1	LPBC04
Upper Potomac	Sunfish[b]	135-157	10	UPSF01
	Largemouth bass	310-390	3	UPLB01
	American eel	271-330	10	UPAE01
	Carp	522-559	3	UPCA01
	Channel catfish	351-412	3	UPCC01
	Channel catfish	351	1	UPCC101
	Channel catfish	370	1	UPCC102
	Channel catfish	412	1	UPCC103
	Channel catfish	491	1	UPCC02
Lower Anacostia	Sunfish[c]	131-152	8	LASF01
	Largemouth bass	332-369	3	LALB01
	American eel	264-306	10	LAAE01
	Carp	493-527	3	LACA01
	Channel catfish	416-458	3	LACC01
	Blue catfish	470-494	3	LABC01
Upper Anacostia	Sunfish[d]	155-174	10	UASF01
	Largemouth bass	350-417	3	UALB01
	American eel	320	1	UAAE01
	Carp	524-572	3	UACA01
	Channel catfish	414-435	3	UACC01
	Blue catfish	503-505	2	UABC01

[a] Three bluegill plus seven pumpkinseed
b Seven bluegill plus three pumpkinseed
[c] Seven pumpkinseed plus one bluegill
[d] Ten bluegill

Table 3a. List of analytes.

Trace elements	*OC pesticides*	*PCB congeners*		*PAHs*
Arsenic	p,p' -DDE	PCB#8	PCB#114	napthalene
Selenium	p,p'-DDD	PCB# 9	PCB#118	C1-C4 napthalenes
Mercury	p,p'-DDT	PCB#10	PCB#123	biphenyl
Aluminum	o,p'-DDE	PCB#16	PCB#126	acenaphthalene
Boron	o,p'-DDD	PCB#17	PCB#128	acenapthene
Barium	o,p'-DDT	PCB#20	PCB#138	fluorene
Beryllium	HCB	PCB#22	PCB#153	C1-C4 fluorenes
Cadmium	∀-BHC	PCB#25	PCB#156	phenanthrene
Chromium	(-BHC	PCB#28	PCB#157	anthracene
Copper	dieldrin	PCB#29	PCB#158	C1-C4 phenanthrenes
Iron	heptachlor epoxide	PCB#30	PCB#166	dibenzothiophene
Magnesium	oxychlordane	PCB#31	PCB#167	C1-C4 dibenzothiophenes
Manganese	∀-chlordane	PCB#33	PCB#169	fluoranthene
Molybdenum	(-chlordane	PCB#39	PCB#170	pyrene
Nickel	trans-nonachlor	PCB#41	PCB#189	benz(a)anthracene
Lead	endrin	PCB#48		chrysene
Strontium	mirex	PCB#49		C1-C4 chrysenes
Vanadium	toxaphene	PCB#52		benzo(b)fluoranthene
Zinc	PCB- total	PCB#53		benzo(k)fluoranthene
		PCB#55		benzo(e)pyrene
		PCB#60		benzo(a)pyrene
		PCB#61		perylene
		PCB#63		indeno (1,2,3-cd)pyrene
		PCB#66		dibenz(a,h)anthracene
		PCB#67		benzo(g,h,i)perylene
		PCB#70		2-methylnaphthalene
		PCB#72		2,3,5-trimethylnaphthalene
		PCB#74		1-methylphenanthrene
		PCB#77		
		PCB#80		
		PCB#81		
		PCB#84		
		PCB#87		
		PCB#91		
		PCB#105		
		PCB#110		

Table 3a. List of analytes (continued)

PBDE congeners with detection limits (ppb wet weight) based on 10 gram tissue samples. Method: mass spectroscopy.

BDE 1 (2-MonoBDE) 0.50	BDE 33 (2',3,4-TriBDE) 0.50	BDE 119 (2,3',4,4',6-PentaBDE) 0.75
BDE 2 (3-MonoBDE) 0.50	BDE 35 (3,3',4-TriBDE) 0.50	BDE 126 (3,3',4,4',5-PentaBDE) 0.75
BDE 3 (4-MonoBDE) 0.50	BDE 37 (3,4,4'-TriBDE) 0.50	BDE 138 (2,2',3,4,4',5'-HexaBDE) 1.00
BDE 7 (2,4-DiBDE) 0.50	BDE 47 (2,2',4,4'-TetraBDE) 0.50	BDE 153 (2,2',4,4',5,5'-HexaBDE) 1.00
BDE 8/11 (2,4'-DiBDE/3,3'-DiBDE) 1.00	BDE 49 (2,2',4,5'-TetraBDE) 0.50	BDE 154 (2,2',4,4',5,6'-HexaBDE) 1.00
BDE 10 (2,6-DiBDE) 0.50	BDE 66 (2,3',4,4'-TetraBDE) 0.50	BDE 155 (2,2',4,4',6,6'-HexaBDE) 1.00
BDE 12 (3,4-DiBDE) 0.50	BDE 71 (2,3',4',6-TetraBDE) 0.50	BDE 166 (2,3,4,4',5,6-HexaBDE) 1.00
BDE 13 (3,4'-DiBDE) 0.50	BDE 75 (2,4,4',6-TetraBDE) 0.50	BDE 181 (2,2',3,4,4',5,6-HeptaBDE) 1.25
BDE 15 (4,4'-DiBDE) 0.50	BDE 77 (3,3',4,4'-TetraBDE) 0.50	BDE 183 (2,2',3,4,4',5',6-HeptaBDE) 1.25
BDE 17 (2,2',4-TriBDE) 0.50	BDE 85 (2,2',3,4,4'-PentaBDE) 0.75	BDE 190 (2,3,3',4,4',5,6-HeptaBDE) 1.25
BDE 25 (2,3',4-TriBDE) 0.50	BDE 99 (2,2',4,4',5-PentaBDE) 0.75	
BDE 28 (2,4,4'-TriBDE) 0.50	BDE 100 (2,2',4,4',6-PentaBDE) 0.75	
BDE 30 (2,4,6-TriBDE) 0.50	BDE 116 (2,3,4,5,6-PentaBDE) 0.75	
BDE 32 (2,4',6-TriBDE) 0.50	BDE 118 (2,3',4,4',5-PentaBDE) 0.75	

Table 3b. Minimum acceptable detection limits

Metals (dry weight ppm): Be, Cd –0.10; Hg - 0.20; As, Se, Cr, Cu, Ni, Pb, Sr, V - 0.50; Ba, Mn, Zn - 1.0; B, Mo - 2.0; Al, Fe, Mg - 5.0.
Organochlorine pesticides (wet weight ppm): 0.01
Total PCBs (wet weight ppm): 0.05
PCB congeners (wet weight ppm): 0.00001
PAHs (wet weight ppm): 0.01
PBDE congeners (wet weight ppb): 0.50-1.25 (see Table 1)

Table 4a. Summary of 2007 D.C. fish tissue data for potential contaminants of concern and guidance values (ppm wet weight). Concentrations exceeding a guidance value are in bold.

						Guidance values		
Chemical	Species	Frequency of Detection	Minimum	Maximum	Median	SV *	FDA**	EPA WQC***
Total PCBs	Amer. Eel	5/5	**1.1**	**4.000**	**2.18**	0.0200	2	
	Carp	4/4	**0.444**	**1.09**	**0.844**			
	Blue catfish	6/6	**0.605**	**1.33**	**0.759**			
	Channel cat.	5/5	**0.501**	**1.03**	**0.808**			
	Lgmouth bass	4/4	**0.182**	**0.465**	**0.258**			
	Smallmouth bass	1/1			**0.144**			
	Sunfish	4/4	**0.0473**	**0.129**	**0.057**			
Total Chlordane	Amer. Eel	5/5	0.0927	**0.576**	**0.382**	0.114	0.3	
	Carp	4/4	0.0832	**0.237**	**0.176**			
	Blue catfish	6/6	0.0708	**0.189**	**0.116**			
	Channel cat.	5/5	0.0277	**0.144**	0.0734			
	Lgmouth bass	4/4	0.0118	0.0426	0.0282			
	Smallmouth bass	1/1			0.0126			
	Sunfish	4/4	0.00278	0.0200	0.00478			
Total DDT	Amer. Eel	5/5	**0.147**	**0.574**	**0.285**	0.117	5	
	Carp	4/4	0.0873	**0.142**	**0.127**			
	Blue catfish	6/6	0.105	**0.216**	**0.119**			
	Channel cat.	5/5	0.0537	**0.131**	0.0801			
	Lgmouth bass	4/4	0.0308	0.0449	0.0345			
	Smallmouth bass	1/1			0.0199			
	Sunfish	4/4	0.00544	0.0169	0.00627			
Dieldrin	Amer. Eel	5/5	**0.00874**	**0.110**	**0.0344**	0.00250	0.3	
	Carp	4/4	**0.00923**	**0.0264**	**0.0208**			
	Blue catfish	6/6	0.00108	**0.0131**	**0.00819**			
	Channel cat.	5/5	0.00170	**0.0107**	**0.00624**			
	Lgmouth bass	4/4	0.000810	**0.00304**	0.00235			
	Smallmouth bass	1/1			0.00146			
	Sunfish	4/4	0.000571	**0.00252**	0.000736			
Heptachlor epox.	Amer. Eel	5/5	0.00188	**0.0611**	**0.00689**	0.00439	0.3	
	Carp	4/4	0.00182	**0.00821**	**0.00692**			
	Blue catfish	6/6	0.000429	0.00267	0.00172			
	Channel cat.	5/5	0.000365	0.00340	0.00204			
	Lgmouth bass	3/4	not detected	0.000890	0.000375			
	Smallmouth bass	1/1			not detected			
	Sunfish	1/4	not detected	0.000580	0.000145			
Hexachloro-benzene	Amer. Eel	5/5	0.00130	**0.0353**	0.00447	0.0250		
	Carp	4/4	0.00147	0.005210	0.004435			
	Blue catfish	6/6	0.000275	0.00275	0.00186			
	Channel cat.	4/5	not detected	0.0026	0.00175			
	Lgmouth bass	3/4	not detected	0.000741	0.0003985			
	Smallmouth bass	1/1			0.000313			
	Sunfish	1/4	not detected	0.000848	0.000127			
Total PAH	Amer. Eel	5/5	**0.027**	**0.141**	**0.0814**	0.00547		
	Carp	4/4	**0.0706**	**0.384**	**0.184**			
	Blue catfish	6/6	**0.0113**	**0.114**	**0.0588**			
	Channel cat.	5/5	**0.0408**	**0.182**	**0.0744**			
	Lgmouth bass	4/4	**0.0162**	**0.0312**	**0.0210**			
	Smallmouth bass	1/1			**0.0079**			
	Sunfish	4/4	0.0051	**0.0265**	**0.0126**			
Mercury	Amer. Eel	5/5	0.0800	0.210	0.130	0.400	1	0.3
	Carp	4/4	0.0400	0.0900	0.0700			
	Blue catfish	6/6	0.0770	**0.350**	0.158			
	Channel cat.	5/5	0.0720	0.130	0.0860			
	Lgmouth bass	4/4	0.130	0.290	0.180			
	Smallmouth bass	1/1			0.150			
	Sunfish	4/4	0.0300	0.150	0.0790			

*SVs are from U.S. EPA (2000a)

**U.S. FDA values are compiled from http://seafood.ucdavis/edu/HACCP/compendium/chapt23.htm

***U.S. EPA (2001) Methylmercury fish tissue criterion

Table 4b. Summary of 2007 D.C. fish tissue data for PCBs and PAHs using the Toxic Equivalent Quotient (TEQ) approach. Units are ppb wet weight and values exceeding the screening value are in bold.						
Chemical	Species	Frequency of Detection	Minimum	Maximum	Median	Screening value*
Total PCBs	Amer. Eel	5/5	**0.0234**	**0.0601**	**0.0327**	0.0004
TEQ approach	Carp	4/4	**0.0073**	**0.0170**	**0.0149**	
	Blue catfish	6/6	**0.0101**	**0.0371**	**0.0120**	
	Channel cat.	5/5	**0.00719**	**0.0296**	**0.0116**	
	Lgmouth bass	4/4	**0.00281**	**0.00779**	**0.00380**	
	Smallmouth bass	1/1			**0.00233**	
	Sunfish	4/4	**0.000714**	**0.001855**	**0.000849**	
Total PAH	Amer. Eel	5/5	0.0195	0.0873	0.0409	7
TEQ approach	Carp	4/4	0.0482	0.217	0.129	
	Blue catfish	6/6	0.00740	0.0761	0.0507	
	Channel cat.	5/5	0.0403	0.117	0.0497	
	Lgmouth bass	4/4	0.00590	0.0127	0.00900	
	Smallmouth bass	1/1			0.00200	
	Sunfish	4/4	0.00350	0.0168	0.00955	
*DNREC-DHSS (2005)						

Table 5. Comparisons of total PCBs calculated as the sum of congeners and by the Aroclor method (ppm wet weight). Cases where congeners > Aroclors are in bold.

	Location	Sample ID	Total PCB by Aroclors	Total PCBs sum congeners	% difference	Aroclor> congeners
American eel	Lower Ana	LAAE01	1.49	1.31	12.1	Yes
	Upper Ana	UAAE01	1.10	1.10	0.4	Yes
	Lower Pot	LPAE01	4.00	2.80	30.0	Yes
		LPAE02	2.28	1.87	18.2	Yes
	Upper Pot	UPAE01	2.18	1.65	24.1	Yes
Blue catfish	Upper Ana	LABC01	0.641	0.578	9.9	Yes
	Upper Pot	UABC01	0.605	0.522	13.8	Yes
		LPBC01	0.695	0.569	18.1	Yes
		LPBC02	0.822	0.621	24.4	Yes
		LPBC03	1.300	1.016	21.9	Yes
		LPBC04	1.332	1.163	12.7	Yes
Carp	Lower Ana	**LACA01**	**0.792**	**0.832**	**4.8**	**No**
	Upper Ana	**UACA01**	**0.979**	**1.13**	**13.3**	**No**
	Lower Pot	LPCA01	0.443	0.370	16.5	Yes
	Upper Pot	UPCA01	0.896	0.819	8.6	Yes
Channel catfish	Lower Ana	LACC01	0.964	0.815	15.4	Yes
	Upper Ana	UACC01	0.809	0.692	14.4	Yes
	Lower Pot	LPCC01	1.03	0.834	19.1	Yes
	Upper Pot	UPCC01	0.504	0.421	16.4	Yes
		UPCC02	0.551	0.404	26.7	Yes
samples within composite UPCC01		UPCC101	0.273	0.213	21.9	Yes
		UPCC102	0.464	0.344	25.9	Yes
		UPCC103	0.844	0.722	14.4	Yes
Largemouth Bass	Lower Ana	LALB01	0.465	0.401	13.7	Yes
	Upper Ana	UALB01	0.2439	0.217	10.9	Yes
	Lower Pot	LPLB01	0.182	0.153	15.7	Yes
	Upper Pot	UPLB01	0.272	0.202	25.7	Yes
Smallmouth bass	Lower Pot	LPSB01	0.144	0.127	12.2	Yes
Sunfish	Lower Ana	**LASF01**	**0.0379**	**0.0409**	**7.4**	**No**
	Upper Ana	UASF01	0.1288	0.120	7.0	Yes
	Lower Pot	LPSF01	0.0475	0.0428	10.0	Yes
	Upper Pot	UPSF01	0.0612	0.0463	24.4	Yes
				avg percent diff	15.9	
				stdev	7.0	
				max	30.0	
				min	0.4	
				median	14.9	

Table 6. Summary of 2007 D.C. fish tissue data for selected organic contaminants and metals with guidance values (ppm wet wt)

						Guidance values		
Chemical	Species	Frequency of Detection	Minimum	Maximum	Median	SV *	FDA**	VDH***
Endosulfan	Amer. Eel	0/5	not detected			24		
(I and II)****	Carp	0/4	not detected					
	Blue catfish	0/6	not detected					
	Channel cat.	0/5	not detected					
	Lgmouth bass	1/4	not detected	0.00187	0.00019			
	Smallmouth bass	0/1	not detected					
	Sunfish	0/4	not detected					
Endrin	Amer. Eel	1/5	not detected	0.00083	0.000226	1.2		
	Carp	0/4	not detected					
	Blue catfish	0/6	not detected					
	Channel cat.	0/5	not detected					
	Lgmouth bass	0/4	not detected					
	Smallmouth bass	0/1	not detected					
	Sunfish	0/4	not detected					
gamma-BHC	Amer. Eel	5/5	0.000148	0.00208	0.000259	0.00307	0.3	
	Carp	4/4	0.000064	0.000166	0.000067		(frog legs)	
	Blue catfish	2/6	not detected	0.000199	6.58E-05			
	Channel cat.	0/5	not detected					
	Lgmouth bass	0/4	not detected					
	Smallmouth bass	0/1	not detected					
	Sunfish	0/4	not detected					
Mirex	Amer. Eel	5/5	0.000262	0.00194	0.000578	0.8	0.1	
	Carp	4/4	0.0000990	0.000499	0.000253			
	Blue catfish	6/6	0.000207	0.000400	0.000260			
	Channel cat.	4/5	0.0000490	0.000469	0.000129			
	Lgmouth bass	0/4	not detected					
	Smallmouth bass	0/1	not detected					
	Sunfish	0/4	not detected					
Total PBDEs	Amer. Eel	4/5	not detected	0.0809	0.0335			5
	Carp	4/4	0.0187	0.0790	0.0505			
	Blue catfish	6/6	0.00310	0.0967	0.0258			
	Channel cat.	5/5	0.0102	0.136	0.0437			
	Lgmouth bass	3/4	not detected	0.0268	0.015			
	Smallmouth bass	1/1			0.00560			
	Sunfish	3/4	not detected	0.0259	0.01145			
Arsenic*****	Amer. Eel	4/5	not detected	0.250	0.100	0.0260	76	
	Carp	3/4	not detected	0.1	0.095		(crustacea)	
	Blue catfish	4/6	not detected	0.0800	0.0500		86	
	Channel cat.	3/5	not detected	0.0800	0.0500		(molluscs)	
	Lgmouth bass	4/4	0.0800	0.120	0.100			
	Smallmouth bass	1/1			0.100			
	Sunfish	4/4	0.100	0.160	0.135			
Cadmium	Amer. Eel	0/5	not detected			4	3	
	Carp	0/4	not detected				(crustacea)	
	Blue catfish	0/6	not detected				4	
	Channel cat.	0/5	not detected				(molluscs)	
	Lgmouth bass	0/4	not detected					
	Smallmouth bass	0/1	not detected					
	Sunfish	0/4	not detected					
Chromium	Amer. Eel	5/5	0.200	1.60	0.460		12	
	Carp	2/4	not detected	0.500	0.185		(crustacea)	
	Blue catfish	6/6	0.100	0.320	0.250		13	
	Channel cat.	2/5	not detected	0.200	0.050		(molluscs)	
	Lgmouth bass	4/4	0.100	0.470	0.335			
	Smallmouth bass	1/1			0.620			
	Sunfish	4/4	0.200	1.20	0.200			
Lead	Amer. Eel	5/5	0.200	0.440	0.290		1.5	
	Carp	1/4	not detected	0.100	0.0300		(crustacea)	
	Blue catfish	1/6	not detected	0.0500	0.0225		1.7	
	Channel cat.	1/5	not detected	0.0900	0.0200		(molluscs)	
	Lgmouth bass	2/4	not detected	0.260	0.0600			
	Smallmouth bass	1/1			0.100			
	Sunfish	4/4	0.0400	0.0900	0.0500			
Nickel	Amer. Eel	4/5	0.100	3.50	0.930		70	
	Carp	3/4	not detected	0.350	0.250		(crustacea)	
	Blue catfish	6/6	0.200	0.310	0.200		80	
	Channel cat.	2/5	0.0500	0.740	0.0500		(molluscs)	
	Lgmouth bass	3/4	not detected	2.60	0.505			
	Smallmouth bass	1/1			0.930			
	Sunfish	4/4	0.490	1.10	0.625			
Selenium	Amer. Eel	5/5	0.230	0.490	0.340	20		
	Carp	4/4	0.440	0.680	0.520			
	Blue catfish	6/6	0.0800	0.210	0.160			
	Channel cat.	5/5	0.130	0.190	0.170			
	Lgmouth bass	4/4	0.390	0.460	0.405			
	Smallmouth bass	1/1			0.400			
	Sunfish	4/4	0.300	0.360	0.355			

*SVs are from U.S. EPA (2000a)
*U.S. FDA values are compiled from http://seafood.ucdavis/edu/HACCP/compendium/chapt23.htm
***Virginia Department of Health Guidance Value (R. Tripathi, personal communication)
****Laboratory measured Endosulfan I and Endosulfan II. Only Endosulfan II detected in a single sample.
*****Screening value for arsenic is based on total inorganic arsenic; concentration data are for total arsenic. Based on U.S. FDA (1993) advice, an estimated 10% of total arsenic is inorganic. Any concentrations considered to exceed the guidance would be 10 x higher.

Table 7. Comparisons of fish length and lipid fraction in samples collected in 1993-94, 2000, and 2007.

2007 samples					2000 samples					1993-94 samples				
Site	**Sample**		**Lengths**	**lipid fraction**	**Site**	**Sample**		**Lengths**	**lipid fraction**	**Site**	**Sample**		**Lengths**	**lipid fraction**
	Units	**N**	**(mm)**			**Units**	**N**	**(mm)**			**Units**	**N**	**(mm)**	
American eel														
Lower Ana	LAAE01	10	264-306	0.238	Lower Pot	aelp01	1	620	0.0420					
Upper Ana	UAAE01	1	320	0.249	Upper Pot	aeup01	1	760	0.185					
Lower Pot	LPAE01	3	493-530	0.150										
	LPAE02	4	255-290	0.101										
Upper Pot	UPAE01	10	271-330	0.209						Upper Pot	5-93	4	230-270	0.0812
Carp														
Lower Ana	LACA01	3	493-527	0.0455	Lower Ana	cala01	3	458-520	0.0480	Lower Ana	7-93	4	460-540	0.1092
Upper Ana	UACA01	3	524-572	0.110	Upper Ana	caua01	3	466-495	0.0550	Lower Ana	6-94	3	400-620	0.1232
Lower Pot	LPCA01	3	486-512	0.0527	Lower Pot	calp01	3	418-455	0.0310	Upper Ana	9-93	1	490	0.207
Upper Pot	UPCA01	3	522-559	0.134						Lower Pot	2-94	3	370-530	0.259
										Upper Pot	3-93	3	450-550	0.1646
										Upper Pot	4-94	3	420-530	0.2092
Channel Catfish														
Lower Ana	LACC01	3	416-458	0.105	Lower Ana	ccla01	4	395-450	0.0520	Lower Ana	6-93	3	380-440	0.308
Upper Ana	UACC01	3	414-435	0.0434	Upper Ana	ccua01	4	430-450	0.0970	Lower Ana	7-94	2	380-420	0.276
Lower Pot	LPCC01	3	384-388	0.0274	Lower Pot	cclp01	4	389-476	0.0680	Lower Pot	2-93	3	370-410	0.323
Upper Pot	UPCC01	3	351-412	0.0450	Upper Pot	ccup01	1	508	0.0580	Upper Pot	3-94	2	460	0.233
	UPCC02	1	491	0.0211										
Largemouth bass														
Lower Ana	LALB01	3	332-369	0.00980	Lower Ana	lbla01	3	325-395	0.00500	Lower Ana	5-94	3	270-350	0.0208
Upper Ana	UALB01	3	350-417	0.00920	Upper Ana	lbua01	1	345	0.00800					
Lower Pot	LPLB01	1	250	0.0138	Lower Pot	lblp01	3	336-380	0.00900	Lower Pot	1-93	5	295-335	0.0625
Upper Pot	UPLB01	3	310-390	0.00720	Upper Pot	lbup01	3	302-388	0.0120	Lower Pot	1-94	3	260-370	0.0327
										Upper Pot	4-93	2	245-290	0.0503
Sunfish														
Lower Ana	LASF01	10	131-152	0.00500	Lower Ana	bgla01	7	149-178	0.00700	Lower Ana	8-93	4	148-173	0.0862
Upper Ana	UASF01	10	155-174	0.0128	Lower Pot	bglp01	10	149-184	0.00500	Lower Ana	8-94	1	148-170	0.0734
Lower Pot	LPSF01	10	150-170	0.00600	Upper Pot	puup01	10	141-160	0.0370					
Upper Pot	UPSF01	10	135-157	0.00620										

Table 8. Total PCB concentrations (sum of Aroclors) by wet weight (ug/g tissue) and by ug/g lipid						
	Location	Sample ID	Total PCB by Aroclors	fraction lipid	multip. factor	total PCBs ug/g lipid
American eel	Lower Ana	LAAE01	1.49	0.238	4.2	6.27
	Upper Ana	UAAE01	1.10	0.249	4.0	4.42
	Lower Pot	LPAE01	4.00	0.150	6.7	26.7
		LPAE02	2.28	0.101	9.9	22.6
	Upper Pot	UPAE01	2.18	0.209	4.8	10.4
		median	**2.18**	**0.209**	**4.78**	**10.4**
		mean	**2.21**	**0.189**	**5.91**	**14.1**
		stdev	**1.11**	**0.063**	**2.46**	**9.98**
Blue catfish	Upper Ana	LABC01	0.641	0.0642	15.6	9.98
	Upper Pot	UABC01	0.605	0.0389	25.7	15.6
		LPBC01	0.695	0.0566	17.7	12.3
		LPBC02	0.822	0.00750	133	110
		LPBC03	1.30	0.0391	25.6	33.2
		LPBC04	1.33	0.0616	16.2	21.6
		median	**0.759**	**0.048**	**21.6**	**18.6**
		mean	**0.899**	**0.045**	**39.0**	**33.7**
		stdev	**0.331**	**0.021**	**46.4**	**38.1**
Carp	Lower Ana	LACA01	0.792	0.0455	22.0	17.4
	Upper Ana	UACA01	0.979	0.110	9.1	8.90
	Lower Pot	LPCA01	0.443	0.0527	19.0	8.41
	Upper Pot	UPCA01	0.896	0.134	7.5	6.68
		median	0.844	0.081	14.0	8.657
		mean	0.778	0.086	14.4	10.352
		stdev	0.236	0.043	7.2	4.801
Channel	Lower Ana	LACC01	0.964	0.105	9.5	9.18
catfish	Upper Ana	UACC01	0.809	0.0434	23.0	18.6
	Lower Pot	LPCC01	1.031	0.0274	36.5	37.6
	Upper Pot	UPCC01	0.504	0.0450	22.2	11.2
		UPCC02	0.5511	0.0211	47.4	26.1
		median	**0.809**	**0.0434**	**23.0**	**18.6**
		mean	**0.772**	**0.0484**	**27.7**	**20.6**
		stdev	**0.238**	**0.0333**	**14.6**	**11.7**
samples		UPCC101	0.273	0.0563	17.8	4.85
within composite		UPCC102	0.464	0.0325	30.8	14.3
UPCC01		UPCC103	0.844	0.0677	14.8	12.5
Largemouth	Lower Ana	LALB01	0.465	0.00980	102	47.4
Bass	Upper Ana	UALB01	0.244	0.00920	109	26.5
	Lower Pot	LPLB01	0.182	0.0138	72.5	13.2
	Upper Pot	UPLB01	0.272	0.00720	139	37.8
		median	**0.258**	**0.00950**	**105**	**32.1**
		mean	**0.291**	**0.0100**	**106**	**31.2**
		stdev	**0.122**	**0.0028**	**27**	**14.8**
Smallmouth bass	Lower Pot	LPSB01	0.144	0.00610	164	23.6
Sunfish	Lower Ana	LASF01	0.0379	0.00500	200	7.58
	Upper Ana	UASF01	0.129	0.0128	78.1	10.1
	Lower Pot	LPSF01	0.0475	0.00600	167	7.92
	Upper Pot	UPSF01	0.0612	0.00620	161	9.87
		median	**0.0612**	**0.00610**	**164**	**9.87**
		mean	**0.0839**	**0.00722**	**154**	**11.8**
		stdev	**0.0490**	**0.00316**	**45.2**	**6.70**

Table 9. Comparison of Selected Contaminants by Time (ppm wet weight).

Species	Contaminant	Anacostia			Potomac			All DC Waters		
		93-'95	2000	2007	93-'95	2000	2007	93-'95	2000	2007
American eel (AE)	Total PCB	NS	NS	**1.30**	0.555	0.478	**2.28**	*	*	**2.18**
	Total Chlordane	NS	NS	**0.516**	0.0706	0.0438	**0.157**	*	*	**0.382**
	Total DDT	NS	NS	**0.273**	0.0841	0.0793	**0.285**	*	*	**0.285**
	Dieldrin	NS	NS	**0.0782**	0.00870	0.00957	**0.0341**	*	*	**0.0344**
	Total PAH	NS	NS	**0.117**	**0.234**	ND	0.0614	*	*	**0.0814**
	Mercury	NS	NS	**0.0800**	0.111	0.135	**0.200**	*	*	**0.130**
Carp (CA)	Total PCB	**1.02**	0.758	0.941	**0.728**	0.176	0.670	**0.931**	0.366	0.844
	Total Chlordane	0.180	0.132	**0.218**	0.0938	0.0241	**0.118**	0.121	0.0403	**0.176**
	Total DDT	0.0686	0.102	**0.134**	0.0788	0.0191	**0.108**	0.0788	0.0402	**0.127**
	Dieldrin	0.0159	0.00922	**0.0208**	0.0143	0.00845	**0.0178**	0.0143	0.00845	**0.0208**
	Total PAH	0.083	0.0348	**0.184**	0.078	0.0107	**0.227**	0.0803	0.0234	**0.184**
	Mercury	**0.0835**	ND	0.0600	0.0521	ND	**0.0750**	0.0555	ND	**0.0700**
Channel catfish (CC)	Total PCB	1.12	**2.07**	0.886	0.899	**0.902**	0.503	1.07	**1.41**	0.808
	Total Chlordane	0.175	**0.312**	0.142	**0.127**	0.0819	0.0525	0.128	**0.203**	0.0734
	Total DDT	0.163	**0.322**	0.114	**0.127**	0.126	0.0735	0.135	**0.226**	0.0801
	Dieldrin	0.0229	**0.0251**	0.0102	0.0139	**0.0155**	0.00609	0.0155	0.0230	0.00624
	Total PAH	**1.89**	0.137	0.112	0.101	**0.136**	0.0744	**0.243**	0.137	0.0744
	Mercury	0.0608	0.0737	**0.120**	0.0569	0.0553	**0.0720**	0.0588	0.0689	**0.0860**
Largemouth bass (LB)	Total PCB	0.270	0.305	**0.354**	**0.344**	0.161	0.227	**0.297**	0.242	0.258
	Total Chlordane	0.0300	0.0297	**0.0389**	**0.0335**	0.0130	0.017	0.0300	0.0192	**0.0734**
	Total DDT	0.0360	0.0348	**0.0388**	**0.0435**	0.0218	0.0336	**0.0410**	0.0270	0.0345
	Dieldrin	0.00250	0.00226	**0.00286**	**0.00378**	0.00184	0.00142	0.00260	0.00226	0.00235
	Total PAH	**0.0310**	0.00680	0.0266	**0.0590**	0.00549	0.0182	**0.0463**	0.00680	0.0210
	Mercury	0.0784	0.136	**0.180**	0.0831	0.118	**0.210**	0.0807	0.128	**0.180**
Sunfish (SF)	Total PCB	**0.382**	0.171	0.0882	NS	**0.0578**	0.0570	*	**0.0997**	0.0570
	Total Chlordane	**0.126**	0.00679	0.0127	NS	**0.00463**	0.00347	*	**0.00487**	0.00478
	Total DDT	**0.0550**	0.0126	0.0112	NS	**0.00817**	0.00627	*	**0.0109**	0.00627
	Dieldrin	**0.00825**	0.00132	0.00168	NS	**0.00121**	0.000604	*	**0.00132**	0.000736
	Total PAH	**0.0970**	0.00200	0.0220	NS	0.00200	**0.00645**	*	0.00200	**0.0126**
	Mercury	**0.0540**	ND	0.0460	NS	0.0541	**0.123**	*	NC	**0.0790**

2007 vs. 2007 comparison for PCBs and chlordane (# species)

PCBs	**Anacostia**	2↑, 2↓	**Potomac**	3↑, 2↓	**DC waters**	2↑, 2↓
chlordane	**Anacostia**	3 ↑, 1↓	**Potomac**	3↑, 2↓		2↑, 2↓

Medians shown if there were more than one sample analyzed.
ppm wet weight; highest concentration in each river in bold.
NS=not sampled, ND=not detected, NC= cannot be calculated accurately, one detected concentration + two non-detects
* Only sampled from one river

Table 10. Meal thresholds for the general public used by Virginia* and the Great Lakes Protocol for a Uniform Fish Advisory.

Protocol	**Total PCB Concentrations (ppm wet weight)**	**Advice**	
Virginia	0.050-0.500	2 meals/month	
	>0.500	Do not consume	
Great Lakes	>0.05 – 0.22	1 meal/week	
Protocol	>0.22 – 0.95	1 meal/month	
	>0.95 – 1.89	6 meals/year	
	> 1.89	Do not consume	
Recommendations using median concentrations for each species: 2007 data for all D.C. waters			
Species	**Median total PCB conc.**	**Meals-VA**	**Meals-Great Lakes**
American eel	2.18	Do not consume	Do not consume
Blue catfish	0.759	Do not consume	1 meal/month
Channel catfish	0.808	Do not consume	1 meal/month
Carp	0.844	Do not consume	1 meal/month
Largemouth bass	0.258	2 meals/month	1 meal/month
Smallmouth bass	0.144	2 meals/month	1 meal/week
Sunfish	0.0570	2 meals/month	1 meal/week

* The Virginia Department of Health states that women who are pregnant or may become pregnant, nursing mothers, and young children are advised not to eat any fish contaminated with PCBs or mercury from the respective advisory areas.

FIGURES

Figure 1. Map of Washington, D.C. highlighting the Potomac and Anacostia Rivers.

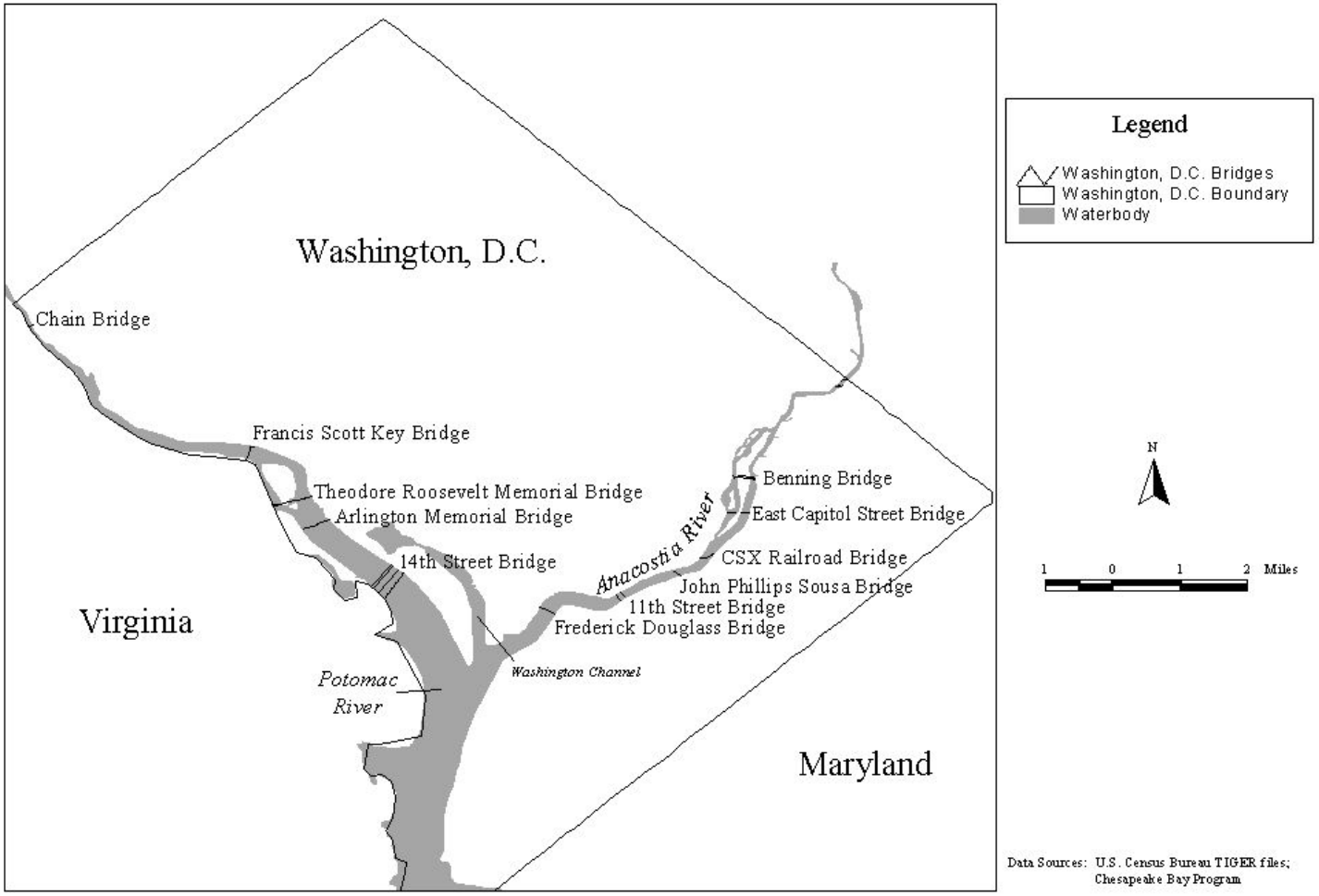


Figure 2. Range of total PCB concentrations in composite fish samples collected in 2007 from District of Columbia waters

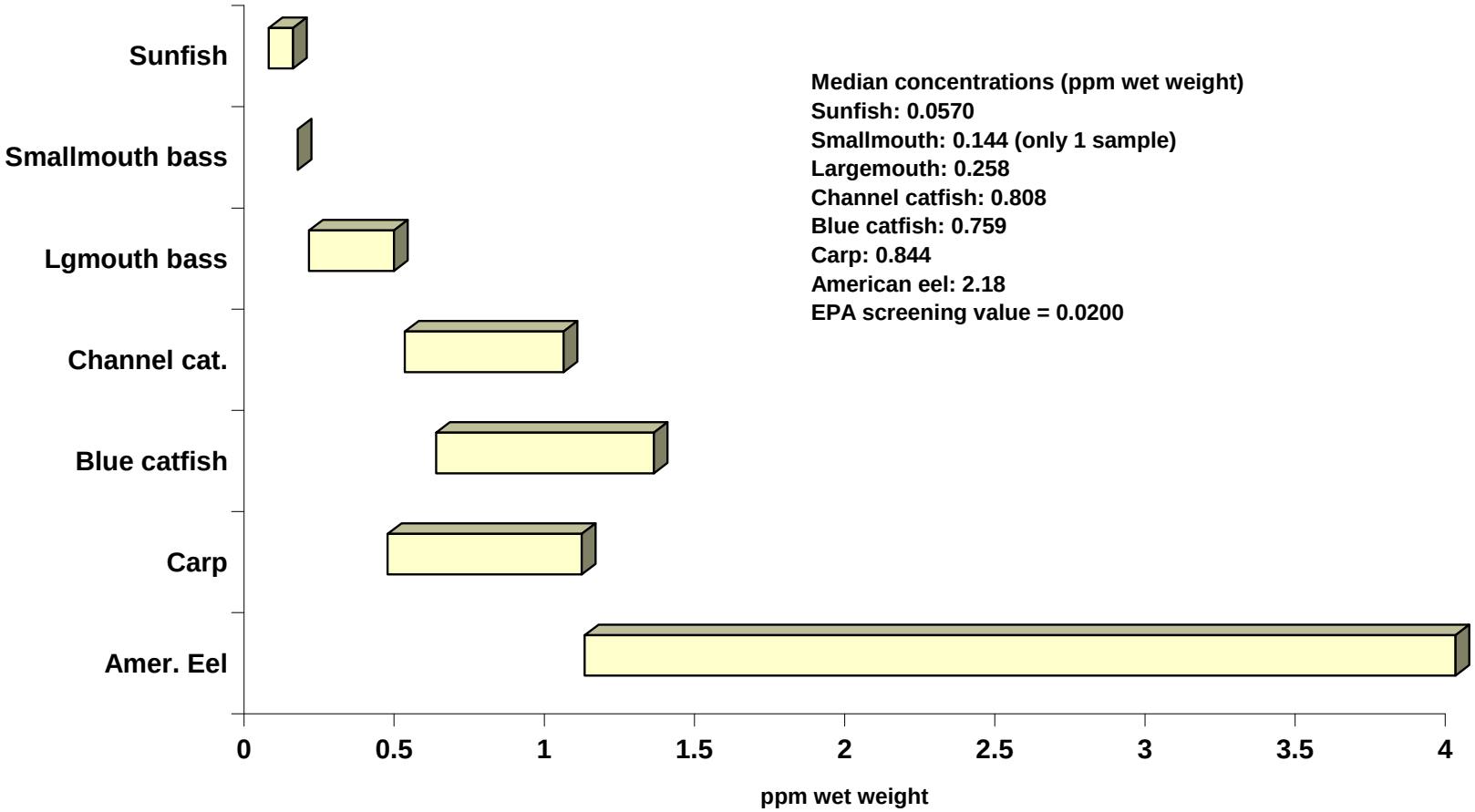


Figure 3. Range of total chlordane concentrations in composite fish samples collected in 2007 from District of Columbia waters

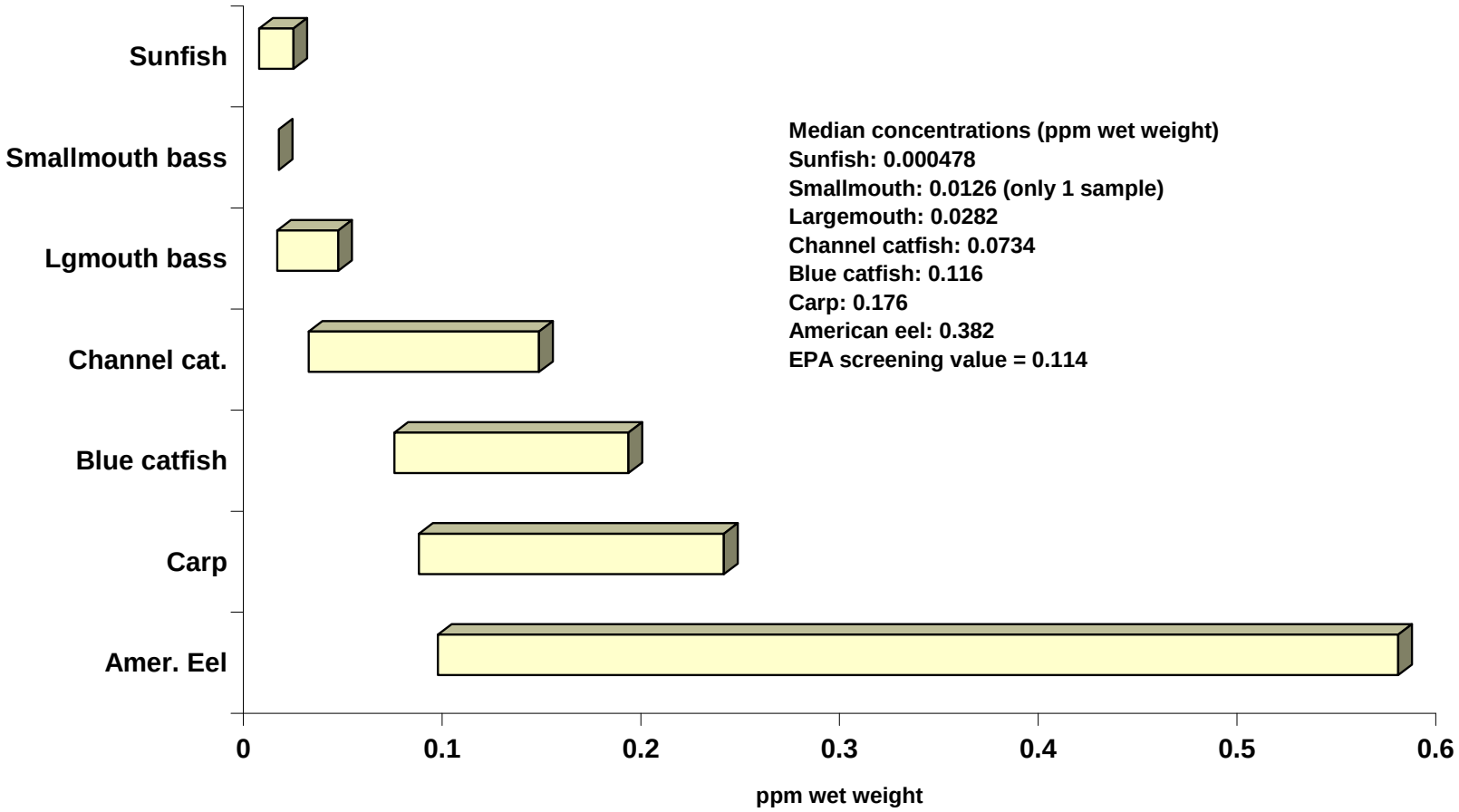


Figure 4. Range of total DDT concentrations in composite fish samples collected in 2007 from District of Columbia waters

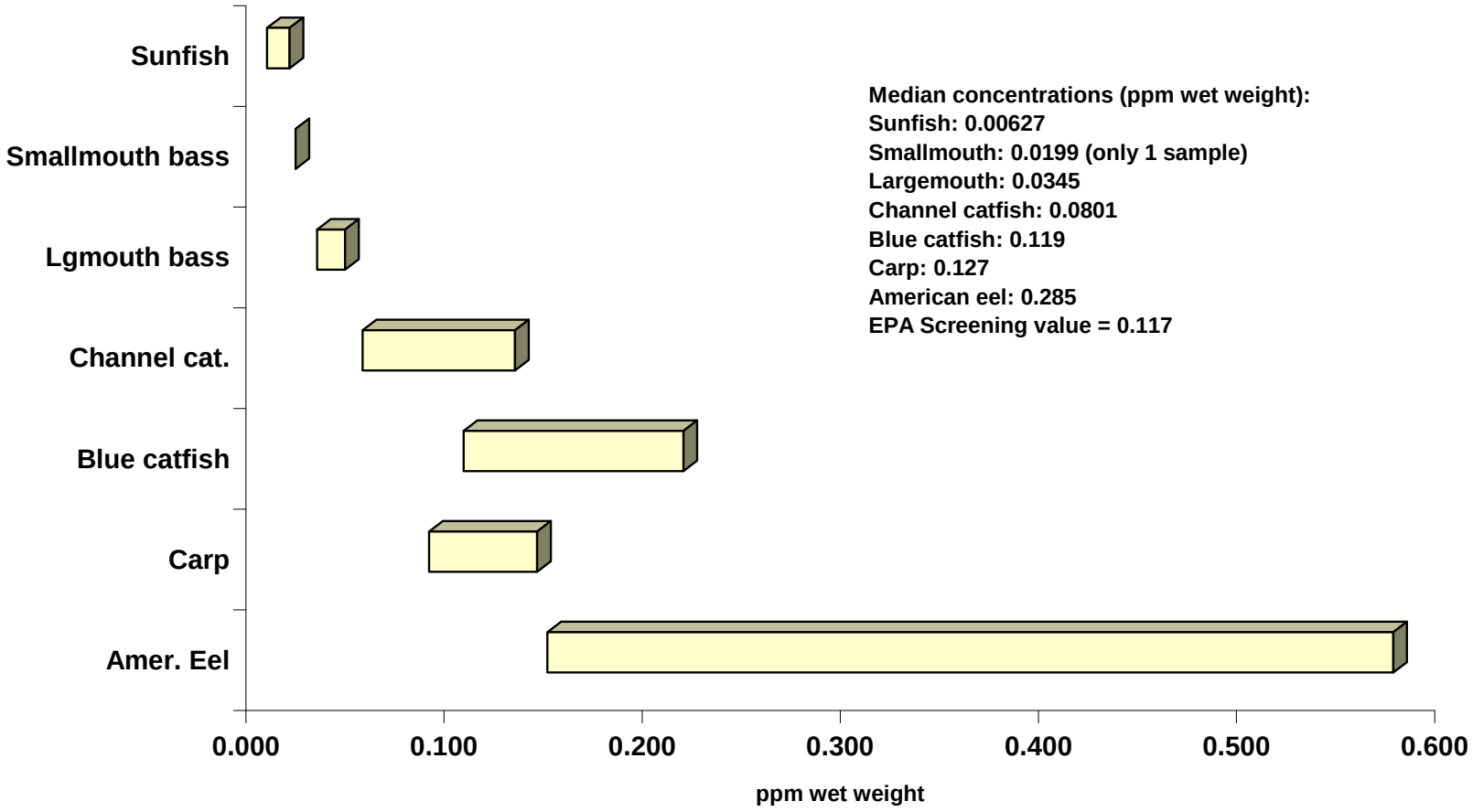


Figure 5. Range of dieldrin concentrations in composite fish samples collected in 2007 from District of Columbia waters

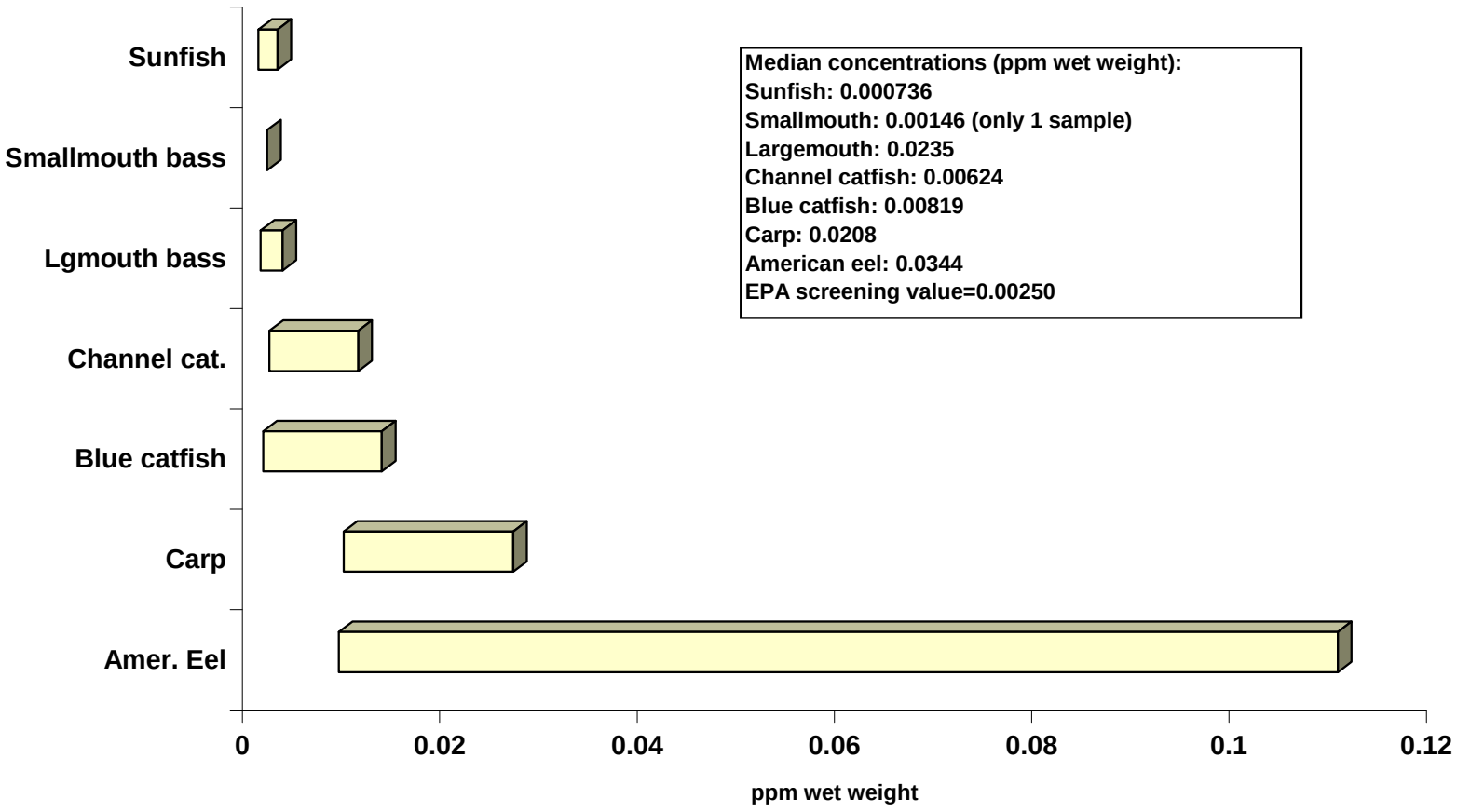


Figure 6. Range of total PAH concentrations in composite fish samples collected in 2007 from District of Columbia waters

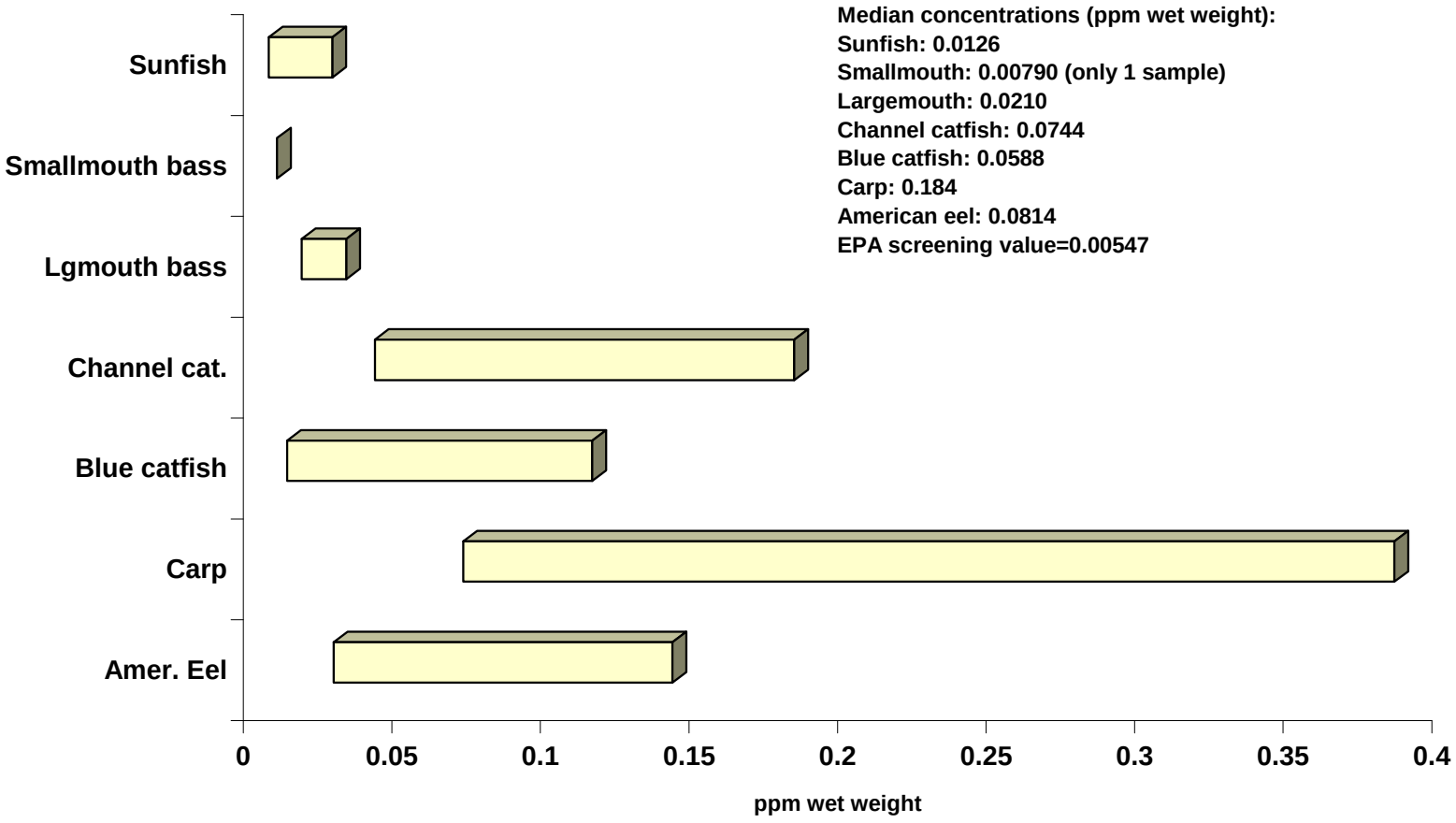


Figure 7. Comparison of median total PCB concentrations in composite fish samples from the waters of the District of Columbia for three sampling periods

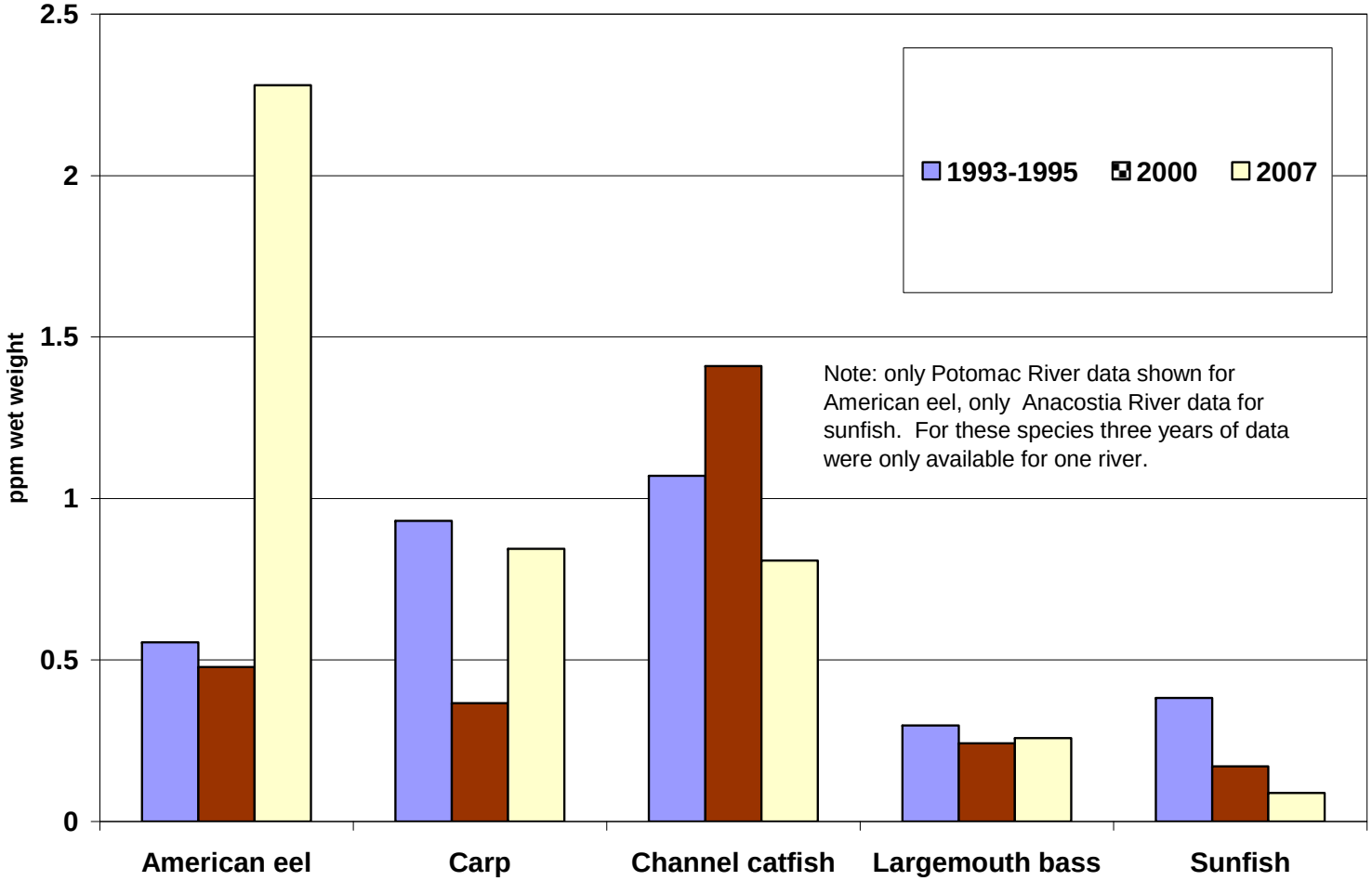


Figure 8. Comparison of median total chlordane concentrations in composite fish samples from the waters of the District of Columbia for three sampling periods

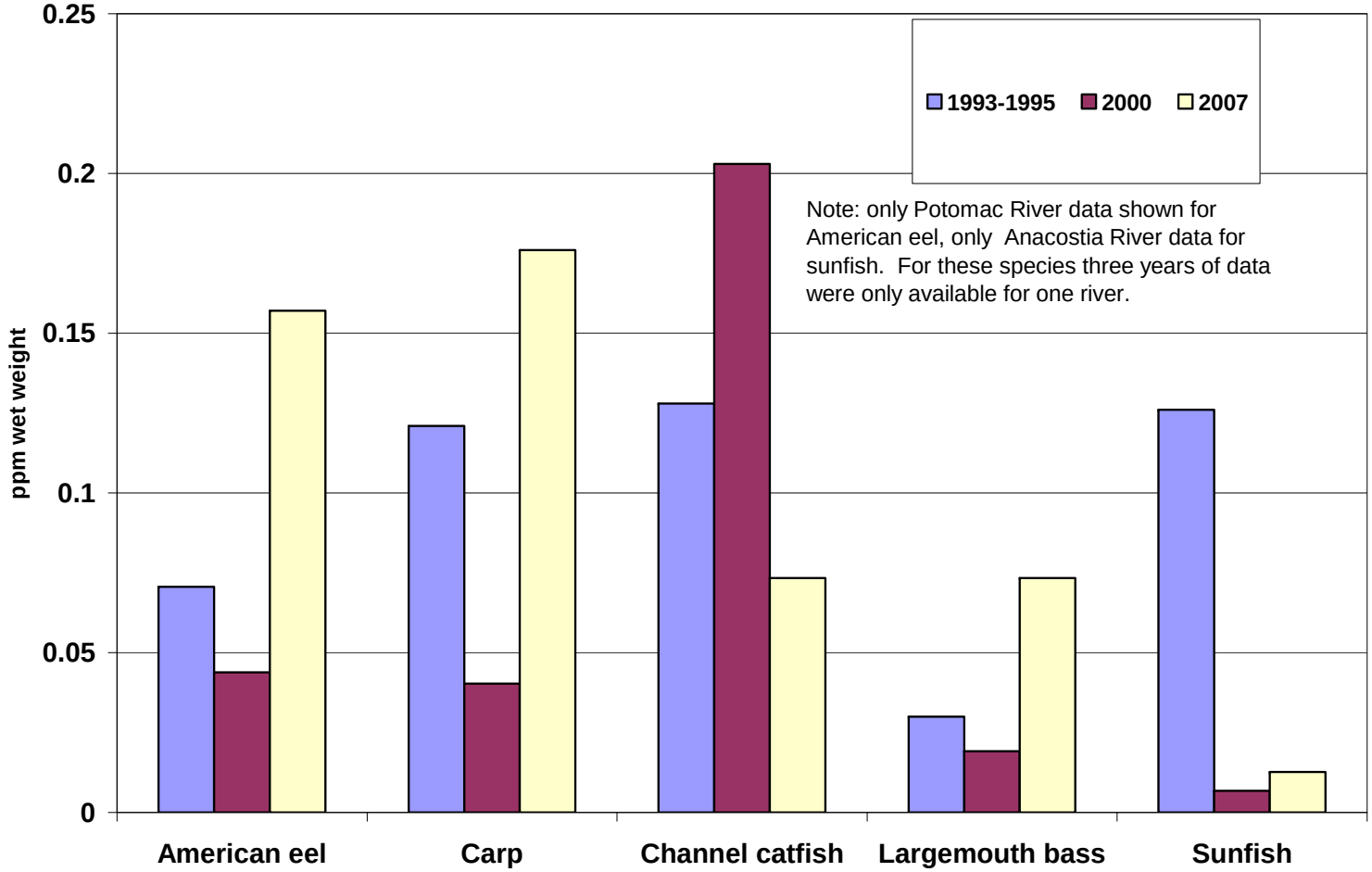


Figure 9. Comparison of median total DDT concentrations in composite fish samples from the waters of the District of Columbia for three sampling periods

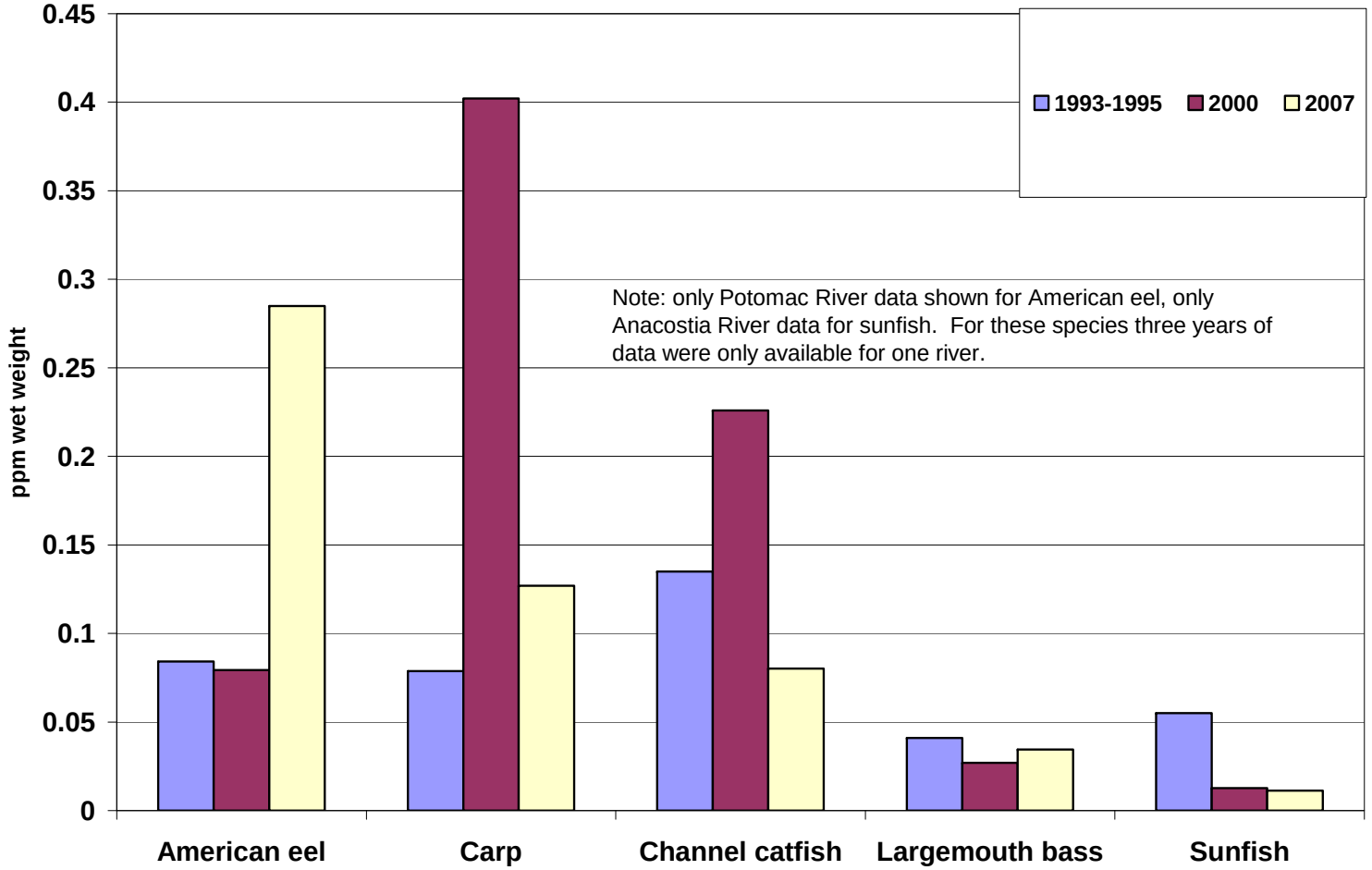
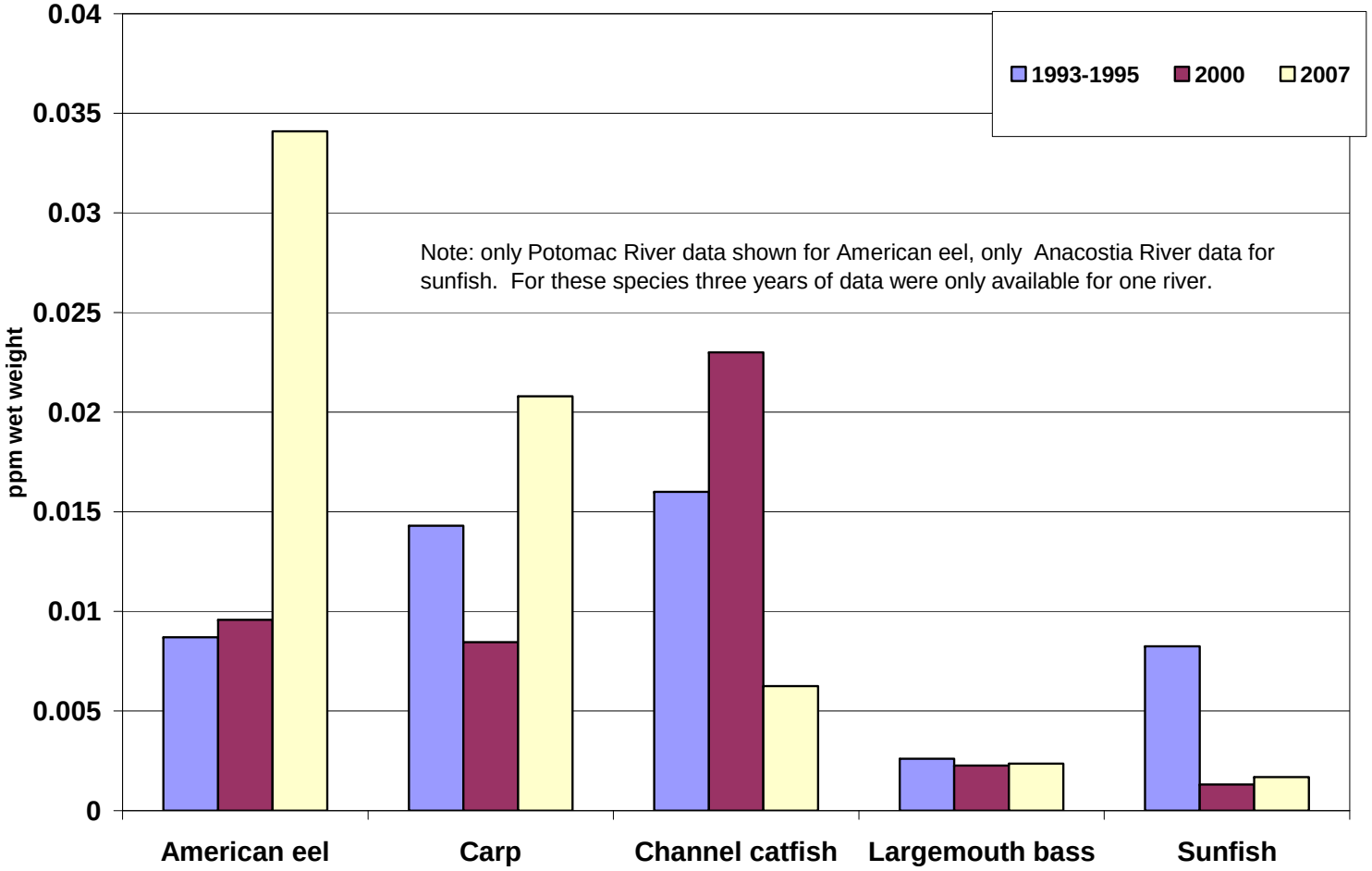


Figure 10. Comparison of median dieldrin concentrations in composite fish samples from the waters of the District of Columbia for three sampling periods



APPENDIX A

U.S. Fish and Wildlife Service

Chesapeake Bay Field Office

Standard Operating Procedures Used for the Analysis of Fish Tissues

U.S. Fish and Wildlife Service

Chesapeake Bay Field Office

STANDARD OPERATING PROCEDURES

102. Chain of Custody Forms

A. Objective:

Chain of Custody forms will be initiated for all water, sediment, soil, and tissue samples collected.

B. Procedures:

1. Chain of custody forms will be initiated in the field when samples are collected. Depending on the goals of the study, chain of custody forms should be completed for each sample or group of samples.

2. An example of a chain of custody form is attached to this SOP. All blocks on the form shall be filled in. At the time of collection and for each transfer of custody, the signature of the sampler and subsequent recipients as well as the dates and times shall be recorded.

3. Also included on the form will be a description of the sampling site location, storage locations, sample type (e.g. water, sediment, soil, or tissue), sample number, sample container size and type, and any preservatives used.

4. The original form will stay with the samples during storage, shipment, and analysis. Copies of the forms should be made by the individuals transferring the samples after each change of custody.

5. After the analyses are complete and the samples disposed of, the completed chain of custody forms should be sent back to the place of origin (usually the Chesapeake Bay Field Office).

U.S. Fish and Wildlife Service

Chesapeake Bay Field Office

STANDARD OPERATING PROCEDURES

103. GENERAL SAMPLE COLLECTION, HANDLING, AND SHIPMENT

Revised 2/94; Version 94-1

A. Objective

1. General procedures for sample collection, handling, and shipment. Methods may vary depending on sample type and study goals.

B. Collection and Handling Procedures

1. Labelling. Sample containers should be labelled prior to or during sample collection. Labels should be affixed to the sample container and include the sample number, initials of collector, type of preservatives (if any), weight (tissue samples) and the date, time, and place of collection. A unique, project specific sample number should also be written on the sample container wall and lid with an indelible marker. Glass containers should be wrapped with strapping tape prior to affixing the labels to reduce breakage during shipment.

2. Just after sampling, sample closures should be sealed with chain of custody tape (to guard against tampering) and placed in zip-locked bags that are labelled with the sample numbers. If the samples are to be shipped in a cardboard box, chain of custody tape can be applied to the box rather than each bottle. The sample number, initials of the collector, and the date and time of collection should be recorded on the tape.

3. Record important information and observations in the field log book. Included in the sampling record should be the purpose of sampling, locations, name, address, and phone number of the field contact, producer of material being sampled (originator of contamination source if known), type of sample, sample numbers, volume (water), weight (sediment, soil, and tissue), sample container type and size, sampling method, date and time of collection, maps, photos, field observations, weather conditions, chemical and physical parameters at each sampling site, and the signatures of personnel responsible for sampling and recording the observations.

4. Search for signs of wildlife mortality at each sampling site and, if possible, collect any dead wildlife for contaminants analysis according to sampling procedures above.

5. Chain of Custody forms will be initiated in the field. See SOP 102.

6. Commercially pre-cleaned sample bottles should be used for contaminants sampling. As a general rule, samples for metals analyses are stored in plastic containers and samples for organic analyses are stored in glass containers with teflon or foil lined lids. Samples should be preserved according to study needs or placed on ice immediately after collection and stored during transport in coolers to protect them from sunlight and temperature. Most samples will be stored in the dark and either frozen at -20BC or refrigerated at 4BC prior to shipment.

7. There are generally four different types of samples that may be collected during a study: Water, Soil, Sediment, and Tissue (Plant and Animal). See the SOP's for each sample type for matrix-specific procedures.

C. Sample Shipment

1. Samples can be shipped after an Authorization to Ship Notice is received from the Patuxent Analytical Control Facility (PACF).

2. Samples should be shipped on wet or dry ice to maintain the desired temperature. Sediments, soils, and tissues are usually shipped frozen on dry ice. Water samples are shipped cooled on wet ice.

3. Prior to placing the samples into the shipping cooler, wrap the sample bottles in styrofoam wrap, place the bottles into the original manufacturers shipping container, and put the shipping container into a large plastic garbage bag. Place the shipping container into the shipping cooler and pack any empty space with newspaper. Add ten pounds of ice and seal the cooler with tape. For dry ice shipments, the shipping cooler should be constructed of styrofoam within a cardboard outer box (Polyfoam Packers Corp.). High quality plastic coolers (Coleman, Igloo, etc.) can be used if necessary. Wet ice shipments can be can be made in styrofoam or plastic coolers.

4. A cover letter with copies of the catalog and the Authorization to Ship Notice and a self-addressed return label should be placed in a plastic bag and included inside the shipping cooler.

5. Sample shipments should be sent via Federal Express government overnight service. Federal Express dry ice stickers should be placed on shipping coolers that contain dry ice. Sample shipments must be arranged so that delivery will be made when an authorized recipient is available to sign for a shipment. Allow for two days shipping time for overnight service.

6. Call the analytical laboratory when the shipment is made.

U.S. Fish and Wildlife Service

Chesapeake Bay Field Office

STANDARD OPERATING PROCEDURES

SOP 114. PREPARING FISH AND INVERTEBRATE TISSUES FOR CHEMICAL ANALYSIS

Revised 5/98; Version 98-1

This SOP is based on the following guidance documents: Environmental Protection Agency (1995), Maryland Department of the Environment (1989), and Puget Sound Estuary Program (1990a,b).

A. Objective

1. Collection and preparation of samples for chemical analyses to meet all QA/QC requirements for monitoring programs

B. Preparation

1. For small specimens, obtain commercially prepared and certified pre-cleaned glass bottles with teflon lids.

2. For large specimens, obtain heavy duty aluminum foil.

C. Fish and Invertebrate Collection

1. Collection methods include electrofishing, various nets, rod and reel, and crab and eel pots.

2. Fish and invertebrates are placed in 5 gallon buckets which are labeled according to each collection site. Care in labeling the buckets is vital -- use waterproof markers and cards that are tied to the bucket handles. If a particular size is targeted, it may be necessary to capture a large number of specimens, sort by size, and release those not needed. In this case, it is essential that sufficient site water and buckets be used to avoid mortality.

D. Packaging Whole Specimens

1. To store whole fish or crabs for resection at the analytical laboratory, rinse the fish with deionized water, pat dry with a paper towel, and place an identifying tag in the fish mouth. Wrap

with the dull side of the aluminum foil facing the specimen. Use wrapping tape to encircle the specimen. Attach a stick-on sample label to the outside of the aluminum foil. Place in a ziplock or plastic trash bag. Use an indelible marker to identify the specimen on the plastic bag.

2. Store prepared specimens on ice. In the laboratory, freeze specimens and send packed in dry ice to an analytical laboratory.

E. Tissue Resection

1. Fish are scaled according to EPA (1995) methods by laying it flat on aluminum foil and using a stainless steel fillet knife that is cleaned with pesticide residue grade acetone or isopropanol and rinsed with deionized water between each sample.

2. Fish total length and crab carapace width are measured to the nearest millimeter.

3. Fish are filleted and crabs are picked to obtain samples of tissues of concern for human health risk assessment.

4. For ecological risk assessment, whole specimens are used.

5. Use only stainless steel instruments and dissecting trays. Clean these between samples (or composite samples) by:

a. Washing in laboratory detergent
b. Rinsing with tap water
c. Rinsing with deionized water
d. Rinsing with pesticide grade acetone or isopropanol
e. Rinsing with deionized water

6. Filleting is conducted on a board covered with heavy duty aluminum foil which is changed after each fish.

7. Follow EPA (1995) guidance on filleting methods. Typically, the skin is removed from fish without scales (catfish and eels). Skin-on fillets should include the belly flap and dark muscle.

8. If whole body analyses are to be performed on the remainder of the tissue (or on whole specimens), place small specimens in chemically clean glass sample jars with teflon lids. Large specimens are double wrapped in heavy duty aluminum foil and labeled as described in D.1.

G. Compositing

1. For analysis of organics and metals, a total of 50-100 grams of tissue is required. This may require compositing a number of specimens into a single sample. Compositing may also be used as a method of obtaining a more accurate estimate of the average concentration when only a small number of samples can be analyzed.

2. Size considerations addressed by EPA (1995) are used as guidance. Within each composite, the shortest fish should be at least 75% of the longest fish. The average lengths of the individual fish from replicate composite samples from the same site should be within 10% (unless different size classes are targeted).

H. Shipping

1. Follow general guidelines of SOP 103 for general sample handling and shipment.

2. Ship all samples with dry ice following overnight shippers= packing and labeling instructions.

I. References

Environmental Protection Agency (EPA). 1995. Guidance for assessing chemical contaminant data for use in fish advisories. Volume 1. Fish sampling and analysis. Second edition. EPA 823-R-95-007.

Maryland Department of the Environment (MDE). 1989. Sample collection guidelines and techniques. MDE, Toxics, Environmental Science and Health, Ecological Assessment Division, Baltimore, MD.

Puget Sound Estuary Program. 1990a. Recommended guidelines for measuring organic compounds in Puget Sound sediments and tissue samples. Prepared by PTI Environmental Services for EPA Region 10, Seattle, WA.

Puget Sound Estuary Program. 1990a. Recommended guidelines for measuring metals in Puget Sound water, sediment, and tissue samples. Prepared by PTI Environmental Services for EPA Region 10, Seattle, WA.

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WATER QUALITY DIVISION
51 N STREET, NE
WASHINGTON, DC 20002

FISH CHAIN OF CUSTODY

Sample No.	Fish Species	Station	Date	Method of Capture	Weight (1) (gm)
UA-07-001	Largemouth Bass	UPPER Anacostia	9/18/07	Electro-fishing	
UA-07-002	"	"	"	"	
UA-07-003	"	"	"	"	
LA07-003	Carp	Lower Anacostia	8/16/07	"	
LA 07-002	Channel Catfish	Lower Anacostia	8/16/07	"	
LA07-001	Largemouth Bass	Lower Anacostia	8/16/07	"	
LA07-001	Carp	Lower Anacostia	8/16/07	"	
LA-07-002	Blue Catfish	Lower Anacostia	10/16/07	"	
LP-07-007	EEL	Lower Potomac	~~8/2~~ 10/23/07	"	
LP-07-005	EEL	Lower Potomac	10/23/07	"	
LP-07-008	EEL	Lower Potomac	10/23/07	"	
LP-07-006	EEL	Lower Potomac	10/23/07	"	
UA-07-007	Blue gill	UPPER Anacostia	9/18/07	"	
UA-07-010	Blue gill	UPPER Anacostia	"	"	
UA-07-002	Blue gill	UPPER Anacostia	"	"	
UA-07-008	Blue gill	UPPER Anacostia	"	"	
UA-07-005	Blue gill	UPPER Anacostia	"	"	
UA-07-001	Blue gill	UPPER Anacostia	"	"	

	Name	Date
Sample Collected by:	JS, LL, DR, ET	11/7/07
Transported by:	[signature]	11/7/07
Transported by:		
Received by:		

(1) Weight not taken at time of capture. GEH 11/7/07

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FISH CHAIN OF CUSTODY

Sample No.	Fish Species	Station	Date	Method of Capture	Weight (gm) ①
UA-07-004	Bluegill	UPPER Anacostia	9/18/07	Electro-fishing	
UA-07-006	Blue gill	UPPER Anacostia	9/18/07	"	
UA-07-009	Bluegill	UPPER Anacostia	9/18/07	"	
UA-07-003	Bluegill	UPPER Anacostia	9/18/07	"	
LA-07-002	Pumpkin seed	Lower Anacostia	8/16/07	"	
LA-07-003	Pumpkin Seed	Lower Anacostia	8/16/07	"	
LA-07-001	Pumpkin Seed	Lower Anacostia	8/16/07	"	
UP-07-007	Bluegill	UPPER ~~Anacostia~~ Potomac	9/7/07	"	
UP-07-011	Pumpkin Seed	UPPER Potomac	9/7/07	"	
UP-07-010	Blue gill	UPPER Potomac	9/7/07	"	
UP-07-002	Bluegill	Upper Potomac	9/7/07	"	
UP-07-008	Pumpkin Seed	UPPER Potomac	9/7/07	"	
UP-07-001	Bluegill	Upper Potomac	9/7/07	"	
UP-07-003	Blue gill	Upper Potomac	9/7/07	"	
UP-07-004	Blue gill	Upper Potomac	9/7/07	"	
UP-07-012	Blue gill	Upper Potomac	9/7/07	"	
UP-07-009	Pumpkin Seed	Upper Potomac	9/7/07	"	
UP-07-005	Blue gill	UPPER potomac	9/7/07	"	
		Upper Potomac	9/7/07	"	

	Name	Date
Sample Collected by:	JS, LL, DR, ET	11/7/07
Transported by:	[signature]	11/7/07
Transported by:		
Received by:		

① Weight not taken at time of capture - GEH 11/7/07

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FISH CHAIN OF CUSTODY

Sample No.	Fish Species	Station	Date	Method of Capture	Weight (gm) ①
UP-07-006	Blue gill	UPPER Potomac	9/7/07	Electro-Fishing	
UP-07-001	CARP	UPPER Potomac	9/7/07	"	
UP-07-003	Carp	UPPER Potomac	9/7/07	"	
UP-07-002	Carp	UPPER Potomac	9/7/07	"	
LP-07-004	Small Mouth Bass	Lower Potomac	10/23/07	"	
UP-07-003	Channel Catfish	UPPER Potomac	9/7/07	"	
UP-07-002	Channel Catfish	UPPER Potomac	9/7/07	"	
UP-07-001	Channel Catfish	UPPER Potomac	9/7/07	"	
UP-07-004	Channel Catfish	UPPER Potomac	10-23-07	"	

	Name	Date
Sample Collected by:	JS, LL, DR, ET	11/7/07
Transported by:	Fred Pailey	11/7/07
Transported by:		
Received by:		

Weight not taken at time of capture. GEH 11/7/07

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FISH CHAIN OF CUSTODY

Sample No.	Fish Species	Station	Date	Method of Capture	Weight① (gm)
LA07003	Large mouth Bass	Lower Anacostia	8/16/07	Electro fishing.	
LA07003	channel catfish	Lower Anacosta	8/16/07	"	
LA07002	Large mouth Bass	Lower Anacostia.	8/16/07	"	
UA07003	channel catfish	upper Anacostia	9/18/07	"	
LA07002	Carp	Lower Anacostia	8/16/07	"	
LA07001	channel catfish	Lower Anacostia	8/16/07	"	
UA07004	Carp	upper Anacostia	9/18/07	"	
UA07003	Blue catfish	upper Anacostia	10/16/07	"	
LA07001	Blue catfish	Lower Anacostia	10/16/07	"	
LA07003	Blue catfish	Lower Anacostia	10/16/07	"	
UA07002	Blue catfish	upper Anacostia	10/16/07	"	
LP07006	Large mouth Bass	Lower Potomac	10/23/07	"	
UA07001	Carp	upper Anacostia	9/18/07	"	
LP07003	Blue catfish	Lower Potomac	10/23/07	"	

	Name	Date
Sample Collected by:	JS, LL, DR, ET	11/7/07
Transported by:	[illegible]	11/7/07
Transported by:		
Received by:		

① ~~Wt~~ Weight not taken at time of capture. GEH 11/7/07

(Bag)

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FISH CHAIN OF CUSTODY

Sample No.	Fish Species	Station	Date	Method of Capture	Weight (gm) (1)
LA07010	American eel	Lower Anacostia	8/16/07	Electro fishing	
LA0707	"	"	"	"	
LA07006	"	"	"	"	
LA07001	"	"	"	"	
LA07006	"	"	"	"	
LA0708	"	"	"	"	
LA07002	"	"	"	"	
LA07003	"	"	"	"	
LA0709	"	"	"	"	
LA07012	"	"	"	"	
LA07011	"	"	"	"	
LA07004	"	"	"	"	
LA07013	American eel	Lower Anacostia	8/16/07	"	

	Name	Date
Sample Collected by:	JS, LL, DR, ET	11/7/07
Transported by:	[illegible]	11/7/07
Transported by:		
Received by:		

(1) weight not taken at time of capture.

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Bay

FISH CHAIN OF CUSTODY

Sample No.	Fish Species	Station	Date	Method of Capture	Weight (gm) ①
LA07006	Sunfish	Lower Anacostia	8/16/07	Electro fishing	
LA07003	Sunfish	Lower Anacostia	"	"	
LA07010	Sunfish	Lower Anacostia	"	"	
LA07009	Sunfish	Lower Anacostia	"	"	
LA07004	Sunfish	Lower Anacostia	"	"	
LA07005	Sunfish	Lower Anacostia	"	"	
LA07008	Sunfish	Lower Anacostia	"	"	
LA07002	Sunfish	Lower Anacostia	"	"	
LA07001	Sunfish	Lower Anacostia	"	"	
LA07007	Sunfish	Lower Anacostia	8/16/07	"	

	Name	Date
Sample Collected by:	JS, LL, DR, EJ	11/7/07
Transported by:	[illegible]	11/7/07
Transported by:		
Received by:		

① Not taken at time of capture. GEH 11/7/07

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WATER QUALITY DIVISION
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WASHINGTON, DC 20002

Bag

FISH CHAIN OF CUSTODY

Sample No.	Fish Species	Station	Date	Method of Capture	Weight (gm) ①
UP07001	Largemouth Bass	Upper Potomac	9/7/07	Electro Fishing.	
UP07003	"	"	9/7/07	"	
UP07002	"	"	9/7/07	"	
UP07008	American eel	Upper Potomac	"	"	
UP07006	"	"	"	"	
UP07004	"	"	"	"	
UP07005	"	"	"	"	
UP07007	"	"	"	"	
UP07009	"	"	"	"	
UP07003	"	"	"	"	
UP07010	"	"	"	"	
UP07002	"	"	"	"	
UP07011	"	"	"	"	
UP07012	"	"	"	"	
UP07001	"	"	9/7/07	"	

	Name	Date
Sample Collected by:	JS, LL, DR, ET	11/7/07
Transported by:	[illegible]	11/7/07
Transported by:		
Received by:		

① Weight not taken at time of capture.

TDI Brooks

TDI-Brooks International

Amanda J. Fryer 1902 Pinon College Station TX 77845 phone (979) 693-3446 fax (979) 693-6389 amandafryer@tdi-bi.com

June 24, 2008

Mr. Fred Pinkney
Chesapeake Bay Ecological Services
Field Office
177 Admiral Cochrane Drive
Annapolis, Maryland 21401

Mr. Pinkney:

B&B Laboratories received a shipment of one (1) ice chest that was sent using Federal Express on June 23, 2008 and arrived on June 24, 2008 in College Station, Texas. The cooler arrived sealed and in good condition.

Cooler Number	Temperature	Samples Received
1	-17.6°C	32 Tissue Samples

The tissue samples were collected between November 26, 2007 and December 28, 2007 in support of the USFWS Catalog 5020129 (D.C. Fish Tissue project). The samples were logged in according to B&B Laboratories standard operating procedure (B&B 1009). There are no discrepancies to report. The tissue samples are being stored in an access-controlled freezer (-20.0°C) until processing. The tissue samples are to be analyzed for PAH, OC and PBDE.

If I can provide additional information please contact me. Once again, thank you for allowing TDI-Brooks/B&B Laboratories to assist with your analytical requirements on this project.

Sincerely yours,

Amanda J. Fryer

Amanda J. Fryer
Sample Custodian

cc: Mr. Juan Ramirez
Ms. Donell S. Frank

U.S. FISH AND WILDLIFE SERVICE
Chesapeake Bay Field Office

177 Admiral Cochrane Dr.
Annapolis, Maryland 21401
(410) 573-4519

CHAIN OF CUSTODY RECORD

PROJ. NO.

PROJECT NAME: DC Fish Tissue (5020129)

SAMPLERS: (Signature) Fred Pinkney

received 6-24-08

STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	collected:	NO. ~~OF CONTAINERS~~ in composite		REMARKS	Length range (mm)
Lower Potomac	6/23/08	10:00	✓		LPSF01	11-26-07	10	✓	Sunfish	150-170
					LPLB01	12-4-07	1	✓	Largemouth bass	250
			✓		LPSB01	12-4-07	3	✓	Smallmouth bass	354-374
			✓		LPAE01	11-28-07	3	✓	American eel	493-530
			✓		LPAE02	11-28-07	4	✓	American eel	255-290
			✓		LPCA01	12-20-07	3	✓	Carp	486-512
			✓		LPCC01	12-13-07	3	✓	Channel catfish	384-388
			✓		LPBC01	12-18-07	5	✓	Blue catfish	430-490
					LPBC02	12-19-07	1	✓	Blue catfish	952
					LPBC03	12-19-07	1	✓	Blue catfish	819
					LPBC04	12-19-07	1	✓	Blue catfish	959
Upper Potomac			✓		UPSF01	11-26-07	10	✓	Sunfish	135-157
			✓		UPLB01	12-4-07	3	✓	Largemout Bass	310-390
			✓		UPAE01	11-28-07	10	✓	American eel	271-330
			✓		UPCA01	12-20-07	3	✓	Carp	522-559

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Fred Pinkney	6/23/08 1055	Amanda Tyu		6-24-08 9:30am	
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks	
		Amanda Tyu	6-24-08 9:30am		

Distribution: Original Accompanies Shipment; Copy to Coordinator

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Chesapeake Bay Field Office

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Annapolis, Maryland 21401
(410) 573-4519

CHAIN OF CUSTODY RECORD

PROJ. NO.

PROJECT NAME: See p. 1

SAMPLERS: (Signature)

STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	collected:	NO. ~~OF CONTAINERS~~ in composite	received 6-24-08	REMARKS: Species	Length range (mm)
Upper potomac	06/23/08	10:00	✓		UPCC01	12-13-07	3	✓	Channel catfish	351-412
					UPCC101	12-13-07	1	✓	Channel catfish	351
					UPCC102	12-13-07	1	✓	Channel catfish	370
					UPCC103	12-13-07	1	✓	Channel catfish	412
					UPCC02	12-13-07	1	✓	Channel catfish	491
Lower Ana.			✓		LASF01	11-26-07	8	✓	Sunfish	131-152
			✓		LALB01	12-28-07	3	✓	Largemouth bass	332-369
			✓		LAAE01	11-28-07	10	✓	American eel	264-306
			✓		LACA01	12-20-07	3	✓	Carp	493-527
			✓		LACC01	12-13-07	3	✓	Channel catfish	416-458
			✓		LABC01	12-13-07	3	✓	Blue catfish	470-494
Upper Ana.			✓		UASF01	10-26-07	10	✓	Sunfish	155-174
			✓		UALB01	12-4-07	3	✓	Largemouth bass	350-417
			✓		UAAE01	11-28-07	1	✓	American eel	320
			✓		UACA01	12-20-07	3	✓	Carp	524-572

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
[signature]	6/23/08 1055	Amanda Yu		6-24-08 9:30am	
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature) Amanda Yu	Date / Time 6-24-08 9:30am	Remarks	

Distribution: Original Accompanies Shipment; Copy to Coordinator

U.S. FISH AND WILDLIFE SERVICE
Chesapeake Bay Field Office

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(410) 573-4519

CHAIN OF CUSTODY RECORD

3 of 3

PROJ. NO.

PROJECT NAME: See p. 1

SAMPLERS: (Signature)

STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. ~~OF CONTAINERS~~ in composite	received 6-24-08	REMARKS
Upper Ana	6/23/08	10:00	✓		collected:			Length range (mm)
			✓		UACC01 12-13-07	3	✓	Channel catfish 414-435
					UABC01 12-13-07	2	✓	Blue catfish 503-505

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
[illegible]	6/23/08 1055	Amanda Tyler		6-24-08 9:30am	
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature) Amanda Tyler	Date / Time 6-24-08 9:30am	Remarks	

Distribution: Original Accompanies Shipment; Copy to Coordinator

APPENDIX B

Analytical chemistry report files including method descriptions

Section 1: Organic data from TDI Brooks

Section 2: Metals data from LET, Inc.

Analytical Results Report TOC

Page 2 - Chapter 1. : ECDMS Analytical Results Report 1/28/2009

Page 3 - Chapter 2. : Bulk Data

Page 5 - Chapter 4. : Contaminant Concentrations

Page 332 - Chapter 5. : Procedural Blanks

Page 351 - Chapter 6. : Duplicates

Page 381 - Chapter 7. : Spike Recoveries

Page 390 - Chapter 8. : Reference Materials

Page 406 - Chapter 9. : Laboratory Notes

Page 430 - Chapter 10. : QAQC Summary

Page 431 - Chapter 11. : QA/QC Anomalies

Page 474 - Chapter 12. : Analytical Methods

1. ECDMS Analytical Results Report 1/28/2009

Catalog Number	Purchase Order Number	Lab ID	Catalog Submitter	ECDMS User ID
5020129	94420-08-Y867	TDI	Pinkney, Fred - Annapolis, MD	r5afo

Catalog Title	Fish Tissue Analysis: DC Dept of the Environment
Lab Name:	TDI - Brooks International, Inc.
Regional Study ID:	5F01
Regional Study Title:	Emergency Analytical Funds

Notes, Symbols and Abbreviations Used
Based on the report options selected the report should be **printed in landscape mode**
Notes, Symbols and Abbreviations Used The following may appear before a reported result (e.g. < 1234). < - Less than symbol indicates that the actual result is less than the reported detection limit. > - Greater than symbol indicates that the actual result is greater than the reported result.
All results are reported as 3 significant digits.
All results are reported as parts per million (ppm), or percent, unless otherwise noted.

1. Integrity Report

Lab Receipt Date	06/24/2008	**Lab Approval Date**	08/04/2008

Catalog Problems
Submitter postponed TM analysis due to budget. Samples aliquoted and are being stored at B&B Labs waiting for decision from submitter.
Problem Resolution

2. Bulk Data

Sample Number	Sample Matrix	Sample Weight (grams)	Percent Lipid	Percent Moisture
LACA01	Fillets with Skin	139.5	4.55	72.1
LALB01	Fillets with Skin	153.6	0.980	79.3
LASF01	Fillets with Skin	68.71	0.500	80.1
LPCA01	Fillets with Skin	96.27	5.27	76.4
LPLB01	Fillets with Skin	51.99	1.38	77.1
LPSB01	Fillets with Skin	96.83	0.610	80.4
LPSF01	Fillets with Skin	113.07	0.600	83.0
UACA01	Fillets with Skin	131.49	11.0	72.1
UALB01	Fillets with Skin	140.27	0.920	77.7
UASF01	Fillets with Skin	110.93	1.28	79.4
UPCA01	Fillets with Skin	142.69	13.4	70.9
UPLB01	Fillets with Skin	134.59	0.720	79.6
UPSF01	Fillets with Skin	99.24	0.620	80.4
LAAE01	Fillets without Skin	112.92	23.8	63.1
LABC01	Fillets without Skin	202.57	6.42	78.0
LACC01	Fillets without Skin	98.57	10.5	78.3
LPAE01	Fillets without Skin	89.55	15.0	66.3
LPAE02	Fillets without Skin	63.56	10.1	72.2
LPBC01	Fillets without Skin	100.93	5.66	78.8
LPBC02	Fillets without Skin	100.22	0.750	83.0
LPBC03	Fillets without Skin	100.18	3.91	78.8
LPBC04	Fillets without Skin	97.91	6.16	76.6
LPCC01	Fillets without Skin	97.91	2.74	80.9
UAAE01	Fillets without Skin	39.52	24.9	62.5
UABC01	Fillets without Skin	116.76	3.89	79.0
UACC01	Fillets without Skin	102.91	4.34	77.1
UPAE01	Fillets without Skin	110.1	20.9	66.4
UPCC01	Fillets without Skin	138.19	4.50	78.5
UPCC02	Fillets without Skin	119.14	2.11	78.9
UPCC101	Fillets without Skin	47.71	5.63	78.1

Sample Number	Sample Matrix	Sample Weight (grams)	Percent Lipid	Percent Moisture
UPCC102	Fillets without Skin	41.4	3.25	78.6
UPCC103	Fillets without Skin	50.03	6.77	75.9

4. Contaminant Concentrations

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
1,2,3,4-Tetrachlorobenzene						
	LACA01	Fillets with Skin	< 0.000383	0.000383	< 0.000107	0.000107
	LALB01	Fillets with Skin	< 0.000522	0.000522	< 0.000108	0.000108
	*LASF01	Fillets with Skin	< 0.000528	0.000528	< 0.000105	0.000105
	LPCA01	Fillets with Skin	< 0.000439	0.000439	< 0.000103	0.000103
	LPLB01	Fillets with Skin	< 0.000469	0.000469	< 0.000107	0.000107
	LPSB01	Fillets with Skin	< 0.000491	0.000491	< 0.0000960	0.0000960
	*LPSF01	Fillets with Skin	< 0.000580	0.000580	< 0.0000990	0.0000990
	UACA01	Fillets with Skin	< 0.000369	0.000369	< 0.000103	0.000103
	UALB01	Fillets with Skin	< 0.000472	0.000472	< 0.000105	0.000105
	UASF01	Fillets with Skin	< 0.000509	0.000509	< 0.000105	0.000105
	UPCA01	Fillets with Skin	< 0.000344	0.000344	< 0.000100	0.000100
	UPLB01	Fillets with Skin	< 0.000517	0.000517	< 0.000106	0.000106
	UPSF01	Fillets with Skin	< 0.000529	0.000529	< 0.000104	0.000104
	LAAE01	Fillets without Skin	< 0.000277	0.000277	< 0.000102	0.000102
	LABC01	Fillets without Skin	< 0.000486	0.000486	< 0.000107	0.000107
	LACC01	Fillets without Skin	< 0.000466	0.000466	< 0.000101	0.000101
	LPAE01	Fillets without Skin	< 0.000321	0.000321	< 0.000108	0.000108
	LPAE02	Fillets without Skin	< 0.000383	0.000383	< 0.000107	0.000107
	LPBC01	Fillets without Skin	< 0.000481	0.000481	< 0.000102	0.000102
	LPBC02	Fillets without Skin	< 0.000562	0.000562	< 0.0000950	0.0000950
	LPBC03	Fillets without	< 0.000446	0.000446	< 0.0000950	0.0000950

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	LPBC04	Fillets without Skin	< 0.000467	0.000467	< 0.000109	0.000109
	LPCC01	Fillets without Skin	< 0.000572	0.000572	< 0.000109	0.000109
	UAAE01	Fillets without Skin	0.000480	0.000272	0.000180	0.000102
	UABC01	Fillets without Skin	< 0.000498	0.000498	< 0.000104	0.000104
	UACC01	Fillets without Skin	< 0.000436	0.000436	< 0.000100	0.000100
	UPAE01	Fillets without Skin	< 0.000287	0.000287	< 0.0000960	0.0000960
	UPCC01	Fillets without Skin	0.000538	0.000497	0.000116	0.000107
	UPCC02	Fillets without Skin	< 0.000508	0.000508	< 0.000107	0.000107
	UPCC101	Fillets without Skin	0.000968	0.000488	0.000212	0.000107
	UPCC102	Fillets without Skin	< 0.000503	0.000503	< 0.000107	0.000107
	UPCC103	Fillets without Skin	< 0.000448	0.000448	< 0.000108	0.000108
1,2,4,5-Tetrachlorobenzene						
	LACA01	Fillets with Skin	0.00118	0.000761	0.000330	0.000212
	LALB01	Fillets with Skin	0.00112	0.00104	0.000232	0.000215
	*LASF01	Fillets with Skin	0.00118	0.00105	0.000235	0.000209
	LPCA01	Fillets with Skin	0.0163	0.000872	0.00384	0.000206
	LPLB01	Fillets with Skin	0.00111	0.000933	0.000254	0.000213
	LPSB01	Fillets with Skin	0.00124	0.000975	0.000243	0.000191
	*LPSF01	Fillets with Skin	0.00214	0.00115	0.000365	0.000196
	UACA01	Fillets with Skin	0.00139	0.000734	0.000388	0.000205

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.00120	0.000938	0.000267	0.000209
	UASF01	Fillets with Skin	< 0.00101	0.00101	< 0.000208	0.000208
	UPCA01	Fillets with Skin	0.000799	0.000684	0.000233	0.000199
	UPLB01	Fillets with Skin	0.00142	0.00103	0.000291	0.000210
	UPSF01	Fillets with Skin	0.00115	0.00105	0.000226	0.000206
	LAAE01	Fillets without Skin	0.00419	0.000550	0.00154	0.000203
	LABC01	Fillets without Skin	0.0566	0.000966	0.0125	0.000213
	LACC01	Fillets without Skin	0.00151	0.000926	0.000326	0.000201
	LPAE01	Fillets without Skin	0.00822	0.000639	0.00278	0.000216
	LPAE02	Fillets without Skin	< 0.000762	0.000762	< 0.000212	0.000212
	LPBC01	Fillets without Skin	0.00476	0.000956	0.00101	0.000203
	LPBC02	Fillets without Skin	0.00131	0.00112	0.000222	0.000190
	LPBC03	Fillets without Skin	< 0.000887	0.000887	< 0.000188	0.000188
	LPBC04	Fillets without Skin	< 0.000928	0.000928	< 0.000217	0.000217
	LPCC01	Fillets without Skin	< 0.00114	0.00114	< 0.000217	0.000217
	UAAE01	Fillets without Skin	0.00208	0.000541	0.000780	0.000203
	UABC01	Fillets without Skin	0.00327	0.000990	0.000685	0.000208
	UACC01	Fillets without Skin	0.00104	0.000866	0.000239	0.000199
	UPAE01	Fillets without Skin	< 0.000570	0.000570	< 0.000192	0.000192

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.00102	0.000989	0.000219	0.000213
	UPCC02	Fillets without Skin	0.00166	0.00101	0.000351	0.000213
	UPCC101	Fillets without Skin	0.00121	0.000971	0.000265	0.000213
	UPCC102	Fillets without Skin	0.00110	0.000999	0.000236	0.000213
	UPCC103	Fillets without Skin	0.00101	0.000890	0.000243	0.000215
1,6,7-Trimethyl-naphthalene						
	LACA01	Fillets with Skin	0.00825	0.00156	0.00230	0.000436
	LALB01	Fillets with Skin	0.00435	0.00213	0.000900	0.000441
	LASF01	Fillets with Skin	< 0.00216	0.00216	< 0.000429	0.000429
	LPCA01	Fillets with Skin	0.00424	0.00179	0.00100	0.000422
	LPLB01	Fillets with Skin	0.00262	0.00192	0.000600	0.000438
	LPSB01	Fillets with Skin	0.00255	0.00200	0.000500	0.000393
	LPSF01	Fillets with Skin	< 0.00236	0.00236	< 0.000403	0.000403
	UACA01	Fillets with Skin	0.0133	0.00151	0.00370	0.000420
	UALB01	Fillets with Skin	0.00269	0.00193	0.000600	0.000430
	UASF01	Fillets with Skin	0.00486	0.00208	0.00100	0.000428
	UPCA01	Fillets with Skin	0.0110	0.00140	0.00320	0.000409
	UPLB01	Fillets with Skin	< 0.00211	0.00211	< 0.000431	0.000431
	UPSF01	Fillets with Skin	< 0.00216	0.00216	< 0.000423	0.000423
	LAAE01	Fillets without Skin	0.00271	0.00113	0.00100	0.000417
	LABC01	Fillets without Skin	0.00273	0.00198	0.000600	0.000436
	LACC01	Fillets without Skin	0.0240	0.00190	0.00520	0.000412
	LPAE01	Fillets without Skin	0.00148	0.00131	0.000500	0.000442

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	0.00180	0.00156	0.000500	0.000435
	LPBC01	Fillets without Skin	0.0104	0.00196	0.00220	0.000416
	LPBC02	Fillets without Skin	< 0.00230	0.00230	< 0.000389	0.000389
	LPBC03	Fillets without Skin	< 0.00182	0.00182	< 0.000386	0.000386
	LPBC04	Fillets without Skin	0.00428	0.00190	0.00100	0.000445
	LPCC01	Fillets without Skin	0.00262	0.00234	0.000500	0.000446
	UAAE01	Fillets without Skin	< 0.00111	0.00111	< 0.000416	0.000416
	UABC01	Fillets without Skin	0.0129	0.00203	0.00270	0.000426
	UACC01	Fillets without Skin	0.00829	0.00178	0.00190	0.000408
	UPAE01	Fillets without Skin	0.00149	0.00117	0.000500	0.000393
	UPCC01	Fillets without Skin	0.00650	0.00203	0.00140	0.000437
	UPCC02	Fillets without Skin	0.0355	0.00207	0.00750	0.000437
	UPCC101	Fillets without Skin	0.00822	0.00199	0.00180	0.000436
	UPCC102	Fillets without Skin	0.00468	0.00205	0.00100	0.000438
	UPCC103	Fillets without Skin	0.00622	0.00183	0.00150	0.000441
1-methylnaphthalene						
	LACA01	Fillets with Skin	0.0445	0.00266	0.0124	0.000742
	LALB01	Fillets with Skin	0.00387	0.00363	0.000800	0.000751

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LASF01	Fillets with Skin	< 0.00367	0.00367	< 0.000731	0.000731
	LPCA01	Fillets with Skin	0.0127	0.00305	0.00300	0.000720
	LPLB01	Fillets with Skin	< 0.00326	0.00326	< 0.000747	0.000747
	LPSB01	Fillets with Skin	< 0.00341	0.00341	< 0.000669	0.000669
	LPSF01	Fillets with Skin	< 0.00403	0.00403	< 0.000687	0.000687
	UACA01	Fillets with Skin	0.0204	0.00257	0.00570	0.000716
	UALB01	Fillets with Skin	0.00359	0.00328	0.000800	0.000732
	UASF01	Fillets with Skin	0.00437	0.00354	0.000900	0.000729
	UPCA01	Fillets with Skin	0.114	0.00239	0.0333	0.000697
	UPLB01	Fillets with Skin	< 0.00360	0.00360	< 0.000735	0.000735
	UPSF01	Fillets with Skin	< 0.00368	0.00368	< 0.000721	0.000721
	LAAE01	Fillets without Skin	0.00895	0.00192	0.00330	0.000710
	LABC01	Fillets without Skin	0.00636	0.00338	0.00140	0.000744
	LACC01	Fillets without Skin	0.0258	0.00324	0.00560	0.000702
	LPAE01	Fillets without Skin	0.00652	0.00224	0.00220	0.000754
	LPAE02	Fillets without Skin	0.00828	0.00267	0.00230	0.000741
	LPBC01	Fillets without Skin	0.0127	0.00335	0.00270	0.000709
	LPBC02	Fillets without Skin	< 0.00391	0.00391	< 0.000663	0.000663
	LPBC03	Fillets without Skin	< 0.00310	0.00310	< 0.000657	0.000657
	LPBC04	Fillets without Skin	0.0111	0.00325	0.00260	0.000758
	LPCC01	Fillets without Skin	0.0120	0.00398	0.00230	0.000760
	UAAE01	Fillets without	0.0141	0.00189	0.00530	0.000709

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.0143	0.00346	0.00300	0.000727
	UACC01	Fillets without Skin	0.0109	0.00303	0.00250	0.000695
	UPAE01	Fillets without Skin	0.0164	0.00200	0.00550	0.000670
	UPCC01	Fillets without Skin	0.0190	0.00346	0.00410	0.000745
	UPCC02	Fillets without Skin	0.0251	0.00353	0.00530	0.000745
	UPCC101	Fillets without Skin	0.0329	0.00340	0.00720	0.000744
	UPCC102	Fillets without Skin	0.0164	0.00350	0.00350	0.000747
	UPCC103	Fillets without Skin	0.0182	0.00312	0.00440	0.000751
1-methylphenanthrene						
	LACA01	Fillets with Skin	0.00323	0.00179	0.000900	0.000500
	LALB01	Fillets with Skin	< 0.00245	0.00245	< 0.000506	0.000506
	LASF01	Fillets with Skin	< 0.00247	0.00247	< 0.000492	0.000492
	LPCA01	Fillets with Skin	< 0.00206	0.00206	< 0.000485	0.000485
	LPLB01	Fillets with Skin	< 0.00220	0.00220	< 0.000503	0.000503
	LPSB01	Fillets with Skin	< 0.00230	0.00230	< 0.000451	0.000451
	LPSF01	Fillets with Skin	< 0.00272	0.00272	< 0.000463	0.000463
	UACA01	Fillets with Skin	0.00251	0.00173	0.000700	0.000482
	UALB01	Fillets with Skin	< 0.00221	0.00221	< 0.000493	0.000493
	UASF01	Fillets with Skin	< 0.00239	0.00239	< 0.000491	0.000491
	UPCA01	Fillets with Skin	0.00343	0.00161	0.00100	0.000470
	UPLB01	Fillets with Skin	< 0.00242	0.00242	< 0.000495	0.000495
	UPSF01	Fillets with Skin	< 0.00248	0.00248	< 0.000486	0.000486

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	0.00271	0.00130	0.00100	0.000479
	LABC01	Fillets without Skin	< 0.00228	0.00228	< 0.000501	0.000501
	LACC01	Fillets without Skin	0.00554	0.00218	0.00120	0.000473
	LPAE01	Fillets without Skin	< 0.00150	0.00150	< 0.000508	0.000508
	LPAE02	Fillets without Skin	< 0.00180	0.00180	< 0.000499	0.000499
	LPBC01	Fillets without Skin	0.00330	0.00225	0.000700	0.000478
	LPBC02	Fillets without Skin	< 0.00263	0.00263	< 0.000447	0.000447
	LPBC03	Fillets without Skin	< 0.00209	0.00209	< 0.000443	0.000443
	LPBC04	Fillets without Skin	< 0.00219	0.00219	< 0.000511	0.000511
	LPCC01	Fillets without Skin	< 0.00268	0.00268	< 0.000512	0.000512
	UAAE01	Fillets without Skin	< 0.00127	0.00127	< 0.000478	0.000478
	UABC01	Fillets without Skin	< 0.00233	0.00233	< 0.000489	0.000489
	UACC01	Fillets without Skin	0.00349	0.00204	0.000800	0.000468
	UPAE01	Fillets without Skin	< 0.00134	0.00134	< 0.000451	0.000451
	UPCC01	Fillets without Skin	< 0.00233	0.00233	< 0.000502	0.000502
	UPCC02	Fillets without Skin	0.00711	0.00238	0.00150	0.000502
	UPCC101	Fillets without Skin	< 0.00229	0.00229	< 0.000501	0.000501

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	0.00281	0.00236	0.000600	0.000503
	UPCC103	Fillets without Skin	< 0.00210	0.00210	< 0.000506	0.000506
2,6-dimethylnaphthalene						
	LACA01	Fillets with Skin	0.0190	0.00229	0.00530	0.000639
	LALB01	Fillets with Skin	0.00339	0.00313	0.000700	0.000646
	LASF01	Fillets with Skin	< 0.00316	0.00316	< 0.000629	0.000629
	LPCA01	Fillets with Skin	0.00763	0.00263	0.00180	0.000619
	LPLB01	Fillets with Skin	0.00306	0.00281	0.000700	0.000642
	LPSB01	Fillets with Skin	< 0.00294	0.00294	< 0.000576	0.000576
	LPSF01	Fillets with Skin	< 0.00347	0.00347	< 0.000591	0.000591
	UACA01	Fillets with Skin	0.0151	0.00221	0.00420	0.000616
	UALB01	Fillets with Skin	0.00403	0.00282	0.000900	0.000630
	UASF01	Fillets with Skin	0.00486	0.00305	0.00100	0.000628
	UPCA01	Fillets with Skin	0.0398	0.00206	0.0116	0.000600
	UPLB01	Fillets with Skin	< 0.00309	0.00309	< 0.000632	0.000632
	UPSF01	Fillets with Skin	< 0.00317	0.00317	< 0.000620	0.000620
	LAAE01	Fillets without Skin	0.00407	0.00166	0.00150	0.000611
	LABC01	Fillets without Skin	0.00500	0.00291	0.00110	0.000640
	LACC01	Fillets without Skin	0.0254	0.00279	0.00550	0.000604
	LPAE01	Fillets without Skin	< 0.00192	0.00192	< 0.000649	0.000649
	LPAE02	Fillets without Skin	0.00324	0.00230	0.000900	0.000637
	LPBC01	Fillets without Skin	0.0264	0.00288	0.00560	0.000610
	LPBC02	Fillets without Skin	< 0.00336	0.00336	< 0.000571	0.000571

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	< 0.00267	0.00267	< 0.000566	0.000566
	LPBC04	Fillets without Skin	0.00685	0.00279	0.00160	0.000653
	LPCC01	Fillets without Skin	0.00629	0.00343	0.00120	0.000654
	UAAE01	Fillets without Skin	0.00480	0.00163	0.00180	0.000610
	UABC01	Fillets without Skin	0.00953	0.00298	0.00200	0.000625
	UACC01	Fillets without Skin	0.00785	0.00261	0.00180	0.000598
	UPAE01	Fillets without Skin	0.00328	0.00172	0.00110	0.000577
	UPCC01	Fillets without Skin	0.0130	0.00298	0.00280	0.000641
	UPCC02	Fillets without Skin	0.0512	0.00304	0.0108	0.000641
	UPCC101	Fillets without Skin	0.0233	0.00292	0.00510	0.000640
	UPCC102	Fillets without Skin	0.00983	0.00301	0.00210	0.000642
	UPCC103	Fillets without Skin	0.0112	0.00268	0.00270	0.000646
2-methylnaphthalene						
	LACA01	Fillets with Skin	0.0456	0.00287	0.0127	0.000801
	LALB01	Fillets with Skin	0.00435	0.00392	0.000900	0.000810
	LASF01	Fillets with Skin	< 0.00396	0.00396	< 0.000788	0.000788
	LPCA01	Fillets with Skin	0.0174	0.00329	0.00410	0.000777
	LPLB01	Fillets with Skin	0.00393	0.00352	0.000900	0.000806
	LPSB01	Fillets with Skin	< 0.00368	0.00368	< 0.000722	0.000722
	LPSF01	Fillets with Skin	< 0.00435	0.00435	< 0.000741	0.000741
	UACA01	Fillets with Skin	0.0230	0.00277	0.00640	0.000772

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.00403	0.00354	0.000900	0.000790
	UASF01	Fillets with Skin	0.00437	0.00382	0.000900	0.000787
	UPCA01	Fillets with Skin	0.116	0.00258	0.0339	0.000752
	UPLB01	Fillets with Skin	0.00391	0.00388	0.000800	0.000793
	UPSF01	Fillets with Skin	< 0.00397	0.00397	< 0.000778	0.000778
	LAAE01	Fillets without Skin	0.00705	0.00208	0.00260	0.000766
	LABC01	Fillets without Skin	0.0100	0.00365	0.00220	0.000802
	LACC01	Fillets without Skin	0.0203	0.00350	0.00440	0.000758
	LPAE01	Fillets without Skin	0.00711	0.00241	0.00240	0.000813
	LPAE02	Fillets without Skin	0.0126	0.00288	0.00350	0.000799
	LPBC01	Fillets without Skin	0.0217	0.00361	0.00460	0.000765
	LPBC02	Fillets without Skin	< 0.00422	0.00422	< 0.000716	0.000716
	LPBC03	Fillets without Skin	0.00519	0.00335	0.00110	0.000709
	LPBC04	Fillets without Skin	0.0171	0.00350	0.00400	0.000818
	LPCC01	Fillets without Skin	0.0225	0.00430	0.00430	0.000820
	UAAE01	Fillets without Skin	0.0133	0.00204	0.00500	0.000765
	UABC01	Fillets without Skin	0.0181	0.00374	0.00380	0.000784
	UACC01	Fillets without Skin	0.0122	0.00327	0.00280	0.000750
	UPAE01	Fillets without Skin	0.0185	0.00215	0.00620	0.000723

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.0237	0.00373	0.00510	0.000804
	UPCC02	Fillets without Skin	0.0365	0.00381	0.00770	0.000804
	UPCC101	Fillets without Skin	0.0256	0.00366	0.00560	0.000802
	UPCC102	Fillets without Skin	0.0136	0.00377	0.00290	0.000806
	UPCC103	Fillets without Skin	0.0377	0.00336	0.00910	0.000810
Aldrin						
	LACA01	Fillets with Skin	< 0.000364	0.000364	< 0.000102	0.000102
	LALB01	Fillets with Skin	< 0.000497	0.000497	< 0.000103	0.000103
	*LASF01	Fillets with Skin	< 0.000502	0.000502	< 0.000100	0.000100
	LPCA01	Fillets with Skin	< 0.000417	0.000417	< 0.0000980	0.0000980
	LPLB01	Fillets with Skin	< 0.000446	0.000446	< 0.000102	0.000102
	LPSB01	Fillets with Skin	< 0.000467	0.000467	< 0.0000920	0.0000920
	*LPSF01	Fillets with Skin	< 0.000551	0.000551	< 0.0000940	0.0000940
	UACA01	Fillets with Skin	< 0.000351	0.000351	< 0.0000980	0.0000980
	UALB01	Fillets with Skin	< 0.000449	0.000449	< 0.000100	0.000100
	UASF01	Fillets with Skin	< 0.000485	0.000485	< 0.000100	0.000100
	UPCA01	Fillets with Skin	< 0.000327	0.000327	< 0.0000950	0.0000950
	UPLB01	Fillets with Skin	< 0.000492	0.000492	< 0.000101	0.000101
	UPSF01	Fillets with Skin	< 0.000503	0.000503	< 0.0000990	0.0000990
	LAAE01	Fillets without Skin	< 0.000263	0.000263	< 0.0000970	0.0000970
	LABC01	Fillets without Skin	< 0.000462	0.000462	< 0.000102	0.000102
	LACC01	Fillets without Skin	0.000659	0.000443	0.000143	0.0000960
	LPAE01	Fillets without Skin	< 0.000306	0.000306	< 0.000103	0.000103

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 0.000365	0.000365	< 0.000101	0.000101
	LPBC01	Fillets without Skin	< 0.000458	0.000458	< 0.0000970	0.0000970
	LPBC02	Fillets without Skin	< 0.000535	0.000535	< 0.0000910	0.0000910
	LPBC03	Fillets without Skin	< 0.000424	0.000424	< 0.0000900	0.0000900
	LPBC04	Fillets without Skin	< 0.000444	0.000444	< 0.000104	0.000104
	LPCC01	Fillets without Skin	< 0.000545	0.000545	< 0.000104	0.000104
	UAAE01	Fillets without Skin	< 0.000259	0.000259	< 0.0000970	0.0000970
	UABC01	Fillets without Skin	< 0.000474	0.000474	< 0.0000990	0.0000990
	UACC01	Fillets without Skin	0.000781	0.000415	0.000179	0.0000950
	UPAE01	Fillets without Skin	< 0.000273	0.000273	< 0.0000920	0.0000920
	UPCC01	Fillets without Skin	< 0.000473	0.000473	< 0.000102	0.000102
	UPCC02	Fillets without Skin	< 0.000483	0.000483	< 0.000102	0.000102
	UPCC101	Fillets without Skin	< 0.000464	0.000464	< 0.000102	0.000102
	UPCC102	Fillets without Skin	< 0.000478	0.000478	< 0.000102	0.000102
	UPCC103	Fillets without Skin	< 0.000426	0.000426	< 0.000103	0.000103
BDE# 1						
	LACA01	Fillets with Skin	0.0402	0.0214	0.0112	0.00596
	LALB01	Fillets with Skin	< 0.0237	0.0237	< 0.00491	0.00491

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LASF01	Fillets with Skin	0.0518	0.0308	0.0103	0.00613
	LPCA01	Fillets with Skin	< 0.0256	0.0256	< 0.00604	0.00604
	LPLB01	Fillets with Skin	< 0.0273	0.0273	< 0.00625	0.00625
	LPSB01	Fillets with Skin	< 0.0325	0.0325	< 0.00637	0.00637
	LPSF01	Fillets with Skin	< 0.0365	0.0365	< 0.00622	0.00622
	UACA01	Fillets with Skin	0.0352	0.0176	0.00980	0.00492
	UALB01	Fillets with Skin	0.0359	0.0277	0.00800	0.00618
	UASF01	Fillets with Skin	0.0423	0.0258	0.00870	0.00532
	UPCA01	Fillets with Skin	< 0.0194	0.0194	< 0.00566	0.00566
	UPLB01	Fillets with Skin	< 0.0313	0.0313	< 0.00640	0.00640
	UPSF01	Fillets with Skin	< 0.0312	0.0312	< 0.00611	0.00611
	LAAE01	Fillets without Skin	0.0290	0.0152	0.0107	0.00560
	LABC01	Fillets without Skin	0.0464	0.0221	0.0102	0.00487
	LACC01	Fillets without Skin	0.0466	0.0293	0.0101	0.00635
	LPAE01	Fillets without Skin	< 0.0183	0.0183	< 0.00616	0.00616
	LPAE02	Fillets without Skin	< 0.0203	0.0203	< 0.00565	0.00565
	LPBC01	Fillets without Skin	< 0.0267	0.0267	< 0.00567	0.00567
	LPBC02	Fillets without Skin	< 0.0307	0.0307	< 0.00521	0.00521
	LPBC03	Fillets without Skin	< 0.0287	0.0287	< 0.00607	0.00607
	LPBC04	Fillets without Skin	< 0.0247	0.0247	< 0.00577	0.00577
	LPCC01	Fillets without Skin	< 0.0320	0.0320	< 0.00612	0.00612
	UAAE01	Fillets without	0.0397	0.0171	0.0149	0.00641

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.0748	0.0279	0.0157	0.00586
	UACC01	Fillets without Skin	0.0663	0.0276	0.0152	0.00633
	UPAE01	Fillets without Skin	< 0.0180	0.0180	< 0.00606	0.00606
	UPCC01	Fillets without Skin	< 0.0262	0.0262	< 0.00565	0.00565
	UPCC02	Fillets without Skin	0.0540	0.0278	0.0114	0.00587
	UPCC101	Fillets without Skin	0.0356	0.0284	0.00780	0.00621
	UPCC102	Fillets without Skin	0.0496	0.0265	0.0106	0.00567
	UPCC103	Fillets without Skin	0.0278	0.0236	0.00670	0.00570
BDE# 10						
	LACA01	Fillets with Skin	< 0.0214	0.0214	< 0.00596	0.00596
	LALB01	Fillets with Skin	< 0.0237	0.0237	< 0.00491	0.00491
	LASF01	Fillets with Skin	< 0.0308	0.0308	< 0.00613	0.00613
	LPCA01	Fillets with Skin	< 0.0256	0.0256	< 0.00604	0.00604
	LPLB01	Fillets with Skin	< 0.0273	0.0273	< 0.00625	0.00625
	LPSB01	Fillets with Skin	< 0.0325	0.0325	< 0.00637	0.00637
	LPSF01	Fillets with Skin	< 0.0365	0.0365	< 0.00622	0.00622
	UACA01	Fillets with Skin	< 0.0176	0.0176	< 0.00492	0.00492
	UALB01	Fillets with Skin	< 0.0277	0.0277	< 0.00618	0.00618
	UASF01	Fillets with Skin	< 0.0258	0.0258	< 0.00532	0.00532
	UPCA01	Fillets with Skin	< 0.0194	0.0194	< 0.00566	0.00566
	UPLB01	Fillets with Skin	< 0.0313	0.0313	< 0.00640	0.00640
	UPSF01	Fillets with Skin	< 0.0312	0.0312	< 0.00611	0.00611

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	< 0.0152	0.0152	< 0.00560	0.00560
	LABC01	Fillets without Skin	< 0.0221	0.0221	< 0.00487	0.00487
	LACC01	Fillets without Skin	< 0.0293	0.0293	< 0.00635	0.00635
	LPAE01	Fillets without Skin	< 0.0183	0.0183	< 0.00616	0.00616
	LPAE02	Fillets without Skin	< 0.0203	0.0203	< 0.00565	0.00565
	LPBC01	Fillets without Skin	< 0.0267	0.0267	< 0.00567	0.00567
	LPBC02	Fillets without Skin	< 0.0307	0.0307	< 0.00521	0.00521
	LPBC03	Fillets without Skin	< 0.0287	0.0287	< 0.00607	0.00607
	LPBC04	Fillets without Skin	< 0.0247	0.0247	< 0.00577	0.00577
	LPCC01	Fillets without Skin	< 0.0320	0.0320	< 0.00612	0.00612
	UAAE01	Fillets without Skin	< 0.0171	0.0171	< 0.00641	0.00641
	UABC01	Fillets without Skin	< 0.0279	0.0279	< 0.00586	0.00586
	UACC01	Fillets without Skin	< 0.0276	0.0276	< 0.00633	0.00633
	UPAE01	Fillets without Skin	< 0.0180	0.0180	< 0.00606	0.00606
	UPCC01	Fillets without Skin	< 0.0262	0.0262	< 0.00565	0.00565
	UPCC02	Fillets without Skin	< 0.0278	0.0278	< 0.00587	0.00587
	UPCC101	Fillets without Skin	< 0.0284	0.0284	< 0.00621	0.00621

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	< 0.0265	0.0265	< 0.00567	0.00567
	UPCC103	Fillets without Skin	< 0.0236	0.0236	< 0.00570	0.00570
BDE# 100						
	LACA01	Fillets with Skin	0.0337	0.0152	0.00940	0.00423
	LALB01	Fillets with Skin	< 0.0168	0.0168	< 0.00348	0.00348
	LASF01	Fillets with Skin	< 0.0219	0.0219	< 0.00435	0.00435
	LPCA01	Fillets with Skin	< 0.0182	0.0182	< 0.00428	0.00428
	LPLB01	Fillets with Skin	< 0.0194	0.0194	< 0.00443	0.00443
	LPSB01	Fillets with Skin	< 0.0231	0.0231	< 0.00452	0.00452
	LPSF01	Fillets with Skin	< 0.0259	0.0259	< 0.00442	0.00442
	UACA01	Fillets with Skin	0.0344	0.0125	0.00960	0.00349
	UALB01	Fillets with Skin	< 0.0196	0.0196	< 0.00438	0.00438
	UASF01	Fillets with Skin	< 0.0183	0.0183	< 0.00378	0.00378
	UPCA01	Fillets with Skin	0.0251	0.0138	0.00730	0.00401
	UPLB01	Fillets with Skin	< 0.0222	0.0222	< 0.00454	0.00454
	UPSF01	Fillets with Skin	< 0.0221	0.0221	< 0.00433	0.00433
	LAAE01	Fillets without Skin	0.0388	0.0108	0.0143	0.00397
	LABC01	Fillets without Skin	0.0741	0.0157	0.0163	0.00346
	LACC01	Fillets without Skin	0.0794	0.0208	0.0172	0.00450
	LPAE01	Fillets without Skin	< 0.0130	0.0130	< 0.00438	0.00438
	LPAE02	Fillets without Skin	0.0313	0.0144	0.00870	0.00401
	LPBC01	Fillets without Skin	< 0.0190	0.0190	< 0.00402	0.00402
	LPBC02	Fillets without Skin	0.0401	0.0218	0.00680	0.00370

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	0.0415	0.0203	0.00880	0.00431
	LPBC04	Fillets without Skin	< 0.0175	0.0175	< 0.00409	0.00409
	LPCC01	Fillets without Skin	0.0241	0.0227	0.00460	0.00434
	UAAE01	Fillets without Skin	0.0496	0.0121	0.0186	0.00455
	UABC01	Fillets without Skin	0.0553	0.0198	0.0116	0.00416
	UACC01	Fillets without Skin	0.0868	0.0196	0.0199	0.00450
	UPAE01	Fillets without Skin	< 0.0128	0.0128	< 0.00430	0.00430
	UPCC01	Fillets without Skin	0.0297	0.0186	0.00640	0.00401
	UPCC02	Fillets without Skin	0.0270	0.0197	0.00570	0.00417
	UPCC101	Fillets without Skin	0.0365	0.0201	0.00800	0.00441
	UPCC102	Fillets without Skin	0.0595	0.0188	0.0127	0.00402
	UPCC103	Fillets without Skin	0.0469	0.0168	0.0113	0.00404
BDE# 11						
	LACA01	Fillets with Skin	< 0.0214	0.0214	< 0.00596	0.00596
	LALB01	Fillets with Skin	< 0.0237	0.0237	< 0.00491	0.00491
	LASF01	Fillets with Skin	< 0.0308	0.0308	< 0.00613	0.00613
	LPCA01	Fillets with Skin	< 0.0256	0.0256	< 0.00604	0.00604
	LPLB01	Fillets with Skin	< 0.0273	0.0273	< 0.00625	0.00625
	LPSB01	Fillets with Skin	< 0.0325	0.0325	< 0.00637	0.00637
	LPSF01	Fillets with Skin	< 0.0365	0.0365	< 0.00622	0.00622
	UACA01	Fillets with Skin	< 0.0176	0.0176	< 0.00492	0.00492

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	< 0.0277	0.0277	< 0.00618	0.00618
	UASF01	Fillets with Skin	< 0.0258	0.0258	< 0.00532	0.00532
	UPCA01	Fillets with Skin	< 0.0194	0.0194	< 0.00566	0.00566
	UPLB01	Fillets with Skin	< 0.0313	0.0313	< 0.00640	0.00640
	UPSF01	Fillets with Skin	< 0.0312	0.0312	< 0.00611	0.00611
	LAAE01	Fillets without Skin	< 0.0152	0.0152	< 0.00560	0.00560
	LABC01	Fillets without Skin	< 0.0221	0.0221	< 0.00487	0.00487
	LACC01	Fillets without Skin	< 0.0293	0.0293	< 0.00635	0.00635
	LPAE01	Fillets without Skin	< 0.0183	0.0183	< 0.00616	0.00616
	LPAE02	Fillets without Skin	< 0.0203	0.0203	< 0.00565	0.00565
	LPBC01	Fillets without Skin	< 0.0267	0.0267	< 0.00567	0.00567
	LPBC02	Fillets without Skin	< 0.0307	0.0307	< 0.00521	0.00521
	LPBC03	Fillets without Skin	< 0.0287	0.0287	< 0.00607	0.00607
	LPBC04	Fillets without Skin	< 0.0247	0.0247	< 0.00577	0.00577
	LPCC01	Fillets without Skin	< 0.0320	0.0320	< 0.00612	0.00612
	UAAE01	Fillets without Skin	< 0.0171	0.0171	< 0.00641	0.00641
	UABC01	Fillets without Skin	< 0.0279	0.0279	< 0.00586	0.00586
	UACC01	Fillets without Skin	< 0.0276	0.0276	< 0.00633	0.00633
	UPAE01	Fillets without Skin	< 0.0180	0.0180	< 0.00606	0.00606

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	< 0.0262	0.0262	< 0.00565	0.00565
	UPCC02	Fillets without Skin	< 0.0278	0.0278	< 0.00587	0.00587
	UPCC101	Fillets without Skin	< 0.0284	0.0284	< 0.00621	0.00621
	UPCC102	Fillets without Skin	< 0.0265	0.0265	< 0.00567	0.00567
	UPCC103	Fillets without Skin	< 0.0236	0.0236	< 0.00570	0.00570
BDE# 116						
	LACA01	Fillets with Skin	< 0.0152	0.0152	< 0.00423	0.00423
	LALB01	Fillets with Skin	< 0.0168	0.0168	< 0.00348	0.00348
	LASF01	Fillets with Skin	< 0.0219	0.0219	< 0.00435	0.00435
	LPCA01	Fillets with Skin	< 0.0182	0.0182	< 0.00428	0.00428
	LPLB01	Fillets with Skin	< 0.0194	0.0194	< 0.00443	0.00443
	LPSB01	Fillets with Skin	< 0.0231	0.0231	< 0.00452	0.00452
	LPSF01	Fillets with Skin	< 0.0259	0.0259	< 0.00442	0.00442
	UACA01	Fillets with Skin	< 0.0125	0.0125	< 0.00349	0.00349
	UALB01	Fillets with Skin	< 0.0196	0.0196	< 0.00438	0.00438
	UASF01	Fillets with Skin	< 0.0183	0.0183	< 0.00378	0.00378
	UPCA01	Fillets with Skin	< 0.0138	0.0138	< 0.00401	0.00401
	UPLB01	Fillets with Skin	< 0.0222	0.0222	< 0.00454	0.00454
	UPSF01	Fillets with Skin	< 0.0221	0.0221	< 0.00433	0.00433
	LAAE01	Fillets without Skin	< 0.0108	0.0108	< 0.00397	0.00397
	LABC01	Fillets without Skin	< 0.0157	0.0157	< 0.00346	0.00346
	LACC01	Fillets without Skin	< 0.0208	0.0208	< 0.00450	0.00450
	LPAE01	Fillets without Skin	< 0.0130	0.0130	< 0.00438	0.00438

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 0.0144	0.0144	< 0.00401	0.00401
	LPBC01	Fillets without Skin	< 0.0190	0.0190	< 0.00402	0.00402
	LPBC02	Fillets without Skin	< 0.0218	0.0218	< 0.00370	0.00370
	LPBC03	Fillets without Skin	< 0.0203	0.0203	< 0.00431	0.00431
	LPBC04	Fillets without Skin	< 0.0175	0.0175	< 0.00409	0.00409
	LPCC01	Fillets without Skin	< 0.0227	0.0227	< 0.00434	0.00434
	UAAE01	Fillets without Skin	< 0.0121	0.0121	< 0.00455	0.00455
	UABC01	Fillets without Skin	< 0.0198	0.0198	< 0.00416	0.00416
	UACC01	Fillets without Skin	< 0.0196	0.0196	< 0.00450	0.00450
	UPAE01	Fillets without Skin	< 0.0128	0.0128	< 0.00430	0.00430
	UPCC01	Fillets without Skin	< 0.0186	0.0186	< 0.00401	0.00401
	UPCC02	Fillets without Skin	< 0.0197	0.0197	< 0.00417	0.00417
	UPCC101	Fillets without Skin	< 0.0201	0.0201	< 0.00441	0.00441
	UPCC102	Fillets without Skin	< 0.0188	0.0188	< 0.00402	0.00402
	UPCC103	Fillets without Skin	< 0.0168	0.0168	< 0.00404	0.00404
BDE# 118						
	LACA01	Fillets with Skin	< 0.0152	0.0152	< 0.00423	0.00423
	LALB01	Fillets with Skin	< 0.0168	0.0168	< 0.00348	0.00348

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LASF01	Fillets with Skin	< 0.0219	0.0219	< 0.00435	0.00435
	LPCA01	Fillets with Skin	< 0.0182	0.0182	< 0.00428	0.00428
	LPLB01	Fillets with Skin	< 0.0194	0.0194	< 0.00443	0.00443
	LPSB01	Fillets with Skin	< 0.0231	0.0231	< 0.00452	0.00452
	LPSF01	Fillets with Skin	< 0.0259	0.0259	< 0.00442	0.00442
	UACA01	Fillets with Skin	< 0.0125	0.0125	< 0.00349	0.00349
	UALB01	Fillets with Skin	< 0.0196	0.0196	< 0.00438	0.00438
	UASF01	Fillets with Skin	< 0.0183	0.0183	< 0.00378	0.00378
	UPCA01	Fillets with Skin	< 0.0138	0.0138	< 0.00401	0.00401
	UPLB01	Fillets with Skin	< 0.0222	0.0222	< 0.00454	0.00454
	UPSF01	Fillets with Skin	< 0.0221	0.0221	< 0.00433	0.00433
	LAAE01	Fillets without Skin	< 0.0108	0.0108	< 0.00397	0.00397
	LABC01	Fillets without Skin	< 0.0157	0.0157	< 0.00346	0.00346
	LACC01	Fillets without Skin	< 0.0208	0.0208	< 0.00450	0.00450
	LPAE01	Fillets without Skin	< 0.0130	0.0130	< 0.00438	0.00438
	LPAE02	Fillets without Skin	< 0.0144	0.0144	< 0.00401	0.00401
	LPBC01	Fillets without Skin	< 0.0190	0.0190	< 0.00402	0.00402
	LPBC02	Fillets without Skin	< 0.0218	0.0218	< 0.00370	0.00370
	LPBC03	Fillets without Skin	< 0.0203	0.0203	< 0.00431	0.00431
	LPBC04	Fillets without Skin	< 0.0175	0.0175	< 0.00409	0.00409
	LPCC01	Fillets without Skin	< 0.0227	0.0227	< 0.00434	0.00434
	UAAE01	Fillets without	< 0.0121	0.0121	< 0.00455	0.00455

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	< 0.0198	0.0198	< 0.00416	0.00416
	UACC01	Fillets without Skin	< 0.0196	0.0196	< 0.00450	0.00450
	UPAE01	Fillets without Skin	< 0.0128	0.0128	< 0.00430	0.00430
	UPCC01	Fillets without Skin	< 0.0186	0.0186	< 0.00401	0.00401
	UPCC02	Fillets without Skin	< 0.0197	0.0197	< 0.00417	0.00417
	UPCC101	Fillets without Skin	< 0.0201	0.0201	< 0.00441	0.00441
	UPCC102	Fillets without Skin	< 0.0188	0.0188	< 0.00402	0.00402
	UPCC103	Fillets without Skin	< 0.0168	0.0168	< 0.00404	0.00404
BDE# 119						
	LACA01	Fillets with Skin	< 0.0152	0.0152	< 0.00423	0.00423
	LALB01	Fillets with Skin	< 0.0168	0.0168	< 0.00348	0.00348
	LASF01	Fillets with Skin	< 0.0219	0.0219	< 0.00435	0.00435
	LPCA01	Fillets with Skin	< 0.0182	0.0182	< 0.00428	0.00428
	LPLB01	Fillets with Skin	< 0.0194	0.0194	< 0.00443	0.00443
	LPSB01	Fillets with Skin	< 0.0231	0.0231	< 0.00452	0.00452
	LPSF01	Fillets with Skin	< 0.0259	0.0259	< 0.00442	0.00442
	UACA01	Fillets with Skin	< 0.0125	0.0125	< 0.00349	0.00349
	UALB01	Fillets with Skin	< 0.0196	0.0196	< 0.00438	0.00438
	UASF01	Fillets with Skin	< 0.0183	0.0183	< 0.00378	0.00378
	UPCA01	Fillets with Skin	< 0.0138	0.0138	< 0.00401	0.00401
	UPLB01	Fillets with Skin	< 0.0222	0.0222	< 0.00454	0.00454
	UPSF01	Fillets with Skin	< 0.0221	0.0221	< 0.00433	0.00433

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	< 0.0108	0.0108	< 0.00397	0.00397
	LABC01	Fillets without Skin	< 0.0157	0.0157	< 0.00346	0.00346
	LACC01	Fillets without Skin	< 0.0208	0.0208	< 0.00450	0.00450
	LPAE01	Fillets without Skin	< 0.0130	0.0130	< 0.00438	0.00438
	LPAE02	Fillets without Skin	< 0.0144	0.0144	< 0.00401	0.00401
	LPBC01	Fillets without Skin	< 0.0190	0.0190	< 0.00402	0.00402
	LPBC02	Fillets without Skin	< 0.0218	0.0218	< 0.00370	0.00370
	LPBC03	Fillets without Skin	< 0.0203	0.0203	< 0.00431	0.00431
	LPBC04	Fillets without Skin	< 0.0175	0.0175	< 0.00409	0.00409
	LPCC01	Fillets without Skin	< 0.0227	0.0227	< 0.00434	0.00434
	UAAE01	Fillets without Skin	< 0.0121	0.0121	< 0.00455	0.00455
	UABC01	Fillets without Skin	< 0.0198	0.0198	< 0.00416	0.00416
	UACC01	Fillets without Skin	< 0.0196	0.0196	< 0.00450	0.00450
	UPAE01	Fillets without Skin	< 0.0128	0.0128	< 0.00430	0.00430
	UPCC01	Fillets without Skin	< 0.0186	0.0186	< 0.00401	0.00401
	UPCC02	Fillets without Skin	< 0.0197	0.0197	< 0.00417	0.00417
	UPCC101	Fillets without Skin	< 0.0201	0.0201	< 0.00441	0.00441

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	< 0.0188	0.0188	< 0.00402	0.00402
	UPCC103	Fillets without Skin	< 0.0168	0.0168	< 0.00404	0.00404
BDE# 12						
	LACA01	Fillets with Skin	< 0.0214	0.0214	< 0.00596	0.00596
	LALB01	Fillets with Skin	< 0.0237	0.0237	< 0.00491	0.00491
	LASF01	Fillets with Skin	< 0.0308	0.0308	< 0.00613	0.00613
	LPCA01	Fillets with Skin	< 0.0256	0.0256	< 0.00604	0.00604
	LPLB01	Fillets with Skin	< 0.0273	0.0273	< 0.00625	0.00625
	LPSB01	Fillets with Skin	< 0.0325	0.0325	< 0.00637	0.00637
	LPSF01	Fillets with Skin	< 0.0365	0.0365	< 0.00622	0.00622
	UACA01	Fillets with Skin	< 0.0176	0.0176	< 0.00492	0.00492
	UALB01	Fillets with Skin	< 0.0277	0.0277	< 0.00618	0.00618
	UASF01	Fillets with Skin	< 0.0258	0.0258	< 0.00532	0.00532
	UPCA01	Fillets with Skin	< 0.0194	0.0194	< 0.00566	0.00566
	UPLB01	Fillets with Skin	< 0.0313	0.0313	< 0.00640	0.00640
	UPSF01	Fillets with Skin	< 0.0312	0.0312	< 0.00611	0.00611
	LAAE01	Fillets without Skin	< 0.0152	0.0152	< 0.00560	0.00560
	LABC01	Fillets without Skin	< 0.0221	0.0221	< 0.00487	0.00487
	LACC01	Fillets without Skin	< 0.0293	0.0293	< 0.00635	0.00635
	LPAE01	Fillets without Skin	< 0.0183	0.0183	< 0.00616	0.00616
	LPAE02	Fillets without Skin	< 0.0203	0.0203	< 0.00565	0.00565
	LPBC01	Fillets without Skin	< 0.0267	0.0267	< 0.00567	0.00567
	LPBC02	Fillets without Skin	< 0.0307	0.0307	< 0.00521	0.00521

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	< 0.0287	0.0287	< 0.00607	0.00607
	LPBC04	Fillets without Skin	< 0.0247	0.0247	< 0.00577	0.00577
	LPCC01	Fillets without Skin	< 0.0320	0.0320	< 0.00612	0.00612
	UAAE01	Fillets without Skin	< 0.0171	0.0171	< 0.00641	0.00641
	UABC01	Fillets without Skin	< 0.0279	0.0279	< 0.00586	0.00586
	UACC01	Fillets without Skin	< 0.0276	0.0276	< 0.00633	0.00633
	UPAE01	Fillets without Skin	< 0.0180	0.0180	< 0.00606	0.00606
	UPCC01	Fillets without Skin	< 0.0262	0.0262	< 0.00565	0.00565
	UPCC02	Fillets without Skin	< 0.0278	0.0278	< 0.00587	0.00587
	UPCC101	Fillets without Skin	< 0.0284	0.0284	< 0.00621	0.00621
	UPCC102	Fillets without Skin	< 0.0265	0.0265	< 0.00567	0.00567
	UPCC103	Fillets without Skin	< 0.0236	0.0236	< 0.00570	0.00570
BDE# 126						
	LACA01	Fillets with Skin	< 0.0152	0.0152	< 0.00423	0.00423
	LALB01	Fillets with Skin	< 0.0168	0.0168	< 0.00348	0.00348
	LASF01	Fillets with Skin	< 0.0219	0.0219	< 0.00435	0.00435
	LPCA01	Fillets with Skin	< 0.0182	0.0182	< 0.00428	0.00428
	LPLB01	Fillets with Skin	< 0.0194	0.0194	< 0.00443	0.00443
	LPSB01	Fillets with Skin	< 0.0231	0.0231	< 0.00452	0.00452
	LPSF01	Fillets with Skin	< 0.0259	0.0259	< 0.00442	0.00442
	UACA01	Fillets with Skin	< 0.0125	0.0125	< 0.00349	0.00349

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	< 0.0196	0.0196	< 0.00438	0.00438
	UASF01	Fillets with Skin	< 0.0183	0.0183	< 0.00378	0.00378
	UPCA01	Fillets with Skin	< 0.0138	0.0138	< 0.00401	0.00401
	UPLB01	Fillets with Skin	< 0.0222	0.0222	< 0.00454	0.00454
	UPSF01	Fillets with Skin	< 0.0221	0.0221	< 0.00433	0.00433
	LAAE01	Fillets without Skin	< 0.0108	0.0108	< 0.00397	0.00397
	LABC01	Fillets without Skin	< 0.0157	0.0157	< 0.00346	0.00346
	LACC01	Fillets without Skin	< 0.0208	0.0208	< 0.00450	0.00450
	LPAE01	Fillets without Skin	< 0.0130	0.0130	< 0.00438	0.00438
	LPAE02	Fillets without Skin	< 0.0144	0.0144	< 0.00401	0.00401
	LPBC01	Fillets without Skin	< 0.0190	0.0190	< 0.00402	0.00402
	LPBC02	Fillets without Skin	< 0.0218	0.0218	< 0.00370	0.00370
	LPBC03	Fillets without Skin	< 0.0203	0.0203	< 0.00431	0.00431
	LPBC04	Fillets without Skin	< 0.0175	0.0175	< 0.00409	0.00409
	LPCC01	Fillets without Skin	< 0.0227	0.0227	< 0.00434	0.00434
	UAAE01	Fillets without Skin	< 0.0121	0.0121	< 0.00455	0.00455
	UABC01	Fillets without Skin	< 0.0198	0.0198	< 0.00416	0.00416
	UACC01	Fillets without Skin	< 0.0196	0.0196	< 0.00450	0.00450
	UPAE01	Fillets without Skin	< 0.0128	0.0128	< 0.00430	0.00430

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	< 0.0186	0.0186	< 0.00401	0.00401
	UPCC02	Fillets without Skin	< 0.0197	0.0197	< 0.00417	0.00417
	UPCC101	Fillets without Skin	< 0.0201	0.0201	< 0.00441	0.00441
	UPCC102	Fillets without Skin	< 0.0188	0.0188	< 0.00402	0.00402
	UPCC103	Fillets without Skin	< 0.0168	0.0168	< 0.00404	0.00404
BDE# 13						
	LACA01	Fillets with Skin	< 0.0214	0.0214	< 0.00596	0.00596
	LALB01	Fillets with Skin	< 0.0237	0.0237	< 0.00491	0.00491
	LASF01	Fillets with Skin	< 0.0308	0.0308	< 0.00613	0.00613
	LPCA01	Fillets with Skin	< 0.0256	0.0256	< 0.00604	0.00604
	LPLB01	Fillets with Skin	< 0.0273	0.0273	< 0.00625	0.00625
	LPSB01	Fillets with Skin	< 0.0325	0.0325	< 0.00637	0.00637
	LPSF01	Fillets with Skin	< 0.0365	0.0365	< 0.00622	0.00622
	UACA01	Fillets with Skin	< 0.0176	0.0176	< 0.00492	0.00492
	UALB01	Fillets with Skin	< 0.0277	0.0277	< 0.00618	0.00618
	UASF01	Fillets with Skin	< 0.0258	0.0258	< 0.00532	0.00532
	UPCA01	Fillets with Skin	< 0.0194	0.0194	< 0.00566	0.00566
	UPLB01	Fillets with Skin	< 0.0313	0.0313	< 0.00640	0.00640
	UPSF01	Fillets with Skin	< 0.0312	0.0312	< 0.00611	0.00611
	LAAE01	Fillets without Skin	< 0.0152	0.0152	< 0.00560	0.00560
	LABC01	Fillets without Skin	< 0.0221	0.0221	< 0.00487	0.00487
	LACC01	Fillets without Skin	< 0.0293	0.0293	< 0.00635	0.00635
	LPAE01	Fillets without Skin	< 0.0183	0.0183	< 0.00616	0.00616

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 0.0203	0.0203	< 0.00565	0.00565
	LPBC01	Fillets without Skin	< 0.0267	0.0267	< 0.00567	0.00567
	LPBC02	Fillets without Skin	< 0.0307	0.0307	< 0.00521	0.00521
	LPBC03	Fillets without Skin	< 0.0287	0.0287	< 0.00607	0.00607
	LPBC04	Fillets without Skin	< 0.0247	0.0247	< 0.00577	0.00577
	LPCC01	Fillets without Skin	< 0.0320	0.0320	< 0.00612	0.00612
	UAAE01	Fillets without Skin	< 0.0171	0.0171	< 0.00641	0.00641
	UABC01	Fillets without Skin	< 0.0279	0.0279	< 0.00586	0.00586
	UACC01	Fillets without Skin	< 0.0276	0.0276	< 0.00633	0.00633
	UPAE01	Fillets without Skin	< 0.0180	0.0180	< 0.00606	0.00606
	UPCC01	Fillets without Skin	< 0.0262	0.0262	< 0.00565	0.00565
	UPCC02	Fillets without Skin	< 0.0278	0.0278	< 0.00587	0.00587
	UPCC101	Fillets without Skin	< 0.0284	0.0284	< 0.00621	0.00621
	UPCC102	Fillets without Skin	< 0.0265	0.0265	< 0.00567	0.00567
	UPCC103	Fillets without Skin	< 0.0236	0.0236	< 0.00570	0.00570
BDE# 138						
	LACA01	Fillets with Skin	< 0.0266	0.0266	< 0.00742	0.00742
	LALB01	Fillets with Skin	< 0.0296	0.0296	< 0.00611	0.00611

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LASF01	Fillets with Skin	< 0.0384	0.0384	< 0.00764	0.00764
	LPCA01	Fillets with Skin	< 0.0319	0.0319	< 0.00752	0.00752
	LPLB01	Fillets with Skin	< 0.0340	0.0340	< 0.00778	0.00778
	LPSB01	Fillets with Skin	< 0.0405	0.0405	< 0.00794	0.00794
	LPSF01	Fillets with Skin	< 0.0455	0.0455	< 0.00776	0.00776
	UACA01	Fillets with Skin	< 0.0220	0.0220	< 0.00612	0.00612
	UALB01	Fillets with Skin	< 0.0345	0.0345	< 0.00770	0.00770
	UASF01	Fillets with Skin	< 0.0322	0.0322	< 0.00663	0.00663
	UPCA01	Fillets with Skin	< 0.0242	0.0242	< 0.00705	0.00705
	UPLB01	Fillets with Skin	< 0.0390	0.0390	< 0.00797	0.00797
	UPSF01	Fillets with Skin	< 0.0388	0.0388	< 0.00761	0.00761
	LAAE01	Fillets without Skin	< 0.0189	0.0189	< 0.00697	0.00697
	LABC01	Fillets without Skin	< 0.0276	0.0276	< 0.00607	0.00607
	LACC01	Fillets without Skin	< 0.0365	0.0365	< 0.00791	0.00791
	LPAE01	Fillets without Skin	< 0.0228	0.0228	< 0.00768	0.00768
	LPAE02	Fillets without Skin	< 0.0253	0.0253	< 0.00704	0.00704
	LPBC01	Fillets without Skin	< 0.0333	0.0333	< 0.00706	0.00706
	LPBC02	Fillets without Skin	< 0.0383	0.0383	< 0.00649	0.00649
	LPBC03	Fillets without Skin	< 0.0357	0.0357	< 0.00756	0.00756
	LPBC04	Fillets without Skin	< 0.0308	0.0308	< 0.00719	0.00719
	LPCC01	Fillets without Skin	< 0.0399	0.0399	< 0.00762	0.00762
	UAAE01	Fillets without	< 0.0213	0.0213	< 0.00799	0.00799

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	< 0.0348	0.0348	< 0.00730	0.00730
	UACC01	Fillets without Skin	< 0.0344	0.0344	< 0.00789	0.00789
	UPAE01	Fillets without Skin	< 0.0225	0.0225	< 0.00755	0.00755
	UPCC01	Fillets without Skin	< 0.0327	0.0327	< 0.00704	0.00704
	UPCC02	Fillets without Skin	< 0.0347	0.0347	< 0.00732	0.00732
	UPCC101	Fillets without Skin	< 0.0353	0.0353	< 0.00774	0.00774
	UPCC102	Fillets without Skin	< 0.0331	0.0331	< 0.00706	0.00706
	UPCC103	Fillets without Skin	< 0.0294	0.0294	< 0.00710	0.00710
BDE# 15						
	LACA01	Fillets with Skin	< 0.0214	0.0214	< 0.00596	0.00596
	LALB01	Fillets with Skin	< 0.0237	0.0237	< 0.00491	0.00491
	LASF01	Fillets with Skin	< 0.0308	0.0308	< 0.00613	0.00613
	LPCA01	Fillets with Skin	< 0.0256	0.0256	< 0.00604	0.00604
	LPLB01	Fillets with Skin	< 0.0273	0.0273	< 0.00625	0.00625
	LPSB01	Fillets with Skin	< 0.0325	0.0325	< 0.00637	0.00637
	LPSF01	Fillets with Skin	< 0.0365	0.0365	< 0.00622	0.00622
	UACA01	Fillets with Skin	< 0.0176	0.0176	< 0.00492	0.00492
	UALB01	Fillets with Skin	< 0.0277	0.0277	< 0.00618	0.00618
	UASF01	Fillets with Skin	< 0.0258	0.0258	< 0.00532	0.00532
	UPCA01	Fillets with Skin	< 0.0194	0.0194	< 0.00566	0.00566
	UPLB01	Fillets with Skin	< 0.0313	0.0313	< 0.00640	0.00640
	UPSF01	Fillets with Skin	< 0.0312	0.0312	< 0.00611	0.00611

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	< 0.0152	0.0152	< 0.00560	0.00560
	LABC01	Fillets without Skin	< 0.0221	0.0221	< 0.00487	0.00487
	LACC01	Fillets without Skin	< 0.0293	0.0293	< 0.00635	0.00635
	LPAE01	Fillets without Skin	< 0.0183	0.0183	< 0.00616	0.00616
	LPAE02	Fillets without Skin	< 0.0203	0.0203	< 0.00565	0.00565
	LPBC01	Fillets without Skin	< 0.0267	0.0267	< 0.00567	0.00567
	LPBC02	Fillets without Skin	< 0.0307	0.0307	< 0.00521	0.00521
	LPBC03	Fillets without Skin	< 0.0287	0.0287	< 0.00607	0.00607
	LPBC04	Fillets without Skin	< 0.0247	0.0247	< 0.00577	0.00577
	LPCC01	Fillets without Skin	< 0.0320	0.0320	< 0.00612	0.00612
	UAAE01	Fillets without Skin	< 0.0171	0.0171	< 0.00641	0.00641
	UABC01	Fillets without Skin	< 0.0279	0.0279	< 0.00586	0.00586
	UACC01	Fillets without Skin	< 0.0276	0.0276	< 0.00633	0.00633
	UPAE01	Fillets without Skin	< 0.0180	0.0180	< 0.00606	0.00606
	UPCC01	Fillets without Skin	< 0.0262	0.0262	< 0.00565	0.00565
	UPCC02	Fillets without Skin	< 0.0278	0.0278	< 0.00587	0.00587
	UPCC101	Fillets without Skin	< 0.0284	0.0284	< 0.00621	0.00621

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	< 0.0265	0.0265	< 0.00567	0.00567
	UPCC103	Fillets without Skin	< 0.0236	0.0236	< 0.00570	0.00570
BDE# 153						
	LACA01	Fillets with Skin	< 0.0144	0.0144	< 0.00401	0.00401
	LALB01	Fillets with Skin	< 0.0160	0.0160	< 0.00330	0.00330
	LASF01	Fillets with Skin	< 0.0207	0.0207	< 0.00413	0.00413
	LPCA01	Fillets with Skin	< 0.0172	0.0172	< 0.00407	0.00407
	LPLB01	Fillets with Skin	< 0.0184	0.0184	< 0.00421	0.00421
	LPSB01	Fillets with Skin	< 0.0219	0.0219	< 0.00429	0.00429
	LPSF01	Fillets with Skin	< 0.0246	0.0246	< 0.00419	0.00419
	UACA01	Fillets with Skin	< 0.0119	0.0119	< 0.00331	0.00331
	UALB01	Fillets with Skin	< 0.0186	0.0186	< 0.00416	0.00416
	UASF01	Fillets with Skin	< 0.0174	0.0174	< 0.00358	0.00358
	UPCA01	Fillets with Skin	< 0.0131	0.0131	< 0.00381	0.00381
	UPLB01	Fillets with Skin	< 0.0211	0.0211	< 0.00431	0.00431
	UPSF01	Fillets with Skin	< 0.0210	0.0210	< 0.00411	0.00411
	LAAE01	Fillets without Skin	< 0.0102	0.0102	< 0.00377	0.00377
	LABC01	Fillets without Skin	< 0.0149	0.0149	< 0.00328	0.00328
	LACC01	Fillets without Skin	0.0254	0.0197	0.00550	0.00427
	LPAE01	Fillets without Skin	0.0190	0.0123	0.00640	0.00415
	LPAE02	Fillets without Skin	< 0.0137	0.0137	< 0.00380	0.00380
	LPBC01	Fillets without Skin	< 0.0180	0.0180	< 0.00382	0.00382
	LPBC02	Fillets without Skin	< 0.0207	0.0207	< 0.00351	0.00351

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	< 0.0193	0.0193	< 0.00409	0.00409
	LPBC04	Fillets without Skin	< 0.0166	0.0166	< 0.00388	0.00388
	LPCC01	Fillets without Skin	< 0.0216	0.0216	< 0.00412	0.00412
	UAAE01	Fillets without Skin	0.0155	0.0115	0.00580	0.00432
	UABC01	Fillets without Skin	< 0.0188	0.0188	< 0.00395	0.00395
	UACC01	Fillets without Skin	0.0336	0.0186	0.00770	0.00426
	UPAE01	Fillets without Skin	< 0.0121	0.0121	< 0.00408	0.00408
	UPCC01	Fillets without Skin	< 0.0177	0.0177	< 0.00380	0.00380
	UPCC02	Fillets without Skin	< 0.0187	0.0187	< 0.00395	0.00395
	UPCC101	Fillets without Skin	< 0.0191	0.0191	< 0.00418	0.00418
	UPCC102	Fillets without Skin	< 0.0179	0.0179	< 0.00382	0.00382
	UPCC103	Fillets without Skin	< 0.0159	0.0159	< 0.00384	0.00384
BDE# 154						
	LACA01	Fillets with Skin	< 0.0171	0.0171	< 0.00476	0.00476
	LALB01	Fillets with Skin	< 0.0190	0.0190	< 0.00392	0.00392
	LASF01	Fillets with Skin	< 0.0246	0.0246	< 0.00489	0.00489
	LPCA01	Fillets with Skin	< 0.0204	0.0204	< 0.00482	0.00482
	LPLB01	Fillets with Skin	< 0.0218	0.0218	< 0.00499	0.00499
	LPSB01	Fillets with Skin	< 0.0259	0.0259	< 0.00509	0.00509
	LPSF01	Fillets with Skin	< 0.0291	0.0291	< 0.00497	0.00497
	UACA01	Fillets with Skin	0.0172	0.0141	0.00480	0.00392

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	< 0.0221	0.0221	< 0.00493	0.00493
	UASF01	Fillets with Skin	< 0.0206	0.0206	< 0.00425	0.00425
	UPCA01	Fillets with Skin	< 0.0155	0.0155	< 0.00452	0.00452
	UPLB01	Fillets with Skin	< 0.0250	0.0250	< 0.00511	0.00511
	UPSF01	Fillets with Skin	< 0.0249	0.0249	< 0.00488	0.00488
	LAAE01	Fillets without Skin	< 0.0121	0.0121	< 0.00447	0.00447
	LABC01	Fillets without Skin	< 0.0177	0.0177	< 0.00389	0.00389
	LACC01	Fillets without Skin	< 0.0234	0.0234	< 0.00507	0.00507
	LPAE01	Fillets without Skin	0.0202	0.0146	0.00680	0.00492
	LPAE02	Fillets without Skin	< 0.0162	0.0162	< 0.00451	0.00451
	LPBC01	Fillets without Skin	< 0.0213	0.0213	< 0.00452	0.00452
	LPBC02	Fillets without Skin	< 0.0245	0.0245	< 0.00416	0.00416
	LPBC03	Fillets without Skin	< 0.0229	0.0229	< 0.00485	0.00485
	LPBC04	Fillets without Skin	< 0.0197	0.0197	< 0.00460	0.00460
	LPCC01	Fillets without Skin	< 0.0256	0.0256	< 0.00488	0.00488
	UAAE01	Fillets without Skin	< 0.0136	0.0136	< 0.00512	0.00512
	UABC01	Fillets without Skin	< 0.0223	0.0223	< 0.00468	0.00468
	UACC01	Fillets without Skin	0.0288	0.0221	0.00660	0.00506
	UPAE01	Fillets without Skin	< 0.0144	0.0144	< 0.00484	0.00484

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	< 0.0209	0.0209	< 0.00451	0.00451
	UPCC02	Fillets without Skin	< 0.0222	0.0222	< 0.00469	0.00469
	UPCC101	Fillets without Skin	< 0.0226	0.0226	< 0.00496	0.00496
	UPCC102	Fillets without Skin	< 0.0212	0.0212	< 0.00452	0.00452
	UPCC103	Fillets without Skin	< 0.0189	0.0189	< 0.00455	0.00455
BDE# 155						
	LACA01	Fillets with Skin	< 0.0171	0.0171	< 0.00476	0.00476
	LALB01	Fillets with Skin	< 0.0190	0.0190	< 0.00392	0.00392
	LASF01	Fillets with Skin	< 0.0246	0.0246	< 0.00489	0.00489
	LPCA01	Fillets with Skin	< 0.0204	0.0204	< 0.00482	0.00482
	LPLB01	Fillets with Skin	< 0.0218	0.0218	< 0.00499	0.00499
	LPSB01	Fillets with Skin	< 0.0259	0.0259	< 0.00509	0.00509
	LPSF01	Fillets with Skin	< 0.0291	0.0291	< 0.00497	0.00497
	UACA01	Fillets with Skin	< 0.0141	0.0141	< 0.00392	0.00392
	UALB01	Fillets with Skin	< 0.0221	0.0221	< 0.00493	0.00493
	UASF01	Fillets with Skin	< 0.0206	0.0206	< 0.00425	0.00425
	UPCA01	Fillets with Skin	< 0.0155	0.0155	< 0.00452	0.00452
	UPLB01	Fillets with Skin	< 0.0250	0.0250	< 0.00511	0.00511
	UPSF01	Fillets with Skin	< 0.0249	0.0249	< 0.00488	0.00488
	LAAE01	Fillets without Skin	< 0.0121	0.0121	< 0.00447	0.00447
	LABC01	Fillets without Skin	< 0.0177	0.0177	< 0.00389	0.00389
	LACC01	Fillets without Skin	< 0.0234	0.0234	< 0.00507	0.00507
	LPAE01	Fillets without Skin	< 0.0146	0.0146	< 0.00492	0.00492

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 0.0162	0.0162	< 0.00451	0.00451
	LPBC01	Fillets without Skin	< 0.0213	0.0213	< 0.00452	0.00452
	LPBC02	Fillets without Skin	< 0.0245	0.0245	< 0.00416	0.00416
	LPBC03	Fillets without Skin	< 0.0229	0.0229	< 0.00485	0.00485
	LPBC04	Fillets without Skin	< 0.0197	0.0197	< 0.00460	0.00460
	LPCC01	Fillets without Skin	< 0.0256	0.0256	< 0.00488	0.00488
	UAAE01	Fillets without Skin	< 0.0136	0.0136	< 0.00512	0.00512
	UABC01	Fillets without Skin	< 0.0223	0.0223	< 0.00468	0.00468
	UACC01	Fillets without Skin	< 0.0221	0.0221	< 0.00506	0.00506
	UPAE01	Fillets without Skin	< 0.0144	0.0144	< 0.00484	0.00484
	UPCC01	Fillets without Skin	< 0.0209	0.0209	< 0.00451	0.00451
	UPCC02	Fillets without Skin	< 0.0222	0.0222	< 0.00469	0.00469
	UPCC101	Fillets without Skin	< 0.0226	0.0226	< 0.00496	0.00496
	UPCC102	Fillets without Skin	< 0.0212	0.0212	< 0.00452	0.00452
	UPCC103	Fillets without Skin	< 0.0189	0.0189	< 0.00455	0.00455
BDE# 166						
	LACA01	Fillets with Skin	< 0.0171	0.0171	< 0.00476	0.00476
	LALB01	Fillets with Skin	< 0.0190	0.0190	< 0.00392	0.00392

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LASF01	Fillets with Skin	< 0.0246	0.0246	< 0.00489	0.00489
	LPCA01	Fillets with Skin	< 0.0204	0.0204	< 0.00482	0.00482
	LPLB01	Fillets with Skin	< 0.0218	0.0218	< 0.00499	0.00499
	LPSB01	Fillets with Skin	< 0.0259	0.0259	< 0.00509	0.00509
	LPSF01	Fillets with Skin	< 0.0291	0.0291	< 0.00497	0.00497
	UACA01	Fillets with Skin	< 0.0141	0.0141	< 0.00392	0.00392
	UALB01	Fillets with Skin	< 0.0221	0.0221	< 0.00493	0.00493
	UASF01	Fillets with Skin	< 0.0206	0.0206	< 0.00425	0.00425
	UPCA01	Fillets with Skin	< 0.0155	0.0155	< 0.00452	0.00452
	UPLB01	Fillets with Skin	< 0.0250	0.0250	< 0.00511	0.00511
	UPSF01	Fillets with Skin	< 0.0249	0.0249	< 0.00488	0.00488
	LAAE01	Fillets without Skin	< 0.0121	0.0121	< 0.00447	0.00447
	LABC01	Fillets without Skin	< 0.0177	0.0177	< 0.00389	0.00389
	LACC01	Fillets without Skin	< 0.0234	0.0234	< 0.00507	0.00507
	LPAE01	Fillets without Skin	< 0.0146	0.0146	< 0.00492	0.00492
	LPAE02	Fillets without Skin	< 0.0162	0.0162	< 0.00451	0.00451
	LPBC01	Fillets without Skin	< 0.0213	0.0213	< 0.00452	0.00452
	LPBC02	Fillets without Skin	< 0.0245	0.0245	< 0.00416	0.00416
	LPBC03	Fillets without Skin	< 0.0229	0.0229	< 0.00485	0.00485
	LPBC04	Fillets without Skin	< 0.0197	0.0197	< 0.00460	0.00460
	LPCC01	Fillets without Skin	< 0.0256	0.0256	< 0.00488	0.00488
	UAAE01	Fillets without	< 0.0136	0.0136	< 0.00512	0.00512

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	< 0.0223	0.0223	< 0.00468	0.00468
	UACC01	Fillets without Skin	< 0.0221	0.0221	< 0.00506	0.00506
	UPAE01	Fillets without Skin	< 0.0144	0.0144	< 0.00484	0.00484
	UPCC01	Fillets without Skin	< 0.0209	0.0209	< 0.00451	0.00451
	UPCC02	Fillets without Skin	< 0.0222	0.0222	< 0.00469	0.00469
	UPCC101	Fillets without Skin	< 0.0226	0.0226	< 0.00496	0.00496
	UPCC102	Fillets without Skin	< 0.0212	0.0212	< 0.00452	0.00452
	UPCC103	Fillets without Skin	< 0.0189	0.0189	< 0.00455	0.00455
BDE# 17						
	LACA01	Fillets with Skin	< 0.0214	0.0214	< 0.00596	0.00596
	LALB01	Fillets with Skin	< 0.0237	0.0237	< 0.00491	0.00491
	LASF01	Fillets with Skin	< 0.0308	0.0308	< 0.00613	0.00613
	LPCA01	Fillets with Skin	< 0.0256	0.0256	< 0.00604	0.00604
	LPLB01	Fillets with Skin	< 0.0273	0.0273	< 0.00625	0.00625
	LPSB01	Fillets with Skin	< 0.0325	0.0325	< 0.00637	0.00637
	LPSF01	Fillets with Skin	< 0.0365	0.0365	< 0.00622	0.00622
	UACA01	Fillets with Skin	< 0.0176	0.0176	< 0.00492	0.00492
	UALB01	Fillets with Skin	< 0.0277	0.0277	< 0.00618	0.00618
	UASF01	Fillets with Skin	< 0.0258	0.0258	< 0.00532	0.00532
	UPCA01	Fillets with Skin	< 0.0194	0.0194	< 0.00566	0.00566
	UPLB01	Fillets with Skin	< 0.0313	0.0313	< 0.00640	0.00640
	UPSF01	Fillets with Skin	< 0.0312	0.0312	< 0.00611	0.00611

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	< 0.0152	0.0152	< 0.00560	0.00560
	LABC01	Fillets without Skin	< 0.0221	0.0221	< 0.00487	0.00487
	LACC01	Fillets without Skin	< 0.0293	0.0293	< 0.00635	0.00635
	LPAE01	Fillets without Skin	< 0.0183	0.0183	< 0.00616	0.00616
	LPAE02	Fillets without Skin	< 0.0203	0.0203	< 0.00565	0.00565
	LPBC01	Fillets without Skin	< 0.0267	0.0267	< 0.00567	0.00567
	LPBC02	Fillets without Skin	< 0.0307	0.0307	< 0.00521	0.00521
	LPBC03	Fillets without Skin	< 0.0287	0.0287	< 0.00607	0.00607
	LPBC04	Fillets without Skin	< 0.0247	0.0247	< 0.00577	0.00577
	LPCC01	Fillets without Skin	< 0.0320	0.0320	< 0.00612	0.00612
	UAAE01	Fillets without Skin	< 0.0171	0.0171	< 0.00641	0.00641
	UABC01	Fillets without Skin	< 0.0279	0.0279	< 0.00586	0.00586
	UACC01	Fillets without Skin	< 0.0276	0.0276	< 0.00633	0.00633
	UPAE01	Fillets without Skin	< 0.0180	0.0180	< 0.00606	0.00606
	UPCC01	Fillets without Skin	< 0.0262	0.0262	< 0.00565	0.00565
	UPCC02	Fillets without Skin	< 0.0278	0.0278	< 0.00587	0.00587
	UPCC101	Fillets without Skin	< 0.0284	0.0284	< 0.00621	0.00621

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	< 0.0265	0.0265	< 0.00567	0.00567
	UPCC103	Fillets without Skin	< 0.0236	0.0236	< 0.00570	0.00570
BDE# 181						
	LACA01	Fillets with Skin	< 0.0190	0.0190	< 0.00529	0.00529
	LALB01	Fillets with Skin	< 0.0211	0.0211	< 0.00435	0.00435
	LASF01	Fillets with Skin	< 0.0273	0.0273	< 0.00544	0.00544
	LPCA01	Fillets with Skin	< 0.0227	0.0227	< 0.00536	0.00536
	LPLB01	Fillets with Skin	< 0.0242	0.0242	< 0.00554	0.00554
	LPSB01	Fillets with Skin	< 0.0288	0.0288	< 0.00565	0.00565
	LPSF01	Fillets with Skin	< 0.0324	0.0324	< 0.00552	0.00552
	UACA01	Fillets with Skin	< 0.0156	0.0156	< 0.00436	0.00436
	UALB01	Fillets with Skin	< 0.0246	0.0246	< 0.00548	0.00548
	UASF01	Fillets with Skin	< 0.0229	0.0229	< 0.00472	0.00472
	UPCA01	Fillets with Skin	< 0.0172	0.0172	< 0.00502	0.00502
	UPLB01	Fillets with Skin	< 0.0278	0.0278	< 0.00568	0.00568
	UPSF01	Fillets with Skin	< 0.0276	0.0276	< 0.00542	0.00542
	LAAE01	Fillets without Skin	< 0.0135	0.0135	< 0.00496	0.00496
	LABC01	Fillets without Skin	< 0.0196	0.0196	< 0.00432	0.00432
	LACC01	Fillets without Skin	< 0.0260	0.0260	< 0.00563	0.00563
	LPAE01	Fillets without Skin	< 0.0162	0.0162	< 0.00547	0.00547
	LPAE02	Fillets without Skin	< 0.0180	0.0180	< 0.00501	0.00501
	LPBC01	Fillets without Skin	< 0.0237	0.0237	< 0.00503	0.00503
	LPBC02	Fillets without Skin	< 0.0272	0.0272	< 0.00462	0.00462

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	< 0.0254	0.0254	< 0.00539	0.00539
	LPBC04	Fillets without Skin	< 0.0219	0.0219	< 0.00512	0.00512
	LPCC01	Fillets without Skin	< 0.0284	0.0284	< 0.00543	0.00543
	UAAE01	Fillets without Skin	< 0.0152	0.0152	< 0.00569	0.00569
	UABC01	Fillets without Skin	< 0.0248	0.0248	< 0.00520	0.00520
	UACC01	Fillets without Skin	< 0.0245	0.0245	< 0.00562	0.00562
	UPAE01	Fillets without Skin	< 0.0160	0.0160	< 0.00538	0.00538
	UPCC01	Fillets without Skin	< 0.0233	0.0233	< 0.00501	0.00501
	UPCC02	Fillets without Skin	< 0.0247	0.0247	< 0.00521	0.00521
	UPCC101	Fillets without Skin	< 0.0252	0.0252	< 0.00551	0.00551
	UPCC102	Fillets without Skin	< 0.0235	0.0235	< 0.00503	0.00503
	UPCC103	Fillets without Skin	< 0.0210	0.0210	< 0.00505	0.00505
BDE# 183						
	LACA01	Fillets with Skin	< 0.0190	0.0190	< 0.00529	0.00529
	LALB01	Fillets with Skin	< 0.0211	0.0211	< 0.00435	0.00435
	LASF01	Fillets with Skin	< 0.0273	0.0273	< 0.00544	0.00544
	LPCA01	Fillets with Skin	< 0.0227	0.0227	< 0.00536	0.00536
	LPLB01	Fillets with Skin	< 0.0242	0.0242	< 0.00554	0.00554
	LPSB01	Fillets with Skin	< 0.0288	0.0288	< 0.00565	0.00565
	LPSF01	Fillets with Skin	< 0.0324	0.0324	< 0.00552	0.00552
	UACA01	Fillets with Skin	< 0.0156	0.0156	< 0.00436	0.00436

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	< 0.0246	0.0246	< 0.00548	0.00548
	UASF01	Fillets with Skin	< 0.0229	0.0229	< 0.00472	0.00472
	UPCA01	Fillets with Skin	< 0.0172	0.0172	< 0.00502	0.00502
	UPLB01	Fillets with Skin	< 0.0278	0.0278	< 0.00568	0.00568
	UPSF01	Fillets with Skin	< 0.0276	0.0276	< 0.00542	0.00542
	LAAE01	Fillets without Skin	< 0.0135	0.0135	< 0.00496	0.00496
	LABC01	Fillets without Skin	< 0.0196	0.0196	< 0.00432	0.00432
	LACC01	Fillets without Skin	< 0.0260	0.0260	< 0.00563	0.00563
	LPAE01	Fillets without Skin	< 0.0162	0.0162	< 0.00547	0.00547
	LPAE02	Fillets without Skin	< 0.0180	0.0180	< 0.00501	0.00501
	LPBC01	Fillets without Skin	< 0.0237	0.0237	< 0.00503	0.00503
	LPBC02	Fillets without Skin	< 0.0272	0.0272	< 0.00462	0.00462
	LPBC03	Fillets without Skin	< 0.0254	0.0254	< 0.00539	0.00539
	LPBC04	Fillets without Skin	< 0.0219	0.0219	< 0.00512	0.00512
	LPCC01	Fillets without Skin	< 0.0284	0.0284	< 0.00543	0.00543
	UAAE01	Fillets without Skin	< 0.0152	0.0152	< 0.00569	0.00569
	UABC01	Fillets without Skin	< 0.0248	0.0248	< 0.00520	0.00520
	UACC01	Fillets without Skin	< 0.0245	0.0245	< 0.00562	0.00562
	UPAE01	Fillets without Skin	< 0.0160	0.0160	< 0.00538	0.00538

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	< 0.0233	0.0233	< 0.00501	0.00501
	UPCC02	Fillets without Skin	< 0.0247	0.0247	< 0.00521	0.00521
	UPCC101	Fillets without Skin	< 0.0252	0.0252	< 0.00551	0.00551
	UPCC102	Fillets without Skin	< 0.0235	0.0235	< 0.00503	0.00503
	UPCC103	Fillets without Skin	< 0.0210	0.0210	< 0.00505	0.00505
BDE# 190						
	LACA01	Fillets with Skin	< 0.0189	0.0189	< 0.00526	0.00526
	LALB01	Fillets with Skin	< 0.0210	0.0210	< 0.00433	0.00433
	LASF01	Fillets with Skin	< 0.0272	0.0272	< 0.00541	0.00541
	LPCA01	Fillets with Skin	< 0.0226	0.0226	< 0.00533	0.00533
	LPLB01	Fillets with Skin	< 0.0241	0.0241	< 0.00552	0.00552
	LPSB01	Fillets with Skin	< 0.0287	0.0287	< 0.00563	0.00563
	LPSF01	Fillets with Skin	< 0.0322	0.0322	< 0.00550	0.00550
	UACA01	Fillets with Skin	< 0.0156	0.0156	< 0.00434	0.00434
	UALB01	Fillets with Skin	< 0.0244	0.0244	< 0.00545	0.00545
	UASF01	Fillets with Skin	< 0.0228	0.0228	< 0.00470	0.00470
	UPCA01	Fillets with Skin	< 0.0171	0.0171	< 0.00500	0.00500
	UPLB01	Fillets with Skin	< 0.0276	0.0276	< 0.00565	0.00565
	UPSF01	Fillets with Skin	< 0.0275	0.0275	< 0.00539	0.00539
	LAAE01	Fillets without Skin	< 0.0134	0.0134	< 0.00494	0.00494
	LABC01	Fillets without Skin	< 0.0195	0.0195	< 0.00430	0.00430
	LACC01	Fillets without Skin	< 0.0259	0.0259	< 0.00560	0.00560
	LPAE01	Fillets without Skin	< 0.0161	0.0161	< 0.00544	0.00544

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 0.0179	0.0179	< 0.00499	0.00499
	LPBC01	Fillets without Skin	< 0.0236	0.0236	< 0.00500	0.00500
	LPBC02	Fillets without Skin	< 0.0271	0.0271	< 0.00460	0.00460
	LPBC03	Fillets without Skin	< 0.0253	0.0253	< 0.00536	0.00536
	LPBC04	Fillets without Skin	< 0.0218	0.0218	< 0.00509	0.00509
	LPCC01	Fillets without Skin	< 0.0283	0.0283	< 0.00540	0.00540
	UAAE01	Fillets without Skin	< 0.0151	0.0151	< 0.00566	0.00566
	UABC01	Fillets without Skin	< 0.0247	0.0247	< 0.00518	0.00518
	UACC01	Fillets without Skin	< 0.0244	0.0244	< 0.00559	0.00559
	UPAE01	Fillets without Skin	< 0.0159	0.0159	< 0.00535	0.00535
	UPCC01	Fillets without Skin	< 0.0231	0.0231	< 0.00499	0.00499
	UPCC02	Fillets without Skin	< 0.0246	0.0246	< 0.00519	0.00519
	UPCC101	Fillets without Skin	< 0.0250	0.0250	< 0.00549	0.00549
	UPCC102	Fillets without Skin	< 0.0234	0.0234	< 0.00500	0.00500
	UPCC103	Fillets without Skin	< 0.0209	0.0209	< 0.00503	0.00503
BDE# 2						
	LACA01	Fillets with Skin	< 0.0214	0.0214	< 0.00596	0.00596
	LALB01	Fillets with Skin	< 0.0237	0.0237	< 0.00491	0.00491

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LASF01	Fillets with Skin	< 0.0308	0.0308	< 0.00613	0.00613
	LPCA01	Fillets with Skin	< 0.0256	0.0256	< 0.00604	0.00604
	LPLB01	Fillets with Skin	< 0.0273	0.0273	< 0.00625	0.00625
	LPSB01	Fillets with Skin	< 0.0325	0.0325	< 0.00637	0.00637
	LPSF01	Fillets with Skin	< 0.0365	0.0365	< 0.00622	0.00622
	UACA01	Fillets with Skin	< 0.0176	0.0176	< 0.00492	0.00492
	UALB01	Fillets with Skin	< 0.0277	0.0277	< 0.00618	0.00618
	UASF01	Fillets with Skin	< 0.0258	0.0258	< 0.00532	0.00532
	UPCA01	Fillets with Skin	< 0.0194	0.0194	< 0.00566	0.00566
	UPLB01	Fillets with Skin	< 0.0313	0.0313	< 0.00640	0.00640
	UPSF01	Fillets with Skin	< 0.0312	0.0312	< 0.00611	0.00611
	LAAE01	Fillets without Skin	< 0.0152	0.0152	< 0.00560	0.00560
	LABC01	Fillets without Skin	< 0.0221	0.0221	< 0.00487	0.00487
	LACC01	Fillets without Skin	< 0.0293	0.0293	< 0.00635	0.00635
	LPAE01	Fillets without Skin	< 0.0183	0.0183	< 0.00616	0.00616
	LPAE02	Fillets without Skin	< 0.0203	0.0203	< 0.00565	0.00565
	LPBC01	Fillets without Skin	< 0.0267	0.0267	< 0.00567	0.00567
	LPBC02	Fillets without Skin	< 0.0307	0.0307	< 0.00521	0.00521
	LPBC03	Fillets without Skin	< 0.0287	0.0287	< 0.00607	0.00607
	LPBC04	Fillets without Skin	< 0.0247	0.0247	< 0.00577	0.00577
	LPCC01	Fillets without Skin	< 0.0320	0.0320	< 0.00612	0.00612
	UAAE01	Fillets without	< 0.0171	0.0171	< 0.00641	0.00641

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	< 0.0279	0.0279	< 0.00586	0.00586
	UACC01	Fillets without Skin	< 0.0276	0.0276	< 0.00633	0.00633
	UPAE01	Fillets without Skin	< 0.0180	0.0180	< 0.00606	0.00606
	UPCC01	Fillets without Skin	< 0.0262	0.0262	< 0.00565	0.00565
	UPCC02	Fillets without Skin	< 0.0278	0.0278	< 0.00587	0.00587
	UPCC101	Fillets without Skin	< 0.0284	0.0284	< 0.00621	0.00621
	UPCC102	Fillets without Skin	< 0.0265	0.0265	< 0.00567	0.00567
	UPCC103	Fillets without Skin	< 0.0236	0.0236	< 0.00570	0.00570
BDE# 25						
	LACA01	Fillets with Skin	< 0.0214	0.0214	< 0.00596	0.00596
	LALB01	Fillets with Skin	< 0.0237	0.0237	< 0.00491	0.00491
	LASF01	Fillets with Skin	< 0.0308	0.0308	< 0.00613	0.00613
	LPCA01	Fillets with Skin	< 0.0256	0.0256	< 0.00604	0.00604
	LPLB01	Fillets with Skin	< 0.0273	0.0273	< 0.00625	0.00625
	LPSB01	Fillets with Skin	< 0.0325	0.0325	< 0.00637	0.00637
	LPSF01	Fillets with Skin	< 0.0365	0.0365	< 0.00622	0.00622
	UACA01	Fillets with Skin	< 0.0176	0.0176	< 0.00492	0.00492
	UALB01	Fillets with Skin	< 0.0277	0.0277	< 0.00618	0.00618
	UASF01	Fillets with Skin	< 0.0258	0.0258	< 0.00532	0.00532
	UPCA01	Fillets with Skin	< 0.0194	0.0194	< 0.00566	0.00566
	UPLB01	Fillets with Skin	< 0.0313	0.0313	< 0.00640	0.00640
	UPSF01	Fillets with Skin	< 0.0312	0.0312	< 0.00611	0.00611

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	< 0.0152	0.0152	< 0.00560	0.00560
	LABC01	Fillets without Skin	< 0.0221	0.0221	< 0.00487	0.00487
	LACC01	Fillets without Skin	< 0.0293	0.0293	< 0.00635	0.00635
	LPAE01	Fillets without Skin	< 0.0183	0.0183	< 0.00616	0.00616
	LPAE02	Fillets without Skin	< 0.0203	0.0203	< 0.00565	0.00565
	LPBC01	Fillets without Skin	< 0.0267	0.0267	< 0.00567	0.00567
	LPBC02	Fillets without Skin	< 0.0307	0.0307	< 0.00521	0.00521
	LPBC03	Fillets without Skin	< 0.0287	0.0287	< 0.00607	0.00607
	LPBC04	Fillets without Skin	< 0.0247	0.0247	< 0.00577	0.00577
	LPCC01	Fillets without Skin	< 0.0320	0.0320	< 0.00612	0.00612
	UAAE01	Fillets without Skin	< 0.0171	0.0171	< 0.00641	0.00641
	UABC01	Fillets without Skin	< 0.0279	0.0279	< 0.00586	0.00586
	UACC01	Fillets without Skin	< 0.0276	0.0276	< 0.00633	0.00633
	UPAE01	Fillets without Skin	< 0.0180	0.0180	< 0.00606	0.00606
	UPCC01	Fillets without Skin	< 0.0262	0.0262	< 0.00565	0.00565
	UPCC02	Fillets without Skin	< 0.0278	0.0278	< 0.00587	0.00587
	UPCC101	Fillets without Skin	< 0.0284	0.0284	< 0.00621	0.00621

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	< 0.0265	0.0265	< 0.00567	0.00567
	UPCC103	Fillets without Skin	< 0.0236	0.0236	< 0.00570	0.00570
BDE# 28						
	LACA01	Fillets with Skin	0.0187	0.0100	0.00520	0.00279
	LALB01	Fillets with Skin	< 0.0111	0.0111	< 0.00230	0.00230
	LASF01	Fillets with Skin	< 0.0144	0.0144	< 0.00287	0.00287
	LPCA01	Fillets with Skin	0.0250	0.0120	0.00590	0.00282
	LPLB01	Fillets with Skin	< 0.0128	0.0128	< 0.00292	0.00292
	LPSB01	Fillets with Skin	< 0.0152	0.0152	< 0.00298	0.00298
	LPSF01	Fillets with Skin	< 0.0171	0.0171	< 0.00291	0.00291
	UACA01	Fillets with Skin	0.0190	0.00824	0.00530	0.00230
	UALB01	Fillets with Skin	< 0.0129	0.0129	< 0.00289	0.00289
	UASF01	Fillets with Skin	< 0.0121	0.0121	< 0.00249	0.00249
	UPCA01	Fillets with Skin	0.0168	0.00908	0.00490	0.00265
	UPLB01	Fillets with Skin	< 0.0146	0.0146	< 0.00299	0.00299
	UPSF01	Fillets with Skin	< 0.0146	0.0146	< 0.00286	0.00286
	LAAE01	Fillets without Skin	< 0.00710	0.00710	< 0.00262	0.00262
	LABC01	Fillets without Skin	0.0109	0.0104	0.00240	0.00228
	LACC01	Fillets without Skin	< 0.0137	0.0137	< 0.00297	0.00297
	LPAE01	Fillets without Skin	< 0.00855	0.00855	< 0.00288	0.00288
	LPAE02	Fillets without Skin	< 0.00951	0.00951	< 0.00264	0.00264
	LPBC01	Fillets without Skin	< 0.0125	0.0125	< 0.00265	0.00265
	LPBC02	Fillets without Skin	< 0.0144	0.0144	< 0.00244	0.00244

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	< 0.0134	0.0134	< 0.00284	0.00284
	LPBC04	Fillets without Skin	0.0146	0.0115	0.00340	0.00270
	LPCC01	Fillets without Skin	< 0.0150	0.0150	< 0.00286	0.00286
	UAAE01	Fillets without Skin	< 0.00800	0.00800	< 0.00300	0.00300
	UABC01	Fillets without Skin	< 0.0131	0.0131	< 0.00274	0.00274
	UACC01	Fillets without Skin	< 0.0129	0.0129	< 0.00296	0.00296
	UPAE01	Fillets without Skin	< 0.00844	0.00844	< 0.00284	0.00284
	UPCC01	Fillets without Skin	< 0.0123	0.0123	< 0.00264	0.00264
	UPCC02	Fillets without Skin	< 0.0130	0.0130	< 0.00275	0.00275
	UPCC101	Fillets without Skin	< 0.0133	0.0133	< 0.00291	0.00291
	UPCC102	Fillets without Skin	< 0.0124	0.0124	< 0.00265	0.00265
	UPCC103	Fillets without Skin	< 0.0111	0.0111	< 0.00266	0.00266
BDE# 3						
	LACA01	Fillets with Skin	< 0.0214	0.0214	< 0.00596	0.00596
	LALB01	Fillets with Skin	< 0.0237	0.0237	< 0.00491	0.00491
	LASF01	Fillets with Skin	< 0.0308	0.0308	< 0.00613	0.00613
	LPCA01	Fillets with Skin	< 0.0256	0.0256	< 0.00604	0.00604
	LPLB01	Fillets with Skin	< 0.0273	0.0273	< 0.00625	0.00625
	LPSB01	Fillets with Skin	< 0.0325	0.0325	< 0.00637	0.00637
	LPSF01	Fillets with Skin	< 0.0365	0.0365	< 0.00622	0.00622
	UACA01	Fillets with Skin	< 0.0176	0.0176	< 0.00492	0.00492

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	< 0.0277	0.0277	< 0.00618	0.00618
	UASF01	Fillets with Skin	< 0.0258	0.0258	< 0.00532	0.00532
	UPCA01	Fillets with Skin	< 0.0194	0.0194	< 0.00566	0.00566
	UPLB01	Fillets with Skin	< 0.0313	0.0313	< 0.00640	0.00640
	UPSF01	Fillets with Skin	< 0.0312	0.0312	< 0.00611	0.00611
	LAAE01	Fillets without Skin	< 0.0152	0.0152	< 0.00560	0.00560
	LABC01	Fillets without Skin	0.0323	0.0221	0.00710	0.00487
	LACC01	Fillets without Skin	< 0.0293	0.0293	< 0.00635	0.00635
	LPAE01	Fillets without Skin	< 0.0183	0.0183	< 0.00616	0.00616
	LPAE02	Fillets without Skin	< 0.0203	0.0203	< 0.00565	0.00565
	LPBC01	Fillets without Skin	< 0.0267	0.0267	< 0.00567	0.00567
	LPBC02	Fillets without Skin	< 0.0307	0.0307	< 0.00521	0.00521
	LPBC03	Fillets without Skin	< 0.0287	0.0287	< 0.00607	0.00607
	LPBC04	Fillets without Skin	< 0.0247	0.0247	< 0.00577	0.00577
	LPCC01	Fillets without Skin	< 0.0320	0.0320	< 0.00612	0.00612
	UAAE01	Fillets without Skin	< 0.0171	0.0171	< 0.00641	0.00641
	UABC01	Fillets without Skin	< 0.0279	0.0279	< 0.00586	0.00586
	UACC01	Fillets without Skin	< 0.0276	0.0276	< 0.00633	0.00633
	UPAE01	Fillets without Skin	< 0.0180	0.0180	< 0.00606	0.00606

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	< 0.0262	0.0262	< 0.00565	0.00565
	UPCC02	Fillets without Skin	< 0.0278	0.0278	< 0.00587	0.00587
	UPCC101	Fillets without Skin	< 0.0284	0.0284	< 0.00621	0.00621
	UPCC102	Fillets without Skin	< 0.0265	0.0265	< 0.00567	0.00567
	UPCC103	Fillets without Skin	< 0.0236	0.0236	< 0.00570	0.00570
BDE# 30						
	LACA01	Fillets with Skin	< 0.0214	0.0214	< 0.00596	0.00596
	LALB01	Fillets with Skin	< 0.0237	0.0237	< 0.00491	0.00491
	LASF01	Fillets with Skin	< 0.0308	0.0308	< 0.00613	0.00613
	LPCA01	Fillets with Skin	< 0.0256	0.0256	< 0.00604	0.00604
	LPLB01	Fillets with Skin	< 0.0273	0.0273	< 0.00625	0.00625
	LPSB01	Fillets with Skin	< 0.0325	0.0325	< 0.00637	0.00637
	LPSF01	Fillets with Skin	< 0.0365	0.0365	< 0.00622	0.00622
	UACA01	Fillets with Skin	< 0.0176	0.0176	< 0.00492	0.00492
	UALB01	Fillets with Skin	< 0.0277	0.0277	< 0.00618	0.00618
	UASF01	Fillets with Skin	< 0.0258	0.0258	< 0.00532	0.00532
	UPCA01	Fillets with Skin	< 0.0194	0.0194	< 0.00566	0.00566
	UPLB01	Fillets with Skin	< 0.0313	0.0313	< 0.00640	0.00640
	UPSF01	Fillets with Skin	< 0.0312	0.0312	< 0.00611	0.00611
	LAAE01	Fillets without Skin	< 0.0152	0.0152	< 0.00560	0.00560
	LABC01	Fillets without Skin	< 0.0221	0.0221	< 0.00487	0.00487
	LACC01	Fillets without Skin	< 0.0293	0.0293	< 0.00635	0.00635
	LPAE01	Fillets without Skin	< 0.0183	0.0183	< 0.00616	0.00616

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 0.0203	0.0203	< 0.00565	0.00565
	LPBC01	Fillets without Skin	< 0.0267	0.0267	< 0.00567	0.00567
	LPBC02	Fillets without Skin	< 0.0307	0.0307	< 0.00521	0.00521
	LPBC03	Fillets without Skin	< 0.0287	0.0287	< 0.00607	0.00607
	LPBC04	Fillets without Skin	< 0.0247	0.0247	< 0.00577	0.00577
	LPCC01	Fillets without Skin	< 0.0320	0.0320	< 0.00612	0.00612
	UAAE01	Fillets without Skin	< 0.0171	0.0171	< 0.00641	0.00641
	UABC01	Fillets without Skin	< 0.0279	0.0279	< 0.00586	0.00586
	UACC01	Fillets without Skin	< 0.0276	0.0276	< 0.00633	0.00633
	UPAE01	Fillets without Skin	< 0.0180	0.0180	< 0.00606	0.00606
	UPCC01	Fillets without Skin	< 0.0262	0.0262	< 0.00565	0.00565
	UPCC02	Fillets without Skin	< 0.0278	0.0278	< 0.00587	0.00587
	UPCC101	Fillets without Skin	< 0.0284	0.0284	< 0.00621	0.00621
	UPCC102	Fillets without Skin	< 0.0265	0.0265	< 0.00567	0.00567
	UPCC103	Fillets without Skin	< 0.0236	0.0236	< 0.00570	0.00570
BDE# 32						
	LACA01	Fillets with Skin	< 0.0214	0.0214	< 0.00596	0.00596
	LALB01	Fillets with Skin	< 0.0237	0.0237	< 0.00491	0.00491

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LASF01	Fillets with Skin	< 0.0308	0.0308	< 0.00613	0.00613
	LPCA01	Fillets with Skin	< 0.0256	0.0256	< 0.00604	0.00604
	LPLB01	Fillets with Skin	< 0.0273	0.0273	< 0.00625	0.00625
	LPSB01	Fillets with Skin	< 0.0325	0.0325	< 0.00637	0.00637
	LPSF01	Fillets with Skin	< 0.0365	0.0365	< 0.00622	0.00622
	UACA01	Fillets with Skin	< 0.0176	0.0176	< 0.00492	0.00492
	UALB01	Fillets with Skin	< 0.0277	0.0277	< 0.00618	0.00618
	UASF01	Fillets with Skin	< 0.0258	0.0258	< 0.00532	0.00532
	UPCA01	Fillets with Skin	< 0.0194	0.0194	< 0.00566	0.00566
	UPLB01	Fillets with Skin	< 0.0313	0.0313	< 0.00640	0.00640
	UPSF01	Fillets with Skin	< 0.0312	0.0312	< 0.00611	0.00611
	LAAE01	Fillets without Skin	< 0.0152	0.0152	< 0.00560	0.00560
	LABC01	Fillets without Skin	< 0.0221	0.0221	< 0.00487	0.00487
	LACC01	Fillets without Skin	< 0.0293	0.0293	< 0.00635	0.00635
	LPAE01	Fillets without Skin	< 0.0183	0.0183	< 0.00616	0.00616
	LPAE02	Fillets without Skin	< 0.0203	0.0203	< 0.00565	0.00565
	LPBC01	Fillets without Skin	< 0.0267	0.0267	< 0.00567	0.00567
	LPBC02	Fillets without Skin	< 0.0307	0.0307	< 0.00521	0.00521
	LPBC03	Fillets without Skin	< 0.0287	0.0287	< 0.00607	0.00607
	LPBC04	Fillets without Skin	< 0.0247	0.0247	< 0.00577	0.00577
	LPCC01	Fillets without Skin	< 0.0320	0.0320	< 0.00612	0.00612
	UAAE01	Fillets without	< 0.0171	0.0171	< 0.00641	0.00641

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	< 0.0279	0.0279	< 0.00586	0.00586
	UACC01	Fillets without Skin	< 0.0276	0.0276	< 0.00633	0.00633
	UPAE01	Fillets without Skin	< 0.0180	0.0180	< 0.00606	0.00606
	UPCC01	Fillets without Skin	< 0.0262	0.0262	< 0.00565	0.00565
	UPCC02	Fillets without Skin	< 0.0278	0.0278	< 0.00587	0.00587
	UPCC101	Fillets without Skin	< 0.0284	0.0284	< 0.00621	0.00621
	UPCC102	Fillets without Skin	< 0.0265	0.0265	< 0.00567	0.00567
	UPCC103	Fillets without Skin	< 0.0236	0.0236	< 0.00570	0.00570
BDE# 33						
	LACA01	Fillets with Skin	< 0.0214	0.0214	< 0.00596	0.00596
	LALB01	Fillets with Skin	< 0.0237	0.0237	< 0.00491	0.00491
	LASF01	Fillets with Skin	< 0.0308	0.0308	< 0.00613	0.00613
	LPCA01	Fillets with Skin	< 0.0256	0.0256	< 0.00604	0.00604
	LPLB01	Fillets with Skin	< 0.0273	0.0273	< 0.00625	0.00625
	LPSB01	Fillets with Skin	< 0.0325	0.0325	< 0.00637	0.00637
	LPSF01	Fillets with Skin	< 0.0365	0.0365	< 0.00622	0.00622
	UACA01	Fillets with Skin	< 0.0176	0.0176	< 0.00492	0.00492
	UALB01	Fillets with Skin	< 0.0277	0.0277	< 0.00618	0.00618
	UASF01	Fillets with Skin	< 0.0258	0.0258	< 0.00532	0.00532
	UPCA01	Fillets with Skin	< 0.0194	0.0194	< 0.00566	0.00566
	UPLB01	Fillets with Skin	< 0.0313	0.0313	< 0.00640	0.00640
	UPSF01	Fillets with Skin	< 0.0312	0.0312	< 0.00611	0.00611

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	< 0.0152	0.0152	< 0.00560	0.00560
	LABC01	Fillets without Skin	< 0.0221	0.0221	< 0.00487	0.00487
	LACC01	Fillets without Skin	< 0.0293	0.0293	< 0.00635	0.00635
	LPAE01	Fillets without Skin	< 0.0183	0.0183	< 0.00616	0.00616
	LPAE02	Fillets without Skin	< 0.0203	0.0203	< 0.00565	0.00565
	LPBC01	Fillets without Skin	< 0.0267	0.0267	< 0.00567	0.00567
	LPBC02	Fillets without Skin	< 0.0307	0.0307	< 0.00521	0.00521
	LPBC03	Fillets without Skin	< 0.0287	0.0287	< 0.00607	0.00607
	LPBC04	Fillets without Skin	< 0.0247	0.0247	< 0.00577	0.00577
	LPCC01	Fillets without Skin	< 0.0320	0.0320	< 0.00612	0.00612
	UAAE01	Fillets without Skin	< 0.0171	0.0171	< 0.00641	0.00641
	UABC01	Fillets without Skin	< 0.0279	0.0279	< 0.00586	0.00586
	UACC01	Fillets without Skin	< 0.0276	0.0276	< 0.00633	0.00633
	UPAE01	Fillets without Skin	< 0.0180	0.0180	< 0.00606	0.00606
	UPCC01	Fillets without Skin	< 0.0262	0.0262	< 0.00565	0.00565
	UPCC02	Fillets without Skin	< 0.0278	0.0278	< 0.00587	0.00587
	UPCC101	Fillets without Skin	< 0.0284	0.0284	< 0.00621	0.00621

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	< 0.0265	0.0265	< 0.00567	0.00567
	UPCC103	Fillets without Skin	< 0.0236	0.0236	< 0.00570	0.00570
BDE# 35						
	LACA01	Fillets with Skin	< 0.0214	0.0214	< 0.00596	0.00596
	LALB01	Fillets with Skin	< 0.0237	0.0237	< 0.00491	0.00491
	LASF01	Fillets with Skin	< 0.0308	0.0308	< 0.00613	0.00613
	LPCA01	Fillets with Skin	< 0.0256	0.0256	< 0.00604	0.00604
	LPLB01	Fillets with Skin	< 0.0273	0.0273	< 0.00625	0.00625
	LPSB01	Fillets with Skin	< 0.0325	0.0325	< 0.00637	0.00637
	LPSF01	Fillets with Skin	< 0.0365	0.0365	< 0.00622	0.00622
	UACA01	Fillets with Skin	< 0.0176	0.0176	< 0.00492	0.00492
	UALB01	Fillets with Skin	< 0.0277	0.0277	< 0.00618	0.00618
	UASF01	Fillets with Skin	< 0.0258	0.0258	< 0.00532	0.00532
	UPCA01	Fillets with Skin	< 0.0194	0.0194	< 0.00566	0.00566
	UPLB01	Fillets with Skin	< 0.0313	0.0313	< 0.00640	0.00640
	UPSF01	Fillets with Skin	< 0.0312	0.0312	< 0.00611	0.00611
	LAAE01	Fillets without Skin	< 0.0152	0.0152	< 0.00560	0.00560
	LABC01	Fillets without Skin	< 0.0221	0.0221	< 0.00487	0.00487
	LACC01	Fillets without Skin	< 0.0293	0.0293	< 0.00635	0.00635
	LPAE01	Fillets without Skin	< 0.0183	0.0183	< 0.00616	0.00616
	LPAE02	Fillets without Skin	< 0.0203	0.0203	< 0.00565	0.00565
	LPBC01	Fillets without Skin	< 0.0267	0.0267	< 0.00567	0.00567
	LPBC02	Fillets without Skin	< 0.0307	0.0307	< 0.00521	0.00521

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	< 0.0287	0.0287	< 0.00607	0.00607
	LPBC04	Fillets without Skin	< 0.0247	0.0247	< 0.00577	0.00577
	LPCC01	Fillets without Skin	< 0.0320	0.0320	< 0.00612	0.00612
	UAAE01	Fillets without Skin	< 0.0171	0.0171	< 0.00641	0.00641
	UABC01	Fillets without Skin	< 0.0279	0.0279	< 0.00586	0.00586
	UACC01	Fillets without Skin	< 0.0276	0.0276	< 0.00633	0.00633
	UPAE01	Fillets without Skin	< 0.0180	0.0180	< 0.00606	0.00606
	UPCC01	Fillets without Skin	< 0.0262	0.0262	< 0.00565	0.00565
	UPCC02	Fillets without Skin	< 0.0278	0.0278	< 0.00587	0.00587
	UPCC101	Fillets without Skin	< 0.0284	0.0284	< 0.00621	0.00621
	UPCC102	Fillets without Skin	< 0.0265	0.0265	< 0.00567	0.00567
	UPCC103	Fillets without Skin	< 0.0236	0.0236	< 0.00570	0.00570
BDE# 37						
	LACA01	Fillets with Skin	< 0.0214	0.0214	< 0.00596	0.00596
	LALB01	Fillets with Skin	< 0.0237	0.0237	< 0.00491	0.00491
	LASF01	Fillets with Skin	< 0.0308	0.0308	< 0.00613	0.00613
	LPCA01	Fillets with Skin	< 0.0256	0.0256	< 0.00604	0.00604
	LPLB01	Fillets with Skin	< 0.0273	0.0273	< 0.00625	0.00625
	LPSB01	Fillets with Skin	< 0.0325	0.0325	< 0.00637	0.00637
	LPSF01	Fillets with Skin	< 0.0365	0.0365	< 0.00622	0.00622
	UACA01	Fillets with Skin	< 0.0176	0.0176	< 0.00492	0.00492

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	< 0.0277	0.0277	< 0.00618	0.00618
	UASF01	Fillets with Skin	< 0.0258	0.0258	< 0.00532	0.00532
	UPCA01	Fillets with Skin	< 0.0194	0.0194	< 0.00566	0.00566
	UPLB01	Fillets with Skin	< 0.0313	0.0313	< 0.00640	0.00640
	UPSF01	Fillets with Skin	< 0.0312	0.0312	< 0.00611	0.00611
	LAAE01	Fillets without Skin	< 0.0152	0.0152	< 0.00560	0.00560
	LABC01	Fillets without Skin	< 0.0221	0.0221	< 0.00487	0.00487
	LACC01	Fillets without Skin	< 0.0293	0.0293	< 0.00635	0.00635
	LPAE01	Fillets without Skin	< 0.0183	0.0183	< 0.00616	0.00616
	LPAE02	Fillets without Skin	< 0.0203	0.0203	< 0.00565	0.00565
	LPBC01	Fillets without Skin	< 0.0267	0.0267	< 0.00567	0.00567
	LPBC02	Fillets without Skin	< 0.0307	0.0307	< 0.00521	0.00521
	LPBC03	Fillets without Skin	< 0.0287	0.0287	< 0.00607	0.00607
	LPBC04	Fillets without Skin	< 0.0247	0.0247	< 0.00577	0.00577
	LPCC01	Fillets without Skin	< 0.0320	0.0320	< 0.00612	0.00612
	UAAE01	Fillets without Skin	< 0.0171	0.0171	< 0.00641	0.00641
	UABC01	Fillets without Skin	< 0.0279	0.0279	< 0.00586	0.00586
	UACC01	Fillets without Skin	< 0.0276	0.0276	< 0.00633	0.00633
	UPAE01	Fillets without Skin	< 0.0180	0.0180	< 0.00606	0.00606

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	< 0.0262	0.0262	< 0.00565	0.00565
	UPCC02	Fillets without Skin	< 0.0278	0.0278	< 0.00587	0.00587
	UPCC101	Fillets without Skin	< 0.0284	0.0284	< 0.00621	0.00621
	UPCC102	Fillets without Skin	< 0.0265	0.0265	< 0.00567	0.00567
	UPCC103	Fillets without Skin	< 0.0236	0.0236	< 0.00570	0.00570
BDE# 47						
	LACA01	Fillets with Skin	0.169	0.0110	0.0471	0.00305
	LALB01	Fillets with Skin	0.0760	0.0122	0.0157	0.00251
	LASF01	Fillets with Skin	0.0261	0.0158	0.00520	0.00314
	LPCA01	Fillets with Skin	0.0271	0.0131	0.00640	0.00309
	LPLB01	Fillets with Skin	< 0.0140	0.0140	< 0.00320	0.00320
	LPSB01	Fillets with Skin	< 0.0166	0.0166	< 0.00326	0.00326
	LPSF01	Fillets with Skin	< 0.0187	0.0187	< 0.00319	0.00319
	UACA01	Fillets with Skin	0.154	0.00903	0.0430	0.00252
	UALB01	Fillets with Skin	0.0587	0.0142	0.0131	0.00316
	UASF01	Fillets with Skin	0.0520	0.0132	0.0107	0.00272
	UPCA01	Fillets with Skin	0.0182	0.00994	0.00530	0.00290
	UPLB01	Fillets with Skin	< 0.0160	0.0160	< 0.00328	0.00328
	UPSF01	Fillets with Skin	0.0184	0.0160	0.00360	0.00313
	LAAE01	Fillets without Skin	0.0976	0.00777	0.0360	0.00287
	LABC01	Fillets without Skin	0.179	0.0113	0.0393	0.00249
	LACC01	Fillets without Skin	0.220	0.0150	0.0477	0.00325
	LPAE01	Fillets without Skin	0.0196	0.00936	0.00660	0.00316

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	0.0133	0.0104	0.00370	0.00289
	LPBC01	Fillets without Skin	0.0146	0.0137	0.00310	0.00290
	LPBC02	Fillets without Skin	0.0171	0.0157	0.00290	0.00267
	LPBC03	Fillets without Skin	0.0208	0.0147	0.00440	0.00311
	LPBC04	Fillets without Skin	0.0411	0.0126	0.00960	0.00295
	LPCC01	Fillets without Skin	< 0.0164	0.0164	< 0.00313	0.00313
	UAAE01	Fillets without Skin	0.0960	0.00875	0.0360	0.00328
	UABC01	Fillets without Skin	0.174	0.0143	0.0365	0.00300
	UACC01	Fillets without Skin	0.217	0.0142	0.0497	0.00324
	UPAE01	Fillets without Skin	< 0.00924	0.00924	< 0.00310	0.00310
	UPCC01	Fillets without Skin	< 0.0134	0.0134	< 0.00289	0.00289
	UPCC02	Fillets without Skin	0.0857	0.0142	0.0181	0.00301
	UPCC101	Fillets without Skin	0.106	0.0145	0.0232	0.00318
	UPCC102	Fillets without Skin	0.140	0.0136	0.0300	0.00290
	UPCC103	Fillets without Skin	0.135	0.0121	0.0326	0.00292
BDE# 49/71						
	LACA01	Fillets with Skin	0.0219	0.0118	0.00610	0.00329
	LALB01	Fillets with Skin	< 0.0131	0.0131	< 0.00271	0.00271

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LASF01	Fillets with Skin	< 0.0170	0.0170	< 0.00339	0.00339
	LPCA01	Fillets with Skin	0.0271	0.0141	0.00640	0.00334
	LPLB01	Fillets with Skin	< 0.0151	0.0151	< 0.00345	0.00345
	LPSB01	Fillets with Skin	< 0.0179	0.0179	< 0.00352	0.00352
	LPSF01	Fillets with Skin	< 0.0202	0.0202	< 0.00344	0.00344
	UACA01	Fillets with Skin	0.0204	0.00974	0.00570	0.00272
	UALB01	Fillets with Skin	< 0.0153	0.0153	< 0.00341	0.00341
	UASF01	Fillets with Skin	< 0.0143	0.0143	< 0.00294	0.00294
	UPCA01	Fillets with Skin	0.0182	0.0107	0.00530	0.00312
	UPLB01	Fillets with Skin	< 0.0173	0.0173	< 0.00353	0.00353
	UPSF01	Fillets with Skin	< 0.0172	0.0172	< 0.00337	0.00337
	LAAE01	Fillets without Skin	0.0108	0.00838	0.00400	0.00309
	LABC01	Fillets without Skin	0.0232	0.0122	0.00510	0.00269
	LACC01	Fillets without Skin	< 0.0162	0.0162	< 0.00351	0.00351
	LPAE01	Fillets without Skin	0.0196	0.0101	0.00660	0.00340
	LPAE02	Fillets without Skin	0.0133	0.0112	0.00370	0.00312
	LPBC01	Fillets without Skin	< 0.0148	0.0148	< 0.00313	0.00313
	LPBC02	Fillets without Skin	0.0171	0.0170	0.00290	0.00288
	LPBC03	Fillets without Skin	0.0208	0.0158	0.00440	0.00335
	LPBC04	Fillets without Skin	0.0411	0.0136	0.00960	0.00319
	LPCC01	Fillets without Skin	< 0.0177	0.0177	< 0.00338	0.00338
	UAAE01	Fillets without	< 0.00944	0.00944	< 0.00354	0.00354

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.0172	0.0154	0.00360	0.00324
	UACC01	Fillets without Skin	< 0.0153	0.0153	< 0.00350	0.00350
	UPAE01	Fillets without Skin	< 0.00997	0.00997	< 0.00335	0.00335
	UPCC01	Fillets without Skin	< 0.0145	0.0145	< 0.00312	0.00312
	UPCC02	Fillets without Skin	< 0.0154	0.0154	< 0.00324	0.00324
	UPCC101	Fillets without Skin	< 0.0157	0.0157	< 0.00343	0.00343
	UPCC102	Fillets without Skin	< 0.0147	0.0147	< 0.00313	0.00313
	UPCC103	Fillets without Skin	0.0145	0.0131	0.00350	0.00315
BDE# 66						
	LACA01	Fillets with Skin	< 0.0132	0.0132	< 0.00368	0.00368
	LALB01	Fillets with Skin	< 0.0146	0.0146	< 0.00303	0.00303
	LASF01	Fillets with Skin	< 0.0190	0.0190	< 0.00378	0.00378
	LPCA01	Fillets with Skin	< 0.0158	0.0158	< 0.00372	0.00372
	LPLB01	Fillets with Skin	< 0.0168	0.0168	< 0.00386	0.00386
	LPSB01	Fillets with Skin	< 0.0200	0.0200	< 0.00393	0.00393
	LPSF01	Fillets with Skin	< 0.0225	0.0225	< 0.00384	0.00384
	UACA01	Fillets with Skin	< 0.0109	0.0109	< 0.00303	0.00303
	UALB01	Fillets with Skin	< 0.0171	0.0171	< 0.00381	0.00381
	UASF01	Fillets with Skin	< 0.0159	0.0159	< 0.00328	0.00328
	UPCA01	Fillets with Skin	< 0.0120	0.0120	< 0.00349	0.00349
	UPLB01	Fillets with Skin	< 0.0193	0.0193	< 0.00395	0.00395
	UPSF01	Fillets with Skin	< 0.0192	0.0192	< 0.00377	0.00377

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	< 0.00936	0.00936	< 0.00345	0.00345
	LABC01	Fillets without Skin	< 0.0137	0.0137	< 0.00300	0.00300
	LACC01	Fillets without Skin	< 0.0181	0.0181	< 0.00392	0.00392
	LPAE01	Fillets without Skin	< 0.0113	0.0113	< 0.00380	0.00380
	LPAE02	Fillets without Skin	< 0.0125	0.0125	< 0.00348	0.00348
	LPBC01	Fillets without Skin	< 0.0165	0.0165	< 0.00350	0.00350
	LPBC02	Fillets without Skin	< 0.0189	0.0189	< 0.00321	0.00321
	LPBC03	Fillets without Skin	< 0.0177	0.0177	< 0.00375	0.00375
	LPBC04	Fillets without Skin	< 0.0152	0.0152	< 0.00356	0.00356
	LPCC01	Fillets without Skin	< 0.0198	0.0198	< 0.00377	0.00377
	UAAE01	Fillets without Skin	< 0.0105	0.0105	< 0.00395	0.00395
	UABC01	Fillets without Skin	< 0.0172	0.0172	< 0.00362	0.00362
	UACC01	Fillets without Skin	< 0.0170	0.0170	< 0.00391	0.00391
	UPAE01	Fillets without Skin	< 0.0111	0.0111	< 0.00374	0.00374
	UPCC01	Fillets without Skin	< 0.0162	0.0162	< 0.00348	0.00348
	UPCC02	Fillets without Skin	< 0.0172	0.0172	< 0.00362	0.00362
	UPCC101	Fillets without Skin	< 0.0175	0.0175	< 0.00383	0.00383

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	< 0.0164	0.0164	< 0.00350	0.00350
	UPCC103	Fillets without Skin	< 0.0146	0.0146	< 0.00351	0.00351
BDE# 7						
	LACA01	Fillets with Skin	< 0.0214	0.0214	< 0.00596	0.00596
	LALB01	Fillets with Skin	< 0.0237	0.0237	< 0.00491	0.00491
	LASF01	Fillets with Skin	< 0.0308	0.0308	< 0.00613	0.00613
	LPCA01	Fillets with Skin	< 0.0256	0.0256	< 0.00604	0.00604
	LPLB01	Fillets with Skin	< 0.0273	0.0273	< 0.00625	0.00625
	LPSB01	Fillets with Skin	< 0.0325	0.0325	< 0.00637	0.00637
	LPSF01	Fillets with Skin	< 0.0365	0.0365	< 0.00622	0.00622
	UACA01	Fillets with Skin	< 0.0176	0.0176	< 0.00492	0.00492
	UALB01	Fillets with Skin	< 0.0277	0.0277	< 0.00618	0.00618
	UASF01	Fillets with Skin	< 0.0258	0.0258	< 0.00532	0.00532
	UPCA01	Fillets with Skin	< 0.0194	0.0194	< 0.00566	0.00566
	UPLB01	Fillets with Skin	< 0.0313	0.0313	< 0.00640	0.00640
	UPSF01	Fillets with Skin	< 0.0312	0.0312	< 0.00611	0.00611
	LAAE01	Fillets without Skin	< 0.0152	0.0152	< 0.00560	0.00560
	LABC01	Fillets without Skin	< 0.0221	0.0221	< 0.00487	0.00487
	LACC01	Fillets without Skin	< 0.0293	0.0293	< 0.00635	0.00635
	LPAE01	Fillets without Skin	< 0.0183	0.0183	< 0.00616	0.00616
	LPAE02	Fillets without Skin	< 0.0203	0.0203	< 0.00565	0.00565
	LPBC01	Fillets without Skin	< 0.0267	0.0267	< 0.00567	0.00567
	LPBC02	Fillets without Skin	< 0.0307	0.0307	< 0.00521	0.00521

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	< 0.0287	0.0287	< 0.00607	0.00607
	LPBC04	Fillets without Skin	< 0.0247	0.0247	< 0.00577	0.00577
	LPCC01	Fillets without Skin	< 0.0320	0.0320	< 0.00612	0.00612
	UAAE01	Fillets without Skin	< 0.0171	0.0171	< 0.00641	0.00641
	UABC01	Fillets without Skin	< 0.0279	0.0279	< 0.00586	0.00586
	UACC01	Fillets without Skin	< 0.0276	0.0276	< 0.00633	0.00633
	UPAE01	Fillets without Skin	< 0.0180	0.0180	< 0.00606	0.00606
	UPCC01	Fillets without Skin	< 0.0262	0.0262	< 0.00565	0.00565
	UPCC02	Fillets without Skin	< 0.0278	0.0278	< 0.00587	0.00587
	UPCC101	Fillets without Skin	< 0.0284	0.0284	< 0.00621	0.00621
	UPCC102	Fillets without Skin	< 0.0265	0.0265	< 0.00567	0.00567
	UPCC103	Fillets without Skin	< 0.0236	0.0236	< 0.00570	0.00570
BDE# 75						
	LACA01	Fillets with Skin	< 0.0118	0.0118	< 0.00329	0.00329
	LALB01	Fillets with Skin	< 0.0131	0.0131	< 0.00271	0.00271
	LASF01	Fillets with Skin	< 0.0170	0.0170	< 0.00339	0.00339
	LPCA01	Fillets with Skin	< 0.0141	0.0141	< 0.00334	0.00334
	LPLB01	Fillets with Skin	< 0.0151	0.0151	< 0.00345	0.00345
	LPSB01	Fillets with Skin	< 0.0179	0.0179	< 0.00352	0.00352
	LPSF01	Fillets with Skin	< 0.0202	0.0202	< 0.00344	0.00344
	UACA01	Fillets with Skin	< 0.00974	0.00974	< 0.00272	0.00272

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	< 0.0153	0.0153	< 0.00341	0.00341
	UASF01	Fillets with Skin	< 0.0143	0.0143	< 0.00294	0.00294
	UPCA01	Fillets with Skin	< 0.0107	0.0107	< 0.00312	0.00312
	UPLB01	Fillets with Skin	< 0.0173	0.0173	< 0.00353	0.00353
	UPSF01	Fillets with Skin	< 0.0172	0.0172	< 0.00337	0.00337
	LAAE01	Fillets without Skin	< 0.00838	0.00838	< 0.00309	0.00309
	LABC01	Fillets without Skin	< 0.0122	0.0122	< 0.00269	0.00269
	LACC01	Fillets without Skin	< 0.0162	0.0162	< 0.00351	0.00351
	LPAE01	Fillets without Skin	< 0.0101	0.0101	< 0.00340	0.00340
	LPAE02	Fillets without Skin	< 0.0112	0.0112	< 0.00312	0.00312
	LPBC01	Fillets without Skin	< 0.0148	0.0148	< 0.00313	0.00313
	LPBC02	Fillets without Skin	< 0.0170	0.0170	< 0.00288	0.00288
	LPBC03	Fillets without Skin	< 0.0158	0.0158	< 0.00335	0.00335
	LPBC04	Fillets without Skin	< 0.0136	0.0136	< 0.00319	0.00319
	LPCC01	Fillets without Skin	< 0.0177	0.0177	< 0.00338	0.00338
	UAAE01	Fillets without Skin	< 0.00944	0.00944	< 0.00354	0.00354
	UABC01	Fillets without Skin	< 0.0154	0.0154	< 0.00324	0.00324
	UACC01	Fillets without Skin	< 0.0153	0.0153	< 0.00350	0.00350
	UPAE01	Fillets without Skin	< 0.00997	0.00997	< 0.00335	0.00335

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	< 0.0145	0.0145	< 0.00312	0.00312
	UPCC02	Fillets without Skin	< 0.0154	0.0154	< 0.00324	0.00324
	UPCC101	Fillets without Skin	< 0.0157	0.0157	< 0.00343	0.00343
	UPCC102	Fillets without Skin	< 0.0147	0.0147	< 0.00313	0.00313
	UPCC103	Fillets without Skin	< 0.0131	0.0131	< 0.00315	0.00315
BDE# 77						
	LACA01	Fillets with Skin	< 0.0118	0.0118	< 0.00329	0.00329
	LALB01	Fillets with Skin	< 0.0131	0.0131	< 0.00271	0.00271
	LASF01	Fillets with Skin	< 0.0170	0.0170	< 0.00339	0.00339
	LPCA01	Fillets with Skin	< 0.0141	0.0141	< 0.00334	0.00334
	LPLB01	Fillets with Skin	< 0.0151	0.0151	< 0.00345	0.00345
	LPSB01	Fillets with Skin	< 0.0179	0.0179	< 0.00352	0.00352
	LPSF01	Fillets with Skin	< 0.0202	0.0202	< 0.00344	0.00344
	UACA01	Fillets with Skin	< 0.00974	0.00974	< 0.00272	0.00272
	UALB01	Fillets with Skin	< 0.0153	0.0153	< 0.00341	0.00341
	UASF01	Fillets with Skin	< 0.0143	0.0143	< 0.00294	0.00294
	UPCA01	Fillets with Skin	< 0.0107	0.0107	< 0.00312	0.00312
	UPLB01	Fillets with Skin	< 0.0173	0.0173	< 0.00353	0.00353
	UPSF01	Fillets with Skin	< 0.0172	0.0172	< 0.00337	0.00337
	LAAE01	Fillets without Skin	< 0.00838	0.00838	< 0.00309	0.00309
	LABC01	Fillets without Skin	< 0.0122	0.0122	< 0.00269	0.00269
	LACC01	Fillets without Skin	< 0.0162	0.0162	< 0.00351	0.00351
	LPAE01	Fillets without Skin	< 0.0101	0.0101	< 0.00340	0.00340

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 0.0112	0.0112	< 0.00312	0.00312
	LPBC01	Fillets without Skin	< 0.0148	0.0148	< 0.00313	0.00313
	LPBC02	Fillets without Skin	< 0.0170	0.0170	< 0.00288	0.00288
	LPBC03	Fillets without Skin	< 0.0158	0.0158	< 0.00335	0.00335
	LPBC04	Fillets without Skin	< 0.0136	0.0136	< 0.00319	0.00319
	LPCC01	Fillets without Skin	< 0.0177	0.0177	< 0.00338	0.00338
	UAAE01	Fillets without Skin	< 0.00944	0.00944	< 0.00354	0.00354
	UABC01	Fillets without Skin	< 0.0154	0.0154	< 0.00324	0.00324
	UACC01	Fillets without Skin	< 0.0153	0.0153	< 0.00350	0.00350
	UPAE01	Fillets without Skin	< 0.00997	0.00997	< 0.00335	0.00335
	UPCC01	Fillets without Skin	< 0.0145	0.0145	< 0.00312	0.00312
	UPCC02	Fillets without Skin	< 0.0154	0.0154	< 0.00324	0.00324
	UPCC101	Fillets without Skin	< 0.0157	0.0157	< 0.00343	0.00343
	UPCC102	Fillets without Skin	< 0.0147	0.0147	< 0.00313	0.00313
	UPCC103	Fillets without Skin	< 0.0131	0.0131	< 0.00315	0.00315
BDE# 8						
	LACA01	Fillets with Skin	< 0.0214	0.0214	< 0.00596	0.00596
	LALB01	Fillets with Skin	< 0.0237	0.0237	< 0.00491	0.00491

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LASF01	Fillets with Skin	< 0.0308	0.0308	< 0.00613	0.00613
	LPCA01	Fillets with Skin	< 0.0256	0.0256	< 0.00604	0.00604
	LPLB01	Fillets with Skin	< 0.0273	0.0273	< 0.00625	0.00625
	LPSB01	Fillets with Skin	< 0.0325	0.0325	< 0.00637	0.00637
	LPSF01	Fillets with Skin	< 0.0365	0.0365	< 0.00622	0.00622
	UACA01	Fillets with Skin	< 0.0176	0.0176	< 0.00492	0.00492
	UALB01	Fillets with Skin	< 0.0277	0.0277	< 0.00618	0.00618
	UASF01	Fillets with Skin	< 0.0258	0.0258	< 0.00532	0.00532
	UPCA01	Fillets with Skin	< 0.0194	0.0194	< 0.00566	0.00566
	UPLB01	Fillets with Skin	< 0.0313	0.0313	< 0.00640	0.00640
	UPSF01	Fillets with Skin	< 0.0312	0.0312	< 0.00611	0.00611
	LAAE01	Fillets without Skin	< 0.0152	0.0152	< 0.00560	0.00560
	LABC01	Fillets without Skin	< 0.0221	0.0221	< 0.00487	0.00487
	LACC01	Fillets without Skin	< 0.0293	0.0293	< 0.00635	0.00635
	LPAE01	Fillets without Skin	< 0.0183	0.0183	< 0.00616	0.00616
	LPAE02	Fillets without Skin	< 0.0203	0.0203	< 0.00565	0.00565
	LPBC01	Fillets without Skin	< 0.0267	0.0267	< 0.00567	0.00567
	LPBC02	Fillets without Skin	< 0.0307	0.0307	< 0.00521	0.00521
	LPBC03	Fillets without Skin	< 0.0287	0.0287	< 0.00607	0.00607
	LPBC04	Fillets without Skin	< 0.0247	0.0247	< 0.00577	0.00577
	LPCC01	Fillets without Skin	< 0.0320	0.0320	< 0.00612	0.00612
	UAAE01	Fillets without	< 0.0171	0.0171	< 0.00641	0.00641

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	< 0.0279	0.0279	< 0.00586	0.00586
	UACC01	Fillets without Skin	< 0.0276	0.0276	< 0.00633	0.00633
	UPAE01	Fillets without Skin	< 0.0180	0.0180	< 0.00606	0.00606
	UPCC01	Fillets without Skin	< 0.0262	0.0262	< 0.00565	0.00565
	UPCC02	Fillets without Skin	< 0.0278	0.0278	< 0.00587	0.00587
	UPCC101	Fillets without Skin	< 0.0284	0.0284	< 0.00621	0.00621
	UPCC102	Fillets without Skin	< 0.0265	0.0265	< 0.00567	0.00567
	UPCC103	Fillets without Skin	< 0.0236	0.0236	< 0.00570	0.00570
BDE# 85						
	LACA01	Fillets with Skin	< 0.0128	0.0128	< 0.00358	0.00358
	LALB01	Fillets with Skin	< 0.0143	0.0143	< 0.00295	0.00295
	LASF01	Fillets with Skin	< 0.0185	0.0185	< 0.00368	0.00368
	LPCA01	Fillets with Skin	< 0.0154	0.0154	< 0.00363	0.00363
	LPLB01	Fillets with Skin	< 0.0164	0.0164	< 0.00375	0.00375
	LPSB01	Fillets with Skin	< 0.0195	0.0195	< 0.00383	0.00383
	LPSF01	Fillets with Skin	< 0.0219	0.0219	< 0.00374	0.00374
	UACA01	Fillets with Skin	< 0.0106	0.0106	< 0.00295	0.00295
	UALB01	Fillets with Skin	< 0.0166	0.0166	< 0.00371	0.00371
	UASF01	Fillets with Skin	< 0.0155	0.0155	< 0.00320	0.00320
	UPCA01	Fillets with Skin	< 0.0117	0.0117	< 0.00340	0.00340
	UPLB01	Fillets with Skin	< 0.0188	0.0188	< 0.00384	0.00384
	UPSF01	Fillets with Skin	< 0.0187	0.0187	< 0.00367	0.00367

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	< 0.00912	0.00912	< 0.00336	0.00336
	LABC01	Fillets without Skin	< 0.0133	0.0133	< 0.00293	0.00293
	LACC01	Fillets without Skin	< 0.0176	0.0176	< 0.00381	0.00381
	LPAE01	Fillets without Skin	< 0.0110	0.0110	< 0.00370	0.00370
	LPAE02	Fillets without Skin	< 0.0122	0.0122	< 0.00339	0.00339
	LPBC01	Fillets without Skin	< 0.0161	0.0161	< 0.00340	0.00340
	LPBC02	Fillets without Skin	< 0.0185	0.0185	< 0.00313	0.00313
	LPBC03	Fillets without Skin	< 0.0172	0.0172	< 0.00365	0.00365
	LPBC04	Fillets without Skin	< 0.0148	0.0148	< 0.00346	0.00346
	LPCC01	Fillets without Skin	< 0.0193	0.0193	< 0.00368	0.00368
	UAAE01	Fillets without Skin	< 0.0103	0.0103	< 0.00385	0.00385
	UABC01	Fillets without Skin	< 0.0168	0.0168	< 0.00352	0.00352
	UACC01	Fillets without Skin	< 0.0166	0.0166	< 0.00381	0.00381
	UPAE01	Fillets without Skin	< 0.0108	0.0108	< 0.00364	0.00364
	UPCC01	Fillets without Skin	< 0.0157	0.0157	< 0.00339	0.00339
	UPCC02	Fillets without Skin	< 0.0167	0.0167	< 0.00353	0.00353
	UPCC101	Fillets without Skin	< 0.0170	0.0170	< 0.00373	0.00373

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	< 0.0159	0.0159	< 0.00340	0.00340
	UPCC103	Fillets without Skin	< 0.0142	0.0142	< 0.00342	0.00342
BDE# 99						
	LACA01	Fillets with Skin	< 0.0101	0.0101	< 0.00281	0.00281
	LALB01	Fillets with Skin	0.0392	0.0112	0.00810	0.00232
	LASF01	Fillets with Skin	0.0191	0.0145	0.00380	0.00289
	LPCA01	Fillets with Skin	< 0.0121	0.0121	< 0.00285	0.00285
	LPLB01	Fillets with Skin	< 0.0129	0.0129	< 0.00295	0.00295
	LPSB01	Fillets with Skin	0.0286	0.0153	0.00560	0.00301
	LPSF01	Fillets with Skin	< 0.0172	0.0172	< 0.00294	0.00294
	UACA01	Fillets with Skin	< 0.00832	0.00832	< 0.00232	0.00232
	UALB01	Fillets with Skin	0.0255	0.0131	0.00570	0.00291
	UASF01	Fillets with Skin	0.0316	0.0122	0.00650	0.00251
	UPCA01	Fillets with Skin	< 0.00916	0.00916	< 0.00267	0.00267
	UPLB01	Fillets with Skin	0.0303	0.0148	0.00620	0.00302
	UPSF01	Fillets with Skin	< 0.0147	0.0147	< 0.00288	0.00288
	LAAE01	Fillets without Skin	0.0103	0.00716	0.00380	0.00264
	LABC01	Fillets without Skin	0.0741	0.0104	0.0163	0.00230
	LACC01	Fillets without Skin	0.156	0.0138	0.0337	0.00299
	LPAE01	Fillets without Skin	0.0210	0.00862	0.00710	0.00291
	LPAE02	Fillets without Skin	< 0.00959	0.00959	< 0.00266	0.00266
	LPBC01	Fillets without Skin	< 0.0126	0.0126	< 0.00267	0.00267
	LPBC02	Fillets without Skin	0.0289	0.0145	0.00490	0.00246

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	0.0250	0.0135	0.00530	0.00286
	LPBC04	Fillets without Skin	0.0257	0.0116	0.00600	0.00272
	LPCC01	Fillets without Skin	0.0293	0.0151	0.00560	0.00289
	UAAE01	Fillets without Skin	0.0149	0.00806	0.00560	0.00302
	UABC01	Fillets without Skin	0.102	0.0132	0.0213	0.00276
	UACC01	Fillets without Skin	0.161	0.0130	0.0368	0.00299
	UPAE01	Fillets without Skin	< 0.00851	0.00851	< 0.00286	0.00286
	UPCC01	Fillets without Skin	0.0381	0.0124	0.00820	0.00266
	UPCC02	Fillets without Skin	0.0403	0.0131	0.00850	0.00277
	UPCC101	Fillets without Skin	0.0616	0.0134	0.0135	0.00293
	UPCC102	Fillets without Skin	0.0796	0.0125	0.0170	0.00267
	UPCC103	Fillets without Skin	0.0556	0.0111	0.0134	0.00269
BHC (Total)						
	LACA01	Fillets with Skin	< 0.00283	0.00283	< 0.000788	0.000788
	LALB01	Fillets with Skin	< 0.00386	0.00386	< 0.000797	0.000797
	*LASF01	Fillets with Skin	< 0.00390	0.00390	< 0.000776	0.000776
	LPCA01	Fillets with Skin	< 0.00324	0.00324	< 0.000764	0.000764
	LPLB01	Fillets with Skin	< 0.00346	0.00346	< 0.000793	0.000793
	LPSB01	Fillets with Skin	< 0.00362	0.00362	< 0.000710	0.000710
	*LPSF01	Fillets with Skin	< 0.00428	0.00428	< 0.000729	0.000729
	UACA01	Fillets with Skin	< 0.00272	0.00272	< 0.000760	0.000760

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	< 0.00348	0.00348	< 0.000777	0.000777
	UASF01	Fillets with Skin	< 0.00376	0.00376	< 0.000774	0.000774
	UPCA01	Fillets with Skin	< 0.00254	0.00254	< 0.000740	0.000740
	UPLB01	Fillets with Skin	< 0.00382	0.00382	< 0.000780	0.000780
	UPSF01	Fillets with Skin	< 0.00391	0.00391	< 0.000765	0.000765
	LAAE01	Fillets without Skin	< 0.00204	0.00204	< 0.000754	0.000754
	LABC01	Fillets without Skin	< 0.00359	0.00359	< 0.000789	0.000789
	LACC01	Fillets without Skin	< 0.00344	0.00344	< 0.000746	0.000746
	LPAE01	Fillets without Skin	< 0.00237	0.00237	< 0.000800	0.000800
	LPAE02	Fillets without Skin	0.00777	0.00283	0.00216	0.000786
	LPBC01	Fillets without Skin	< 0.00355	0.00355	< 0.000753	0.000753
	LPBC02	Fillets without Skin	< 0.00415	0.00415	< 0.000704	0.000704
	LPBC03	Fillets without Skin	< 0.00329	0.00329	< 0.000698	0.000698
	LPBC04	Fillets without Skin	< 0.00345	0.00345	< 0.000805	0.000805
	LPCC01	Fillets without Skin	< 0.00423	0.00423	< 0.000807	0.000807
	UAAE01	Fillets without Skin	0.00650	0.00201	0.00244	0.000754
	UABC01	Fillets without Skin	< 0.00368	0.00368	< 0.000771	0.000771
	UACC01	Fillets without Skin	< 0.00322	0.00322	< 0.000737	0.000737
	UPAE01	Fillets without Skin	< 0.00212	0.00212	< 0.000711	0.000711

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	< 0.00367	0.00367	< 0.000791	0.000791
	UPCC02	Fillets without Skin	< 0.00375	0.00375	< 0.000791	0.000791
	UPCC101	Fillets without Skin	< 0.00360	0.00360	< 0.000789	0.000789
	UPCC102	Fillets without Skin	< 0.00371	0.00371	< 0.000793	0.000793
	UPCC103	Fillets without Skin	< 0.00331	0.00331	< 0.000797	0.000797
Benzo(a)anthracene						
	LACA01	Fillets with Skin	< 0.00133	0.00133	< 0.000371	0.000371
	LALB01	Fillets with Skin	< 0.00182	0.00182	< 0.000375	0.000375
	LASF01	Fillets with Skin	< 0.00184	0.00184	< 0.000365	0.000365
	LPCA01	Fillets with Skin	< 0.00153	0.00153	< 0.000360	0.000360
	LPLB01	Fillets with Skin	< 0.00163	0.00163	< 0.000373	0.000373
	LPSB01	Fillets with Skin	< 0.00171	0.00171	< 0.000335	0.000335
	LPSF01	Fillets with Skin	< 0.00202	0.00202	< 0.000344	0.000344
	UACA01	Fillets with Skin	< 0.00128	0.00128	< 0.000358	0.000358
	UALB01	Fillets with Skin	< 0.00164	0.00164	< 0.000366	0.000366
	UASF01	Fillets with Skin	< 0.00177	0.00177	< 0.000365	0.000365
	UPCA01	Fillets with Skin	< 0.00120	0.00120	< 0.000349	0.000349
	UPLB01	Fillets with Skin	< 0.00180	0.00180	< 0.000368	0.000368
	UPSF01	Fillets with Skin	< 0.00184	0.00184	< 0.000361	0.000361
	LAAE01	Fillets without Skin	< 0.000963	0.000963	< 0.000355	0.000355
	LABC01	Fillets without Skin	< 0.00169	0.00169	< 0.000372	0.000372
	LACC01	Fillets without Skin	< 0.00162	0.00162	< 0.000351	0.000351
	LPAE01	Fillets without Skin	< 0.00112	0.00112	< 0.000377	0.000377

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 0.00133	0.00133	< 0.000370	0.000370
	LPBC01	Fillets without Skin	< 0.00167	0.00167	< 0.000354	0.000354
	LPBC02	Fillets without Skin	< 0.00196	0.00196	< 0.000332	0.000332
	LPBC03	Fillets without Skin	< 0.00155	0.00155	< 0.000329	0.000329
	LPBC04	Fillets without Skin	< 0.00162	0.00162	< 0.000379	0.000379
	LPCC01	Fillets without Skin	< 0.00199	0.00199	< 0.000380	0.000380
	UAAE01	Fillets without Skin	< 0.000945	0.000945	< 0.000354	0.000354
	UABC01	Fillets without Skin	< 0.00173	0.00173	< 0.000363	0.000363
	UACC01	Fillets without Skin	0.00174	0.00152	0.000400	0.000347
	UPAE01	Fillets without Skin	< 0.000998	0.000998	< 0.000335	0.000335
	UPCC01	Fillets without Skin	< 0.00173	0.00173	< 0.000373	0.000373
	UPCC02	Fillets without Skin	< 0.00176	0.00176	< 0.000373	0.000373
	UPCC101	Fillets without Skin	< 0.00170	0.00170	< 0.000372	0.000372
	UPCC102	Fillets without Skin	< 0.00175	0.00175	< 0.000373	0.000373
	UPCC103	Fillets without Skin	< 0.00156	0.00156	< 0.000375	0.000375
C1-Fluoranthenes & Pyrenes						
	LACA01	Fillets with Skin	< 0.00216	0.00216	< 0.000604	0.000604
	LALB01	Fillets with Skin	< 0.00295	0.00295	< 0.000611	0.000611

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LASF01	Fillets with Skin	< 0.00299	0.00299	< 0.000594	0.000594
	LPCA01	Fillets with Skin	< 0.00248	0.00248	< 0.000585	0.000585
	LPLB01	Fillets with Skin	< 0.00265	0.00265	< 0.000607	0.000607
	LPSB01	Fillets with Skin	< 0.00277	0.00277	< 0.000544	0.000544
	LPSF01	Fillets with Skin	< 0.00328	0.00328	< 0.000559	0.000559
	UACA01	Fillets with Skin	< 0.00209	0.00209	< 0.000582	0.000582
	UALB01	Fillets with Skin	< 0.00267	0.00267	< 0.000595	0.000595
	UASF01	Fillets with Skin	< 0.00288	0.00288	< 0.000593	0.000593
	UPCA01	Fillets with Skin	< 0.00195	0.00195	< 0.000567	0.000567
	UPLB01	Fillets with Skin	< 0.00292	0.00292	< 0.000598	0.000598
	UPSF01	Fillets with Skin	< 0.00299	0.00299	< 0.000586	0.000586
	LAAE01	Fillets without Skin	0.0122	0.00157	0.00450	0.000578
	LABC01	Fillets without Skin	< 0.00275	0.00275	< 0.000605	0.000605
	LACC01	Fillets without Skin	< 0.00264	0.00264	< 0.000571	0.000571
	LPAE01	Fillets without Skin	< 0.00182	0.00182	< 0.000613	0.000613
	LPAE02	Fillets without Skin	< 0.00217	0.00217	< 0.000602	0.000602
	LPBC01	Fillets without Skin	< 0.00272	0.00272	< 0.000576	0.000576
	LPBC02	Fillets without Skin	< 0.00318	0.00318	< 0.000539	0.000539
	LPBC03	Fillets without Skin	< 0.00252	0.00252	< 0.000535	0.000535
	LPBC04	Fillets without Skin	0.00899	0.00264	0.00210	0.000617
	LPCC01	Fillets without Skin	< 0.00324	0.00324	< 0.000618	0.000618
	UAAE01	Fillets without	< 0.00154	0.00154	< 0.000576	0.000576

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	< 0.00282	0.00282	< 0.000591	0.000591
	UACC01	Fillets without Skin	< 0.00246	0.00246	< 0.000565	0.000565
	UPAE01	Fillets without Skin	< 0.00162	0.00162	< 0.000545	0.000545
	UPCC01	Fillets without Skin	< 0.00281	0.00281	< 0.000606	0.000606
	UPCC02	Fillets without Skin	< 0.00287	0.00287	< 0.000606	0.000606
	UPCC101	Fillets without Skin	< 0.00276	0.00276	< 0.000605	0.000605
	UPCC102	Fillets without Skin	< 0.00284	0.00284	< 0.000607	0.000607
	UPCC103	Fillets without Skin	< 0.00253	0.00253	< 0.000611	0.000611
C1-Phenanthrenes & Anthracenes						
	LACA01	Fillets with Skin	0.0136	0.00209	0.00380	0.000582
	LALB01	Fillets with Skin	0.00484	0.00285	0.00100	0.000589
	LASF01	Fillets with Skin	0.00502	0.00288	0.00100	0.000573
	LPCA01	Fillets with Skin	0.00721	0.00239	0.00170	0.000564
	LPLB01	Fillets with Skin	0.00306	0.00256	0.000700	0.000585
	LPSB01	Fillets with Skin	< 0.00268	0.00268	< 0.000525	0.000525
	LPSF01	Fillets with Skin	0.00352	0.00316	0.000600	0.000539
	UACA01	Fillets with Skin	0.0151	0.00201	0.00420	0.000561
	UALB01	Fillets with Skin	< 0.00257	0.00257	< 0.000574	0.000574
	UASF01	Fillets with Skin	0.00437	0.00278	0.000900	0.000572
	UPCA01	Fillets with Skin	0.0148	0.00188	0.00430	0.000547
	UPLB01	Fillets with Skin	0.00294	0.00282	0.000600	0.000576
	UPSF01	Fillets with Skin	< 0.00289	0.00289	< 0.000565	0.000565

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	0.00976	0.00151	0.00360	0.000557
	LABC01	Fillets without Skin	< 0.00265	0.00265	< 0.000583	0.000583
	LACC01	Fillets without Skin	0.0208	0.00254	0.00450	0.000551
	LPAE01	Fillets without Skin	< 0.00175	0.00175	< 0.000591	0.000591
	LPAE02	Fillets without Skin	0.00468	0.00209	0.00130	0.000581
	LPBC01	Fillets without Skin	< 0.00262	0.00262	< 0.000556	0.000556
	LPBC02	Fillets without Skin	< 0.00307	0.00307	< 0.000520	0.000520
	LPBC03	Fillets without Skin	< 0.00243	0.00243	< 0.000516	0.000516
	LPBC04	Fillets without Skin	< 0.00255	0.00255	< 0.000595	0.000595
	LPCC01	Fillets without Skin	< 0.00312	0.00312	< 0.000596	0.000596
	UAAE01	Fillets without Skin	< 0.00148	0.00148	< 0.000556	0.000556
	UABC01	Fillets without Skin	< 0.00272	0.00272	< 0.000570	0.000570
	UACC01	Fillets without Skin	0.0135	0.00238	0.00310	0.000545
	UPAE01	Fillets without Skin	0.00506	0.00156	0.00170	0.000526
	UPCC01	Fillets without Skin	0.00836	0.00271	0.00180	0.000584
	UPCC02	Fillets without Skin	0.0298	0.00277	0.00630	0.000584
	UPCC101	Fillets without Skin	0.0110	0.00266	0.00240	0.000583

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	0.00890	0.00274	0.00190	0.000585
	UPCC103	Fillets without Skin	< 0.00244	0.00244	< 0.000589	0.000589
C1-chrysenes						
	LACA01	Fillets with Skin	< 0.00332	0.00332	< 0.000924	0.000924
	LALB01	Fillets with Skin	< 0.00452	0.00452	< 0.000935	0.000935
	LASF01	Fillets with Skin	< 0.00457	0.00457	< 0.000910	0.000910
	LPCA01	Fillets with Skin	< 0.00380	0.00380	< 0.000896	0.000896
	LPLB01	Fillets with Skin	< 0.00406	0.00406	< 0.000929	0.000929
	LPSB01	Fillets with Skin	< 0.00425	0.00425	< 0.000833	0.000833
	LPSF01	Fillets with Skin	< 0.00502	0.00502	< 0.000855	0.000855
	UACA01	Fillets with Skin	< 0.00320	0.00320	< 0.000891	0.000891
	UALB01	Fillets with Skin	< 0.00408	0.00408	< 0.000911	0.000911
	UASF01	Fillets with Skin	< 0.00441	0.00441	< 0.000908	0.000908
	UPCA01	Fillets with Skin	< 0.00298	0.00298	< 0.000868	0.000868
	UPLB01	Fillets with Skin	< 0.00448	0.00448	< 0.000915	0.000915
	UPSF01	Fillets with Skin	< 0.00458	0.00458	< 0.000898	0.000898
	LAAE01	Fillets without Skin	< 0.00240	0.00240	< 0.000884	0.000884
	LABC01	Fillets without Skin	< 0.00421	0.00421	< 0.000926	0.000926
	LACC01	Fillets without Skin	< 0.00404	0.00404	< 0.000874	0.000874
	LPAE01	Fillets without Skin	< 0.00278	0.00278	< 0.000938	0.000938
	LPAE02	Fillets without Skin	< 0.00332	0.00332	< 0.000922	0.000922
	LPBC01	Fillets without Skin	< 0.00416	0.00416	< 0.000882	0.000882
	LPBC02	Fillets without Skin	< 0.00487	0.00487	< 0.000825	0.000825

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	< 0.00386	0.00386	< 0.000818	0.000818
	LPBC04	Fillets without Skin	< 0.00404	0.00404	< 0.000944	0.000944
	LPCC01	Fillets without Skin	< 0.00496	0.00496	< 0.000946	0.000946
	UAAE01	Fillets without Skin	< 0.00235	0.00235	< 0.000882	0.000882
	UABC01	Fillets without Skin	< 0.00431	0.00431	< 0.000904	0.000904
	UACC01	Fillets without Skin	< 0.00377	0.00377	< 0.000865	0.000865
	UPAE01	Fillets without Skin	< 0.00248	0.00248	< 0.000834	0.000834
	UPCC01	Fillets without Skin	< 0.00431	0.00431	< 0.000927	0.000927
	UPCC02	Fillets without Skin	< 0.00439	0.00439	< 0.000927	0.000927
	UPCC101	Fillets without Skin	< 0.00423	0.00423	< 0.000926	0.000926
	UPCC102	Fillets without Skin	< 0.00435	0.00435	< 0.000929	0.000929
	UPCC103	Fillets without Skin	< 0.00388	0.00388	< 0.000935	0.000935
C1-dibenzothiophenes						
	LACA01	Fillets with Skin	0.00754	0.00239	0.00210	0.000666
	LALB01	Fillets with Skin	< 0.00326	0.00326	< 0.000674	0.000674
	LASF01	Fillets with Skin	< 0.00330	0.00330	< 0.000656	0.000656
	LPCA01	Fillets with Skin	0.00466	0.00274	0.00110	0.000646
	LPLB01	Fillets with Skin	< 0.00293	0.00293	< 0.000670	0.000670
	LPSB01	Fillets with Skin	< 0.00306	0.00306	< 0.000600	0.000600
	LPSF01	Fillets with Skin	< 0.00362	0.00362	< 0.000617	0.000617
	UACA01	Fillets with Skin	< 0.00230	0.00230	< 0.000642	0.000642

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	< 0.00294	0.00294	< 0.000657	0.000657
	UASF01	Fillets with Skin	< 0.00318	0.00318	< 0.000655	0.000655
	UPCA01	Fillets with Skin	0.00789	0.00215	0.00230	0.000626
	UPLB01	Fillets with Skin	< 0.00323	0.00323	< 0.000660	0.000660
	UPSF01	Fillets with Skin	< 0.00330	0.00330	< 0.000647	0.000647
	LAAE01	Fillets without Skin	0.0108	0.00173	0.00400	0.000637
	LABC01	Fillets without Skin	< 0.00303	0.00303	< 0.000667	0.000667
	LACC01	Fillets without Skin	< 0.00291	0.00291	< 0.000630	0.000630
	LPAE01	Fillets without Skin	< 0.00200	0.00200	< 0.000677	0.000677
	LPAE02	Fillets without Skin	< 0.00239	0.00239	< 0.000665	0.000665
	LPBC01	Fillets without Skin	< 0.00300	0.00300	< 0.000636	0.000636
	LPBC02	Fillets without Skin	< 0.00351	0.00351	< 0.000595	0.000595
	LPBC03	Fillets without Skin	< 0.00278	0.00278	< 0.000590	0.000590
	LPBC04	Fillets without Skin	< 0.00291	0.00291	< 0.000681	0.000681
	LPCC01	Fillets without Skin	< 0.00357	0.00357	< 0.000682	0.000682
	UAAE01	Fillets without Skin	0.0144	0.00170	0.00540	0.000636
	UABC01	Fillets without Skin	< 0.00311	0.00311	< 0.000652	0.000652
	UACC01	Fillets without Skin	< 0.00272	0.00272	< 0.000623	0.000623
	UPAE01	Fillets without Skin	< 0.00179	0.00179	< 0.000601	0.000601

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	< 0.00310	0.00310	< 0.000669	0.000669
	UPCC02	Fillets without Skin	0.0114	0.00317	0.00240	0.000669
	UPCC101	Fillets without Skin	0.00913	0.00305	0.00200	0.000667
	UPCC102	Fillets without Skin	0.00515	0.00314	0.00110	0.000670
	UPCC103	Fillets without Skin	0.00456	0.00280	0.00110	0.000674
C1-fluorenes						
	LACA01	Fillets with Skin	< 0.00291	0.00291	< 0.000811	0.000811
	LALB01	Fillets with Skin	0.00677	0.00397	0.00140	0.000820
	LASF01	Fillets with Skin	0.00402	0.00401	0.000800	0.000798
	LPCA01	Fillets with Skin	0.00678	0.00333	0.00160	0.000786
	LPLB01	Fillets with Skin	0.00393	0.00356	0.000900	0.000815
	LPSB01	Fillets with Skin	0.00408	0.00373	0.000800	0.000731
	LPSF01	Fillets with Skin	< 0.00440	0.00440	< 0.000750	0.000750
	UACA01	Fillets with Skin	< 0.00280	0.00280	< 0.000782	0.000782
	UALB01	Fillets with Skin	0.00762	0.00358	0.00170	0.000800
	UASF01	Fillets with Skin	< 0.00387	0.00387	< 0.000797	0.000797
	UPCA01	Fillets with Skin	0.0237	0.00261	0.00690	0.000761
	UPLB01	Fillets with Skin	0.00489	0.00393	0.00100	0.000803
	UPSF01	Fillets with Skin	< 0.00402	0.00402	< 0.000787	0.000787
	LAAE01	Fillets without Skin	0.00732	0.00210	0.00270	0.000776
	LABC01	Fillets without Skin	< 0.00369	0.00369	< 0.000812	0.000812
	LACC01	Fillets without Skin	< 0.00354	0.00354	< 0.000767	0.000767
	LPAE01	Fillets without Skin	0.00415	0.00244	0.00140	0.000823

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	0.00540	0.00291	0.00150	0.000809
	LPBC01	Fillets without Skin	0.0227	0.00365	0.00480	0.000774
	LPBC02	Fillets without Skin	< 0.00427	0.00427	< 0.000724	0.000724
	LPBC03	Fillets without Skin	< 0.00339	0.00339	< 0.000718	0.000718
	LPBC04	Fillets without Skin	0.00899	0.00355	0.00210	0.000828
	LPCC01	Fillets without Skin	0.00786	0.00435	0.00150	0.000830
	UAAE01	Fillets without Skin	0.0101	0.00206	0.00380	0.000774
	UABC01	Fillets without Skin	< 0.00378	0.00378	< 0.000793	0.000793
	UACC01	Fillets without Skin	< 0.00331	0.00331	< 0.000759	0.000759
	UPAE01	Fillets without Skin	0.00744	0.00218	0.00250	0.000732
	UPCC01	Fillets without Skin	0.00882	0.00378	0.00190	0.000814
	UPCC02	Fillets without Skin	0.0379	0.00386	0.00800	0.000814
	UPCC101	Fillets without Skin	0.0123	0.00371	0.00270	0.000812
	UPCC102	Fillets without Skin	0.00749	0.00382	0.00160	0.000815
	UPCC103	Fillets without Skin	0.0116	0.00340	0.00280	0.000820
C1-naphthalenes						
	LACA01	Fillets with Skin	0.0574	0.00553	0.0160	0.00154
	LALB01	Fillets with Skin	< 0.00754	0.00754	< 0.00156	0.00156

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LASF01	Fillets with Skin	< 0.00762	0.00762	< 0.00152	0.00152
	LPCA01	Fillets with Skin	0.0195	0.00634	0.00460	0.00149
	LPLB01	Fillets with Skin	< 0.00678	0.00678	< 0.00155	0.00155
	LPSB01	Fillets with Skin	< 0.00708	0.00708	< 0.00139	0.00139
	LPSF01	Fillets with Skin	< 0.00837	0.00837	< 0.00143	0.00143
	UACA01	Fillets with Skin	0.0276	0.00533	0.00770	0.00149
	UALB01	Fillets with Skin	< 0.00681	0.00681	< 0.00152	0.00152
	UASF01	Fillets with Skin	< 0.00736	0.00736	< 0.00151	0.00151
	UPCA01	Fillets with Skin	0.149	0.00497	0.0433	0.00145
	UPLB01	Fillets with Skin	< 0.00747	0.00747	< 0.00153	0.00153
	UPSF01	Fillets with Skin	< 0.00764	0.00764	< 0.00150	0.00150
	LAAE01	Fillets without Skin	0.0100	0.00400	0.00370	0.00148
	LABC01	Fillets without Skin	0.0105	0.00702	0.00230	0.00154
	LACC01	Fillets without Skin	0.0295	0.00673	0.00640	0.00146
	LPAE01	Fillets without Skin	0.00860	0.00464	0.00290	0.00156
	LPAE02	Fillets without Skin	0.0133	0.00554	0.00370	0.00154
	LPBC01	Fillets without Skin	0.0222	0.00695	0.00470	0.00147
	LPBC02	Fillets without Skin	< 0.00812	0.00812	< 0.00138	0.00138
	LPBC03	Fillets without Skin	< 0.00644	0.00644	< 0.00136	0.00136
	LPBC04	Fillets without Skin	0.0180	0.00674	0.00420	0.00158
	LPCC01	Fillets without Skin	0.0225	0.00827	0.00430	0.00158
	UAAE01	Fillets without	0.0176	0.00392	0.00660	0.00147

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.0205	0.00719	0.00430	0.00151
	UACC01	Fillets without Skin	0.0148	0.00629	0.00340	0.00144
	UPAE01	Fillets without Skin	0.0226	0.00414	0.00760	0.00139
	UPCC01	Fillets without Skin	0.0274	0.00718	0.00590	0.00155
	UPCC02	Fillets without Skin	0.0393	0.00733	0.00830	0.00155
	UPCC101	Fillets without Skin	0.0370	0.00705	0.00810	0.00154
	UPCC102	Fillets without Skin	0.0192	0.00726	0.00410	0.00155
	UPCC103	Fillets without Skin	0.0357	0.00647	0.00860	0.00156
C2-Phenanthrenes & Anthracenes						
	LACA01	Fillets with Skin	< 0.00209	0.00209	< 0.000582	0.000582
	LALB01	Fillets with Skin	0.00822	0.00285	0.00170	0.000589
	LASF01	Fillets with Skin	0.00653	0.00288	0.00130	0.000573
	LPCA01	Fillets with Skin	0.00933	0.00239	0.00220	0.000564
	LPLB01	Fillets with Skin	0.00656	0.00256	0.00150	0.000585
	LPSB01	Fillets with Skin	0.00561	0.00268	0.00110	0.000525
	LPSF01	Fillets with Skin	< 0.00316	0.00316	< 0.000539	0.000539
	UACA01	Fillets with Skin	< 0.00201	0.00201	< 0.000561	0.000561
	UALB01	Fillets with Skin	< 0.00257	0.00257	< 0.000574	0.000574
	UASF01	Fillets with Skin	< 0.00278	0.00278	< 0.000572	0.000572
	UPCA01	Fillets with Skin	0.0134	0.00188	0.00390	0.000547
	UPLB01	Fillets with Skin	0.00440	0.00282	0.000900	0.000576
	UPSF01	Fillets with Skin	< 0.00289	0.00289	< 0.000565	0.000565

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	0.0214	0.00151	0.00790	0.000557
	LABC01	Fillets without Skin	< 0.00265	0.00265	< 0.000583	0.000583
	LACC01	Fillets without Skin	< 0.00254	0.00254	< 0.000551	0.000551
	LPAE01	Fillets without Skin	< 0.00175	0.00175	< 0.000591	0.000591
	LPAE02	Fillets without Skin	0.0140	0.00209	0.00390	0.000581
	LPBC01	Fillets without Skin	< 0.00262	0.00262	< 0.000556	0.000556
	LPBC02	Fillets without Skin	< 0.00307	0.00307	< 0.000520	0.000520
	LPBC03	Fillets without Skin	< 0.00243	0.00243	< 0.000516	0.000516
	LPBC04	Fillets without Skin	< 0.00255	0.00255	< 0.000595	0.000595
	LPCC01	Fillets without Skin	< 0.00312	0.00312	< 0.000596	0.000596
	UAAE01	Fillets without Skin	< 0.00148	0.00148	< 0.000556	0.000556
	UABC01	Fillets without Skin	< 0.00272	0.00272	< 0.000570	0.000570
	UACC01	Fillets without Skin	< 0.00238	0.00238	< 0.000545	0.000545
	UPAE01	Fillets without Skin	0.0104	0.00156	0.00350	0.000526
	UPCC01	Fillets without Skin	0.0102	0.00271	0.00220	0.000584
	UPCC02	Fillets without Skin	< 0.00277	0.00277	< 0.000584	0.000584
	UPCC101	Fillets without Skin	< 0.00266	0.00266	< 0.000583	0.000583

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	< 0.00274	0.00274	< 0.000585	0.000585
	UPCC103	Fillets without Skin	< 0.00244	0.00244	< 0.000589	0.000589
C2-chrysenes						
	LACA01	Fillets with Skin	< 0.00332	0.00332	< 0.000924	0.000924
	LALB01	Fillets with Skin	< 0.00452	0.00452	< 0.000935	0.000935
	LASF01	Fillets with Skin	< 0.00457	0.00457	< 0.000910	0.000910
	LPCA01	Fillets with Skin	< 0.00380	0.00380	< 0.000896	0.000896
	LPLB01	Fillets with Skin	< 0.00406	0.00406	< 0.000929	0.000929
	LPSB01	Fillets with Skin	< 0.00425	0.00425	< 0.000833	0.000833
	LPSF01	Fillets with Skin	< 0.00502	0.00502	< 0.000855	0.000855
	UACA01	Fillets with Skin	< 0.00320	0.00320	< 0.000891	0.000891
	UALB01	Fillets with Skin	< 0.00408	0.00408	< 0.000911	0.000911
	UASF01	Fillets with Skin	< 0.00441	0.00441	< 0.000908	0.000908
	UPCA01	Fillets with Skin	< 0.00298	0.00298	< 0.000868	0.000868
	UPLB01	Fillets with Skin	< 0.00448	0.00448	< 0.000915	0.000915
	UPSF01	Fillets with Skin	< 0.00458	0.00458	< 0.000898	0.000898
	LAAE01	Fillets without Skin	< 0.00240	0.00240	< 0.000884	0.000884
	LABC01	Fillets without Skin	< 0.00421	0.00421	< 0.000926	0.000926
	LACC01	Fillets without Skin	< 0.00404	0.00404	< 0.000874	0.000874
	LPAE01	Fillets without Skin	< 0.00278	0.00278	< 0.000938	0.000938
	LPAE02	Fillets without Skin	< 0.00332	0.00332	< 0.000922	0.000922
	LPBC01	Fillets without Skin	< 0.00416	0.00416	< 0.000882	0.000882
	LPBC02	Fillets without Skin	< 0.00487	0.00487	< 0.000825	0.000825

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	< 0.00386	0.00386	< 0.000818	0.000818
	LPBC04	Fillets without Skin	< 0.00404	0.00404	< 0.000944	0.000944
	LPCC01	Fillets without Skin	< 0.00496	0.00496	< 0.000946	0.000946
	UAAE01	Fillets without Skin	< 0.00235	0.00235	< 0.000882	0.000882
	UABC01	Fillets without Skin	< 0.00431	0.00431	< 0.000904	0.000904
	UACC01	Fillets without Skin	< 0.00377	0.00377	< 0.000865	0.000865
	UPAE01	Fillets without Skin	< 0.00248	0.00248	< 0.000834	0.000834
	UPCC01	Fillets without Skin	< 0.00431	0.00431	< 0.000927	0.000927
	UPCC02	Fillets without Skin	< 0.00439	0.00439	< 0.000927	0.000927
	UPCC101	Fillets without Skin	< 0.00423	0.00423	< 0.000926	0.000926
	UPCC102	Fillets without Skin	< 0.00435	0.00435	< 0.000929	0.000929
	UPCC103	Fillets without Skin	< 0.00388	0.00388	< 0.000935	0.000935
C2-dibenzothiophenes						
	LACA01	Fillets with Skin	< 0.00239	0.00239	< 0.000666	0.000666
	LALB01	Fillets with Skin	< 0.00326	0.00326	< 0.000674	0.000674
	LASF01	Fillets with Skin	< 0.00330	0.00330	< 0.000656	0.000656
	LPCA01	Fillets with Skin	< 0.00274	0.00274	< 0.000646	0.000646
	LPLB01	Fillets with Skin	< 0.00293	0.00293	< 0.000670	0.000670
	LPSB01	Fillets with Skin	< 0.00306	0.00306	< 0.000600	0.000600
	LPSF01	Fillets with Skin	< 0.00362	0.00362	< 0.000617	0.000617
	UACA01	Fillets with Skin	< 0.00230	0.00230	< 0.000642	0.000642

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	< 0.00294	0.00294	< 0.000657	0.000657
	UASF01	Fillets with Skin	< 0.00318	0.00318	< 0.000655	0.000655
	UPCA01	Fillets with Skin	< 0.00215	0.00215	< 0.000626	0.000626
	UPLB01	Fillets with Skin	< 0.00323	0.00323	< 0.000660	0.000660
	UPSF01	Fillets with Skin	< 0.00330	0.00330	< 0.000647	0.000647
	LAAE01	Fillets without Skin	0.00624	0.00173	0.00230	0.000637
	LABC01	Fillets without Skin	< 0.00303	0.00303	< 0.000667	0.000667
	LACC01	Fillets without Skin	< 0.00291	0.00291	< 0.000630	0.000630
	LPAE01	Fillets without Skin	< 0.00200	0.00200	< 0.000677	0.000677
	LPAE02	Fillets without Skin	< 0.00239	0.00239	< 0.000665	0.000665
	LPBC01	Fillets without Skin	< 0.00300	0.00300	< 0.000636	0.000636
	LPBC02	Fillets without Skin	< 0.00351	0.00351	< 0.000595	0.000595
	LPBC03	Fillets without Skin	< 0.00278	0.00278	< 0.000590	0.000590
	LPBC04	Fillets without Skin	< 0.00291	0.00291	< 0.000681	0.000681
	LPCC01	Fillets without Skin	< 0.00357	0.00357	< 0.000682	0.000682
	UAAE01	Fillets without Skin	< 0.00170	0.00170	< 0.000636	0.000636
	UABC01	Fillets without Skin	< 0.00311	0.00311	< 0.000652	0.000652
	UACC01	Fillets without Skin	< 0.00272	0.00272	< 0.000623	0.000623
	UPAE01	Fillets without Skin	< 0.00179	0.00179	< 0.000601	0.000601

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	< 0.00310	0.00310	< 0.000669	0.000669
	UPCC02	Fillets without Skin	< 0.00317	0.00317	< 0.000669	0.000669
	UPCC101	Fillets without Skin	< 0.00305	0.00305	< 0.000667	0.000667
	UPCC102	Fillets without Skin	< 0.00314	0.00314	< 0.000670	0.000670
	UPCC103	Fillets without Skin	< 0.00280	0.00280	< 0.000674	0.000674
C2-fluorenes						
	LACA01	Fillets with Skin	< 0.00291	0.00291	< 0.000811	0.000811
	LALB01	Fillets with Skin	< 0.00397	0.00397	< 0.000820	0.000820
	LASF01	Fillets with Skin	0.00804	0.00401	0.00160	0.000798
	LPCA01	Fillets with Skin	< 0.00333	0.00333	< 0.000786	0.000786
	LPLB01	Fillets with Skin	0.00612	0.00356	0.00140	0.000815
	LPSB01	Fillets with Skin	0.00612	0.00373	0.00120	0.000731
	LPSF01	Fillets with Skin	0.00528	0.00440	0.000900	0.000750
	UACA01	Fillets with Skin	< 0.00280	0.00280	< 0.000782	0.000782
	UALB01	Fillets with Skin	< 0.00358	0.00358	< 0.000800	0.000800
	UASF01	Fillets with Skin	< 0.00387	0.00387	< 0.000797	0.000797
	UPCA01	Fillets with Skin	< 0.00261	0.00261	< 0.000761	0.000761
	UPLB01	Fillets with Skin	< 0.00393	0.00393	< 0.000803	0.000803
	UPSF01	Fillets with Skin	< 0.00402	0.00402	< 0.000787	0.000787
	LAAE01	Fillets without Skin	< 0.00210	0.00210	< 0.000776	0.000776
	LABC01	Fillets without Skin	< 0.00369	0.00369	< 0.000812	0.000812
	LACC01	Fillets without Skin	< 0.00354	0.00354	< 0.000767	0.000767
	LPAE01	Fillets without Skin	< 0.00244	0.00244	< 0.000823	0.000823

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 0.00291	0.00291	< 0.000809	0.000809
	LPBC01	Fillets without Skin	< 0.00365	0.00365	< 0.000774	0.000774
	LPBC02	Fillets without Skin	< 0.00427	0.00427	< 0.000724	0.000724
	LPBC03	Fillets without Skin	< 0.00339	0.00339	< 0.000718	0.000718
	LPBC04	Fillets without Skin	< 0.00355	0.00355	< 0.000828	0.000828
	LPCC01	Fillets without Skin	< 0.00435	0.00435	< 0.000830	0.000830
	UAAE01	Fillets without Skin	< 0.00206	0.00206	< 0.000774	0.000774
	UABC01	Fillets without Skin	< 0.00378	0.00378	< 0.000793	0.000793
	UACC01	Fillets without Skin	< 0.00331	0.00331	< 0.000759	0.000759
	UPAE01	Fillets without Skin	< 0.00218	0.00218	< 0.000732	0.000732
	UPCC01	Fillets without Skin	< 0.00378	0.00378	< 0.000814	0.000814
	UPCC02	Fillets without Skin	0.0346	0.00386	0.00730	0.000814
	UPCC101	Fillets without Skin	< 0.00371	0.00371	< 0.000812	0.000812
	UPCC102	Fillets without Skin	< 0.00382	0.00382	< 0.000815	0.000815
	UPCC103	Fillets without Skin	< 0.00340	0.00340	< 0.000820	0.000820
C2-naphthalenes						
	LACA01	Fillets with Skin	0.0843	0.00703	0.0235	0.00196
	LALB01	Fillets with Skin	0.0121	0.00959	0.00250	0.00198

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LASF01	Fillets with Skin	< 0.00969	0.00969	< 0.00193	0.00193
	LPCA01	Fillets with Skin	0.0242	0.00806	0.00570	0.00190
	LPLB01	Fillets with Skin	< 0.00861	0.00861	< 0.00197	0.00197
	LPSB01	Fillets with Skin	< 0.00900	0.00900	< 0.00177	0.00177
	LPSF01	Fillets with Skin	< 0.0106	0.0106	< 0.00181	0.00181
	UACA01	Fillets with Skin	0.0707	0.00678	0.0197	0.00189
	UALB01	Fillets with Skin	0.0103	0.00866	0.00230	0.00193
	UASF01	Fillets with Skin	0.0131	0.00935	0.00270	0.00192
	UPCA01	Fillets with Skin	0.170	0.00632	0.0495	0.00184
	UPLB01	Fillets with Skin	0.0122	0.00949	0.00250	0.00194
	UPSF01	Fillets with Skin	< 0.00972	0.00972	< 0.00190	0.00190
	LAAE01	Fillets without Skin	0.0190	0.00508	0.00700	0.00188
	LABC01	Fillets without Skin	0.0173	0.00892	0.00380	0.00196
	LACC01	Fillets without Skin	0.0914	0.00856	0.0198	0.00185
	LPAE01	Fillets without Skin	< 0.00590	0.00590	< 0.00199	0.00199
	LPAE02	Fillets without Skin	0.0104	0.00704	0.00290	0.00196
	LPBC01	Fillets without Skin	0.0831	0.00883	0.0176	0.00187
	LPBC02	Fillets without Skin	< 0.0103	0.0103	< 0.00175	0.00175
	LPBC03	Fillets without Skin	< 0.00819	0.00819	< 0.00174	0.00174
	LPBC04	Fillets without Skin	0.0205	0.00857	0.00480	0.00200
	LPCC01	Fillets without Skin	0.0194	0.0105	0.00370	0.00201
	UAAE01	Fillets without	0.0213	0.00499	0.00800	0.00187

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.0429	0.00914	0.00900	0.00192
	UACC01	Fillets without Skin	0.0349	0.00800	0.00800	0.00183
	UPAE01	Fillets without Skin	0.0152	0.00527	0.00510	0.00177
	UPCC01	Fillets without Skin	0.0376	0.00913	0.00810	0.00197
	UPCC02	Fillets without Skin	0.149	0.00932	0.0315	0.00197
	UPCC101	Fillets without Skin	0.0758	0.00896	0.0166	0.00196
	UPCC102	Fillets without Skin	0.0379	0.00922	0.00810	0.00197
	UPCC103	Fillets without Skin	0.0336	0.00822	0.00810	0.00198
C3-Phenanthrenes & Anthracenes						
	LACA01	Fillets with Skin	< 0.00209	0.00209	< 0.000582	0.000582
	LALB01	Fillets with Skin	0.0237	0.00285	0.00490	0.000589
	LASF01	Fillets with Skin	< 0.00288	0.00288	< 0.000573	0.000573
	LPCA01	Fillets with Skin	0.0174	0.00239	0.00410	0.000564
	LPLB01	Fillets with Skin	0.00918	0.00256	0.00210	0.000585
	LPSB01	Fillets with Skin	0.0117	0.00268	0.00230	0.000525
	LPSF01	Fillets with Skin	< 0.00316	0.00316	< 0.000539	0.000539
	UACA01	Fillets with Skin	< 0.00201	0.00201	< 0.000561	0.000561
	UALB01	Fillets with Skin	< 0.00257	0.00257	< 0.000574	0.000574
	UASF01	Fillets with Skin	< 0.00278	0.00278	< 0.000572	0.000572
	UPCA01	Fillets with Skin	0.0288	0.00188	0.00840	0.000547
	UPLB01	Fillets with Skin	0.00832	0.00282	0.00170	0.000576
	UPSF01	Fillets with Skin	< 0.00289	0.00289	< 0.000565	0.000565

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	0.0426	0.00151	0.0157	0.000557
	LABC01	Fillets without Skin	< 0.00265	0.00265	< 0.000583	0.000583
	LACC01	Fillets without Skin	< 0.00254	0.00254	< 0.000551	0.000551
	LPAE01	Fillets without Skin	< 0.00175	0.00175	< 0.000591	0.000591
	LPAE02	Fillets without Skin	0.0893	0.00209	0.0248	0.000581
	LPBC01	Fillets without Skin	0.0330	0.00262	0.00700	0.000556
	LPBC02	Fillets without Skin	0.0330	0.00307	0.00560	0.000520
	LPBC03	Fillets without Skin	0.0434	0.00243	0.00920	0.000516
	LPBC04	Fillets without Skin	0.0604	0.00255	0.0141	0.000595
	LPCC01	Fillets without Skin	< 0.00312	0.00312	< 0.000596	0.000596
	UAAE01	Fillets without Skin	< 0.00148	0.00148	< 0.000556	0.000556
	UABC01	Fillets without Skin	< 0.00272	0.00272	< 0.000570	0.000570
	UACC01	Fillets without Skin	< 0.00238	0.00238	< 0.000545	0.000545
	UPAE01	Fillets without Skin	0.0372	0.00156	0.0125	0.000526
	UPCC01	Fillets without Skin	0.0172	0.00271	0.00370	0.000584
	UPCC02	Fillets without Skin	< 0.00277	0.00277	< 0.000584	0.000584
	UPCC101	Fillets without Skin	< 0.00266	0.00266	< 0.000583	0.000583

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	< 0.00274	0.00274	< 0.000585	0.000585
	UPCC103	Fillets without Skin	< 0.00244	0.00244	< 0.000589	0.000589
C3-chrysenes						
	LACA01	Fillets with Skin	< 0.00332	0.00332	< 0.000924	0.000924
	LALB01	Fillets with Skin	< 0.00452	0.00452	< 0.000935	0.000935
	LASF01	Fillets with Skin	< 0.00457	0.00457	< 0.000910	0.000910
	LPCA01	Fillets with Skin	< 0.00380	0.00380	< 0.000896	0.000896
	LPLB01	Fillets with Skin	< 0.00406	0.00406	< 0.000929	0.000929
	LPSB01	Fillets with Skin	< 0.00425	0.00425	< 0.000833	0.000833
	LPSF01	Fillets with Skin	< 0.00502	0.00502	< 0.000855	0.000855
	UACA01	Fillets with Skin	< 0.00320	0.00320	< 0.000891	0.000891
	UALB01	Fillets with Skin	< 0.00408	0.00408	< 0.000911	0.000911
	UASF01	Fillets with Skin	< 0.00441	0.00441	< 0.000908	0.000908
	UPCA01	Fillets with Skin	< 0.00298	0.00298	< 0.000868	0.000868
	UPLB01	Fillets with Skin	< 0.00448	0.00448	< 0.000915	0.000915
	UPSF01	Fillets with Skin	< 0.00458	0.00458	< 0.000898	0.000898
	LAAE01	Fillets without Skin	< 0.00240	0.00240	< 0.000884	0.000884
	LABC01	Fillets without Skin	< 0.00421	0.00421	< 0.000926	0.000926
	LACC01	Fillets without Skin	< 0.00404	0.00404	< 0.000874	0.000874
	LPAE01	Fillets without Skin	< 0.00278	0.00278	< 0.000938	0.000938
	LPAE02	Fillets without Skin	< 0.00332	0.00332	< 0.000922	0.000922
	LPBC01	Fillets without Skin	< 0.00416	0.00416	< 0.000882	0.000882
	LPBC02	Fillets without Skin	< 0.00487	0.00487	< 0.000825	0.000825

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	< 0.00386	0.00386	< 0.000818	0.000818
	LPBC04	Fillets without Skin	< 0.00404	0.00404	< 0.000944	0.000944
	LPCC01	Fillets without Skin	< 0.00496	0.00496	< 0.000946	0.000946
	UAAE01	Fillets without Skin	< 0.00235	0.00235	< 0.000882	0.000882
	UABC01	Fillets without Skin	< 0.00431	0.00431	< 0.000904	0.000904
	UACC01	Fillets without Skin	< 0.00377	0.00377	< 0.000865	0.000865
	UPAE01	Fillets without Skin	< 0.00248	0.00248	< 0.000834	0.000834
	UPCC01	Fillets without Skin	< 0.00431	0.00431	< 0.000927	0.000927
	UPCC02	Fillets without Skin	< 0.00439	0.00439	< 0.000927	0.000927
	UPCC101	Fillets without Skin	< 0.00423	0.00423	< 0.000926	0.000926
	UPCC102	Fillets without Skin	< 0.00435	0.00435	< 0.000929	0.000929
	UPCC103	Fillets without Skin	< 0.00388	0.00388	< 0.000935	0.000935
C3-dibenzothiophenes						
	LACA01	Fillets with Skin	< 0.00239	0.00239	< 0.000666	0.000666
	LALB01	Fillets with Skin	< 0.00326	0.00326	< 0.000674	0.000674
	LASF01	Fillets with Skin	< 0.00330	0.00330	< 0.000656	0.000656
	LPCA01	Fillets with Skin	< 0.00274	0.00274	< 0.000646	0.000646
	LPLB01	Fillets with Skin	< 0.00293	0.00293	< 0.000670	0.000670
	LPSB01	Fillets with Skin	< 0.00306	0.00306	< 0.000600	0.000600
	LPSF01	Fillets with Skin	< 0.00362	0.00362	< 0.000617	0.000617
	UACA01	Fillets with Skin	< 0.00230	0.00230	< 0.000642	0.000642

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	< 0.00294	0.00294	< 0.000657	0.000657
	UASF01	Fillets with Skin	< 0.00318	0.00318	< 0.000655	0.000655
	UPCA01	Fillets with Skin	< 0.00215	0.00215	< 0.000626	0.000626
	UPLB01	Fillets with Skin	< 0.00323	0.00323	< 0.000660	0.000660
	UPSF01	Fillets with Skin	< 0.00330	0.00330	< 0.000647	0.000647
	LAAE01	Fillets without Skin	0.0108	0.00173	0.00400	0.000637
	LABC01	Fillets without Skin	< 0.00303	0.00303	< 0.000667	0.000667
	LACC01	Fillets without Skin	< 0.00291	0.00291	< 0.000630	0.000630
	LPAE01	Fillets without Skin	< 0.00200	0.00200	< 0.000677	0.000677
	LPAE02	Fillets without Skin	< 0.00239	0.00239	< 0.000665	0.000665
	LPBC01	Fillets without Skin	< 0.00300	0.00300	< 0.000636	0.000636
	LPBC02	Fillets without Skin	< 0.00351	0.00351	< 0.000595	0.000595
	LPBC03	Fillets without Skin	< 0.00278	0.00278	< 0.000590	0.000590
	LPBC04	Fillets without Skin	< 0.00291	0.00291	< 0.000681	0.000681
	LPCC01	Fillets without Skin	< 0.00357	0.00357	< 0.000682	0.000682
	UAAE01	Fillets without Skin	< 0.00170	0.00170	< 0.000636	0.000636
	UABC01	Fillets without Skin	< 0.00311	0.00311	< 0.000652	0.000652
	UACC01	Fillets without Skin	< 0.00272	0.00272	< 0.000623	0.000623
	UPAE01	Fillets without Skin	< 0.00179	0.00179	< 0.000601	0.000601

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	< 0.00310	0.00310	< 0.000669	0.000669
	UPCC02	Fillets without Skin	< 0.00317	0.00317	< 0.000669	0.000669
	UPCC101	Fillets without Skin	< 0.00305	0.00305	< 0.000667	0.000667
	UPCC102	Fillets without Skin	< 0.00314	0.00314	< 0.000670	0.000670
	UPCC103	Fillets without Skin	< 0.00280	0.00280	< 0.000674	0.000674
C3-fluorenes						
	LACA01	Fillets with Skin	< 0.00291	0.00291	< 0.000811	0.000811
	LALB01	Fillets with Skin	< 0.00397	0.00397	< 0.000820	0.000820
	LASF01	Fillets with Skin	< 0.00401	0.00401	< 0.000798	0.000798
	LPCA01	Fillets with Skin	< 0.00333	0.00333	< 0.000786	0.000786
	LPLB01	Fillets with Skin	< 0.00356	0.00356	< 0.000815	0.000815
	LPSB01	Fillets with Skin	< 0.00373	0.00373	< 0.000731	0.000731
	LPSF01	Fillets with Skin	< 0.00440	0.00440	< 0.000750	0.000750
	UACA01	Fillets with Skin	< 0.00280	0.00280	< 0.000782	0.000782
	UALB01	Fillets with Skin	< 0.00358	0.00358	< 0.000800	0.000800
	UASF01	Fillets with Skin	< 0.00387	0.00387	< 0.000797	0.000797
	UPCA01	Fillets with Skin	< 0.00261	0.00261	< 0.000761	0.000761
	UPLB01	Fillets with Skin	< 0.00393	0.00393	< 0.000803	0.000803
	UPSF01	Fillets with Skin	< 0.00402	0.00402	< 0.000787	0.000787
	LAAE01	Fillets without Skin	< 0.00210	0.00210	< 0.000776	0.000776
	LABC01	Fillets without Skin	< 0.00369	0.00369	< 0.000812	0.000812
	LACC01	Fillets without Skin	< 0.00354	0.00354	< 0.000767	0.000767
	LPAE01	Fillets without Skin	< 0.00244	0.00244	< 0.000823	0.000823

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 0.00291	0.00291	< 0.000809	0.000809
	LPBC01	Fillets without Skin	< 0.00365	0.00365	< 0.000774	0.000774
	LPBC02	Fillets without Skin	< 0.00427	0.00427	< 0.000724	0.000724
	LPBC03	Fillets without Skin	< 0.00339	0.00339	< 0.000718	0.000718
	LPBC04	Fillets without Skin	< 0.00355	0.00355	< 0.000828	0.000828
	LPCC01	Fillets without Skin	< 0.00435	0.00435	< 0.000830	0.000830
	UAAE01	Fillets without Skin	< 0.00206	0.00206	< 0.000774	0.000774
	UABC01	Fillets without Skin	< 0.00378	0.00378	< 0.000793	0.000793
	UACC01	Fillets without Skin	< 0.00331	0.00331	< 0.000759	0.000759
	UPAE01	Fillets without Skin	< 0.00218	0.00218	< 0.000732	0.000732
	UPCC01	Fillets without Skin	< 0.00378	0.00378	< 0.000814	0.000814
	UPCC02	Fillets without Skin	< 0.00386	0.00386	< 0.000814	0.000814
	UPCC101	Fillets without Skin	< 0.00371	0.00371	< 0.000812	0.000812
	UPCC102	Fillets without Skin	< 0.00382	0.00382	< 0.000815	0.000815
	UPCC103	Fillets without Skin	< 0.00340	0.00340	< 0.000820	0.000820
C3-naphthalenes						
	LACA01	Fillets with Skin	0.0685	0.00703	0.0191	0.00196
	LALB01	Fillets with Skin	0.0184	0.00959	0.00380	0.00198

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LASF01	Fillets with Skin	0.0121	0.00969	0.00240	0.00193
	LPCA01	Fillets with Skin	0.0221	0.00806	0.00520	0.00190
	LPLB01	Fillets with Skin	0.0122	0.00861	0.00280	0.00197
	LPSB01	Fillets with Skin	< 0.00900	0.00900	< 0.00177	0.00177
	LPSF01	Fillets with Skin	0.0123	0.0106	0.00210	0.00181
	UACA01	Fillets with Skin	0.0897	0.00678	0.0250	0.00189
	UALB01	Fillets with Skin	0.0152	0.00866	0.00340	0.00193
	UASF01	Fillets with Skin	0.0243	0.00935	0.00500	0.00192
	UPCA01	Fillets with Skin	0.0769	0.00632	0.0224	0.00184
	UPLB01	Fillets with Skin	0.0147	0.00949	0.00300	0.00194
	UPSF01	Fillets with Skin	< 0.00972	0.00972	< 0.00190	0.00190
	LAAE01	Fillets without Skin	0.0252	0.00508	0.00930	0.00188
	LABC01	Fillets without Skin	0.0245	0.00892	0.00540	0.00196
	LACC01	Fillets without Skin	0.130	0.00856	0.0282	0.00185
	LPAE01	Fillets without Skin	< 0.00590	0.00590	< 0.00199	0.00199
	LPAE02	Fillets without Skin	0.0133	0.00704	0.00370	0.00196
	LPBC01	Fillets without Skin	0.108	0.00883	0.0228	0.00187
	LPBC02	Fillets without Skin	0.0124	0.0103	0.00210	0.00175
	LPBC03	Fillets without Skin	< 0.00819	0.00819	< 0.00174	0.00174
	LPBC04	Fillets without Skin	0.0257	0.00857	0.00600	0.00200
	LPCC01	Fillets without Skin	0.0178	0.0105	0.00340	0.00201
	UAAE01	Fillets without	0.0291	0.00499	0.0109	0.00187

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.0596	0.00914	0.0125	0.00192
	UACC01	Fillets without Skin	0.0467	0.00800	0.0107	0.00183
	UPAE01	Fillets without Skin	0.0134	0.00527	0.00450	0.00177
	UPCC01	Fillets without Skin	0.0292	0.00913	0.00630	0.00197
	UPCC02	Fillets without Skin	0.173	0.00932	0.0366	0.00197
	UPCC101	Fillets without Skin	0.0475	0.00896	0.0104	0.00196
	UPCC102	Fillets without Skin	0.0211	0.00922	0.00450	0.00197
	UPCC103	Fillets without Skin	0.0303	0.00822	0.00730	0.00198
C4-Phenanthrenes & Anthracenes						
	LACA01	Fillets with Skin	< 0.00209	0.00209	< 0.000582	0.000582
	LALB01	Fillets with Skin	< 0.00285	0.00285	< 0.000589	0.000589
	LASF01	Fillets with Skin	< 0.00288	0.00288	< 0.000573	0.000573
	LPCA01	Fillets with Skin	< 0.00239	0.00239	< 0.000564	0.000564
	LPLB01	Fillets with Skin	< 0.00256	0.00256	< 0.000585	0.000585
	LPSB01	Fillets with Skin	< 0.00268	0.00268	< 0.000525	0.000525
	LPSF01	Fillets with Skin	< 0.00316	0.00316	< 0.000539	0.000539
	UACA01	Fillets with Skin	< 0.00201	0.00201	< 0.000561	0.000561
	UALB01	Fillets with Skin	< 0.00257	0.00257	< 0.000574	0.000574
	UASF01	Fillets with Skin	< 0.00278	0.00278	< 0.000572	0.000572
	UPCA01	Fillets with Skin	0.0134	0.00188	0.00390	0.000547
	UPLB01	Fillets with Skin	< 0.00282	0.00282	< 0.000576	0.000576
	UPSF01	Fillets with Skin	< 0.00289	0.00289	< 0.000565	0.000565

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	< 0.00151	0.00151	< 0.000557	0.000557
	LABC01	Fillets without Skin	< 0.00265	0.00265	< 0.000583	0.000583
	LACC01	Fillets without Skin	< 0.00254	0.00254	< 0.000551	0.000551
	LPAE01	Fillets without Skin	< 0.00175	0.00175	< 0.000591	0.000591
	LPAE02	Fillets without Skin	< 0.00209	0.00209	< 0.000581	0.000581
	LPBC01	Fillets without Skin	< 0.00262	0.00262	< 0.000556	0.000556
	LPBC02	Fillets without Skin	< 0.00307	0.00307	< 0.000520	0.000520
	LPBC03	Fillets without Skin	< 0.00243	0.00243	< 0.000516	0.000516
	LPBC04	Fillets without Skin	< 0.00255	0.00255	< 0.000595	0.000595
	LPCC01	Fillets without Skin	< 0.00312	0.00312	< 0.000596	0.000596
	UAAE01	Fillets without Skin	< 0.00148	0.00148	< 0.000556	0.000556
	UABC01	Fillets without Skin	< 0.00272	0.00272	< 0.000570	0.000570
	UACC01	Fillets without Skin	< 0.00238	0.00238	< 0.000545	0.000545
	UPAE01	Fillets without Skin	0.00655	0.00156	0.00220	0.000526
	UPCC01	Fillets without Skin	< 0.00271	0.00271	< 0.000584	0.000584
	UPCC02	Fillets without Skin	< 0.00277	0.00277	< 0.000584	0.000584
	UPCC101	Fillets without Skin	< 0.00266	0.00266	< 0.000583	0.000583

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	< 0.00274	0.00274	< 0.000585	0.000585
	UPCC103	Fillets without Skin	< 0.00244	0.00244	< 0.000589	0.000589
C4-chrysenes						
	LACA01	Fillets with Skin	< 0.00332	0.00332	< 0.000924	0.000924
	LALB01	Fillets with Skin	< 0.00452	0.00452	< 0.000935	0.000935
	LASF01	Fillets with Skin	< 0.00457	0.00457	< 0.000910	0.000910
	LPCA01	Fillets with Skin	< 0.00380	0.00380	< 0.000896	0.000896
	LPLB01	Fillets with Skin	< 0.00406	0.00406	< 0.000929	0.000929
	LPSB01	Fillets with Skin	< 0.00425	0.00425	< 0.000833	0.000833
	LPSF01	Fillets with Skin	< 0.00502	0.00502	< 0.000855	0.000855
	UACA01	Fillets with Skin	< 0.00320	0.00320	< 0.000891	0.000891
	UALB01	Fillets with Skin	< 0.00408	0.00408	< 0.000911	0.000911
	UASF01	Fillets with Skin	< 0.00441	0.00441	< 0.000908	0.000908
	UPCA01	Fillets with Skin	< 0.00298	0.00298	< 0.000868	0.000868
	UPLB01	Fillets with Skin	< 0.00448	0.00448	< 0.000915	0.000915
	UPSF01	Fillets with Skin	< 0.00458	0.00458	< 0.000898	0.000898
	LAAE01	Fillets without Skin	< 0.00240	0.00240	< 0.000884	0.000884
	LABC01	Fillets without Skin	< 0.00421	0.00421	< 0.000926	0.000926
	LACC01	Fillets without Skin	< 0.00404	0.00404	< 0.000874	0.000874
	LPAE01	Fillets without Skin	< 0.00278	0.00278	< 0.000938	0.000938
	LPAE02	Fillets without Skin	< 0.00332	0.00332	< 0.000922	0.000922
	LPBC01	Fillets without Skin	< 0.00416	0.00416	< 0.000882	0.000882
	LPBC02	Fillets without Skin	< 0.00487	0.00487	< 0.000825	0.000825

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	< 0.00386	0.00386	< 0.000818	0.000818
	LPBC04	Fillets without Skin	< 0.00404	0.00404	< 0.000944	0.000944
	LPCC01	Fillets without Skin	< 0.00496	0.00496	< 0.000946	0.000946
	UAAE01	Fillets without Skin	< 0.00235	0.00235	< 0.000882	0.000882
	UABC01	Fillets without Skin	< 0.00431	0.00431	< 0.000904	0.000904
	UACC01	Fillets without Skin	< 0.00377	0.00377	< 0.000865	0.000865
	UPAE01	Fillets without Skin	< 0.00248	0.00248	< 0.000834	0.000834
	UPCC01	Fillets without Skin	< 0.00431	0.00431	< 0.000927	0.000927
	UPCC02	Fillets without Skin	< 0.00439	0.00439	< 0.000927	0.000927
	UPCC101	Fillets without Skin	< 0.00423	0.00423	< 0.000926	0.000926
	UPCC102	Fillets without Skin	< 0.00435	0.00435	< 0.000929	0.000929
	UPCC103	Fillets without Skin	< 0.00388	0.00388	< 0.000935	0.000935
C4-naphthalenes						
	LACA01	Fillets with Skin	0.0545	0.00703	0.0152	0.00196
	LALB01	Fillets with Skin	0.0174	0.00959	0.00360	0.00198
	LASF01	Fillets with Skin	0.0126	0.00969	0.00250	0.00193
	LPCA01	Fillets with Skin	0.0174	0.00806	0.00410	0.00190
	LPLB01	Fillets with Skin	0.0114	0.00861	0.00260	0.00197
	LPSB01	Fillets with Skin	< 0.00900	0.00900	< 0.00177	0.00177
	LPSF01	Fillets with Skin	< 0.0106	0.0106	< 0.00181	0.00181
	UACA01	Fillets with Skin	0.0757	0.00678	0.0211	0.00189

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.0193	0.00866	0.00430	0.00193
	UASF01	Fillets with Skin	0.0209	0.00935	0.00430	0.00192
	UPCA01	Fillets with Skin	0.0257	0.00632	0.00750	0.00184
	UPLB01	Fillets with Skin	< 0.00949	0.00949	< 0.00194	0.00194
	UPSF01	Fillets with Skin	< 0.00972	0.00972	< 0.00190	0.00190
	LAAE01	Fillets without Skin	0.0222	0.00508	0.00820	0.00188
	LABC01	Fillets without Skin	0.0241	0.00892	0.00530	0.00196
	LACC01	Fillets without Skin	0.0960	0.00856	0.0208	0.00185
	LPAE01	Fillets without Skin	< 0.00590	0.00590	< 0.00199	0.00199
	LPAE02	Fillets without Skin	< 0.00704	0.00704	< 0.00196	0.00196
	LPBC01	Fillets without Skin	0.0519	0.00883	0.0110	0.00187
	LPBC02	Fillets without Skin	< 0.0103	0.0103	< 0.00175	0.00175
	LPBC03	Fillets without Skin	< 0.00819	0.00819	< 0.00174	0.00174
	LPBC04	Fillets without Skin	0.0197	0.00857	0.00460	0.00200
	LPCC01	Fillets without Skin	< 0.0105	0.0105	< 0.00201	0.00201
	UAAE01	Fillets without Skin	0.0227	0.00499	0.00850	0.00187
	UABC01	Fillets without Skin	0.0472	0.00914	0.00990	0.00192
	UACC01	Fillets without Skin	0.0419	0.00800	0.00960	0.00183
	UPAE01	Fillets without Skin	0.00923	0.00527	0.00310	0.00177

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.0162	0.00913	0.00350	0.00197
	UPCC02	Fillets without Skin	0.113	0.00932	0.0239	0.00197
	UPCC101	Fillets without Skin	0.0247	0.00896	0.00540	0.00196
	UPCC102	Fillets without Skin	0.0126	0.00922	0.00270	0.00197
	UPCC103	Fillets without Skin	0.0228	0.00822	0.00550	0.00198
DDMU						
	LACA01	Fillets with Skin	0.0489	0.000485	0.0136	0.000135
	LALB01	Fillets with Skin	0.00806	0.000662	0.00167	0.000137
	*LASF01	Fillets with Skin	0.00222	0.000669	0.000441	0.000133
	LPCA01	Fillets with Skin	0.0139	0.000556	0.00327	0.000131
	LPLB01	Fillets with Skin	0.00555	0.000595	0.00127	0.000136
	LPSB01	Fillets with Skin	< 0.000622	0.000622	< 0.000122	0.000122
	*LPSF01	Fillets with Skin	0.00173	0.000734	0.000294	0.000125
	UACA01	Fillets with Skin	0.0378	0.000468	0.0105	0.000130
	UALB01	Fillets with Skin	0.00811	0.000598	0.00181	0.000133
	UASF01	Fillets with Skin	0.00650	0.000645	0.00134	0.000133
	UPCA01	Fillets with Skin	0.0199	0.000436	0.00578	0.000127
	UPLB01	Fillets with Skin	0.00322	0.000655	0.000657	0.000134
	UPSF01	Fillets with Skin	< 0.000671	0.000671	< 0.000131	0.000131
	LAAE01	Fillets without Skin	0.0302	0.000351	0.0111	0.000129
	LABC01	Fillets without Skin	0.0263	0.000616	0.00579	0.000136
	LACC01	Fillets without Skin	0.0358	0.000591	0.00775	0.000128
	LPAE01	Fillets without Skin	0.0294	0.000407	0.00993	0.000137

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 0.000486	0.000486	< 0.000135	0.000135
	LPBC01	Fillets without Skin	0.0248	0.000610	0.00526	0.000129
	LPBC02	Fillets without Skin	0.0288	0.000713	0.00488	0.000121
	LPBC03	Fillets without Skin	0.0204	0.000565	0.00433	0.000120
	LPBC04	Fillets without Skin	0.0394	0.000592	0.00919	0.000138
	LPCC01	Fillets without Skin	< 0.000725	0.000725	< 0.000138	0.000138
	UAAE01	Fillets without Skin	< 0.000345	0.000345	< 0.000129	0.000129
	UABC01	Fillets without Skin	0.0360	0.000631	0.00755	0.000132
	UACC01	Fillets without Skin	0.0268	0.000552	0.00613	0.000127
	UPAE01	Fillets without Skin	< 0.000364	0.000364	< 0.000122	0.000122
	UPCC01	Fillets without Skin	0.00842	0.000630	0.00181	0.000136
	UPCC02	Fillets without Skin	0.0245	0.000643	0.00518	0.000136
	UPCC101	Fillets without Skin	< 0.000619	0.000619	< 0.000136	0.000136
	UPCC102	Fillets without Skin	0.00940	0.000637	0.00201	0.000136
	UPCC103	Fillets without Skin	0.0112	0.000568	0.00269	0.000137
Dibenz(a,h)anthracene						
	LACA01	Fillets with Skin	< 0.00151	0.00151	< 0.000422	0.000422
	LALB01	Fillets with Skin	< 0.00206	0.00206	< 0.000427	0.000427

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LASF01	Fillets with Skin	< 0.00209	0.00209	< 0.000415	0.000415
	LPCA01	Fillets with Skin	< 0.00174	0.00174	< 0.000409	0.000409
	LPLB01	Fillets with Skin	< 0.00186	0.00186	< 0.000424	0.000424
	LPSB01	Fillets with Skin	< 0.00194	0.00194	< 0.000380	0.000380
	LPSF01	Fillets with Skin	< 0.00229	0.00229	< 0.000391	0.000391
	UACA01	Fillets with Skin	< 0.00146	0.00146	< 0.000407	0.000407
	UALB01	Fillets with Skin	< 0.00186	0.00186	< 0.000416	0.000416
	UASF01	Fillets with Skin	< 0.00201	0.00201	< 0.000415	0.000415
	UPCA01	Fillets with Skin	< 0.00136	0.00136	< 0.000396	0.000396
	UPLB01	Fillets with Skin	< 0.00204	0.00204	< 0.000418	0.000418
	UPSF01	Fillets with Skin	< 0.00209	0.00209	< 0.000410	0.000410
	LAAE01	Fillets without Skin	< 0.00109	0.00109	< 0.000404	0.000404
	LABC01	Fillets without Skin	< 0.00192	0.00192	< 0.000423	0.000423
	LACC01	Fillets without Skin	< 0.00184	0.00184	< 0.000399	0.000399
	LPAE01	Fillets without Skin	< 0.00127	0.00127	< 0.000429	0.000429
	LPAE02	Fillets without Skin	< 0.00152	0.00152	< 0.000421	0.000421
	LPBC01	Fillets without Skin	< 0.00190	0.00190	< 0.000403	0.000403
	LPBC02	Fillets without Skin	< 0.00222	0.00222	< 0.000377	0.000377
	LPBC03	Fillets without Skin	< 0.00176	0.00176	< 0.000374	0.000374
	LPBC04	Fillets without Skin	< 0.00185	0.00185	< 0.000431	0.000431
	LPCC01	Fillets without Skin	< 0.00226	0.00226	< 0.000432	0.000432
	UAAE01	Fillets without	< 0.00108	0.00108	< 0.000403	0.000403

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	< 0.00197	0.00197	< 0.000413	0.000413
	UACC01	Fillets without Skin	< 0.00172	0.00172	< 0.000395	0.000395
	UPAE01	Fillets without Skin	< 0.00113	0.00113	< 0.000381	0.000381
	UPCC01	Fillets without Skin	< 0.00197	0.00197	< 0.000424	0.000424
	UPCC02	Fillets without Skin	< 0.00201	0.00201	< 0.000424	0.000424
	UPCC101	Fillets without Skin	< 0.00193	0.00193	< 0.000423	0.000423
	UPCC102	Fillets without Skin	< 0.00199	0.00199	< 0.000424	0.000424
	UPCC103	Fillets without Skin	< 0.00177	0.00177	< 0.000427	0.000427
HCB						
	LACA01	Fillets with Skin	0.0187	0.000928	0.00521	0.000259
	LALB01	Fillets with Skin	0.00239	0.00127	0.000495	0.000262
	*LASF01	Fillets with Skin	< 0.00128	0.00128	< 0.000255	0.000255
	LPCA01	Fillets with Skin	0.00625	0.00106	0.00147	0.000251
	LPLB01	Fillets with Skin	0.00132	0.00114	0.000302	0.000260
	LPSB01	Fillets with Skin	0.00160	0.00119	0.000313	0.000233
	*LPSF01	Fillets with Skin	< 0.00140	0.00140	< 0.000239	0.000239
	UACA01	Fillets with Skin	0.0179	0.000894	0.00499	0.000249
	UALB01	Fillets with Skin	0.00332	0.00114	0.000741	0.000255
	UASF01	Fillets with Skin	0.00412	0.00123	0.000848	0.000254
	UPCA01	Fillets with Skin	0.0133	0.000833	0.00388	0.000243
	UPLB01	Fillets with Skin	< 0.00125	0.00125	< 0.000256	0.000256
	UPSF01	Fillets with Skin	< 0.00128	0.00128	< 0.000251	0.000251

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	0.0297	0.000671	0.0109	0.000247
	LABC01	Fillets without Skin	0.00910	0.00118	0.00200	0.000259
	LACC01	Fillets without Skin	0.0105	0.00113	0.00228	0.000245
	LPAE01	Fillets without Skin	0.0132	0.000778	0.00447	0.000263
	LPAE02	Fillets without Skin	0.00466	0.000929	0.00130	0.000258
	LPBC01	Fillets without Skin	0.00814	0.00116	0.00172	0.000247
	LPBC02	Fillets without Skin	0.00314	0.00136	0.000533	0.000231
	LPBC03	Fillets without Skin	0.00130	0.00108	0.000275	0.000229
	LPBC04	Fillets without Skin	0.00905	0.00113	0.00212	0.000264
	LPCC01	Fillets without Skin	< 0.00139	0.00139	< 0.000265	0.000265
	UAAE01	Fillets without Skin	0.0941	0.000660	0.0353	0.000247
	UABC01	Fillets without Skin	0.0131	0.00121	0.00275	0.000253
	UACC01	Fillets without Skin	0.0113	0.00106	0.00260	0.000242
	UPAE01	Fillets without Skin	0.00704	0.000695	0.00236	0.000233
	UPCC01	Fillets without Skin	0.00328	0.00120	0.000708	0.000260
	UPCC02	Fillets without Skin	0.00831	0.00123	0.00175	0.000260
	UPCC101	Fillets without Skin	0.00218	0.00118	0.000477	0.000259

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	0.00746	0.00122	0.00159	0.000260
	UPCC103	Fillets without Skin	0.00266	0.00108	0.000641	0.000262
Heptachlor						
	LACA01	Fillets with Skin	0.000343	0.000300	0.0000960	0.0000830
	LALB01	Fillets with Skin	< 0.000409	0.000409	< 0.0000840	0.0000840
	*LASF01	Fillets with Skin	< 0.000413	0.000413	< 0.0000820	0.0000820
	LPCA01	Fillets with Skin	< 0.000343	0.000343	< 0.0000810	0.0000810
	LPLB01	Fillets with Skin	< 0.000367	0.000367	< 0.0000840	0.0000840
	LPSB01	Fillets with Skin	< 0.000384	0.000384	< 0.0000750	0.0000750
	*LPSF01	Fillets with Skin	< 0.000453	0.000453	< 0.0000770	0.0000770
	UACA01	Fillets with Skin	< 0.000289	0.000289	< 0.0000810	0.0000810
	UALB01	Fillets with Skin	< 0.000369	0.000369	< 0.0000820	0.0000820
	UASF01	Fillets with Skin	< 0.000399	0.000399	< 0.0000820	0.0000820
	UPCA01	Fillets with Skin	< 0.000269	0.000269	< 0.0000780	0.0000780
	UPLB01	Fillets with Skin	< 0.000405	0.000405	< 0.0000830	0.0000830
	UPSF01	Fillets with Skin	< 0.000414	0.000414	< 0.0000810	0.0000810
	LAAE01	Fillets without Skin	0.00119	0.000217	0.000440	0.0000800
	LABC01	Fillets without Skin	0.000479	0.000380	0.000105	0.0000840
	LACC01	Fillets without Skin	< 0.000365	0.000365	< 0.0000790	0.0000790
	LPAE01	Fillets without Skin	< 0.000251	0.000251	< 0.0000850	0.0000850
	LPAE02	Fillets without Skin	< 0.000300	0.000300	< 0.0000830	0.0000830
	LPBC01	Fillets without Skin	< 0.000376	0.000376	< 0.0000800	0.0000800
	LPBC02	Fillets without Skin	< 0.000440	0.000440	< 0.0000750	0.0000750

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	< 0.000349	0.000349	< 0.0000740	0.0000740
	LPBC04	Fillets without Skin	< 0.000365	0.000365	< 0.0000850	0.0000850
	LPCC01	Fillets without Skin	< 0.000448	0.000448	< 0.0000860	0.0000860
	UAAE01	Fillets without Skin	0.00109	0.000213	0.000408	0.0000800
	UABC01	Fillets without Skin	0.000439	0.000390	0.0000920	0.0000820
	UACC01	Fillets without Skin	< 0.000341	0.000341	< 0.0000780	0.0000780
	UPAE01	Fillets without Skin	< 0.000224	0.000224	< 0.0000750	0.0000750
	UPCC01	Fillets without Skin	< 0.000389	0.000389	< 0.0000840	0.0000840
	UPCC02	Fillets without Skin	< 0.000397	0.000397	< 0.0000840	0.0000840
	UPCC101	Fillets without Skin	< 0.000382	0.000382	< 0.0000840	0.0000840
	UPCC102	Fillets without Skin	< 0.000393	0.000393	< 0.0000840	0.0000840
	UPCC103	Fillets without Skin	< 0.000350	0.000350	< 0.0000840	0.0000840
PCB# 1						
	LACA01	Fillets with Skin	< 0.000735	0.000735	< 0.000205	0.000205
	LALB01	Fillets with Skin	< 0.00100	0.00100	< 0.000207	0.000207
	*LASF01	Fillets with Skin	< 0.00101	0.00101	< 0.000202	0.000202
	LPCA01	Fillets with Skin	< 0.000842	0.000842	< 0.000199	0.000199
	LPLB01	Fillets with Skin	< 0.000900	0.000900	< 0.000206	0.000206
	LPSB01	Fillets with Skin	< 0.000942	0.000942	< 0.000185	0.000185
	*LPSF01	Fillets with Skin	< 0.00111	0.00111	< 0.000190	0.000190
	UACA01	Fillets with Skin	< 0.000708	0.000708	< 0.000197	0.000197

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	< 0.000906	0.000906	< 0.000202	0.000202
	UASF01	Fillets with Skin	< 0.000978	0.000978	< 0.000201	0.000201
	UPCA01	Fillets with Skin	< 0.000660	0.000660	< 0.000192	0.000192
	UPLB01	Fillets with Skin	< 0.000992	0.000992	< 0.000203	0.000203
	UPSF01	Fillets with Skin	< 0.00102	0.00102	< 0.000199	0.000199
	LAAE01	Fillets without Skin	< 0.000531	0.000531	< 0.000196	0.000196
	LABC01	Fillets without Skin	< 0.000933	0.000933	< 0.000205	0.000205
	LACC01	Fillets without Skin	< 0.000895	0.000895	< 0.000194	0.000194
	LPAE01	Fillets without Skin	< 0.000617	0.000617	< 0.000208	0.000208
	LPAE02	Fillets without Skin	< 0.000736	0.000736	< 0.000204	0.000204
	LPBC01	Fillets without Skin	< 0.000923	0.000923	< 0.000196	0.000196
	LPBC02	Fillets without Skin	< 0.00108	0.00108	< 0.000183	0.000183
	LPBC03	Fillets without Skin	< 0.000856	0.000856	< 0.000181	0.000181
	LPBC04	Fillets without Skin	< 0.000896	0.000896	< 0.000209	0.000209
	LPCC01	Fillets without Skin	< 0.00110	0.00110	< 0.000210	0.000210
	UAAE01	Fillets without Skin	< 0.000523	0.000523	< 0.000196	0.000196
	UABC01	Fillets without Skin	< 0.000956	0.000956	< 0.000201	0.000201
	UACC01	Fillets without Skin	< 0.000836	0.000836	< 0.000192	0.000192
	UPAE01	Fillets without Skin	< 0.000551	0.000551	< 0.000185	0.000185

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	< 0.000955	0.000955	< 0.000206	0.000206
	UPCC02	Fillets without Skin	< 0.000974	0.000974	< 0.000206	0.000206
	UPCC101	Fillets without Skin	< 0.000937	0.000937	< 0.000205	0.000205
	UPCC102	Fillets without Skin	< 0.000965	0.000965	< 0.000206	0.000206
	UPCC103	Fillets without Skin	< 0.000860	0.000860	< 0.000207	0.000207
PCB# 101/90						
	*LACA01	Fillets with Skin	0.126	0.000379	0.0352	0.000106
	LALB01	Fillets with Skin	0.0796	0.000518	0.0165	0.000107
	*LASF01	Fillets with Skin	0.0120	0.000523	0.00240	0.000104
	LPCA01	Fillets with Skin	0.0717	0.000435	0.0169	0.000103
	LPLB01	Fillets with Skin	0.0361	0.000465	0.00826	0.000106
	LPSB01	Fillets with Skin	0.0347	0.000486	0.00680	0.0000950
	*LPSF01	Fillets with Skin	0.0140	0.000574	0.00239	0.0000980
	*UACA01	Fillets with Skin	0.176	0.000366	0.0490	0.000102
	UALB01	Fillets with Skin	0.0479	0.000468	0.0107	0.000104
	UASF01	Fillets with Skin	0.0293	0.000505	0.00603	0.000104
	*UPCA01	Fillets with Skin	0.149	0.000341	0.0435	0.0000990
	UPLB01	Fillets with Skin	0.0583	0.000512	0.0119	0.000105
	UPSF01	Fillets with Skin	0.0120	0.000524	0.00235	0.000103
	*LAAE01	Fillets without Skin	0.110	0.000274	0.0408	0.000101
	LABC01	Fillets without Skin	0.108	0.000482	0.0237	0.000106
	LACC01	Fillets without Skin	0.137	0.000462	0.0297	0.000100
	*LPAE01	Fillets without Skin	0.210	0.000318	0.0708	0.000107

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LPAE02	Fillets without Skin	0.367	0.000380	0.102	0.000106
	LPBC01	Fillets without Skin	0.138	0.000477	0.0293	0.000101
	LPBC02	Fillets without Skin	0.0916	0.000557	0.0155	0.0000940
	LPBC03	Fillets without Skin	0.151	0.000442	0.0321	0.0000940
	*LPBC04	Fillets without Skin	0.170	0.000463	0.0397	0.000108
	*LPCC01	Fillets without Skin	0.218	0.000567	0.0416	0.000108
	*UAAE01	Fillets without Skin	0.190	0.000270	0.0713	0.000101
	UABC01	Fillets without Skin	0.106	0.000493	0.0223	0.000104
	UACC01	Fillets without Skin	0.0893	0.000432	0.0205	0.0000990
	*UPAE01	Fillets without Skin	0.200	0.000284	0.0672	0.0000950
	UPCC01	Fillets without Skin	0.0851	0.000493	0.0183	0.000106
	UPCC02	Fillets without Skin	0.0695	0.000503	0.0147	0.000106
	UPCC101	Fillets without Skin	0.0418	0.000484	0.00916	0.000106
	UPCC102	Fillets without Skin	0.0560	0.000498	0.0120	0.000106
	UPCC103	Fillets without Skin	0.153	0.000444	0.0368	0.000107
PCB# 105						
	LACA01	Fillets with Skin	0.0352	0.000669	0.00980	0.000186
	LALB01	Fillets with Skin	0.0162	0.000913	0.00336	0.000189

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	0.00189	0.000922	0.000376	0.000184
	LPCA01	Fillets with Skin	0.0148	0.000767	0.00349	0.000181
	LPLB01	Fillets with Skin	0.00761	0.000820	0.00174	0.000188
	LPSB01	Fillets with Skin	0.00904	0.000857	0.00177	0.000168
	*LPSF01	Fillets with Skin	0.00318	0.00101	0.000542	0.000173
	UACA01	Fillets with Skin	0.0418	0.000645	0.0117	0.000180
	UALB01	Fillets with Skin	0.0137	0.000824	0.00306	0.000184
	UASF01	Fillets with Skin	0.00721	0.000890	0.00148	0.000183
	UPCA01	Fillets with Skin	0.0248	0.000601	0.00722	0.000175
	UPLB01	Fillets with Skin	0.0146	0.000903	0.00298	0.000185
	UPSF01	Fillets with Skin	0.00190	0.000925	0.000372	0.000181
	LAAE01	Fillets without Skin	0.0421	0.000484	0.0155	0.000178
	LABC01	Fillets without Skin	0.0345	0.000849	0.00760	0.000187
	LACC01	Fillets without Skin	0.0480	0.000814	0.0104	0.000176
	LPAE01	Fillets without Skin	0.111	0.000561	0.0374	0.000189
	LPAE02	Fillets without Skin	0.0649	0.000670	0.0180	0.000186
	LPBC01	Fillets without Skin	0.0286	0.000840	0.00607	0.000178
	LPBC02	Fillets without Skin	0.0411	0.000982	0.00697	0.000167
	LPBC03	Fillets without Skin	0.0527	0.000779	0.0112	0.000165
	LPBC04	Fillets without Skin	0.0440	0.000816	0.0103	0.000191
	LPCC01	Fillets without Skin	0.0274	0.00100	0.00522	0.000191
	UAAE01	Fillets without	0.0842	0.000476	0.0316	0.000178

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.0309	0.000870	0.00649	0.000183
	UACC01	Fillets without Skin	0.0436	0.000761	0.0100	0.000174
	UPAE01	Fillets without Skin	0.0300	0.000501	0.0101	0.000168
	UPCC01	Fillets without Skin	0.0152	0.000869	0.00328	0.000187
	UPCC02	Fillets without Skin	0.0208	0.000887	0.00439	0.000187
	UPCC101	Fillets without Skin	0.0111	0.000853	0.00244	0.000187
	UPCC102	Fillets without Skin	0.0227	0.000878	0.00486	0.000188
	UPCC103	Fillets without Skin	0.0349	0.000782	0.00841	0.000189
PCB# 107						
	LACA01	Fillets with Skin	0.00351	0.000379	0.000979	0.000106
	LALB01	Fillets with Skin	< 0.000518	0.000518	< 0.000107	0.000107
	*LASF01	Fillets with Skin	< 0.000523	0.000523	< 0.000104	0.000104
	LPCA01	Fillets with Skin	< 0.000435	0.000435	< 0.000103	0.000103
	LPLB01	Fillets with Skin	< 0.000465	0.000465	< 0.000106	0.000106
	LPSB01	Fillets with Skin	< 0.000486	0.000486	< 0.0000950	0.0000950
	*LPSF01	Fillets with Skin	< 0.000574	0.000574	< 0.0000980	0.0000980
	UACA01	Fillets with Skin	0.00390	0.000366	0.00109	0.000102
	UALB01	Fillets with Skin	0.00155	0.000468	0.000346	0.000104
	UASF01	Fillets with Skin	0.000650	0.000505	0.000134	0.000104
	UPCA01	Fillets with Skin	< 0.000341	0.000341	< 0.0000990	0.0000990
	UPLB01	Fillets with Skin	< 0.000512	0.000512	< 0.000105	0.000105
	UPSF01	Fillets with Skin	< 0.000524	0.000524	< 0.000103	0.000103

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	< 0.000274	0.000274	< 0.000101	0.000101
	LABC01	Fillets without Skin	< 0.000482	0.000482	< 0.000106	0.000106
	LACC01	Fillets without Skin	< 0.000462	0.000462	< 0.000100	0.000100
	LPAE01	Fillets without Skin	< 0.000318	0.000318	< 0.000107	0.000107
	LPAE02	Fillets without Skin	< 0.000380	0.000380	< 0.000106	0.000106
	LPBC01	Fillets without Skin	< 0.000477	0.000477	< 0.000101	0.000101
	LPBC02	Fillets without Skin	< 0.000557	0.000557	< 0.0000940	0.0000940
	LPBC03	Fillets without Skin	< 0.000442	0.000442	< 0.0000940	0.0000940
	LPBC04	Fillets without Skin	< 0.000463	0.000463	< 0.000108	0.000108
	LPCC01	Fillets without Skin	< 0.000567	0.000567	< 0.000108	0.000108
	UAAE01	Fillets without Skin	< 0.000270	0.000270	< 0.000101	0.000101
	UABC01	Fillets without Skin	< 0.000493	0.000493	< 0.000104	0.000104
	UACC01	Fillets without Skin	< 0.000432	0.000432	< 0.0000990	0.0000990
	UPAE01	Fillets without Skin	< 0.000284	0.000284	< 0.0000950	0.0000950
	UPCC01	Fillets without Skin	< 0.000493	0.000493	< 0.000106	0.000106
	UPCC02	Fillets without Skin	< 0.000503	0.000503	< 0.000106	0.000106
	UPCC101	Fillets without Skin	< 0.000484	0.000484	< 0.000106	0.000106

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	< 0.000498	0.000498	< 0.000106	0.000106
	UPCC103	Fillets without Skin	< 0.000444	0.000444	< 0.000107	0.000107
PCB# 110/77						
	LACA01	Fillets with Skin	0.130	0.000408	0.0361	0.000114
	LALB01	Fillets with Skin	0.0355	0.000557	0.00734	0.000115
	*LASF01	Fillets with Skin	0.00822	0.000563	0.00164	0.000112
	LPCA01	Fillets with Skin	0.0504	0.000468	0.0119	0.000110
	LPLB01	Fillets with Skin	0.0210	0.000500	0.00480	0.000115
	LPSB01	Fillets with Skin	0.0200	0.000523	0.00393	0.000103
	*LPSF01	Fillets with Skin	0.00829	0.000618	0.00141	0.000105
	*UACA01	Fillets with Skin	0.139	0.000394	0.0386	0.000110
	UALB01	Fillets with Skin	0.0332	0.000503	0.00740	0.000112
	UASF01	Fillets with Skin	0.0195	0.000543	0.00401	0.000112
	UPCA01	Fillets with Skin	0.0966	0.000367	0.0281	0.000107
	UPLB01	Fillets with Skin	0.0229	0.000552	0.00468	0.000113
	UPSF01	Fillets with Skin	0.00481	0.000565	0.000943	0.000111
	*LAAE01	Fillets without Skin	0.115	0.000295	0.0426	0.000109
	LABC01	Fillets without Skin	0.0776	0.000518	0.0171	0.000114
	LACC01	Fillets without Skin	0.136	0.000497	0.0294	0.000108
	*LPAE01	Fillets without Skin	0.185	0.000343	0.0624	0.000116
	LPAE02	Fillets without Skin	0.116	0.000409	0.0323	0.000114
	LPBC01	Fillets without Skin	0.0872	0.000513	0.0185	0.000109
	LPBC02	Fillets without Skin	0.0192	0.000600	0.00326	0.000102

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	0.125	0.000476	0.0265	0.000101
	LPBC04	Fillets without Skin	0.166	0.000498	0.0389	0.000116
	LPCC01	Fillets without Skin	0.0860	0.000611	0.0164	0.000117
	*UAAE01	Fillets without Skin	0.212	0.000291	0.0794	0.000109
	UABC01	Fillets without Skin	0.0527	0.000531	0.0111	0.000111
	UACC01	Fillets without Skin	0.0808	0.000465	0.0185	0.000107
	*UPAE01	Fillets without Skin	0.135	0.000306	0.0453	0.000103
	UPCC01	Fillets without Skin	0.0540	0.000531	0.0116	0.000114
	UPCC02	Fillets without Skin	0.0506	0.000541	0.0107	0.000114
	UPCC101	Fillets without Skin	0.0270	0.000521	0.00591	0.000114
	UPCC102	Fillets without Skin	0.0461	0.000536	0.00985	0.000115
	UPCC103	Fillets without Skin	0.0804	0.000478	0.0194	0.000115
PCB# 114/131/122						
	LACA01	Fillets with Skin	< 0.000379	0.000379	< 0.000106	0.000106
	LALB01	Fillets with Skin	< 0.000518	0.000518	< 0.000107	0.000107
	*LASF01	Fillets with Skin	< 0.000523	0.000523	< 0.000104	0.000104
	LPCA01	Fillets with Skin	< 0.000435	0.000435	< 0.000103	0.000103
	LPLB01	Fillets with Skin	< 0.000465	0.000465	< 0.000106	0.000106
	LPSB01	Fillets with Skin	< 0.000486	0.000486	< 0.0000950	0.0000950
	*LPSF01	Fillets with Skin	< 0.000574	0.000574	< 0.0000980	0.0000980
	UACA01	Fillets with Skin	< 0.000366	0.000366	< 0.000102	0.000102

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	< 0.000468	0.000468	< 0.000104	0.000104
	UASF01	Fillets with Skin	< 0.000505	0.000505	< 0.000104	0.000104
	UPCA01	Fillets with Skin	< 0.000341	0.000341	< 0.0000990	0.0000990
	UPLB01	Fillets with Skin	< 0.000512	0.000512	< 0.000105	0.000105
	UPSF01	Fillets with Skin	< 0.000524	0.000524	< 0.000103	0.000103
	LAAE01	Fillets without Skin	< 0.000274	0.000274	< 0.000101	0.000101
	LABC01	Fillets without Skin	< 0.000482	0.000482	< 0.000106	0.000106
	LACC01	Fillets without Skin	< 0.000462	0.000462	< 0.000100	0.000100
	LPAE01	Fillets without Skin	< 0.000318	0.000318	< 0.000107	0.000107
	LPAE02	Fillets without Skin	< 0.000380	0.000380	< 0.000106	0.000106
	LPBC01	Fillets without Skin	< 0.000477	0.000477	< 0.000101	0.000101
	LPBC02	Fillets without Skin	< 0.000557	0.000557	< 0.0000940	0.0000940
	LPBC03	Fillets without Skin	< 0.000442	0.000442	< 0.0000940	0.0000940
	LPBC04	Fillets without Skin	< 0.000463	0.000463	< 0.000108	0.000108
	LPCC01	Fillets without Skin	< 0.000567	0.000567	< 0.000108	0.000108
	UAAE01	Fillets without Skin	< 0.000270	0.000270	< 0.000101	0.000101
	UABC01	Fillets without Skin	< 0.000493	0.000493	< 0.000104	0.000104
	UACC01	Fillets without Skin	< 0.000432	0.000432	< 0.0000990	0.0000990
	UPAE01	Fillets without Skin	< 0.000284	0.000284	< 0.0000950	0.0000950

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	< 0.000493	0.000493	< 0.000106	0.000106
	UPCC02	Fillets without Skin	< 0.000503	0.000503	< 0.000106	0.000106
	UPCC101	Fillets without Skin	< 0.000484	0.000484	< 0.000106	0.000106
	UPCC102	Fillets without Skin	< 0.000498	0.000498	< 0.000106	0.000106
	UPCC103	Fillets without Skin	< 0.000444	0.000444	< 0.000107	0.000107
PCB# 118						
	LACA01	Fillets with Skin	0.131	0.000483	0.0365	0.000135
	LALB01	Fillets with Skin	0.0397	0.000659	0.00821	0.000136
	*LASF01	Fillets with Skin	0.00817	0.000666	0.00162	0.000133
	LPCA01	Fillets with Skin	0.0601	0.000554	0.0142	0.000131
	LPLB01	Fillets with Skin	0.0231	0.000592	0.00530	0.000135
	LPSB01	Fillets with Skin	0.0226	0.000619	0.00443	0.000121
	*LPSF01	Fillets with Skin	0.00857	0.000731	0.00146	0.000125
	*UACA01	Fillets with Skin	0.141	0.000466	0.0393	0.000130
	UALB01	Fillets with Skin	0.0408	0.000595	0.00910	0.000133
	UASF01	Fillets with Skin	0.0236	0.000643	0.00485	0.000132
	UPCA01	Fillets with Skin	0.106	0.000434	0.0309	0.000126
	UPLB01	Fillets with Skin	0.0432	0.000652	0.00884	0.000133
	UPSF01	Fillets with Skin	0.00637	0.000668	0.00125	0.000131
	*LAAE01	Fillets without Skin	0.109	0.000349	0.0403	0.000129
	LABC01	Fillets without Skin	0.124	0.000613	0.0274	0.000135
	*LACC01	Fillets without Skin	0.162	0.000588	0.0351	0.000127
	*LPAE01	Fillets without Skin	0.441	0.000405	0.149	0.000137

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LPAE02	Fillets without Skin	0.165	0.000484	0.0459	0.000134
	LPBC01	Fillets without Skin	0.122	0.000607	0.0258	0.000129
	LPBC02	Fillets without Skin	0.174	0.000709	0.0295	0.000120
	*LPBC03	Fillets without Skin	0.164	0.000563	0.0347	0.000119
	*LPBC04	Fillets without Skin	0.170	0.000589	0.0397	0.000138
	LPCC01	Fillets without Skin	0.122	0.000722	0.0233	0.000138
	*UAAE01	Fillets without Skin	0.157	0.000344	0.0588	0.000129
	UABC01	Fillets without Skin	0.140	0.000628	0.0293	0.000132
	*UACC01	Fillets without Skin	0.138	0.000550	0.0316	0.000126
	*UPAE01	Fillets without Skin	0.178	0.000362	0.0598	0.000122
	UPCC01	Fillets without Skin	0.0806	0.000628	0.0174	0.000135
	UPCC02	Fillets without Skin	0.0696	0.000640	0.0147	0.000135
	UPCC101	Fillets without Skin	0.0409	0.000616	0.00896	0.000135
	UPCC102	Fillets without Skin	0.0740	0.000634	0.0158	0.000135
	UPCC103	Fillets without Skin	0.103	0.000565	0.0249	0.000136
PCB# 126						
	LACA01	Fillets with Skin	< 0.000379	0.000379	< 0.000106	0.000106
	LALB01	Fillets with Skin	< 0.000518	0.000518	< 0.000107	0.000107

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	< 0.000523	0.000523	< 0.000104	0.000104
	LPCA01	Fillets with Skin	< 0.000435	0.000435	< 0.000103	0.000103
	LPLB01	Fillets with Skin	< 0.000465	0.000465	< 0.000106	0.000106
	LPSB01	Fillets with Skin	< 0.000486	0.000486	< 0.0000950	0.0000950
	*LPSF01	Fillets with Skin	< 0.000574	0.000574	< 0.0000980	0.0000980
	UACA01	Fillets with Skin	< 0.000366	0.000366	< 0.000102	0.000102
	UALB01	Fillets with Skin	< 0.000468	0.000468	< 0.000104	0.000104
	UASF01	Fillets with Skin	< 0.000505	0.000505	< 0.000104	0.000104
	UPCA01	Fillets with Skin	< 0.000341	0.000341	< 0.0000990	0.0000990
	UPLB01	Fillets with Skin	< 0.000512	0.000512	< 0.000105	0.000105
	UPSF01	Fillets with Skin	< 0.000524	0.000524	< 0.000103	0.000103
	LAAE01	Fillets without Skin	< 0.000274	0.000274	< 0.000101	0.000101
	LABC01	Fillets without Skin	< 0.000482	0.000482	< 0.000106	0.000106
	LACC01	Fillets without Skin	< 0.000462	0.000462	< 0.000100	0.000100
	LPAE01	Fillets without Skin	< 0.000318	0.000318	< 0.000107	0.000107
	LPAE02	Fillets without Skin	< 0.000380	0.000380	< 0.000106	0.000106
	LPBC01	Fillets without Skin	< 0.000477	0.000477	< 0.000101	0.000101
	LPBC02	Fillets without Skin	< 0.000557	0.000557	< 0.0000940	0.0000940
	LPBC03	Fillets without Skin	0.000698	0.000442	0.000148	0.0000940
	LPBC04	Fillets without Skin	< 0.000463	0.000463	< 0.000108	0.000108
	LPCC01	Fillets without Skin	0.000728	0.000567	0.000139	0.000108
	UAAE01	Fillets without	< 0.000270	0.000270	< 0.000101	0.000101

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	< 0.000493	0.000493	< 0.000104	0.000104
	UACC01	Fillets without Skin	< 0.000432	0.000432	< 0.0000990	0.0000990
	UPAE01	Fillets without Skin	< 0.000284	0.000284	< 0.0000950	0.0000950
	UPCC01	Fillets without Skin	< 0.000493	0.000493	< 0.000106	0.000106
	UPCC02	Fillets without Skin	< 0.000503	0.000503	< 0.000106	0.000106
	UPCC101	Fillets without Skin	< 0.000484	0.000484	< 0.000106	0.000106
	UPCC102	Fillets without Skin	< 0.000498	0.000498	< 0.000106	0.000106
	UPCC103	Fillets without Skin	< 0.000444	0.000444	< 0.000107	0.000107
PCB# 128						
	LACA01	Fillets with Skin	0.0206	0.000342	0.00574	0.0000950
	LALB01	Fillets with Skin	0.0126	0.000466	0.00260	0.0000960
	*LASF01	Fillets with Skin	0.00137	0.000471	0.000272	0.0000940
	LPCA01	Fillets with Skin	0.0112	0.000392	0.00264	0.0000920
	LPLB01	Fillets with Skin	0.00592	0.000419	0.00135	0.0000960
	LPSB01	Fillets with Skin	0.00420	0.000438	0.000823	0.0000860
	*LPSF01	Fillets with Skin	0.00145	0.000517	0.000247	0.0000880
	UACA01	Fillets with Skin	0.0297	0.000329	0.00827	0.0000920
	UALB01	Fillets with Skin	0.00767	0.000421	0.00171	0.0000940
	UASF01	Fillets with Skin	0.00417	0.000454	0.000859	0.0000940
	UPCA01	Fillets with Skin	0.0252	0.000307	0.00733	0.0000890
	UPLB01	Fillets with Skin	0.0102	0.000461	0.00210	0.0000940
	UPSF01	Fillets with Skin	0.00163	0.000472	0.000319	0.0000920

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	0.0402	0.000247	0.0148	0.0000910
	LABC01	Fillets without Skin	0.0217	0.000434	0.00476	0.0000950
	LACC01	Fillets without Skin	0.0413	0.000416	0.00894	0.0000900
	*LPAE01	Fillets without Skin	0.112	0.000287	0.0377	0.0000970
	LPAE02	Fillets without Skin	0.0498	0.000342	0.0138	0.0000950
	LPBC01	Fillets without Skin	0.0237	0.000429	0.00503	0.0000910
	LPBC02	Fillets without Skin	0.0513	0.000502	0.00870	0.0000850
	LPBC03	Fillets without Skin	0.0630	0.000398	0.0134	0.0000840
	LPBC04	Fillets without Skin	0.0571	0.000417	0.0133	0.0000970
	LPCC01	Fillets without Skin	0.0274	0.000511	0.00523	0.0000970
	UAAE01	Fillets without Skin	0.0371	0.000243	0.0139	0.0000910
	UABC01	Fillets without Skin	0.0273	0.000444	0.00572	0.0000930
	UACC01	Fillets without Skin	0.0297	0.000389	0.00680	0.0000890
	UPAE01	Fillets without Skin	0.0523	0.000256	0.0176	0.0000860
	UPCC01	Fillets without Skin	0.0159	0.000444	0.00344	0.0000960
	UPCC02	Fillets without Skin	0.0178	0.000453	0.00376	0.0000960
	UPCC101	Fillets without Skin	0.00823	0.000436	0.00180	0.0000950

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	0.0158	0.000448	0.00338	0.0000960
	UPCC103	Fillets without Skin	0.0241	0.000400	0.00581	0.0000960
PCB# 129						
	LACA01	Fillets with Skin	0.00554	0.000365	0.00154	0.000102
	LALB01	Fillets with Skin	0.00293	0.000498	0.000606	0.000103
	*LASF01	Fillets with Skin	0.000519	0.000503	0.000103	0.000100
	LPCA01	Fillets with Skin	0.00257	0.000418	0.000607	0.0000990
	LPLB01	Fillets with Skin	0.00127	0.000447	0.000290	0.000102
	LPSB01	Fillets with Skin	0.00154	0.000467	0.000301	0.0000920
	*LPSF01	Fillets with Skin	0.000622	0.000552	0.000106	0.0000940
	UACA01	Fillets with Skin	0.00752	0.000352	0.00210	0.0000980
	UALB01	Fillets with Skin	0.00164	0.000450	0.000366	0.000100
	UASF01	Fillets with Skin	0.00125	0.000485	0.000257	0.000100
	UPCA01	Fillets with Skin	0.00568	0.000328	0.00166	0.0000960
	UPLB01	Fillets with Skin	0.00202	0.000493	0.000413	0.000101
	UPSF01	Fillets with Skin	< 0.000504	0.000504	< 0.0000990	0.0000990
	LAAE01	Fillets without Skin	0.00562	0.000264	0.00207	0.0000970
	LABC01	Fillets without Skin	0.00255	0.000463	0.000562	0.000102
	LACC01	Fillets without Skin	0.00607	0.000444	0.00132	0.0000960
	LPAE01	Fillets without Skin	0.00925	0.000306	0.00312	0.000103
	LPAE02	Fillets without Skin	0.00476	0.000365	0.00132	0.000101
	LPBC01	Fillets without Skin	0.00313	0.000458	0.000664	0.0000970
	LPBC02	Fillets without Skin	0.00402	0.000536	0.000681	0.0000910

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	0.00844	0.000425	0.00179	0.0000900
	LPBC04	Fillets without Skin	0.00889	0.000445	0.00208	0.000104
	LPCC01	Fillets without Skin	0.00300	0.000545	0.000572	0.000104
	UAAE01	Fillets without Skin	0.00461	0.000259	0.00173	0.0000970
	UABC01	Fillets without Skin	0.00322	0.000474	0.000675	0.000100
	UACC01	Fillets without Skin	0.00334	0.000415	0.000766	0.0000950
	UPAE01	Fillets without Skin	0.00544	0.000273	0.00183	0.0000920
	UPCC01	Fillets without Skin	0.00203	0.000474	0.000437	0.000102
	UPCC02	Fillets without Skin	0.00249	0.000484	0.000526	0.000102
	UPCC101	Fillets without Skin	0.00111	0.000465	0.000244	0.000102
	UPCC102	Fillets without Skin	0.00242	0.000479	0.000516	0.000102
	UPCC103	Fillets without Skin	0.00306	0.000427	0.000738	0.000103
PCB# 136						
	LACA01	Fillets with Skin	< 0.000365	0.000365	< 0.000102	0.000102
	LALB01	Fillets with Skin	< 0.000498	0.000498	< 0.000103	0.000103
	*LASF01	Fillets with Skin	< 0.000503	0.000503	< 0.000100	0.000100
	LPCA01	Fillets with Skin	< 0.000418	0.000418	< 0.0000990	0.0000990
	LPLB01	Fillets with Skin	< 0.000447	0.000447	< 0.000102	0.000102
	LPSB01	Fillets with Skin	0.00260	0.000467	0.000510	0.0000920
	*LPSF01	Fillets with Skin	< 0.000552	0.000552	< 0.0000940	0.0000940
	UACA01	Fillets with Skin	< 0.000352	0.000352	< 0.0000980	0.0000980

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	< 0.000450	0.000450	< 0.000100	0.000100
	UASF01	Fillets with Skin	< 0.000485	0.000485	< 0.000100	0.000100
	UPCA01	Fillets with Skin	< 0.000328	0.000328	< 0.0000960	0.0000960
	UPLB01	Fillets with Skin	< 0.000493	0.000493	< 0.000101	0.000101
	UPSF01	Fillets with Skin	< 0.000504	0.000504	< 0.0000990	0.0000990
	LAAE01	Fillets without Skin	< 0.000264	0.000264	< 0.0000970	0.0000970
	LABC01	Fillets without Skin	< 0.000463	0.000463	< 0.000102	0.000102
	LACC01	Fillets without Skin	< 0.000444	0.000444	< 0.0000960	0.0000960
	LPAE01	Fillets without Skin	< 0.000306	0.000306	< 0.000103	0.000103
	LPAE02	Fillets without Skin	< 0.000365	0.000365	< 0.000101	0.000101
	LPBC01	Fillets without Skin	< 0.000458	0.000458	< 0.0000970	0.0000970
	LPBC02	Fillets without Skin	< 0.000536	0.000536	< 0.0000910	0.0000910
	LPBC03	Fillets without Skin	< 0.000425	0.000425	< 0.0000900	0.0000900
	LPBC04	Fillets without Skin	< 0.000445	0.000445	< 0.000104	0.000104
	LPCC01	Fillets without Skin	0.00491	0.000545	0.000937	0.000104
	UAAE01	Fillets without Skin	< 0.000259	0.000259	< 0.0000970	0.0000970
	UABC01	Fillets without Skin	< 0.000474	0.000474	< 0.000100	0.000100
	UACC01	Fillets without Skin	< 0.000415	0.000415	< 0.0000950	0.0000950
	UPAE01	Fillets without Skin	< 0.000273	0.000273	< 0.0000920	0.0000920

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	< 0.000474	0.000474	< 0.000102	0.000102
	UPCC02	Fillets without Skin	< 0.000484	0.000484	< 0.000102	0.000102
	UPCC101	Fillets without Skin	< 0.000465	0.000465	< 0.000102	0.000102
	UPCC102	Fillets without Skin	< 0.000479	0.000479	< 0.000102	0.000102
	UPCC103	Fillets without Skin	< 0.000427	0.000427	< 0.000103	0.000103
PCB# 138/160						
	*LACA01	Fillets with Skin	0.139	0.000365	0.0388	0.000102
	LALB01	Fillets with Skin	0.163	0.000498	0.0338	0.000103
	*LASF01	Fillets with Skin	0.0165	0.000503	0.00329	0.000100
	LPCA01	Fillets with Skin	0.121	0.000418	0.0286	0.0000990
	LPLB01	Fillets with Skin	0.0622	0.000447	0.0142	0.000102
	LPSB01	Fillets with Skin	0.0562	0.000467	0.0110	0.0000920
	*LPSF01	Fillets with Skin	0.0246	0.000552	0.00419	0.0000940
	*UACA01	Fillets with Skin	0.213	0.000352	0.0595	0.0000980
	UALB01	Fillets with Skin	0.0751	0.000450	0.0168	0.000100
	UASF01	Fillets with Skin	0.0396	0.000485	0.00816	0.000100
	*UPCA01	Fillets with Skin	0.221	0.000328	0.0643	0.0000960
	UPLB01	Fillets with Skin	0.118	0.000493	0.0241	0.000101
	UPSF01	Fillets with Skin	0.0258	0.000504	0.00506	0.0000990
	*LAAE01	Fillets without Skin	0.324	0.000264	0.119	0.0000970
	LABC01	Fillets without Skin	0.254	0.000463	0.0559	0.000102
	*LACC01	Fillets without Skin	0.325	0.000444	0.0703	0.0000960
	*LPAE01	Fillets without Skin	1.03	0.000306	0.347	0.000103

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LPAE02	Fillets without Skin	0.662	0.000365	0.184	0.000101
	LPBC01	Fillets without Skin	0.279	0.000458	0.0590	0.0000970
	*LPBC02	Fillets without Skin	0.363	0.000536	0.0616	0.0000910
	*LPBC03	Fillets without Skin	0.540	0.000425	0.114	0.0000900
	*LPBC04	Fillets without Skin	0.460	0.000445	0.107	0.000104
	*LPCC01	Fillets without Skin	0.427	0.000545	0.0815	0.000104
	*UAAE01	Fillets without Skin	0.206	0.000259	0.0773	0.0000970
	*UABC01	Fillets without Skin	0.181	0.000474	0.0379	0.000100
	*UACC01	Fillets without Skin	0.231	0.000415	0.0530	0.0000950
	*UPAE01	Fillets without Skin	0.580	0.000273	0.195	0.0000920
	UPCC01	Fillets without Skin	0.204	0.000474	0.0438	0.000102
	UPCC02	Fillets without Skin	0.178	0.000484	0.0375	0.000102
	UPCC101	Fillets without Skin	0.0933	0.000465	0.0204	0.000102
	UPCC102	Fillets without Skin	0.161	0.000479	0.0345	0.000102
	*UPCC103	Fillets without Skin	0.250	0.000427	0.0603	0.000103
PCB# 141/179						
	LACA01	Fillets with Skin	0.0264	0.000365	0.00736	0.000102
	LALB01	Fillets with Skin	0.0336	0.000498	0.00695	0.000103

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	0.00241	0.000503	0.000479	0.000100
	LPCA01	Fillets with Skin	0.0221	0.000418	0.00520	0.0000990
	LPLB01	Fillets with Skin	0.00660	0.000447	0.00151	0.000102
	LPSB01	Fillets with Skin	0.00958	0.000467	0.00188	0.0000920
	*LPSF01	Fillets with Skin	0.00504	0.000552	0.000860	0.0000940
	UACA01	Fillets with Skin	0.0417	0.000352	0.0116	0.0000980
	UALB01	Fillets with Skin	0.0104	0.000450	0.00231	0.000100
	UASF01	Fillets with Skin	0.00347	0.000485	0.000714	0.000100
	UPCA01	Fillets with Skin	0.0398	0.000328	0.0116	0.0000960
	UPLB01	Fillets with Skin	0.0180	0.000493	0.00367	0.000101
	UPSF01	Fillets with Skin	0.00251	0.000504	0.000491	0.0000990
	LAAE01	Fillets without Skin	0.0323	0.000264	0.0119	0.0000970
	LABC01	Fillets without Skin	0.0217	0.000463	0.00476	0.000102
	LACC01	Fillets without Skin	0.0375	0.000444	0.00814	0.0000960
	*LPAE01	Fillets without Skin	0.123	0.000306	0.0414	0.000103
	LPAE02	Fillets without Skin	0.0986	0.000365	0.0274	0.000101
	LPBC01	Fillets without Skin	0.0478	0.000458	0.0101	0.0000970
	LPBC02	Fillets without Skin	0.0856	0.000536	0.0145	0.0000910
	LPBC03	Fillets without Skin	0.0872	0.000425	0.0185	0.0000900
	LPBC04	Fillets without Skin	0.104	0.000445	0.0243	0.000104
	LPCC01	Fillets without Skin	0.0580	0.000545	0.0111	0.000104
	UAAE01	Fillets without	0.0571	0.000259	0.0214	0.0000970

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.0251	0.000474	0.00526	0.000100
	UACC01	Fillets without Skin	0.0164	0.000415	0.00376	0.0000950
	UPAE01	Fillets without Skin	0.0515	0.000273	0.0173	0.0000920
	UPCC01	Fillets without Skin	0.0216	0.000474	0.00466	0.000102
	UPCC02	Fillets without Skin	0.0166	0.000484	0.00350	0.000102
	UPCC101	Fillets without Skin	0.00940	0.000465	0.00206	0.000102
	UPCC102	Fillets without Skin	0.0109	0.000479	0.00233	0.000102
	UPCC103	Fillets without Skin	0.0283	0.000427	0.00681	0.000103
PCB# 146						
	LACA01	Fillets with Skin	0.0261	0.000365	0.00729	0.000102
	LALB01	Fillets with Skin	0.0374	0.000498	0.00774	0.000103
	*LASF01	Fillets with Skin	0.00264	0.000503	0.000526	0.000100
	LPCA01	Fillets with Skin	0.0219	0.000418	0.00516	0.0000990
	LPLB01	Fillets with Skin	0.0125	0.000447	0.00286	0.000102
	LPSB01	Fillets with Skin	0.0126	0.000467	0.00247	0.0000920
	*LPSF01	Fillets with Skin	0.00463	0.000552	0.000789	0.0000940
	UACA01	Fillets with Skin	0.0380	0.000352	0.0106	0.0000980
	UALB01	Fillets with Skin	0.0131	0.000450	0.00293	0.000100
	UASF01	Fillets with Skin	0.00623	0.000485	0.00128	0.000100
	UPCA01	Fillets with Skin	0.0411	0.000328	0.0120	0.0000960
	UPLB01	Fillets with Skin	0.0244	0.000493	0.00498	0.000101
	UPSF01	Fillets with Skin	0.00542	0.000504	0.00106	0.0000990

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	0.0724	0.000264	0.0267	0.0000970
	LABC01	Fillets without Skin	0.0445	0.000463	0.00980	0.000102
	LACC01	Fillets without Skin	0.0690	0.000444	0.0150	0.0000960
	*LPAE01	Fillets without Skin	0.233	0.000306	0.0788	0.000103
	*LPAE02	Fillets without Skin	0.208	0.000365	0.0579	0.000101
	LPBC01	Fillets without Skin	0.0464	0.000458	0.00983	0.0000970
	LPBC02	Fillets without Skin	0.0998	0.000536	0.0169	0.0000910
	LPBC03	Fillets without Skin	0.143	0.000425	0.0302	0.0000900
	LPBC04	Fillets without Skin	0.111	0.000445	0.0260	0.000104
	LPCC01	Fillets without Skin	0.103	0.000545	0.0196	0.000104
	UAAE01	Fillets without Skin	0.0579	0.000259	0.0217	0.0000970
	UABC01	Fillets without Skin	0.0468	0.000474	0.00981	0.000100
	UACC01	Fillets without Skin	0.0479	0.000415	0.0110	0.0000950
	*UPAE01	Fillets without Skin	0.143	0.000273	0.0481	0.0000920
	UPCC01	Fillets without Skin	0.0410	0.000474	0.00884	0.000102
	UPCC02	Fillets without Skin	0.0371	0.000484	0.00783	0.000102
	UPCC101	Fillets without Skin	0.0198	0.000465	0.00433	0.000102

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	0.0328	0.000479	0.00700	0.000102
	UPCC103	Fillets without Skin	0.0627	0.000427	0.0151	0.000103
PCB# 149/123						
	LACA01	Fillets with Skin	0.0915	0.000365	0.0255	0.000102
	LALB01	Fillets with Skin	0.0853	0.000498	0.0176	0.000103
	*LASF01	Fillets with Skin	0.00741	0.000503	0.00148	0.000100
	LPCA01	Fillets with Skin	0.0604	0.000418	0.0142	0.0000990
	LPLB01	Fillets with Skin	0.0301	0.000447	0.00688	0.000102
	LPSB01	Fillets with Skin	0.0280	0.000467	0.00548	0.0000920
	*LPSF01	Fillets with Skin	0.0114	0.000552	0.00194	0.0000940
	UACA01	Fillets with Skin	0.123	0.000352	0.0344	0.0000980
	UALB01	Fillets with Skin	0.0295	0.000450	0.00658	0.000100
	UASF01	Fillets with Skin	0.0146	0.000485	0.00300	0.000100
	UPCA01	Fillets with Skin	0.122	0.000328	0.0355	0.0000960
	UPLB01	Fillets with Skin	0.0416	0.000493	0.00850	0.000101
	UPSF01	Fillets with Skin	0.0102	0.000504	0.00199	0.0000990
	*LAAE01	Fillets without Skin	0.143	0.000264	0.0528	0.0000970
	LABC01	Fillets without Skin	0.103	0.000463	0.0227	0.000102
	LACC01	Fillets without Skin	0.117	0.000444	0.0253	0.0000960
	*LPAE01	Fillets without Skin	0.211	0.000306	0.0713	0.000103
	*LPAE02	Fillets without Skin	0.298	0.000365	0.0829	0.000101
	LPBC01	Fillets without Skin	0.113	0.000458	0.0240	0.0000970
	LPBC02	Fillets without Skin	0.108	0.000536	0.0183	0.0000910

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LPBC03	Fillets without Skin	0.248	0.000425	0.0526	0.0000900
	*LPBC04	Fillets without Skin	0.218	0.000445	0.0509	0.000104
	LPCC01	Fillets without Skin	0.209	0.000545	0.0399	0.000104
	*UAAE01	Fillets without Skin	0.133	0.000259	0.0500	0.0000970
	UABC01	Fillets without Skin	0.0719	0.000474	0.0151	0.000100
	UACC01	Fillets without Skin	0.0569	0.000415	0.0130	0.0000950
	*UPAE01	Fillets without Skin	0.231	0.000273	0.0777	0.0000920
	UPCC01	Fillets without Skin	0.0864	0.000474	0.0186	0.000102
	UPCC02	Fillets without Skin	0.0739	0.000484	0.0156	0.000102
	UPCC101	Fillets without Skin	0.0396	0.000465	0.00867	0.000102
	UPCC102	Fillets without Skin	0.0509	0.000479	0.0109	0.000102
	UPCC103	Fillets without Skin	0.151	0.000427	0.0364	0.000103
PCB# 15						
	LACA01	Fillets with Skin	0.0321	0.000735	0.00894	0.000205
	LALB01	Fillets with Skin	0.00708	0.00100	0.00146	0.000207
	*LASF01	Fillets with Skin	0.00330	0.00101	0.000658	0.000202
	LPCA01	Fillets with Skin	0.00426	0.000842	0.00100	0.000199
	LPLB01	Fillets with Skin	0.00232	0.000900	0.000532	0.000206
	LPSB01	Fillets with Skin	0.00467	0.000942	0.000916	0.000185
	*LPSF01	Fillets with Skin	0.00180	0.00111	0.000306	0.000190
	UACA01	Fillets with Skin	0.0345	0.000708	0.00962	0.000197

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.00917	0.000906	0.00205	0.000202
	UASF01	Fillets with Skin	0.00808	0.000978	0.00166	0.000201
	UPCA01	Fillets with Skin	0.00917	0.000660	0.00267	0.000192
	UPLB01	Fillets with Skin	0.00180	0.000992	0.000367	0.000203
	UPSF01	Fillets with Skin	0.00122	0.00102	0.000239	0.000199
	LAAE01	Fillets without Skin	0.00150	0.000531	0.000552	0.000196
	LABC01	Fillets without Skin	0.0161	0.000933	0.00355	0.000205
	LACC01	Fillets without Skin	0.0193	0.000895	0.00418	0.000194
	LPAE01	Fillets without Skin	< 0.000617	0.000617	< 0.000208	0.000208
	LPAE02	Fillets without Skin	0.00108	0.000736	0.000301	0.000204
	LPBC01	Fillets without Skin	0.0158	0.000923	0.00336	0.000196
	LPBC02	Fillets without Skin	0.00122	0.00108	0.000207	0.000183
	LPBC03	Fillets without Skin	0.00201	0.000856	0.000426	0.000181
	LPBC04	Fillets without Skin	0.00811	0.000896	0.00190	0.000209
	LPCC01	Fillets without Skin	0.0228	0.00110	0.00435	0.000210
	UAAE01	Fillets without Skin	0.000704	0.000523	0.000264	0.000196
	UABC01	Fillets without Skin	0.00951	0.000956	0.00200	0.000201
	UACC01	Fillets without Skin	0.0259	0.000836	0.00594	0.000192
	UPAE01	Fillets without Skin	< 0.000551	0.000551	< 0.000185	0.000185

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.0210	0.000955	0.00453	0.000206
	UPCC02	Fillets without Skin	0.0120	0.000974	0.00253	0.000206
	UPCC101	Fillets without Skin	0.00286	0.000937	0.000626	0.000205
	UPCC102	Fillets without Skin	0.0103	0.000965	0.00220	0.000206
	UPCC103	Fillets without Skin	0.0468	0.000860	0.0113	0.000207
PCB# 151						
	LACA01	Fillets with Skin	0.0359	0.000365	0.0100	0.000102
	LALB01	Fillets with Skin	0.0379	0.000498	0.00784	0.000103
	*LASF01	Fillets with Skin	0.00302	0.000503	0.000601	0.000100
	LPCA01	Fillets with Skin	0.0233	0.000418	0.00549	0.0000990
	LPLB01	Fillets with Skin	0.0127	0.000447	0.00290	0.000102
	LPSB01	Fillets with Skin	0.0125	0.000467	0.00246	0.0000920
	*LPSF01	Fillets with Skin	0.00511	0.000552	0.000872	0.0000940
	UACA01	Fillets with Skin	0.0442	0.000352	0.0123	0.0000980
	UALB01	Fillets with Skin	0.0112	0.000450	0.00250	0.000100
	UASF01	Fillets with Skin	0.00699	0.000485	0.00144	0.000100
	UPCA01	Fillets with Skin	0.0520	0.000328	0.0152	0.0000960
	UPLB01	Fillets with Skin	0.0188	0.000493	0.00384	0.000101
	UPSF01	Fillets with Skin	0.00563	0.000504	0.00110	0.0000990
	LAAE01	Fillets without Skin	0.0303	0.000264	0.0112	0.0000970
	LABC01	Fillets without Skin	0.0462	0.000463	0.0102	0.000102
	LACC01	Fillets without Skin	0.0510	0.000444	0.0111	0.0000960
	LPAE01	Fillets without Skin	0.0623	0.000306	0.0210	0.000103

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	0.0631	0.000365	0.0175	0.000101
	LPBC01	Fillets without Skin	0.0493	0.000458	0.0104	0.0000970
	LPBC02	Fillets without Skin	0.0865	0.000536	0.0147	0.0000910
	LPBC03	Fillets without Skin	0.0950	0.000425	0.0201	0.0000900
	LPBC04	Fillets without Skin	0.0992	0.000445	0.0232	0.000104
	LPCC01	Fillets without Skin	0.101	0.000545	0.0194	0.000104
	UAAE01	Fillets without Skin	0.0261	0.000259	0.00977	0.0000970
	UABC01	Fillets without Skin	0.0446	0.000474	0.00935	0.000100
	UACC01	Fillets without Skin	0.0303	0.000415	0.00694	0.0000950
	UPAE01	Fillets without Skin	0.0383	0.000273	0.0129	0.0000920
	UPCC01	Fillets without Skin	0.0402	0.000474	0.00866	0.000102
	UPCC02	Fillets without Skin	0.0313	0.000484	0.00660	0.000102
	UPCC101	Fillets without Skin	0.0186	0.000465	0.00407	0.000102
	UPCC102	Fillets without Skin	0.0239	0.000479	0.00510	0.000102
	UPCC103	Fillets without Skin	0.0680	0.000427	0.0164	0.000103
PCB# 153/132						
	*LACA01	Fillets with Skin	0.173	0.000480	0.0484	0.000134
	LALB01	Fillets with Skin	0.190	0.000655	0.0392	0.000135

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	0.0181	0.000662	0.00361	0.000132
	LPCA01	Fillets with Skin	0.179	0.000550	0.0422	0.000130
	LPLB01	Fillets with Skin	0.0857	0.000588	0.0196	0.000135
	LPSB01	Fillets with Skin	0.0716	0.000615	0.0140	0.000121
	*LPSF01	Fillets with Skin	0.0298	0.000727	0.00509	0.000124
	*UACA01	Fillets with Skin	0.273	0.000463	0.0760	0.000129
	UALB01	Fillets with Skin	0.0954	0.000592	0.0213	0.000132
	UASF01	Fillets with Skin	0.0459	0.000639	0.00945	0.000132
	*UPCA01	Fillets with Skin	0.300	0.000431	0.0876	0.000126
	UPLB01	Fillets with Skin	0.161	0.000648	0.0330	0.000133
	UPSF01	Fillets with Skin	0.0358	0.000664	0.00701	0.000130
	*LAAE01	Fillets without Skin	0.345	0.000347	0.127	0.000128
	LABC01	Fillets without Skin	0.304	0.000609	0.0668	0.000134
	*LACC01	Fillets without Skin	0.573	0.000584	0.124	0.000127
	*LPAE01	Fillets without Skin	1.74	0.000403	0.588	0.000136
	*LPAE02	Fillets without Skin	1.17	0.000481	0.325	0.000134
	LPBC01	Fillets without Skin	0.307	0.000603	0.0650	0.000128
	*LPBC02	Fillets without Skin	0.564	0.000705	0.0957	0.000120
	*LPBC03	Fillets without Skin	0.845	0.000559	0.179	0.000119
	*LPBC04	Fillets without Skin	0.642	0.000585	0.150	0.000137
	*LPCC01	Fillets without Skin	0.903	0.000718	0.172	0.000137
	*UAAE01	Fillets without	0.163	0.000341	0.0613	0.000128

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	*UABC01	Fillets without Skin	0.290	0.000624	0.0608	0.000131
	*UACC01	Fillets without Skin	0.433	0.000546	0.0992	0.000125
	*UPAE01	Fillets without Skin	0.806	0.000360	0.271	0.000121
	UPCC01	Fillets without Skin	0.275	0.000624	0.0592	0.000134
	UPCC02	Fillets without Skin	0.316	0.000636	0.0667	0.000134
	UPCC101	Fillets without Skin	0.185	0.000612	0.0406	0.000134
	UPCC102	Fillets without Skin	0.340	0.000630	0.0726	0.000135
	*UPCC103	Fillets without Skin	0.502	0.000562	0.121	0.000135
PCB# 156/171/202						
	LACA01	Fillets with Skin	0.0205	0.000365	0.00572	0.000102
	LALB01	Fillets with Skin	0.0338	0.000498	0.00698	0.000103
	*LASF01	Fillets with Skin	0.00203	0.000503	0.000404	0.000100
	LPCA01	Fillets with Skin	0.0226	0.000418	0.00533	0.0000990
	LPLB01	Fillets with Skin	0.00750	0.000447	0.00172	0.000102
	LPSB01	Fillets with Skin	0.00703	0.000467	0.00138	0.0000920
	*LPSF01	Fillets with Skin	0.00359	0.000552	0.000613	0.0000940
	UACA01	Fillets with Skin	0.0296	0.000352	0.00825	0.0000980
	UALB01	Fillets with Skin	0.00900	0.000450	0.00201	0.000100
	UASF01	Fillets with Skin	0.00461	0.000485	0.000949	0.000100
	UPCA01	Fillets with Skin	0.0345	0.000328	0.0101	0.0000960
	UPLB01	Fillets with Skin	0.0122	0.000493	0.00249	0.000101
	UPSF01	Fillets with Skin	0.00359	0.000504	0.000704	0.0000990

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	0.0437	0.000264	0.0161	0.0000970
	LABC01	Fillets without Skin	0.0323	0.000463	0.00710	0.000102
	LACC01	Fillets without Skin	0.0503	0.000444	0.0109	0.0000960
	*LPAE01	Fillets without Skin	0.150	0.000306	0.0506	0.000103
	LPAE02	Fillets without Skin	0.103	0.000365	0.0285	0.000101
	LPBC01	Fillets without Skin	0.0350	0.000458	0.00741	0.0000970
	LPBC02	Fillets without Skin	0.0687	0.000536	0.0116	0.0000910
	LPBC03	Fillets without Skin	0.0811	0.000425	0.0172	0.0000900
	LPBC04	Fillets without Skin	0.0845	0.000445	0.0197	0.000104
	LPCC01	Fillets without Skin	0.0654	0.000545	0.0125	0.000104
	UAAE01	Fillets without Skin	0.00704	0.000259	0.00264	0.0000970
	UABC01	Fillets without Skin	0.0333	0.000474	0.00698	0.000100
	UACC01	Fillets without Skin	0.0340	0.000415	0.00778	0.0000950
	UPAE01	Fillets without Skin	0.0714	0.000273	0.0240	0.0000920
	UPCC01	Fillets without Skin	0.0287	0.000474	0.00618	0.000102
	UPCC02	Fillets without Skin	0.0218	0.000484	0.00459	0.000102
	UPCC101	Fillets without Skin	0.0115	0.000465	0.00251	0.000102

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	0.0191	0.000479	0.00407	0.000102
	UPCC103	Fillets without Skin	0.0422	0.000427	0.0102	0.000103
PCB# 158						
	LACA01	Fillets with Skin	0.0183	0.000365	0.00510	0.000102
	LALB01	Fillets with Skin	0.0189	0.000498	0.00391	0.000103
	*LASF01	Fillets with Skin	0.00189	0.000503	0.000376	0.000100
	LPCA01	Fillets with Skin	0.0125	0.000418	0.00295	0.0000990
	LPLB01	Fillets with Skin	0.00782	0.000447	0.00179	0.000102
	LPSB01	Fillets with Skin	0.00768	0.000467	0.00151	0.0000920
	*LPSF01	Fillets with Skin	0.00304	0.000552	0.000518	0.0000940
	UACA01	Fillets with Skin	0.0261	0.000352	0.00729	0.0000980
	UALB01	Fillets with Skin	0.00793	0.000450	0.00177	0.000100
	UASF01	Fillets with Skin	0.00434	0.000485	0.000893	0.000100
	UPCA01	Fillets with Skin	0.0236	0.000328	0.00686	0.0000960
	UPLB01	Fillets with Skin	0.0128	0.000493	0.00262	0.000101
	UPSF01	Fillets with Skin	0.00230	0.000504	0.000452	0.0000990
	LAAE01	Fillets without Skin	0.0412	0.000264	0.0152	0.0000970
	LABC01	Fillets without Skin	0.0204	0.000463	0.00449	0.000102
	LACC01	Fillets without Skin	0.0422	0.000444	0.00916	0.0000960
	*LPAE01	Fillets without Skin	0.154	0.000306	0.0519	0.000103
	LPAE02	Fillets without Skin	0.0784	0.000365	0.0218	0.000101
	LPBC01	Fillets without Skin	0.0222	0.000458	0.00470	0.0000970
	LPBC02	Fillets without Skin	0.0467	0.000536	0.00792	0.0000910

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	0.0492	0.000425	0.0104	0.0000900
	LPBC04	Fillets without Skin	0.0505	0.000445	0.0118	0.000104
	LPCC01	Fillets without Skin	0.0448	0.000545	0.00856	0.000104
	UAAE01	Fillets without Skin	0.0299	0.000259	0.0112	0.0000970
	UABC01	Fillets without Skin	0.0234	0.000474	0.00490	0.000100
	UACC01	Fillets without Skin	0.0291	0.000415	0.00668	0.0000950
	UPAE01	Fillets without Skin	0.0588	0.000273	0.0197	0.0000920
	UPCC01	Fillets without Skin	0.0177	0.000474	0.00382	0.000102
	UPCC02	Fillets without Skin	0.0142	0.000484	0.00300	0.000102
	UPCC101	Fillets without Skin	0.0102	0.000465	0.00223	0.000102
	UPCC102	Fillets without Skin	0.0164	0.000479	0.00351	0.000102
	UPCC103	Fillets without Skin	0.0318	0.000427	0.00768	0.000103
PCB# 16/32						
	LACA01	Fillets with Skin	0.0355	0.000511	0.00989	0.000143
	LALB01	Fillets with Skin	0.00723	0.000698	0.00150	0.000144
	*LASF01	Fillets with Skin	0.00246	0.000705	0.000489	0.000140
	LPCA01	Fillets with Skin	0.00930	0.000586	0.00219	0.000138
	LPLB01	Fillets with Skin	0.00254	0.000627	0.000580	0.000143
	LPSB01	Fillets with Skin	0.00502	0.000655	0.000985	0.000128
	*LPSF01	Fillets with Skin	0.000967	0.000774	0.000165	0.000132
	UACA01	Fillets with Skin	0.0396	0.000493	0.0110	0.000137

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.00895	0.000630	0.00200	0.000141
	UASF01	Fillets with Skin	0.00770	0.000680	0.00158	0.000140
	UPCA01	Fillets with Skin	0.00921	0.000459	0.00268	0.000134
	UPLB01	Fillets with Skin	< 0.000690	0.000690	< 0.000141	0.000141
	UPSF01	Fillets with Skin	< 0.000707	0.000707	< 0.000138	0.000138
	LAAE01	Fillets without Skin	0.00241	0.000370	0.000891	0.000136
	LABC01	Fillets without Skin	0.0283	0.000649	0.00623	0.000143
	LACC01	Fillets without Skin	0.0202	0.000622	0.00438	0.000135
	LPAE01	Fillets without Skin	0.000987	0.000429	0.000333	0.000145
	LPAE02	Fillets without Skin	0.00146	0.000512	0.000406	0.000142
	LPBC01	Fillets without Skin	0.0181	0.000642	0.00384	0.000136
	LPBC02	Fillets without Skin	0.00210	0.000751	0.000355	0.000127
	LPBC03	Fillets without Skin	0.000779	0.000596	0.000165	0.000126
	LPBC04	Fillets without Skin	0.0110	0.000623	0.00257	0.000146
	LPCC01	Fillets without Skin	0.0127	0.000764	0.00242	0.000146
	UAAE01	Fillets without Skin	0.00163	0.000364	0.000612	0.000136
	UABC01	Fillets without Skin	0.0117	0.000665	0.00246	0.000140
	UACC01	Fillets without Skin	0.0275	0.000582	0.00629	0.000133
	UPAE01	Fillets without Skin	0.00152	0.000383	0.000510	0.000129

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.0106	0.000664	0.00228	0.000143
	UPCC02	Fillets without Skin	0.0110	0.000678	0.00231	0.000143
	UPCC101	Fillets without Skin	0.00203	0.000652	0.000445	0.000143
	UPCC102	Fillets without Skin	0.0114	0.000671	0.00244	0.000143
	UPCC103	Fillets without Skin	0.0188	0.000598	0.00454	0.000144
PCB# 166						
	LACA01	Fillets with Skin	0.00195	0.000365	0.000542	0.000102
	LALB01	Fillets with Skin	< 0.000498	0.000498	< 0.000103	0.000103
	*LASF01	Fillets with Skin	< 0.000503	0.000503	< 0.000100	0.000100
	LPCA01	Fillets with Skin	< 0.000418	0.000418	< 0.0000990	0.0000990
	LPLB01	Fillets with Skin	< 0.000447	0.000447	< 0.000102	0.000102
	LPSB01	Fillets with Skin	0.000650	0.000467	0.000128	0.0000920
	*LPSF01	Fillets with Skin	< 0.000552	0.000552	< 0.0000940	0.0000940
	UACA01	Fillets with Skin	0.00298	0.000352	0.000832	0.0000980
	UALB01	Fillets with Skin	0.000753	0.000450	0.000168	0.000100
	UASF01	Fillets with Skin	< 0.000485	0.000485	< 0.000100	0.000100
	UPCA01	Fillets with Skin	< 0.000328	0.000328	< 0.0000960	0.0000960
	UPLB01	Fillets with Skin	0.000673	0.000493	0.000138	0.000101
	UPSF01	Fillets with Skin	< 0.000504	0.000504	< 0.0000990	0.0000990
	LAAE01	Fillets without Skin	0.00260	0.000264	0.000958	0.0000970
	LABC01	Fillets without Skin	0.00202	0.000463	0.000445	0.000102
	LACC01	Fillets without Skin	0.00367	0.000444	0.000795	0.0000960
	LPAE01	Fillets without Skin	< 0.000306	0.000306	< 0.000103	0.000103

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 0.000365	0.000365	< 0.000101	0.000101
	LPBC01	Fillets without Skin	0.00181	0.000458	0.000383	0.0000970
	LPBC02	Fillets without Skin	< 0.000536	0.000536	< 0.0000910	0.0000910
	LPBC03	Fillets without Skin	< 0.000425	0.000425	< 0.0000900	0.0000900
	LPBC04	Fillets without Skin	< 0.000445	0.000445	< 0.000104	0.000104
	LPCC01	Fillets without Skin	< 0.000545	0.000545	< 0.000104	0.000104
	UAAE01	Fillets without Skin	< 0.000259	0.000259	< 0.0000970	0.0000970
	UABC01	Fillets without Skin	0.00254	0.000474	0.000532	0.000100
	UACC01	Fillets without Skin	0.00269	0.000415	0.000616	0.0000950
	UPAE01	Fillets without Skin	< 0.000273	0.000273	< 0.0000920	0.0000920
	UPCC01	Fillets without Skin	< 0.000474	0.000474	< 0.000102	0.000102
	UPCC02	Fillets without Skin	0.00142	0.000484	0.000299	0.000102
	UPCC101	Fillets without Skin	< 0.000465	0.000465	< 0.000102	0.000102
	UPCC102	Fillets without Skin	0.000998	0.000479	0.000213	0.000102
	UPCC103	Fillets without Skin	0.00133	0.000427	0.000320	0.000103
PCB# 167						
	LACA01	Fillets with Skin	0.00531	0.000365	0.00148	0.000102
	LALB01	Fillets with Skin	0.00420	0.000498	0.000868	0.000103

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	< 0.000503	0.000503	< 0.000100	0.000100
	LPCA01	Fillets with Skin	0.00294	0.000418	0.000694	0.0000990
	LPLB01	Fillets with Skin	0.00201	0.000447	0.000459	0.000102
	LPSB01	Fillets with Skin	0.00154	0.000467	0.000301	0.0000920
	*LPSF01	Fillets with Skin	0.000622	0.000552	0.000106	0.0000940
	UACA01	Fillets with Skin	0.00768	0.000352	0.00214	0.0000980
	UALB01	Fillets with Skin	0.00217	0.000450	0.000484	0.000100
	UASF01	Fillets with Skin	0.00119	0.000485	0.000246	0.000100
	UPCA01	Fillets with Skin	0.00656	0.000328	0.00191	0.0000960
	UPLB01	Fillets with Skin	0.00307	0.000493	0.000627	0.000101
	UPSF01	Fillets with Skin	0.000610	0.000504	0.000120	0.0000990
	LAAE01	Fillets without Skin	0.0108	0.000264	0.00397	0.0000970
	LABC01	Fillets without Skin	0.00899	0.000463	0.00198	0.000102
	LACC01	Fillets without Skin	0.0160	0.000444	0.00348	0.0000960
	LPAE01	Fillets without Skin	0.0368	0.000306	0.0124	0.000103
	LPAE02	Fillets without Skin	0.0232	0.000365	0.00645	0.000101
	LPBC01	Fillets without Skin	0.00735	0.000458	0.00156	0.0000970
	LPBC02	Fillets without Skin	0.0114	0.000536	0.00194	0.0000910
	LPBC03	Fillets without Skin	0.0154	0.000425	0.00326	0.0000900
	LPBC04	Fillets without Skin	0.0141	0.000445	0.00330	0.000104
	LPCC01	Fillets without Skin	0.0140	0.000545	0.00267	0.000104
	UAAE01	Fillets without	0.00740	0.000259	0.00277	0.0000970

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.00839	0.000474	0.00176	0.000100
	UACC01	Fillets without Skin	0.0129	0.000415	0.00296	0.0000950
	UPAE01	Fillets without Skin	0.0158	0.000273	0.00531	0.0000920
	UPCC01	Fillets without Skin	0.00705	0.000474	0.00152	0.000102
	UPCC02	Fillets without Skin	0.00460	0.000484	0.000970	0.000102
	UPCC101	Fillets without Skin	0.00339	0.000465	0.000743	0.000102
	UPCC102	Fillets without Skin	0.00504	0.000479	0.00108	0.000102
	UPCC103	Fillets without Skin	0.00922	0.000427	0.00222	0.000103
PCB# 169						
	LACA01	Fillets with Skin	< 0.000365	0.000365	< 0.000102	0.000102
	LALB01	Fillets with Skin	< 0.000498	0.000498	< 0.000103	0.000103
	*LASF01	Fillets with Skin	< 0.000503	0.000503	< 0.000100	0.000100
	LPCA01	Fillets with Skin	< 0.000418	0.000418	< 0.0000990	0.0000990
	LPLB01	Fillets with Skin	< 0.000447	0.000447	< 0.000102	0.000102
	LPSB01	Fillets with Skin	< 0.000467	0.000467	< 0.0000920	0.0000920
	*LPSF01	Fillets with Skin	< 0.000552	0.000552	< 0.0000940	0.0000940
	UACA01	Fillets with Skin	< 0.000352	0.000352	< 0.0000980	0.0000980
	UALB01	Fillets with Skin	< 0.000450	0.000450	< 0.000100	0.000100
	UASF01	Fillets with Skin	< 0.000485	0.000485	< 0.000100	0.000100
	UPCA01	Fillets with Skin	< 0.000328	0.000328	< 0.0000960	0.0000960
	UPLB01	Fillets with Skin	< 0.000493	0.000493	< 0.000101	0.000101
	UPSF01	Fillets with Skin	< 0.000504	0.000504	< 0.0000990	0.0000990

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	< 0.000264	0.000264	< 0.0000970	0.0000970
	LABC01	Fillets without Skin	< 0.000463	0.000463	< 0.000102	0.000102
	LACC01	Fillets without Skin	0.000517	0.000444	0.000112	0.0000960
	LPAE01	Fillets without Skin	< 0.000306	0.000306	< 0.000103	0.000103
	LPAE02	Fillets without Skin	< 0.000365	0.000365	< 0.000101	0.000101
	LPBC01	Fillets without Skin	< 0.000458	0.000458	< 0.0000970	0.0000970
	LPBC02	Fillets without Skin	< 0.000536	0.000536	< 0.0000910	0.0000910
	LPBC03	Fillets without Skin	< 0.000425	0.000425	< 0.0000900	0.0000900
	LPBC04	Fillets without Skin	< 0.000445	0.000445	< 0.000104	0.000104
	LPCC01	Fillets without Skin	< 0.000545	0.000545	< 0.000104	0.000104
	UAAE01	Fillets without Skin	< 0.000259	0.000259	< 0.0000970	0.0000970
	UABC01	Fillets without Skin	< 0.000474	0.000474	< 0.000100	0.000100
	UACC01	Fillets without Skin	< 0.000415	0.000415	< 0.0000950	0.0000950
	UPAE01	Fillets without Skin	< 0.000273	0.000273	< 0.0000920	0.0000920
	UPCC01	Fillets without Skin	< 0.000474	0.000474	< 0.000102	0.000102
	UPCC02	Fillets without Skin	< 0.000484	0.000484	< 0.000102	0.000102
	UPCC101	Fillets without Skin	< 0.000465	0.000465	< 0.000102	0.000102

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	< 0.000479	0.000479	< 0.000102	0.000102
	UPCC103	Fillets without Skin	< 0.000427	0.000427	< 0.000103	0.000103
PCB# 170/190						
	LACA01	Fillets with Skin	0.0453	0.000631	0.0126	0.000176
	LALB01	Fillets with Skin	0.0782	0.000860	0.0162	0.000178
	*LASF01	Fillets with Skin	0.00382	0.000869	0.000761	0.000173
	LPCA01	Fillets with Skin	0.0295	0.000723	0.00695	0.000170
	LPLB01	Fillets with Skin	0.0134	0.000773	0.00307	0.000177
	LPSB01	Fillets with Skin	0.0124	0.000808	0.00242	0.000158
	*LPSF01	Fillets with Skin	0.00663	0.000954	0.00113	0.000163
	UACA01	Fillets with Skin	0.0713	0.000608	0.0199	0.000169
	UALB01	Fillets with Skin	0.0203	0.000777	0.00452	0.000173
	UASF01	Fillets with Skin	0.00867	0.000839	0.00179	0.000173
	UPCA01	Fillets with Skin	0.0775	0.000567	0.0226	0.000165
	UPLB01	Fillets with Skin	0.0283	0.000851	0.00578	0.000174
	UPSF01	Fillets with Skin	0.00793	0.000871	0.00155	0.000171
	*LAAE01	Fillets without Skin	0.0823	0.000456	0.0303	0.000168
	LABC01	Fillets without Skin	0.0340	0.000800	0.00748	0.000176
	LACC01	Fillets without Skin	0.0946	0.000767	0.0205	0.000166
	*LPAE01	Fillets without Skin	0.234	0.000529	0.0790	0.000179
	*LPAE02	Fillets without Skin	0.152	0.000631	0.0424	0.000175
	LPBC01	Fillets without Skin	0.0525	0.000792	0.0111	0.000168
	LPBC02	Fillets without Skin	0.169	0.000926	0.0286	0.000157

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LPBC03	Fillets without Skin	0.155	0.000735	0.0329	0.000156
	LPBC04	Fillets without Skin	0.167	0.000769	0.0391	0.000180
	LPCC01	Fillets without Skin	0.0882	0.000943	0.0168	0.000180
	UAAE01	Fillets without Skin	0.0203	0.000448	0.00761	0.000168
	UABC01	Fillets without Skin	0.0622	0.000820	0.0131	0.000172
	UACC01	Fillets without Skin	0.0644	0.000718	0.0148	0.000164
	*UPAE01	Fillets without Skin	0.173	0.000472	0.0580	0.000159
	UPCC01	Fillets without Skin	0.0401	0.000819	0.00865	0.000176
	UPCC02	Fillets without Skin	0.0442	0.000836	0.00933	0.000176
	UPCC101	Fillets without Skin	0.0164	0.000804	0.00358	0.000176
	UPCC102	Fillets without Skin	0.0297	0.000828	0.00634	0.000177
	UPCC103	Fillets without Skin	0.0614	0.000737	0.0148	0.000178
PCB# 172						
	LACA01	Fillets with Skin	0.00649	0.000480	0.00181	0.000134
	LALB01	Fillets with Skin	0.0138	0.000655	0.00285	0.000135
	*LASF01	Fillets with Skin	< 0.000662	0.000662	< 0.000132	0.000132
	LPCA01	Fillets with Skin	0.00431	0.000550	0.00102	0.000130
	LPLB01	Fillets with Skin	0.00217	0.000588	0.000496	0.000135
	LPSB01	Fillets with Skin	0.00207	0.000615	0.000406	0.000121
	*LPSF01	Fillets with Skin	0.00118	0.000726	0.000200	0.000124
	UACA01	Fillets with Skin	0.0101	0.000462	0.00281	0.000129

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.00319	0.000591	0.000712	0.000132
	UASF01	Fillets with Skin	0.00130	0.000638	0.000268	0.000131
	UPCA01	Fillets with Skin	0.0109	0.000431	0.00318	0.000126
	UPLB01	Fillets with Skin	0.00456	0.000648	0.000933	0.000132
	UPSF01	Fillets with Skin	0.00136	0.000663	0.000266	0.000130
	LAAE01	Fillets without Skin	0.0181	0.000347	0.00668	0.000128
	LABC01	Fillets without Skin	0.00463	0.000609	0.00102	0.000134
	LACC01	Fillets without Skin	0.00983	0.000584	0.00213	0.000127
	LPAE01	Fillets without Skin	0.0324	0.000403	0.0109	0.000136
	LPAE02	Fillets without Skin	0.0256	0.000480	0.00712	0.000133
	LPBC01	Fillets without Skin	0.00633	0.000603	0.00134	0.000128
	LPBC02	Fillets without Skin	0.0259	0.000705	0.00440	0.000119
	LPBC03	Fillets without Skin	0.0279	0.000559	0.00591	0.000118
	LPBC04	Fillets without Skin	0.0245	0.000585	0.00572	0.000137
	LPCC01	Fillets without Skin	0.00842	0.000717	0.00161	0.000137
	UAAE01	Fillets without Skin	0.00320	0.000341	0.00120	0.000128
	UABC01	Fillets without Skin	0.00848	0.000624	0.00178	0.000131
	UACC01	Fillets without Skin	0.00720	0.000546	0.00165	0.000125
	UPAE01	Fillets without Skin	0.0251	0.000359	0.00844	0.000121

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.00490	0.000623	0.00106	0.000134
	UPCC02	Fillets without Skin	0.00645	0.000636	0.00136	0.000134
	UPCC101	Fillets without Skin	0.00223	0.000612	0.000488	0.000134
	UPCC102	Fillets without Skin	0.00431	0.000630	0.000920	0.000135
	UPCC103	Fillets without Skin	0.00664	0.000561	0.00160	0.000135
PCB# 174						
	LACA01	Fillets with Skin	0.0271	0.000480	0.00755	0.000134
	LALB01	Fillets with Skin	0.0338	0.000655	0.00699	0.000135
	*LASF01	Fillets with Skin	0.00236	0.000662	0.000470	0.000132
	LPCA01	Fillets with Skin	0.0158	0.000550	0.00373	0.000130
	LPLB01	Fillets with Skin	0.00761	0.000588	0.00174	0.000135
	LPSB01	Fillets with Skin	0.00798	0.000615	0.00156	0.000121
	*LPSF01	Fillets with Skin	0.00408	0.000726	0.000695	0.000124
	UACA01	Fillets with Skin	0.0394	0.000462	0.0110	0.000129
	UALB01	Fillets with Skin	0.00811	0.000591	0.00181	0.000132
	UASF01	Fillets with Skin	0.00347	0.000638	0.000714	0.000131
	UPCA01	Fillets with Skin	0.0421	0.000431	0.0123	0.000126
	UPLB01	Fillets with Skin	0.00935	0.000648	0.00191	0.000132
	UPSF01	Fillets with Skin	0.00319	0.000663	0.000624	0.000130
	LAAE01	Fillets without Skin	0.0367	0.000347	0.0136	0.000128
	LABC01	Fillets without Skin	0.0152	0.000609	0.00335	0.000134
	LACC01	Fillets without Skin	0.0428	0.000584	0.00928	0.000127
	LPAE01	Fillets without Skin	0.0566	0.000403	0.0191	0.000136

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	0.0508	0.000480	0.0141	0.000133
	LPBC01	Fillets without Skin	0.0286	0.000603	0.00605	0.000128
	LPBC02	Fillets without Skin	0.0684	0.000705	0.0116	0.000119
	LPBC03	Fillets without Skin	0.0744	0.000559	0.0158	0.000118
	LPBC04	Fillets without Skin	0.0802	0.000585	0.0187	0.000137
	LPCC01	Fillets without Skin	0.0416	0.000717	0.00794	0.000137
	UAAE01	Fillets without Skin	0.0117	0.000341	0.00438	0.000128
	UABC01	Fillets without Skin	0.0269	0.000624	0.00565	0.000131
	UACC01	Fillets without Skin	0.0190	0.000546	0.00436	0.000125
	UPAE01	Fillets without Skin	0.0434	0.000359	0.0146	0.000121
	UPCC01	Fillets without Skin	0.0186	0.000623	0.00401	0.000134
	UPCC02	Fillets without Skin	0.0218	0.000636	0.00459	0.000134
	UPCC101	Fillets without Skin	0.00969	0.000612	0.00212	0.000134
	UPCC102	Fillets without Skin	0.0140	0.000630	0.00300	0.000135
	UPCC103	Fillets without Skin	0.0294	0.000561	0.00708	0.000135
PCB# 176/137						
	LACA01	Fillets with Skin	0.00447	0.000480	0.00124	0.000134
	LALB01	Fillets with Skin	0.00220	0.000655	0.000454	0.000135

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	< 0.000662	0.000662	< 0.000132	0.000132
	LPCA01	Fillets with Skin	0.00205	0.000550	0.000483	0.000130
	LPLB01	Fillets with Skin	0.00116	0.000588	0.000266	0.000135
	LPSB01	Fillets with Skin	0.00136	0.000615	0.000267	0.000121
	*LPSF01	Fillets with Skin	< 0.000726	0.000726	< 0.000124	0.000124
	UACA01	Fillets with Skin	0.00664	0.000462	0.00185	0.000129
	UALB01	Fillets with Skin	0.00204	0.000591	0.000455	0.000132
	UASF01	Fillets with Skin	0.00103	0.000638	0.000212	0.000131
	UPCA01	Fillets with Skin	0.00505	0.000431	0.00147	0.000126
	UPLB01	Fillets with Skin	0.00292	0.000648	0.000596	0.000132
	UPSF01	Fillets with Skin	< 0.000663	0.000663	< 0.000130	0.000130
	LAAE01	Fillets without Skin	0.00675	0.000347	0.00249	0.000128
	LABC01	Fillets without Skin	0.00303	0.000609	0.000667	0.000134
	LACC01	Fillets without Skin	0.00725	0.000584	0.00157	0.000127
	LPAE01	Fillets without Skin	0.0177	0.000403	0.00598	0.000136
	LPAE02	Fillets without Skin	0.00739	0.000480	0.00205	0.000133
	LPBC01	Fillets without Skin	0.00398	0.000603	0.000843	0.000128
	LPBC02	Fillets without Skin	0.00751	0.000705	0.00127	0.000119
	LPBC03	Fillets without Skin	0.00915	0.000559	0.00194	0.000118
	LPBC04	Fillets without Skin	0.00949	0.000585	0.00222	0.000137
	LPCC01	Fillets without Skin	0.00344	0.000717	0.000657	0.000137
	UAAE01	Fillets without	0.00880	0.000341	0.00330	0.000128

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.00478	0.000624	0.00100	0.000131
	UACC01	Fillets without Skin	0.00534	0.000546	0.00122	0.000125
	UPAE01	Fillets without Skin	0.00952	0.000359	0.00320	0.000121
	UPCC01	Fillets without Skin	0.00245	0.000623	0.000528	0.000134
	UPCC02	Fillets without Skin	0.00288	0.000636	0.000609	0.000134
	UPCC101	Fillets without Skin	0.00140	0.000612	0.000308	0.000134
	UPCC102	Fillets without Skin	0.00278	0.000630	0.000595	0.000135
	UPCC103	Fillets without Skin	0.00322	0.000561	0.000776	0.000135
PCB# 177						
	LACA01	Fillets with Skin	0.0212	0.000480	0.00590	0.000134
	LALB01	Fillets with Skin	0.0271	0.000655	0.00560	0.000135
	*LASF01	Fillets with Skin	0.00160	0.000662	0.000319	0.000132
	LPCA01	Fillets with Skin	0.0172	0.000550	0.00406	0.000130
	LPLB01	Fillets with Skin	0.00692	0.000588	0.00158	0.000135
	LPSB01	Fillets with Skin	0.00786	0.000615	0.00154	0.000121
	*LPSF01	Fillets with Skin	0.00283	0.000726	0.000483	0.000124
	UACA01	Fillets with Skin	0.0306	0.000462	0.00853	0.000129
	UALB01	Fillets with Skin	0.00598	0.000591	0.00134	0.000132
	UASF01	Fillets with Skin	0.00379	0.000638	0.000781	0.000131
	UPCA01	Fillets with Skin	0.0357	0.000431	0.0104	0.000126
	UPLB01	Fillets with Skin	0.00883	0.000648	0.00180	0.000132
	UPSF01	Fillets with Skin	0.00339	0.000663	0.000664	0.000130

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	0.0591	0.000347	0.0218	0.000128
	LABC01	Fillets without Skin	0.0291	0.000609	0.00640	0.000134
	LACC01	Fillets without Skin	0.0496	0.000584	0.0107	0.000127
	LPAE01	Fillets without Skin	0.0998	0.000403	0.0337	0.000136
	*LPAE02	Fillets without Skin	0.167	0.000480	0.0463	0.000133
	LPBC01	Fillets without Skin	0.0299	0.000603	0.00633	0.000128
	LPBC02	Fillets without Skin	0.00183	0.000705	0.000311	0.000119
	LPBC03	Fillets without Skin	0.0600	0.000559	0.0127	0.000118
	LPBC04	Fillets without Skin	0.0628	0.000585	0.0147	0.000137
	LPCC01	Fillets without Skin	0.0839	0.000717	0.0160	0.000137
	UAAE01	Fillets without Skin	0.0109	0.000341	0.00409	0.000128
	UABC01	Fillets without Skin	0.0117	0.000624	0.00244	0.000131
	UACC01	Fillets without Skin	0.0226	0.000546	0.00518	0.000125
	UPAE01	Fillets without Skin	0.0849	0.000359	0.0285	0.000121
	UPCC01	Fillets without Skin	0.0323	0.000623	0.00696	0.000134
	UPCC02	Fillets without Skin	0.0198	0.000636	0.00418	0.000134
	UPCC101	Fillets without Skin	0.0142	0.000612	0.00312	0.000134

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	0.0199	0.000630	0.00425	0.000135
	UPCC103	Fillets without Skin	0.0537	0.000561	0.0129	0.000135
PCB# 178						
	LACA01	Fillets with Skin	0.00840	0.000480	0.00234	0.000134
	LALB01	Fillets with Skin	0.0173	0.000655	0.00358	0.000135
	*LASF01	Fillets with Skin	0.000850	0.000662	0.000169	0.000132
	LPCA01	Fillets with Skin	0.00741	0.000550	0.00175	0.000130
	LPLB01	Fillets with Skin	0.00476	0.000588	0.00109	0.000135
	LPSB01	Fillets with Skin	0.00432	0.000615	0.000846	0.000121
	*LPSF01	Fillets with Skin	0.00200	0.000726	0.000342	0.000124
	UACA01	Fillets with Skin	0.0121	0.000462	0.00338	0.000129
	UALB01	Fillets with Skin	0.00350	0.000591	0.000781	0.000132
	UASF01	Fillets with Skin	0.00217	0.000638	0.000446	0.000131
	UPCA01	Fillets with Skin	0.0149	0.000431	0.00435	0.000126
	UPLB01	Fillets with Skin	0.00591	0.000648	0.00121	0.000132
	UPSF01	Fillets with Skin	0.00197	0.000663	0.000385	0.000130
	LAAE01	Fillets without Skin	0.0262	0.000347	0.00966	0.000128
	LABC01	Fillets without Skin	0.0174	0.000609	0.00383	0.000134
	LACC01	Fillets without Skin	0.0221	0.000584	0.00478	0.000127
	LPAE01	Fillets without Skin	0.0770	0.000403	0.0260	0.000136
	LPAE02	Fillets without Skin	0.0869	0.000480	0.0241	0.000133
	LPBC01	Fillets without Skin	0.0171	0.000603	0.00361	0.000128
	LPBC02	Fillets without Skin	0.0345	0.000705	0.00585	0.000119

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	0.0423	0.000559	0.00895	0.000118
	LPBC04	Fillets without Skin	0.0386	0.000585	0.00901	0.000137
	LPCC01	Fillets without Skin	0.0414	0.000717	0.00791	0.000137
	UAAE01	Fillets without Skin	0.00557	0.000341	0.00209	0.000128
	UABC01	Fillets without Skin	0.0158	0.000624	0.00332	0.000131
	UACC01	Fillets without Skin	0.0147	0.000546	0.00336	0.000125
	UPAE01	Fillets without Skin	0.0448	0.000359	0.0150	0.000121
	UPCC01	Fillets without Skin	0.0157	0.000623	0.00338	0.000134
	UPCC02	Fillets without Skin	0.0123	0.000636	0.00259	0.000134
	UPCC101	Fillets without Skin	0.00717	0.000612	0.00157	0.000134
	UPCC102	Fillets without Skin	0.0110	0.000630	0.00234	0.000135
	UPCC103	Fillets without Skin	0.0258	0.000561	0.00622	0.000135
PCB# 18						
	LACA01	Fillets with Skin	0.0322	0.000511	0.00897	0.000143
	LALB01	Fillets with Skin	0.00601	0.000698	0.00124	0.000144
	*LASF01	Fillets with Skin	0.00194	0.000705	0.000385	0.000140
	LPCA01	Fillets with Skin	0.00536	0.000586	0.00126	0.000138
	LPLB01	Fillets with Skin	0.00211	0.000627	0.000484	0.000143
	LPSB01	Fillets with Skin	0.00242	0.000655	0.000475	0.000128
	*LPSF01	Fillets with Skin	0.000898	0.000774	0.000153	0.000132
	UACA01	Fillets with Skin	0.0376	0.000493	0.0105	0.000137

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.00749	0.000630	0.00167	0.000141
	UASF01	Fillets with Skin	0.00585	0.000680	0.00120	0.000140
	UPCA01	Fillets with Skin	0.00589	0.000459	0.00172	0.000134
	UPLB01	Fillets with Skin	< 0.000690	0.000690	< 0.000141	0.000141
	UPSF01	Fillets with Skin	< 0.000707	0.000707	< 0.000138	0.000138
	LAAE01	Fillets without Skin	0.00174	0.000370	0.000643	0.000136
	LABC01	Fillets without Skin	0.00782	0.000649	0.00172	0.000143
	LACC01	Fillets without Skin	0.0159	0.000622	0.00346	0.000135
	LPAE01	Fillets without Skin	< 0.000429	0.000429	< 0.000145	0.000145
	LPAE02	Fillets without Skin	< 0.000512	0.000512	< 0.000142	0.000142
	LPBC01	Fillets without Skin	0.0102	0.000642	0.00216	0.000136
	LPBC02	Fillets without Skin	< 0.000751	0.000751	< 0.000127	0.000127
	LPBC03	Fillets without Skin	0.000779	0.000596	0.000165	0.000126
	LPBC04	Fillets without Skin	0.00745	0.000623	0.00174	0.000146
	LPCC01	Fillets without Skin	0.00574	0.000764	0.00110	0.000146
	UAAE01	Fillets without Skin	0.00112	0.000364	0.000420	0.000136
	UABC01	Fillets without Skin	0.00712	0.000665	0.00149	0.000140
	UACC01	Fillets without Skin	0.0211	0.000582	0.00484	0.000133
	UPAE01	Fillets without Skin	< 0.000383	0.000383	< 0.000129	0.000129

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.00884	0.000664	0.00190	0.000143
	UPCC02	Fillets without Skin	0.00939	0.000678	0.00198	0.000143
	UPCC101	Fillets without Skin	0.00189	0.000652	0.000414	0.000143
	UPCC102	Fillets without Skin	0.0117	0.000671	0.00249	0.000143
	UPCC103	Fillets without Skin	0.0131	0.000598	0.00316	0.000144
PCB# 180						
	*LACA01	Fillets with Skin	0.124	0.000480	0.0345	0.000134
	LALB01	Fillets with Skin	0.185	0.000655	0.0382	0.000135
	*LASF01	Fillets with Skin	0.0106	0.000662	0.00210	0.000132
	LPCA01	Fillets with Skin	0.207	0.000550	0.0487	0.000130
	LPLB01	Fillets with Skin	0.0506	0.000588	0.0116	0.000135
	LPSB01	Fillets with Skin	0.0422	0.000615	0.00828	0.000121
	*LPSF01	Fillets with Skin	0.0174	0.000726	0.00297	0.000124
	*UACA01	Fillets with Skin	0.195	0.000462	0.0544	0.000129
	UALB01	Fillets with Skin	0.0628	0.000591	0.0140	0.000132
	UASF01	Fillets with Skin	0.0272	0.000638	0.00560	0.000131
	*UPCA01	Fillets with Skin	0.218	0.000431	0.0636	0.000126
	UPLB01	Fillets with Skin	0.0842	0.000648	0.0172	0.000132
	UPSF01	Fillets with Skin	0.0199	0.000663	0.00389	0.000130
	*LAAE01	Fillets without Skin	0.184	0.000347	0.0678	0.000128
	LABC01	Fillets without Skin	0.196	0.000609	0.0432	0.000134
	*LACC01	Fillets without Skin	0.238	0.000584	0.0517	0.000127
	*LPAE01	Fillets without Skin	0.674	0.000403	0.227	0.000136

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LPAE02	Fillets without Skin	0.381	0.000480	0.106	0.000133
	LPBC01	Fillets without Skin	0.238	0.000603	0.0504	0.000128
	*LPBC02	Fillets without Skin	0.385	0.000705	0.0653	0.000119
	*LPBC03	Fillets without Skin	0.387	0.000559	0.0821	0.000118
	*LPBC04	Fillets without Skin	0.386	0.000585	0.0902	0.000137
	*LPCC01	Fillets without Skin	0.248	0.000717	0.0473	0.000137
	UAAE01	Fillets without Skin	0.0870	0.000341	0.0326	0.000128
	*UABC01	Fillets without Skin	0.149	0.000624	0.0312	0.000131
	*UACC01	Fillets without Skin	0.183	0.000546	0.0420	0.000125
	*UPAE01	Fillets without Skin	0.385	0.000359	0.129	0.000121
	UPCC01	Fillets without Skin	0.151	0.000623	0.0325	0.000134
	UPCC02	Fillets without Skin	0.132	0.000636	0.0278	0.000134
	UPCC101	Fillets without Skin	0.0733	0.000612	0.0161	0.000134
	UPCC102	Fillets without Skin	0.123	0.000630	0.0263	0.000135
	*UPCC103	Fillets without Skin	0.155	0.000561	0.0374	0.000135
PCB# 183						
	LACA01	Fillets with Skin	0.0215	0.000480	0.00600	0.000134
	LALB01	Fillets with Skin	0.0479	0.000655	0.00990	0.000135

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	0.00208	0.000662	0.000413	0.000132
	LPCA01	Fillets with Skin	0.0182	0.000550	0.00429	0.000130
	LPLB01	Fillets with Skin	0.00972	0.000588	0.00222	0.000135
	LPSB01	Fillets with Skin	0.00863	0.000615	0.00169	0.000121
	*LPSF01	Fillets with Skin	0.00408	0.000726	0.000695	0.000124
	UACA01	Fillets with Skin	0.0338	0.000462	0.00943	0.000129
	UALB01	Fillets with Skin	0.0110	0.000591	0.00245	0.000132
	UASF01	Fillets with Skin	0.00510	0.000638	0.00105	0.000131
	UPCA01	Fillets with Skin	0.0376	0.000431	0.0109	0.000126
	UPLB01	Fillets with Skin	0.0178	0.000648	0.00364	0.000132
	UPSF01	Fillets with Skin	0.00474	0.000663	0.000929	0.000130
	LAAE01	Fillets without Skin	0.0525	0.000347	0.0194	0.000128
	LABC01	Fillets without Skin	0.0304	0.000609	0.00668	0.000134
	LACC01	Fillets without Skin	0.0587	0.000584	0.0127	0.000127
	*LPAE01	Fillets without Skin	0.207	0.000403	0.0697	0.000136
	*LPAE02	Fillets without Skin	0.155	0.000480	0.0431	0.000133
	LPBC01	Fillets without Skin	0.0360	0.000603	0.00764	0.000128
	LPBC02	Fillets without Skin	0.0875	0.000705	0.0148	0.000119
	LPBC03	Fillets without Skin	0.102	0.000559	0.0216	0.000118
	LPBC04	Fillets without Skin	0.0896	0.000585	0.0209	0.000137
	LPCC01	Fillets without Skin	0.0814	0.000717	0.0155	0.000137
	UAAE01	Fillets without	0.0103	0.000341	0.00388	0.000128

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.0374	0.000624	0.00786	0.000131
	UACC01	Fillets without Skin	0.0429	0.000546	0.00982	0.000125
	UPAE01	Fillets without Skin	0.0981	0.000359	0.0330	0.000121
	UPCC01	Fillets without Skin	0.0315	0.000623	0.00679	0.000134
	UPCC02	Fillets without Skin	0.0266	0.000636	0.00561	0.000134
	UPCC101	Fillets without Skin	0.0148	0.000612	0.00324	0.000134
	UPCC102	Fillets without Skin	0.0233	0.000630	0.00497	0.000135
	UPCC103	Fillets without Skin	0.0511	0.000561	0.0123	0.000135
PCB# 185						
	LACA01	Fillets with Skin	0.00546	0.000480	0.00152	0.000134
	LALB01	Fillets with Skin	0.00792	0.000655	0.00164	0.000135
	*LASF01	Fillets with Skin	< 0.000662	0.000662	< 0.000132	0.000132
	LPCA01	Fillets with Skin	0.00378	0.000550	0.000892	0.000130
	LPLB01	Fillets with Skin	0.00169	0.000588	0.000387	0.000135
	LPSB01	Fillets with Skin	0.00160	0.000615	0.000313	0.000121
	*LPSF01	Fillets with Skin	< 0.000726	0.000726	< 0.000124	0.000124
	UACA01	Fillets with Skin	0.00788	0.000462	0.00220	0.000129
	UALB01	Fillets with Skin	0.00173	0.000591	0.000386	0.000132
	UASF01	Fillets with Skin	0.000921	0.000638	0.000190	0.000131
	UPCA01	Fillets with Skin	0.00892	0.000431	0.00260	0.000126
	UPLB01	Fillets with Skin	0.00262	0.000648	0.000535	0.000132
	UPSF01	Fillets with Skin	0.000813	0.000663	0.000159	0.000130

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	0.00397	0.000347	0.00147	0.000128
	LABC01	Fillets without Skin	0.00521	0.000609	0.00115	0.000134
	LACC01	Fillets without Skin	0.0108	0.000584	0.00234	0.000127
	LPAE01	Fillets without Skin	0.0105	0.000403	0.00354	0.000136
	LPAE02	Fillets without Skin	0.00961	0.000480	0.00267	0.000133
	LPBC01	Fillets without Skin	0.00633	0.000603	0.00134	0.000128
	LPBC02	Fillets without Skin	0.0163	0.000705	0.00277	0.000119
	LPBC03	Fillets without Skin	0.0162	0.000559	0.00344	0.000118
	LPBC04	Fillets without Skin	0.0165	0.000585	0.00386	0.000137
	LPCC01	Fillets without Skin	0.0129	0.000717	0.00246	0.000137
	UAAE01	Fillets without Skin	0.00141	0.000341	0.000528	0.000128
	UABC01	Fillets without Skin	0.00712	0.000624	0.00149	0.000131
	UACC01	Fillets without Skin	0.00572	0.000546	0.00131	0.000125
	UPAE01	Fillets without Skin	0.00672	0.000359	0.00226	0.000121
	UPCC01	Fillets without Skin	0.00538	0.000623	0.00116	0.000134
	UPCC02	Fillets without Skin	0.00445	0.000636	0.000939	0.000134
	UPCC101	Fillets without Skin	0.00262	0.000612	0.000573	0.000134

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	0.00384	0.000630	0.000819	0.000135
	UPCC103	Fillets without Skin	0.00958	0.000561	0.00231	0.000135
PCB# 187						
	LACA01	Fillets with Skin	0.0760	0.000296	0.0212	0.0000820
	LALB01	Fillets with Skin	0.140	0.000404	0.0290	0.0000830
	*LASF01	Fillets with Skin	0.00637	0.000408	0.00127	0.0000810
	LPCA01	Fillets with Skin	0.0509	0.000339	0.0120	0.0000800
	LPLB01	Fillets with Skin	0.0308	0.000362	0.00705	0.0000830
	LPSB01	Fillets with Skin	0.0291	0.000379	0.00570	0.0000740
	*LPSF01	Fillets with Skin	0.0126	0.000448	0.00216	0.0000760
	UACA01	Fillets with Skin	0.105	0.000285	0.0292	0.0000790
	UALB01	Fillets with Skin	0.0314	0.000364	0.00701	0.0000810
	UASF01	Fillets with Skin	0.0144	0.000393	0.00296	0.0000810
	UPCA01	Fillets with Skin	0.111	0.000266	0.0323	0.0000770
	UPLB01	Fillets with Skin	0.0554	0.000399	0.0113	0.0000820
	UPSF01	Fillets with Skin	0.0146	0.000409	0.00287	0.0000800
	*LAAE01	Fillets without Skin	0.324	0.000214	0.119	0.0000790
	LABC01	Fillets without Skin	0.0937	0.000375	0.0206	0.0000830
	*LACC01	Fillets without Skin	0.142	0.000360	0.0308	0.0000780
	*LPAE01	Fillets without Skin	0.546	0.000248	0.184	0.0000840
	*LPAE02	Fillets without Skin	0.537	0.000296	0.149	0.0000820
	LPBC01	Fillets without Skin	0.104	0.000372	0.0220	0.0000790
	*LPBC02	Fillets without Skin	0.225	0.000434	0.0382	0.0000740

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LPBC03	Fillets without Skin	0.286	0.000345	0.0606	0.0000730
	*LPBC04	Fillets without Skin	0.241	0.000361	0.0564	0.0000840
	*LPCC01	Fillets without Skin	0.270	0.000442	0.0516	0.0000840
	*UAAE01	Fillets without Skin	0.0934	0.000210	0.0350	0.0000790
	UABC01	Fillets without Skin	0.109	0.000385	0.0228	0.0000810
	UACC01	Fillets without Skin	0.114	0.000337	0.0262	0.0000770
	*UPAE01	Fillets without Skin	0.402	0.000222	0.135	0.0000740
	UPCC01	Fillets without Skin	0.0917	0.000384	0.0198	0.0000830
	UPCC02	Fillets without Skin	0.0844	0.000392	0.0178	0.0000830
	UPCC101	Fillets without Skin	0.0473	0.000377	0.0104	0.0000830
	UPCC102	Fillets without Skin	0.0719	0.000388	0.0154	0.0000830
	UPCC103	Fillets without Skin	0.158	0.000346	0.0380	0.0000830
PCB# 189						
	LACA01	Fillets with Skin	0.00114	0.000480	0.000319	0.000134
	LALB01	Fillets with Skin	0.00147	0.000655	0.000303	0.000135
	*LASF01	Fillets with Skin	< 0.000662	0.000662	< 0.000132	0.000132
	LPCA01	Fillets with Skin	0.000735	0.000550	0.000173	0.000130
	LPLB01	Fillets with Skin	< 0.000588	0.000588	< 0.000135	0.000135
	LPSB01	Fillets with Skin	< 0.000615	0.000615	< 0.000121	0.000121
	*LPSF01	Fillets with Skin	< 0.000726	0.000726	< 0.000124	0.000124
	UACA01	Fillets with Skin	0.00187	0.000462	0.000521	0.000129

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	< 0.000591	0.000591	< 0.000132	0.000132
	UASF01	Fillets with Skin	< 0.000638	0.000638	< 0.000131	0.000131
	UPCA01	Fillets with Skin	0.00172	0.000431	0.000502	0.000126
	UPLB01	Fillets with Skin	< 0.000648	0.000648	< 0.000132	0.000132
	UPSF01	Fillets with Skin	< 0.000663	0.000663	< 0.000130	0.000130
	LAAE01	Fillets without Skin	0.00229	0.000347	0.000846	0.000128
	LABC01	Fillets without Skin	< 0.000609	0.000609	< 0.000134	0.000134
	LACC01	Fillets without Skin	0.00151	0.000584	0.000326	0.000127
	LPAE01	Fillets without Skin	0.00440	0.000403	0.00148	0.000136
	LPAE02	Fillets without Skin	0.00325	0.000480	0.000903	0.000133
	LPBC01	Fillets without Skin	0.000964	0.000603	0.000204	0.000128
	LPBC02	Fillets without Skin	0.00340	0.000705	0.000577	0.000119
	LPBC03	Fillets without Skin	0.00370	0.000559	0.000784	0.000118
	LPBC04	Fillets without Skin	0.00370	0.000585	0.000864	0.000137
	LPCC01	Fillets without Skin	0.00108	0.000717	0.000207	0.000137
	UAAE01	Fillets without Skin	0.000832	0.000341	0.000312	0.000128
	UABC01	Fillets without Skin	0.00117	0.000624	0.000246	0.000131
	UACC01	Fillets without Skin	0.00108	0.000546	0.000249	0.000125
	UPAE01	Fillets without Skin	0.00324	0.000359	0.00109	0.000121

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.000717	0.000623	0.000154	0.000134
	UPCC02	Fillets without Skin	0.000880	0.000636	0.000186	0.000134
	UPCC101	Fillets without Skin	< 0.000612	0.000612	< 0.000134	0.000134
	UPCC102	Fillets without Skin	< 0.000630	0.000630	< 0.000135	0.000135
	UPCC103	Fillets without Skin	0.000845	0.000561	0.000204	0.000135
PCB# 191						
	LACA01	Fillets with Skin	0.00191	0.000480	0.000532	0.000134
	LALB01	Fillets with Skin	0.00415	0.000655	0.000858	0.000135
	*LASF01	Fillets with Skin	< 0.000662	0.000662	< 0.000132	0.000132
	LPCA01	Fillets with Skin	0.000998	0.000550	0.000235	0.000130
	LPLB01	Fillets with Skin	0.000793	0.000588	0.000181	0.000135
	LPSB01	Fillets with Skin	< 0.000615	0.000615	< 0.000121	0.000121
	*LPSF01	Fillets with Skin	< 0.000726	0.000726	< 0.000124	0.000124
	UACA01	Fillets with Skin	0.00270	0.000462	0.000754	0.000129
	UALB01	Fillets with Skin	0.000753	0.000591	0.000168	0.000132
	UASF01	Fillets with Skin	< 0.000638	0.000638	< 0.000131	0.000131
	UPCA01	Fillets with Skin	0.00316	0.000431	0.000919	0.000126
	UPLB01	Fillets with Skin	0.00127	0.000648	0.000260	0.000132
	UPSF01	Fillets with Skin	< 0.000663	0.000663	< 0.000130	0.000130
	LAAE01	Fillets without Skin	0.00413	0.000347	0.00152	0.000128
	LABC01	Fillets without Skin	0.00255	0.000609	0.000562	0.000134
	LACC01	Fillets without Skin	0.00433	0.000584	0.000938	0.000127
	LPAE01	Fillets without Skin	0.0141	0.000403	0.00476	0.000136

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	0.00937	0.000480	0.00260	0.000133
	LPBC01	Fillets without Skin	0.00211	0.000603	0.000447	0.000128
	LPBC02	Fillets without Skin	0.00515	0.000705	0.000873	0.000119
	LPBC03	Fillets without Skin	0.00506	0.000559	0.00107	0.000118
	LPBC04	Fillets without Skin	0.00673	0.000585	0.00157	0.000137
	LPCC01	Fillets without Skin	0.00548	0.000717	0.00105	0.000137
	UAAE01	Fillets without Skin	0.000960	0.000341	0.000360	0.000128
	UABC01	Fillets without Skin	0.00278	0.000624	0.000583	0.000131
	UACC01	Fillets without Skin	0.00312	0.000546	0.000716	0.000125
	UPAE01	Fillets without Skin	0.00648	0.000359	0.00218	0.000121
	UPCC01	Fillets without Skin	0.00239	0.000623	0.000515	0.000134
	UPCC02	Fillets without Skin	0.00142	0.000636	0.000299	0.000134
	UPCC101	Fillets without Skin	0.00121	0.000612	0.000265	0.000134
	UPCC102	Fillets without Skin	0.00189	0.000630	0.000404	0.000135
	UPCC103	Fillets without Skin	0.00358	0.000561	0.000864	0.000135
PCB# 194						
	LACA01	Fillets with Skin	0.0147	0.000369	0.00408	0.000103
	LALB01	Fillets with Skin	0.0389	0.000504	0.00804	0.000104

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	0.000944	0.000509	0.000188	0.000101
	LPCA01	Fillets with Skin	0.00898	0.000423	0.00212	0.000100
	LPLB01	Fillets with Skin	0.00386	0.000453	0.000883	0.000104
	LPSB01	Fillets with Skin	0.00355	0.000473	0.000695	0.0000930
	*LPSF01	Fillets with Skin	0.00207	0.000559	0.000353	0.0000950
	UACA01	Fillets with Skin	0.0256	0.000356	0.00714	0.0000990
	UALB01	Fillets with Skin	0.00634	0.000455	0.00141	0.000102
	UASF01	Fillets with Skin	0.00244	0.000491	0.000502	0.000101
	UPCA01	Fillets with Skin	0.0286	0.000332	0.00832	0.0000970
	UPLB01	Fillets with Skin	0.00875	0.000499	0.00179	0.000102
	UPSF01	Fillets with Skin	0.00244	0.000511	0.000478	0.000100
	LAAE01	Fillets without Skin	0.0344	0.000267	0.0127	0.0000990
	LABC01	Fillets without Skin	0.00713	0.000469	0.00157	0.000103
	LACC01	Fillets without Skin	0.0235	0.000450	0.00510	0.0000970
	LPAE01	Fillets without Skin	0.0739	0.000310	0.0249	0.000105
	LPAE02	Fillets without Skin	0.0495	0.000370	0.0138	0.000103
	LPBC01	Fillets without Skin	0.0139	0.000464	0.00295	0.0000980
	LPBC02	Fillets without Skin	0.0676	0.000542	0.0115	0.0000920
	LPBC03	Fillets without Skin	0.0680	0.000430	0.0144	0.0000910
	LPBC04	Fillets without Skin	0.0592	0.000450	0.0138	0.000105
	LPCC01	Fillets without Skin	0.0178	0.000552	0.00340	0.000105
	UAAE01	Fillets without	0.00487	0.000263	0.00182	0.0000990

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.0196	0.000480	0.00410	0.000101
	UACC01	Fillets without Skin	0.0174	0.000420	0.00399	0.0000960
	UPAE01	Fillets without Skin	0.0500	0.000277	0.0168	0.0000930
	UPCC01	Fillets without Skin	0.00914	0.000480	0.00197	0.000103
	UPCC02	Fillets without Skin	0.0148	0.000490	0.00312	0.000103
	UPCC101	Fillets without Skin	0.00416	0.000471	0.000912	0.000103
	UPCC102	Fillets without Skin	0.00867	0.000485	0.00185	0.000104
	UPCC103	Fillets without Skin	0.0130	0.000432	0.00313	0.000104
PCB# 195/208						
	LACA01	Fillets with Skin	0.00771	0.000369	0.00215	0.000103
	LALB01	Fillets with Skin	0.0170	0.000504	0.00351	0.000104
	*LASF01	Fillets with Skin	0.000661	0.000509	0.000131	0.000101
	LPCA01	Fillets with Skin	0.00609	0.000423	0.00144	0.000100
	LPLB01	Fillets with Skin	0.00238	0.000453	0.000544	0.000104
	LPSB01	Fillets with Skin	0.00230	0.000473	0.000452	0.0000930
	*LPSF01	Fillets with Skin	0.00138	0.000559	0.000236	0.0000950
	UACA01	Fillets with Skin	0.0130	0.000356	0.00362	0.0000990
	UALB01	Fillets with Skin	0.00328	0.000455	0.000732	0.000102
	UASF01	Fillets with Skin	0.00141	0.000491	0.000290	0.000101
	UPCA01	Fillets with Skin	0.0147	0.000332	0.00428	0.0000970
	UPLB01	Fillets with Skin	0.00501	0.000499	0.00102	0.000102
	UPSF01	Fillets with Skin	0.00142	0.000511	0.000279	0.000100

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	0.0210	0.000267	0.00773	0.0000990
	LABC01	Fillets without Skin	0.00862	0.000469	0.00190	0.000103
	LACC01	Fillets without Skin	0.0211	0.000450	0.00457	0.0000970
	LPAE01	Fillets without Skin	0.0584	0.000310	0.0197	0.000105
	LPAE02	Fillets without Skin	0.0470	0.000370	0.0131	0.000103
	LPBC01	Fillets without Skin	0.0113	0.000464	0.00239	0.0000980
	LPBC02	Fillets without Skin	0.0342	0.000542	0.00580	0.0000920
	LPBC03	Fillets without Skin	0.0391	0.000430	0.00829	0.0000910
	LPBC04	Fillets without Skin	0.0327	0.000450	0.00763	0.000105
	LPCC01	Fillets without Skin	0.0227	0.000552	0.00433	0.000105
	UAAE01	Fillets without Skin	0.00285	0.000263	0.00107	0.0000990
	UABC01	Fillets without Skin	0.0127	0.000480	0.00267	0.000101
	UACC01	Fillets without Skin	0.0140	0.000420	0.00320	0.0000960
	UPAE01	Fillets without Skin	0.0320	0.000277	0.0107	0.0000930
	UPCC01	Fillets without Skin	0.00884	0.000480	0.00190	0.000103
	UPCC02	Fillets without Skin	0.0110	0.000490	0.00232	0.000103
	UPCC101	Fillets without Skin	0.00416	0.000471	0.000912	0.000103

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	0.00767	0.000485	0.00164	0.000104
	UPCC103	Fillets without Skin	0.0139	0.000432	0.00335	0.000104
PCB# 196/203						
	LACA01	Fillets with Skin	0.0182	0.000369	0.00507	0.000103
	LALB01	Fillets with Skin	0.0492	0.000504	0.0102	0.000104
	*LASF01	Fillets with Skin	0.00156	0.000509	0.000310	0.000101
	LPCA01	Fillets with Skin	0.0147	0.000423	0.00347	0.000100
	LPLB01	Fillets with Skin	0.00750	0.000453	0.00172	0.000104
	LPSB01	Fillets with Skin	0.00668	0.000473	0.00131	0.0000930
	*LPSF01	Fillets with Skin	0.00401	0.000559	0.000683	0.0000950
	UACA01	Fillets with Skin	0.0313	0.000356	0.00873	0.0000990
	UALB01	Fillets with Skin	0.00935	0.000455	0.00209	0.000102
	UASF01	Fillets with Skin	0.00379	0.000491	0.000781	0.000101
	UPCA01	Fillets with Skin	0.0349	0.000332	0.0102	0.0000970
	UPLB01	Fillets with Skin	0.0132	0.000499	0.00271	0.000102
	UPSF01	Fillets with Skin	0.00380	0.000511	0.000744	0.000100
	LAAE01	Fillets without Skin	0.0512	0.000267	0.0189	0.0000990
	LABC01	Fillets without Skin	0.0206	0.000469	0.00453	0.000103
	LACC01	Fillets without Skin	0.0506	0.000450	0.0110	0.0000970
	*LPAE01	Fillets without Skin	0.138	0.000310	0.0466	0.000105
	LPAE02	Fillets without Skin	0.116	0.000370	0.0321	0.000103
	LPBC01	Fillets without Skin	0.0284	0.000464	0.00602	0.0000980
	LPBC02	Fillets without Skin	0.0871	0.000542	0.0148	0.0000920

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	0.0937	0.000430	0.0198	0.0000910
	LPBC04	Fillets without Skin	0.0819	0.000450	0.0191	0.000105
	LPCC01	Fillets without Skin	0.0608	0.000552	0.0116	0.000105
	UAAE01	Fillets without Skin	0.00628	0.000263	0.00235	0.0000990
	UABC01	Fillets without Skin	0.0309	0.000480	0.00649	0.000101
	UACC01	Fillets without Skin	0.0379	0.000420	0.00868	0.0000960
	UPAE01	Fillets without Skin	0.0823	0.000277	0.0276	0.0000930
	UPCC01	Fillets without Skin	0.0223	0.000480	0.00481	0.000103
	UPCC02	Fillets without Skin	0.0256	0.000490	0.00540	0.000103
	UPCC101	Fillets without Skin	0.0102	0.000471	0.00224	0.000103
	UPCC102	Fillets without Skin	0.0182	0.000485	0.00388	0.000104
	UPCC103	Fillets without Skin	0.0345	0.000432	0.00833	0.000104
PCB# 199						
	LACA01	Fillets with Skin	0.0189	0.000369	0.00526	0.000103
	LALB01	Fillets with Skin	0.0411	0.000504	0.00849	0.000104
	*LASF01	Fillets with Skin	0.00217	0.000509	0.000432	0.000101
	LPCA01	Fillets with Skin	0.0134	0.000423	0.00317	0.000100
	LPLB01	Fillets with Skin	0.00793	0.000453	0.00181	0.000104
	LPSB01	Fillets with Skin	0.00768	0.000473	0.00151	0.0000930
	*LPSF01	Fillets with Skin	0.00525	0.000559	0.000895	0.0000950
	UACA01	Fillets with Skin	0.0301	0.000356	0.00840	0.0000990

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.00873	0.000455	0.00195	0.000102
	UASF01	Fillets with Skin	0.00417	0.000491	0.000859	0.000101
	UPCA01	Fillets with Skin	0.0318	0.000332	0.00927	0.0000970
	UPLB01	Fillets with Skin	0.0112	0.000499	0.00229	0.000102
	UPSF01	Fillets with Skin	0.00414	0.000511	0.000810	0.000100
	LAAE01	Fillets without Skin	0.0672	0.000267	0.0248	0.0000990
	LABC01	Fillets without Skin	0.0126	0.000469	0.00277	0.000103
	LACC01	Fillets without Skin	0.0303	0.000450	0.00657	0.0000970
	LPAE01	Fillets without Skin	0.101	0.000310	0.0340	0.000105
	LPAE02	Fillets without Skin	0.0761	0.000370	0.0211	0.000103
	LPBC01	Fillets without Skin	0.0207	0.000464	0.00439	0.0000980
	LPBC02	Fillets without Skin	0.0690	0.000542	0.0117	0.0000920
	LPBC03	Fillets without Skin	0.0754	0.000430	0.0160	0.0000910
	LPBC04	Fillets without Skin	0.0704	0.000450	0.0164	0.000105
	LPCC01	Fillets without Skin	0.0292	0.000552	0.00558	0.000105
	UAAE01	Fillets without Skin	0.0125	0.000263	0.00467	0.0000990
	UABC01	Fillets without Skin	0.0236	0.000480	0.00495	0.000101
	UACC01	Fillets without Skin	0.0231	0.000420	0.00529	0.0000960
	UPAE01	Fillets without Skin	0.0727	0.000277	0.0244	0.0000930

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.0153	0.000480	0.00329	0.000103
	UPCC02	Fillets without Skin	0.0211	0.000490	0.00446	0.000103
	UPCC101	Fillets without Skin	0.00848	0.000471	0.00186	0.000103
	UPCC102	Fillets without Skin	0.0157	0.000485	0.00334	0.000104
	UPCC103	Fillets without Skin	0.0212	0.000432	0.00512	0.000104
PCB# 200/157/173						
	LACA01	Fillets with Skin	0.00191	0.000311	0.000532	0.0000870
	LALB01	Fillets with Skin	0.00591	0.000424	0.00122	0.0000880
	*LASF01	Fillets with Skin	< 0.000428	0.000428	< 0.0000850	0.0000850
	LPCA01	Fillets with Skin	0.00173	0.000356	0.000409	0.0000840
	LPLB01	Fillets with Skin	0.000634	0.000381	0.000145	0.0000870
	LPSB01	Fillets with Skin	0.000768	0.000398	0.000151	0.0000780
	*LPSF01	Fillets with Skin	< 0.000470	0.000470	< 0.0000800	0.0000800
	UACA01	Fillets with Skin	0.00310	0.000299	0.000865	0.0000830
	UALB01	Fillets with Skin	0.000797	0.000383	0.000178	0.0000850
	UASF01	Fillets with Skin	0.000434	0.000413	0.0000890	0.0000850
	UPCA01	Fillets with Skin	0.00387	0.000279	0.00113	0.0000810
	UPLB01	Fillets with Skin	0.00135	0.000419	0.000275	0.0000860
	UPSF01	Fillets with Skin	0.000475	0.000429	0.0000930	0.0000840
	LAAE01	Fillets without Skin	0.00434	0.000225	0.00160	0.0000830
	LABC01	Fillets without Skin	0.00452	0.000394	0.000995	0.0000870
	LACC01	Fillets without Skin	0.00579	0.000378	0.00125	0.0000820
	LPAE01	Fillets without Skin	0.0147	0.000261	0.00495	0.0000880

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	0.0154	0.000311	0.00428	0.0000860
	LPBC01	Fillets without Skin	0.00416	0.000390	0.000881	0.0000830
	LPBC02	Fillets without Skin	0.00890	0.000456	0.00151	0.0000770
	LPBC03	Fillets without Skin	0.0104	0.000362	0.00220	0.0000770
	LPBC04	Fillets without Skin	0.00839	0.000379	0.00196	0.0000880
	LPCC01	Fillets without Skin	0.00931	0.000464	0.00178	0.0000890
	UAAE01	Fillets without Skin	< 0.000221	0.000221	< 0.0000830	0.0000830
	UABC01	Fillets without Skin	0.00371	0.000404	0.000777	0.0000850
	UACC01	Fillets without Skin	0.00312	0.000354	0.000716	0.0000810
	UPAE01	Fillets without Skin	0.00756	0.000233	0.00254	0.0000780
	UPCC01	Fillets without Skin	0.00299	0.000404	0.000643	0.0000870
	UPCC02	Fillets without Skin	0.00308	0.000412	0.000650	0.0000870
	UPCC101	Fillets without Skin	0.00150	0.000396	0.000329	0.0000870
	UPCC102	Fillets without Skin	0.00268	0.000408	0.000572	0.0000870
	UPCC103	Fillets without Skin	0.00491	0.000363	0.00118	0.0000880
PCB# 201						
	LACA01	Fillets with Skin	0.00198	0.000369	0.000553	0.000103
	LALB01	Fillets with Skin	0.00137	0.000504	0.000283	0.000104

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	< 0.000509	0.000509	< 0.000101	0.000101
	LPCA01	Fillets with Skin	0.000998	0.000423	0.000235	0.000100
	LPLB01	Fillets with Skin	< 0.000453	0.000453	< 0.000104	0.000104
	LPSB01	Fillets with Skin	< 0.000473	0.000473	< 0.0000930	0.0000930
	*LPSF01	Fillets with Skin	< 0.000559	0.000559	< 0.0000950	0.0000950
	UACA01	Fillets with Skin	0.00278	0.000356	0.000776	0.0000990
	UALB01	Fillets with Skin	< 0.000455	0.000455	< 0.000102	0.000102
	UASF01	Fillets with Skin	< 0.000491	0.000491	< 0.000101	0.000101
	UPCA01	Fillets with Skin	0.00324	0.000332	0.000944	0.0000970
	UPLB01	Fillets with Skin	< 0.000499	0.000499	< 0.000102	0.000102
	UPSF01	Fillets with Skin	< 0.000511	0.000511	< 0.000100	0.000100
	LAAE01	Fillets without Skin	0.00156	0.000267	0.000575	0.0000990
	LABC01	Fillets without Skin	0.00154	0.000469	0.000339	0.000103
	LACC01	Fillets without Skin	0.00193	0.000450	0.000418	0.0000970
	LPAE01	Fillets without Skin	0.00144	0.000310	0.000486	0.000105
	LPAE02	Fillets without Skin	0.00231	0.000370	0.000641	0.000103
	LPBC01	Fillets without Skin	0.00193	0.000464	0.000409	0.0000980
	LPBC02	Fillets without Skin	0.00393	0.000542	0.000666	0.0000920
	LPBC03	Fillets without Skin	0.00454	0.000430	0.000963	0.0000910
	LPBC04	Fillets without Skin	0.00585	0.000450	0.00137	0.000105
	LPCC01	Fillets without Skin	0.00268	0.000552	0.000511	0.000105
	UAAE01	Fillets without	< 0.000263	0.000263	< 0.0000990	0.0000990

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.00151	0.000480	0.000317	0.000101
	UACC01	Fillets without Skin	0.000954	0.000420	0.000219	0.0000960
	UPAE01	Fillets without Skin	0.00168	0.000277	0.000564	0.0000930
	UPCC01	Fillets without Skin	0.00131	0.000480	0.000283	0.000103
	UPCC02	Fillets without Skin	0.00166	0.000490	0.000351	0.000103
	UPCC101	Fillets without Skin	0.000678	0.000471	0.000149	0.000103
	UPCC102	Fillets without Skin	0.000788	0.000485	0.000168	0.000104
	UPCC103	Fillets without Skin	0.00197	0.000432	0.000476	0.000104
PCB# 205						
	LACA01	Fillets with Skin	0.00111	0.000369	0.000309	0.000103
	LALB01	Fillets with Skin	0.00205	0.000504	0.000424	0.000104
	*LASF01	Fillets with Skin	< 0.000509	0.000509	< 0.000101	0.000101
	LPCA01	Fillets with Skin	0.000841	0.000423	0.000198	0.000100
	LPLB01	Fillets with Skin	< 0.000453	0.000453	< 0.000104	0.000104
	LPSB01	Fillets with Skin	< 0.000473	0.000473	< 0.0000930	0.0000930
	*LPSF01	Fillets with Skin	< 0.000559	0.000559	< 0.0000950	0.0000950
	UACA01	Fillets with Skin	0.00187	0.000356	0.000521	0.0000990
	UALB01	Fillets with Skin	0.000532	0.000455	0.000119	0.000102
	UASF01	Fillets with Skin	< 0.000491	0.000491	< 0.000101	0.000101
	UPCA01	Fillets with Skin	0.00168	0.000332	0.000490	0.0000970
	UPLB01	Fillets with Skin	0.000748	0.000499	0.000153	0.000102
	UPSF01	Fillets with Skin	< 0.000511	0.000511	< 0.000100	0.000100

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	0.00302	0.000267	0.00112	0.0000990
	LABC01	Fillets without Skin	0.00144	0.000469	0.000316	0.000103
	LACC01	Fillets without Skin	0.00268	0.000450	0.000581	0.0000970
	LPAE01	Fillets without Skin	0.00703	0.000310	0.00237	0.000105
	LPAE02	Fillets without Skin	0.00476	0.000370	0.00132	0.000103
	LPBC01	Fillets without Skin	0.00145	0.000464	0.000307	0.0000980
	LPBC02	Fillets without Skin	0.00410	0.000542	0.000696	0.0000920
	LPBC03	Fillets without Skin	0.00422	0.000430	0.000894	0.0000910
	LPBC04	Fillets without Skin	0.00392	0.000450	0.000915	0.000105
	LPCC01	Fillets without Skin	0.00274	0.000552	0.000523	0.000105
	UAAE01	Fillets without Skin	0.000512	0.000263	0.000192	0.0000990
	UABC01	Fillets without Skin	0.00161	0.000480	0.000338	0.000101
	UACC01	Fillets without Skin	0.00208	0.000420	0.000477	0.0000960
	UPAE01	Fillets without Skin	0.00336	0.000277	0.00113	0.0000930
	UPCC01	Fillets without Skin	0.00120	0.000480	0.000257	0.000103
	UPCC02	Fillets without Skin	0.00117	0.000490	0.000248	0.000103
	UPCC101	Fillets without Skin	0.000581	0.000471	0.000127	0.000103

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	0.000946	0.000485	0.000202	0.000104
	UPCC103	Fillets without Skin	0.00181	0.000432	0.000437	0.000104
PCB# 206						
	LACA01	Fillets with Skin	0.00565	0.000336	0.00157	0.0000940
	LALB01	Fillets with Skin	0.00821	0.000458	0.00170	0.0000950
	*LASF01	Fillets with Skin	< 0.000463	0.000463	< 0.0000920	0.0000920
	LPCA01	Fillets with Skin	0.00415	0.000385	0.000979	0.0000910
	LPLB01	Fillets with Skin	0.00148	0.000412	0.000338	0.0000940
	LPSB01	Fillets with Skin	0.00136	0.000430	0.000267	0.0000840
	*LPSF01	Fillets with Skin	0.000898	0.000509	0.000153	0.0000870
	UACA01	Fillets with Skin	0.00975	0.000324	0.00272	0.0000900
	UALB01	Fillets with Skin	0.00226	0.000414	0.000504	0.0000920
	UASF01	Fillets with Skin	0.00103	0.000447	0.000212	0.0000920
	UPCA01	Fillets with Skin	0.00833	0.000302	0.00243	0.0000880
	UPLB01	Fillets with Skin	0.00299	0.000454	0.000612	0.0000930
	UPSF01	Fillets with Skin	0.000678	0.000464	0.000133	0.0000910
	LAAE01	Fillets without Skin	0.0133	0.000243	0.00489	0.0000900
	LABC01	Fillets without Skin	0.00452	0.000427	0.000995	0.0000940
	LACC01	Fillets without Skin	0.0121	0.000409	0.00263	0.0000890
	LPAE01	Fillets without Skin	0.0304	0.000282	0.0103	0.0000950
	LPAE02	Fillets without Skin	0.0124	0.000336	0.00344	0.0000930
	LPBC01	Fillets without Skin	0.00699	0.000422	0.00148	0.0000890
	LPBC02	Fillets without Skin	0.0231	0.000493	0.00392	0.0000840

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	0.0286	0.000391	0.00606	0.0000830
	LPBC04	Fillets without Skin	0.0225	0.000410	0.00526	0.0000960
	LPCC01	Fillets without Skin	0.00618	0.000502	0.00118	0.0000960
	UAAE01	Fillets without Skin	0.00237	0.000239	0.000888	0.0000900
	UABC01	Fillets without Skin	0.00961	0.000437	0.00202	0.0000920
	UACC01	Fillets without Skin	0.00941	0.000382	0.00216	0.0000880
	UPAE01	Fillets without Skin	0.0156	0.000252	0.00522	0.0000850
	UPCC01	Fillets without Skin	0.00424	0.000436	0.000913	0.0000940
	UPCC02	Fillets without Skin	0.00812	0.000445	0.00171	0.0000940
	UPCC101	Fillets without Skin	0.00223	0.000428	0.000488	0.0000940
	UPCC102	Fillets without Skin	0.00536	0.000441	0.00114	0.0000940
	UPCC103	Fillets without Skin	0.00515	0.000393	0.00124	0.0000950
PCB# 209						
	LACA01	Fillets with Skin	0.00244	0.000343	0.000681	0.0000960
	LALB01	Fillets with Skin	0.000880	0.000468	0.000182	0.0000970
	*LASF01	Fillets with Skin	< 0.000473	0.000473	< 0.0000940	0.0000940
	LPCA01	Fillets with Skin	0.00242	0.000393	0.000570	0.0000930
	LPLB01	Fillets with Skin	0.000581	0.000420	0.000133	0.0000960
	LPSB01	Fillets with Skin	0.000591	0.000440	0.000116	0.0000860
	*LPSF01	Fillets with Skin	< 0.000519	0.000519	< 0.0000890	0.0000890
	UACA01	Fillets with Skin	0.00402	0.000331	0.00112	0.0000920

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.000842	0.000423	0.000188	0.0000940
	UASF01	Fillets with Skin	< 0.000456	0.000456	< 0.0000940	0.0000940
	UPCA01	Fillets with Skin	0.00303	0.000308	0.000882	0.0000900
	UPLB01	Fillets with Skin	0.00112	0.000463	0.000229	0.0000950
	UPSF01	Fillets with Skin	< 0.000474	0.000474	< 0.0000930	0.0000930
	LAAE01	Fillets without Skin	0.00568	0.000248	0.00210	0.0000920
	LABC01	Fillets without Skin	0.00383	0.000436	0.000843	0.0000960
	LACC01	Fillets without Skin	0.00753	0.000418	0.00163	0.0000900
	LPAE01	Fillets without Skin	0.0104	0.000288	0.00352	0.0000970
	LPAE02	Fillets without Skin	0.00188	0.000344	0.000523	0.0000950
	LPBC01	Fillets without Skin	0.00416	0.000431	0.000881	0.0000910
	LPBC02	Fillets without Skin	0.0106	0.000504	0.00179	0.0000850
	LPBC03	Fillets without Skin	0.0151	0.000400	0.00320	0.0000850
	LPBC04	Fillets without Skin	0.00856	0.000418	0.00200	0.0000980
	LPCC01	Fillets without Skin	0.00128	0.000513	0.000244	0.0000980
	UAAE01	Fillets without Skin	0.00109	0.000244	0.000408	0.0000920
	UABC01	Fillets without Skin	0.00512	0.000446	0.00107	0.0000940
	UACC01	Fillets without Skin	0.00477	0.000391	0.00109	0.0000900
	UPAE01	Fillets without Skin	0.00396	0.000257	0.00133	0.0000860

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.00227	0.000446	0.000489	0.0000960
	UPCC02	Fillets without Skin	0.00528	0.000455	0.00111	0.0000960
	UPCC101	Fillets without Skin	0.00126	0.000437	0.000276	0.0000960
	UPCC102	Fillets without Skin	0.00299	0.000450	0.000640	0.0000960
	UPCC103	Fillets without Skin	0.00250	0.000401	0.000602	0.0000970
PCB# 22/51						
	LACA01	Fillets with Skin	0.0190	0.000511	0.00530	0.000143
	LALB01	Fillets with Skin	0.00225	0.000698	0.000465	0.000144
	*LASF01	Fillets with Skin	0.000944	0.000705	0.000188	0.000140
	LPCA01	Fillets with Skin	0.00326	0.000586	0.000768	0.000138
	LPLB01	Fillets with Skin	0.000687	0.000627	0.000157	0.000143
	LPSB01	Fillets with Skin	0.00189	0.000655	0.000371	0.000128
	*LPSF01	Fillets with Skin	< 0.000774	0.000774	< 0.000132	0.000132
	UACA01	Fillets with Skin	0.0259	0.000493	0.00721	0.000137
	UALB01	Fillets with Skin	0.00315	0.000630	0.000702	0.000141
	UASF01	Fillets with Skin	0.00417	0.000680	0.000859	0.000140
	UPCA01	Fillets with Skin	0.00240	0.000459	0.000699	0.000134
	UPLB01	Fillets with Skin	< 0.000690	0.000690	< 0.000141	0.000141
	UPSF01	Fillets with Skin	< 0.000707	0.000707	< 0.000138	0.000138
	LAAE01	Fillets without Skin	< 0.000370	0.000370	< 0.000136	0.000136
	LABC01	Fillets without Skin	0.00633	0.000649	0.00139	0.000143
	LACC01	Fillets without Skin	0.00485	0.000622	0.00105	0.000135
	LPAE01	Fillets without Skin	< 0.000429	0.000429	< 0.000145	0.000145

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	0.000612	0.000512	0.000170	0.000142
	LPBC01	Fillets without Skin	0.00524	0.000642	0.00111	0.000136
	LPBC02	Fillets without Skin	0.00105	0.000751	0.000178	0.000127
	LPBC03	Fillets without Skin	0.000908	0.000596	0.000193	0.000126
	LPBC04	Fillets without Skin	0.00458	0.000623	0.00107	0.000146
	LPCC01	Fillets without Skin	< 0.000764	0.000764	< 0.000146	0.000146
	UAAE01	Fillets without Skin	< 0.000364	0.000364	< 0.000136	0.000136
	UABC01	Fillets without Skin	0.00522	0.000665	0.00110	0.000140
	UACC01	Fillets without Skin	0.00494	0.000582	0.00113	0.000133
	UPAE01	Fillets without Skin	< 0.000383	0.000383	< 0.000129	0.000129
	UPCC01	Fillets without Skin	0.00197	0.000664	0.000425	0.000143
	UPCC02	Fillets without Skin	0.00372	0.000678	0.000784	0.000143
	UPCC101	Fillets without Skin	< 0.000652	0.000652	< 0.000143	0.000143
	UPCC102	Fillets without Skin	0.00462	0.000671	0.000987	0.000143
	UPCC103	Fillets without Skin	0.00197	0.000598	0.000476	0.000144
PCB# 24/27						
	LACA01	Fillets with Skin	0.00752	0.000511	0.00210	0.000143
	LALB01	Fillets with Skin	0.00152	0.000698	0.000313	0.000144

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	< 0.000705	0.000705	< 0.000140	0.000140
	LPCA01	Fillets with Skin	0.000998	0.000586	0.000235	0.000138
	LPLB01	Fillets with Skin	0.000740	0.000627	0.000169	0.000143
	LPSB01	Fillets with Skin	< 0.000655	0.000655	< 0.000128	0.000128
	*LPSF01	Fillets with Skin	< 0.000774	0.000774	< 0.000132	0.000132
	UACA01	Fillets with Skin	0.0101	0.000493	0.00283	0.000137
	UALB01	Fillets with Skin	0.00226	0.000630	0.000504	0.000141
	UASF01	Fillets with Skin	0.00168	0.000680	0.000346	0.000140
	UPCA01	Fillets with Skin	0.00168	0.000459	0.000490	0.000134
	UPLB01	Fillets with Skin	< 0.000690	0.000690	< 0.000141	0.000141
	UPSF01	Fillets with Skin	< 0.000707	0.000707	< 0.000138	0.000138
	LAAE01	Fillets without Skin	0.000428	0.000370	0.000158	0.000136
	LABC01	Fillets without Skin	0.00239	0.000649	0.000527	0.000143
	LACC01	Fillets without Skin	0.00395	0.000622	0.000856	0.000135
	LPAE01	Fillets without Skin	< 0.000429	0.000429	< 0.000145	0.000145
	LPAE02	Fillets without Skin	< 0.000512	0.000512	< 0.000142	0.000142
	LPBC01	Fillets without Skin	0.00301	0.000642	0.000638	0.000136
	LPBC02	Fillets without Skin	< 0.000751	0.000751	< 0.000127	0.000127
	LPBC03	Fillets without Skin	< 0.000596	0.000596	< 0.000126	0.000126
	LPBC04	Fillets without Skin	0.00182	0.000623	0.000425	0.000146
	LPCC01	Fillets without Skin	0.00319	0.000764	0.000609	0.000146
	UAAE01	Fillets without	0.000416	0.000364	0.000156	0.000136

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.00205	0.000665	0.000430	0.000140
	UACC01	Fillets without Skin	0.00729	0.000582	0.00167	0.000133
	UPAE01	Fillets without Skin	< 0.000383	0.000383	< 0.000129	0.000129
	UPCC01	Fillets without Skin	0.00305	0.000664	0.000656	0.000143
	UPCC02	Fillets without Skin	0.00240	0.000678	0.000506	0.000143
	UPCC101	Fillets without Skin	< 0.000652	0.000652	< 0.000143	0.000143
	UPCC102	Fillets without Skin	0.00158	0.000671	0.000337	0.000143
	UPCC103	Fillets without Skin	0.00608	0.000598	0.00147	0.000144
PCB# 25						
	LACA01	Fillets with Skin	< 0.000511	0.000511	< 0.000143	0.000143
	LALB01	Fillets with Skin	< 0.000698	0.000698	< 0.000144	0.000144
	*LASF01	Fillets with Skin	< 0.000705	0.000705	< 0.000140	0.000140
	LPCA01	Fillets with Skin	< 0.000586	0.000586	< 0.000138	0.000138
	LPLB01	Fillets with Skin	< 0.000627	0.000627	< 0.000143	0.000143
	LPSB01	Fillets with Skin	< 0.000655	0.000655	< 0.000128	0.000128
	*LPSF01	Fillets with Skin	< 0.000774	0.000774	< 0.000132	0.000132
	UACA01	Fillets with Skin	< 0.000493	0.000493	< 0.000137	0.000137
	UALB01	Fillets with Skin	< 0.000630	0.000630	< 0.000141	0.000141
	UASF01	Fillets with Skin	< 0.000680	0.000680	< 0.000140	0.000140
	UPCA01	Fillets with Skin	< 0.000459	0.000459	< 0.000134	0.000134
	UPLB01	Fillets with Skin	< 0.000690	0.000690	< 0.000141	0.000141
	UPSF01	Fillets with Skin	< 0.000707	0.000707	< 0.000138	0.000138

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	< 0.000370	0.000370	< 0.000136	0.000136
	LABC01	Fillets without Skin	< 0.000649	0.000649	< 0.000143	0.000143
	LACC01	Fillets without Skin	< 0.000622	0.000622	< 0.000135	0.000135
	LPAE01	Fillets without Skin	< 0.000429	0.000429	< 0.000145	0.000145
	LPAE02	Fillets without Skin	< 0.000512	0.000512	< 0.000142	0.000142
	LPBC01	Fillets without Skin	< 0.000642	0.000642	< 0.000136	0.000136
	LPBC02	Fillets without Skin	< 0.000751	0.000751	< 0.000127	0.000127
	LPBC03	Fillets without Skin	< 0.000596	0.000596	< 0.000126	0.000126
	LPBC04	Fillets without Skin	< 0.000623	0.000623	< 0.000146	0.000146
	LPCC01	Fillets without Skin	< 0.000764	0.000764	< 0.000146	0.000146
	UAAE01	Fillets without Skin	< 0.000364	0.000364	< 0.000136	0.000136
	UABC01	Fillets without Skin	< 0.000665	0.000665	< 0.000140	0.000140
	UACC01	Fillets without Skin	< 0.000582	0.000582	< 0.000133	0.000133
	UPAE01	Fillets without Skin	< 0.000383	0.000383	< 0.000129	0.000129
	UPCC01	Fillets without Skin	< 0.000664	0.000664	< 0.000143	0.000143
	UPCC02	Fillets without Skin	< 0.000678	0.000678	< 0.000143	0.000143
	UPCC101	Fillets without Skin	< 0.000652	0.000652	< 0.000143	0.000143

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	< 0.000671	0.000671	< 0.000143	0.000143
	UPCC103	Fillets without Skin	< 0.000598	0.000598	< 0.000144	0.000144
PCB# 26						
	LACA01	Fillets with Skin	0.0196	0.000511	0.00546	0.000143
	LALB01	Fillets with Skin	0.00283	0.000698	0.000586	0.000144
	*LASF01	Fillets with Skin	< 0.000705	0.000705	< 0.000140	0.000140
	LPCA01	Fillets with Skin	0.00289	0.000586	0.000681	0.000138
	LPLB01	Fillets with Skin	0.00111	0.000627	0.000254	0.000143
	LPSB01	Fillets with Skin	0.00183	0.000655	0.000359	0.000128
	*LPSF01	Fillets with Skin	< 0.000774	0.000774	< 0.000132	0.000132
	UACA01	Fillets with Skin	0.0232	0.000493	0.00646	0.000137
	UALB01	Fillets with Skin	0.00328	0.000630	0.000732	0.000141
	UASF01	Fillets with Skin	0.00282	0.000680	0.000580	0.000140
	UPCA01	Fillets with Skin	0.00294	0.000459	0.000858	0.000134
	UPLB01	Fillets with Skin	< 0.000690	0.000690	< 0.000141	0.000141
	UPSF01	Fillets with Skin	< 0.000707	0.000707	< 0.000138	0.000138
	LAAE01	Fillets without Skin	0.00440	0.000370	0.00162	0.000136
	LABC01	Fillets without Skin	0.00442	0.000649	0.000971	0.000143
	LACC01	Fillets without Skin	0.00268	0.000622	0.000581	0.000135
	LPAE01	Fillets without Skin	0.00317	0.000429	0.00107	0.000145
	LPAE02	Fillets without Skin	0.00334	0.000512	0.000929	0.000142
	LPBC01	Fillets without Skin	0.00404	0.000642	0.000856	0.000136
	LPBC02	Fillets without Skin	0.00105	0.000751	0.000178	0.000127

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	0.00130	0.000596	0.000275	0.000126
	LPBC04	Fillets without Skin	0.00513	0.000623	0.00120	0.000146
	LPCC01	Fillets without Skin	0.00140	0.000764	0.000268	0.000146
	UAAE01	Fillets without Skin	0.00208	0.000364	0.000780	0.000136
	UABC01	Fillets without Skin	0.00307	0.000665	0.000644	0.000140
	UACC01	Fillets without Skin	0.00347	0.000582	0.000795	0.000133
	UPAE01	Fillets without Skin	0.00308	0.000383	0.00103	0.000129
	UPCC01	Fillets without Skin	0.00167	0.000664	0.000360	0.000143
	UPCC02	Fillets without Skin	0.00303	0.000678	0.000640	0.000143
	UPCC101	Fillets without Skin	< 0.000652	0.000652	< 0.000143	0.000143
	UPCC102	Fillets without Skin	0.00189	0.000671	0.000404	0.000143
	UPCC103	Fillets without Skin	0.00270	0.000598	0.000650	0.000144
PCB# 28						
	LACA01	Fillets with Skin	0.0920	0.000394	0.0256	0.000110
	LALB01	Fillets with Skin	0.0144	0.000537	0.00298	0.000111
	*LASF01	Fillets with Skin	0.00463	0.000543	0.000921	0.000108
	LPCA01	Fillets with Skin	0.0152	0.000451	0.00358	0.000106
	LPLB01	Fillets with Skin	0.00518	0.000483	0.00118	0.000110
	LPSB01	Fillets with Skin	0.00863	0.000505	0.00169	0.0000990
	*LPSF01	Fillets with Skin	0.00194	0.000596	0.000330	0.000102
	UACA01	Fillets with Skin	0.111	0.000380	0.0309	0.000106

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.0171	0.000485	0.00383	0.000108
	UASF01	Fillets with Skin	0.0181	0.000524	0.00373	0.000108
	UPCA01	Fillets with Skin	0.0207	0.000354	0.00602	0.000103
	UPLB01	Fillets with Skin	0.00172	0.000532	0.000352	0.000109
	UPSF01	Fillets with Skin	0.00149	0.000544	0.000292	0.000107
	LAAE01	Fillets without Skin	0.0343	0.000285	0.0126	0.000105
	LABC01	Fillets without Skin	0.0259	0.000500	0.00570	0.000110
	LACC01	Fillets without Skin	0.0378	0.000479	0.00820	0.000104
	LPAE01	Fillets without Skin	0.0196	0.000331	0.00662	0.000112
	LPAE02	Fillets without Skin	0.0236	0.000394	0.00657	0.000110
	LPBC01	Fillets without Skin	0.0292	0.000495	0.00619	0.000105
	LPBC02	Fillets without Skin	0.0146	0.000578	0.00247	0.0000980
	LPBC03	Fillets without Skin	0.00649	0.000459	0.00138	0.0000970
	LPBC04	Fillets without Skin	0.0344	0.000480	0.00805	0.000112
	LPCC01	Fillets without Skin	0.0167	0.000589	0.00319	0.000112
	UAAE01	Fillets without Skin	0.0216	0.000280	0.00810	0.000105
	UABC01	Fillets without Skin	0.0414	0.000512	0.00868	0.000107
	UACC01	Fillets without Skin	0.0425	0.000448	0.00975	0.000103
	UPAE01	Fillets without Skin	0.0224	0.000295	0.00751	0.0000990

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.0161	0.000512	0.00347	0.000110
	UPCC02	Fillets without Skin	0.0243	0.000522	0.00514	0.000110
	UPCC101	Fillets without Skin	0.00126	0.000502	0.000276	0.000110
	UPCC102	Fillets without Skin	0.0147	0.000517	0.00314	0.000110
	UPCC103	Fillets without Skin	0.0302	0.000461	0.00727	0.000111
PCB# 29						
	LACA01	Fillets with Skin	0.000954	0.000316	0.000266	0.0000880
	LALB01	Fillets with Skin	< 0.000432	0.000432	< 0.0000890	0.0000890
	*LASF01	Fillets with Skin	< 0.000436	0.000436	< 0.0000870	0.0000870
	LPCA01	Fillets with Skin	0.000578	0.000363	0.000136	0.0000850
	LPLB01	Fillets with Skin	< 0.000388	0.000388	< 0.0000890	0.0000890
	LPSB01	Fillets with Skin	< 0.000405	0.000405	< 0.0000790	0.0000790
	*LPSF01	Fillets with Skin	< 0.000479	0.000479	< 0.0000820	0.0000820
	UACA01	Fillets with Skin	0.00127	0.000305	0.000355	0.0000850
	UALB01	Fillets with Skin	< 0.000390	0.000390	< 0.0000870	0.0000870
	UASF01	Fillets with Skin	< 0.000421	0.000421	< 0.0000870	0.0000870
	UPCA01	Fillets with Skin	< 0.000284	0.000284	< 0.0000830	0.0000830
	UPLB01	Fillets with Skin	< 0.000427	0.000427	< 0.0000870	0.0000870
	UPSF01	Fillets with Skin	< 0.000437	0.000437	< 0.0000860	0.0000860
	LAAE01	Fillets without Skin	0.000856	0.000229	0.000316	0.0000840
	LABC01	Fillets without Skin	0.00106	0.000401	0.000234	0.0000880
	LACC01	Fillets without Skin	0.000988	0.000385	0.000214	0.0000830
	LPAE01	Fillets without Skin	0.00107	0.000265	0.000361	0.0000900

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 0.000317	0.000317	< 0.0000880	0.0000880
	LPBC01	Fillets without Skin	0.000844	0.000397	0.000179	0.0000840
	LPBC02	Fillets without Skin	< 0.000464	0.000464	< 0.0000790	0.0000790
	LPBC03	Fillets without Skin	< 0.000369	0.000369	< 0.0000780	0.0000780
	LPBC04	Fillets without Skin	0.000938	0.000386	0.000219	0.0000900
	LPCC01	Fillets without Skin	< 0.000473	0.000473	< 0.0000900	0.0000900
	UAAE01	Fillets without Skin	0.000512	0.000225	0.000192	0.0000840
	UABC01	Fillets without Skin	0.000975	0.000411	0.000205	0.0000860
	UACC01	Fillets without Skin	0.000997	0.000360	0.000229	0.0000830
	UPAE01	Fillets without Skin	0.000880	0.000237	0.000296	0.0000800
	UPCC01	Fillets without Skin	0.00155	0.000411	0.000335	0.0000890
	UPCC02	Fillets without Skin	0.000636	0.000419	0.000134	0.0000890
	UPCC101	Fillets without Skin	0.00155	0.000403	0.000339	0.0000880
	UPCC102	Fillets without Skin	0.000788	0.000415	0.000168	0.0000890
	UPCC103	Fillets without Skin	< 0.000370	0.000370	< 0.0000890	0.0000890
PCB# 31						
	LACA01	Fillets with Skin	0.0593	0.000511	0.0165	0.000143
	LALB01	Fillets with Skin	0.00743	0.000698	0.00154	0.000144

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	0.00236	0.000705	0.000470	0.000140
	LPCA01	Fillets with Skin	0.0107	0.000586	0.00253	0.000138
	LPLB01	Fillets with Skin	0.00349	0.000627	0.000798	0.000143
	LPSB01	Fillets with Skin	0.00656	0.000655	0.00129	0.000128
	*LPSF01	Fillets with Skin	0.00131	0.000774	0.000224	0.000132
	UACA01	Fillets with Skin	0.0732	0.000493	0.0204	0.000137
	UALB01	Fillets with Skin	0.00860	0.000630	0.00192	0.000141
	UASF01	Fillets with Skin	0.0101	0.000680	0.00208	0.000140
	UPCA01	Fillets with Skin	0.0121	0.000459	0.00352	0.000134
	UPLB01	Fillets with Skin	0.000973	0.000690	0.000199	0.000141
	UPSF01	Fillets with Skin	0.00115	0.000707	0.000226	0.000138
	LAAE01	Fillets without Skin	0.0166	0.000370	0.00613	0.000136
	LABC01	Fillets without Skin	0.0148	0.000649	0.00325	0.000143
	LACC01	Fillets without Skin	0.0115	0.000622	0.00250	0.000135
	LPAE01	Fillets without Skin	0.00806	0.000429	0.00272	0.000145
	LPAE02	Fillets without Skin	0.00829	0.000512	0.00230	0.000142
	LPBC01	Fillets without Skin	0.0139	0.000642	0.00294	0.000136
	LPBC02	Fillets without Skin	0.00288	0.000751	0.000489	0.000127
	LPBC03	Fillets without Skin	0.00227	0.000596	0.000481	0.000126
	LPBC04	Fillets without Skin	0.0153	0.000623	0.00357	0.000146
	LPCC01	Fillets without Skin	0.00351	0.000764	0.000669	0.000146
	UAAE01	Fillets without	0.0179	0.000364	0.00671	0.000136

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.0127	0.000665	0.00266	0.000140
	UACC01	Fillets without Skin	0.00946	0.000582	0.00217	0.000133
	UPAE01	Fillets without Skin	0.0100	0.000383	0.00337	0.000129
	UPCC01	Fillets without Skin	0.00550	0.000664	0.00118	0.000143
	UPCC02	Fillets without Skin	0.0107	0.000678	0.00225	0.000143
	UPCC101	Fillets without Skin	< 0.000652	0.000652	< 0.000143	0.000143
	UPCC102	Fillets without Skin	0.00898	0.000671	0.00192	0.000143
	UPCC103	Fillets without Skin	0.00717	0.000598	0.00173	0.000144
PCB# 33/53/20						
	LACA01	Fillets with Skin	0.0182	0.000511	0.00507	0.000143
	LALB01	Fillets with Skin	0.00176	0.000698	0.000363	0.000144
	*LASF01	Fillets with Skin	< 0.000705	0.000705	< 0.000140	0.000140
	LPCA01	Fillets with Skin	0.00299	0.000586	0.000706	0.000138
	LPLB01	Fillets with Skin	< 0.000627	0.000627	< 0.000143	0.000143
	LPSB01	Fillets with Skin	0.00148	0.000655	0.000290	0.000128
	*LPSF01	Fillets with Skin	< 0.000774	0.000774	< 0.000132	0.000132
	UACA01	Fillets with Skin	0.0235	0.000493	0.00656	0.000137
	UALB01	Fillets with Skin	0.00310	0.000630	0.000692	0.000141
	UASF01	Fillets with Skin	0.00304	0.000680	0.000625	0.000140
	UPCA01	Fillets with Skin	0.00307	0.000459	0.000895	0.000134
	UPLB01	Fillets with Skin	< 0.000690	0.000690	< 0.000141	0.000141
	UPSF01	Fillets with Skin	< 0.000707	0.000707	< 0.000138	0.000138

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	< 0.000370	0.000370	< 0.000136	0.000136
	LABC01	Fillets without Skin	0.00303	0.000649	0.000667	0.000143
	LACC01	Fillets without Skin	0.00174	0.000622	0.000377	0.000135
	LPAE01	Fillets without Skin	< 0.000429	0.000429	< 0.000145	0.000145
	LPAE02	Fillets without Skin	< 0.000512	0.000512	< 0.000142	0.000142
	LPBC01	Fillets without Skin	0.00271	0.000642	0.000575	0.000136
	LPBC02	Fillets without Skin	< 0.000751	0.000751	< 0.000127	0.000127
	LPBC03	Fillets without Skin	0.000844	0.000596	0.000179	0.000126
	LPBC04	Fillets without Skin	0.00160	0.000623	0.000374	0.000146
	LPCC01	Fillets without Skin	< 0.000764	0.000764	< 0.000146	0.000146
	UAAE01	Fillets without Skin	0.00262	0.000364	0.000984	0.000136
	UABC01	Fillets without Skin	0.00239	0.000665	0.000501	0.000140
	UACC01	Fillets without Skin	0.00230	0.000582	0.000527	0.000133
	UPAE01	Fillets without Skin	< 0.000383	0.000383	< 0.000129	0.000129
	UPCC01	Fillets without Skin	0.00161	0.000664	0.000347	0.000143
	UPCC02	Fillets without Skin	0.00235	0.000678	0.000495	0.000143
	UPCC101	Fillets without Skin	< 0.000652	0.000652	< 0.000143	0.000143

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	0.00541	0.000671	0.00116	0.000143
	UPCC103	Fillets without Skin	0.00117	0.000598	0.000282	0.000144
PCB# 40						
	LACA01	Fillets with Skin	0.0202	0.000484	0.00563	0.000135
	LALB01	Fillets with Skin	0.00259	0.000660	0.000535	0.000137
	*LASF01	Fillets with Skin	< 0.000668	0.000668	< 0.000133	0.000133
	LPCA01	Fillets with Skin	0.00320	0.000555	0.000756	0.000131
	LPLB01	Fillets with Skin	0.000898	0.000593	0.000206	0.000136
	LPSB01	Fillets with Skin	0.00124	0.000620	0.000243	0.000122
	*LPSF01	Fillets with Skin	< 0.000733	0.000733	< 0.000125	0.000125
	UACA01	Fillets with Skin	0.0237	0.000467	0.00661	0.000130
	UALB01	Fillets with Skin	0.00368	0.000597	0.000820	0.000133
	UASF01	Fillets with Skin	0.00179	0.000644	0.000368	0.000133
	UPCA01	Fillets with Skin	0.00353	0.000435	0.00103	0.000127
	UPLB01	Fillets with Skin	< 0.000654	0.000654	< 0.000134	0.000134
	UPSF01	Fillets with Skin	< 0.000669	0.000669	< 0.000131	0.000131
	LAAE01	Fillets without Skin	0.00660	0.000350	0.00244	0.000129
	LABC01	Fillets without Skin	0.0113	0.000614	0.00249	0.000135
	LACC01	Fillets without Skin	0.00325	0.000589	0.000703	0.000128
	LPAE01	Fillets without Skin	0.00177	0.000406	0.000597	0.000137
	LPAE02	Fillets without Skin	0.00141	0.000485	0.000392	0.000135
	LPBC01	Fillets without Skin	< 0.000608	0.000608	< 0.000129	0.000129
	LPBC02	Fillets without Skin	< 0.000711	0.000711	< 0.000121	0.000121

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	< 0.000564	0.000564	< 0.000120	0.000120
	LPBC04	Fillets without Skin	< 0.000590	0.000590	< 0.000138	0.000138
	LPCC01	Fillets without Skin	0.000893	0.000724	0.000170	0.000138
	UAAE01	Fillets without Skin	0.0126	0.000344	0.00472	0.000129
	UABC01	Fillets without Skin	< 0.000630	0.000630	< 0.000132	0.000132
	UACC01	Fillets without Skin	0.00572	0.000551	0.00131	0.000126
	UPAE01	Fillets without Skin	0.00112	0.000363	0.000376	0.000122
	UPCC01	Fillets without Skin	0.00108	0.000629	0.000232	0.000135
	UPCC02	Fillets without Skin	< 0.000642	0.000642	< 0.000135	0.000135
	UPCC101	Fillets without Skin	< 0.000617	0.000617	< 0.000135	0.000135
	UPCC102	Fillets without Skin	0.00168	0.000635	0.000359	0.000136
	UPCC103	Fillets without Skin	0.00169	0.000566	0.000408	0.000137
PCB# 41/64						
	LACA01	Fillets with Skin	0.0846	0.000484	0.0236	0.000135
	LALB01	Fillets with Skin	0.0135	0.000660	0.00279	0.000137
	*LASF01	Fillets with Skin	0.00330	0.000668	0.000658	0.000133
	LPCA01	Fillets with Skin	0.0115	0.000555	0.00271	0.000131
	LPLB01	Fillets with Skin	0.00518	0.000593	0.00118	0.000136
	LPSB01	Fillets with Skin	0.00638	0.000620	0.00125	0.000122
	*LPSF01	Fillets with Skin	0.00194	0.000733	0.000330	0.000125
	UACA01	Fillets with Skin	0.108	0.000467	0.0302	0.000130

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.0160	0.000597	0.00356	0.000133
	UASF01	Fillets with Skin	0.0111	0.000644	0.00229	0.000133
	UPCA01	Fillets with Skin	0.0154	0.000435	0.00450	0.000127
	UPLB01	Fillets with Skin	0.00187	0.000654	0.000382	0.000134
	UPSF01	Fillets with Skin	0.000678	0.000669	0.000133	0.000131
	LAAE01	Fillets without Skin	0.0756	0.000350	0.0279	0.000129
	LABC01	Fillets without Skin	0.0212	0.000614	0.00467	0.000135
	LACC01	Fillets without Skin	0.0508	0.000589	0.0110	0.000128
	LPAE01	Fillets without Skin	0.0502	0.000406	0.0169	0.000137
	LPAE02	Fillets without Skin	0.0219	0.000485	0.00608	0.000135
	LPBC01	Fillets without Skin	0.0337	0.000608	0.00714	0.000129
	LPBC02	Fillets without Skin	0.0151	0.000711	0.00256	0.000121
	LPBC03	Fillets without Skin	0.0162	0.000564	0.00344	0.000120
	LPBC04	Fillets without Skin	0.0419	0.000590	0.00979	0.000138
	LPCC01	Fillets without Skin	0.0129	0.000724	0.00246	0.000138
	UAAE01	Fillets without Skin	0.0470	0.000344	0.0176	0.000129
	UABC01	Fillets without Skin	0.0341	0.000630	0.00716	0.000132
	UACC01	Fillets without Skin	0.0501	0.000551	0.0115	0.000126
	UPAE01	Fillets without Skin	0.0168	0.000363	0.00563	0.000122

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.0110	0.000629	0.00237	0.000135
	UPCC02	Fillets without Skin	0.0202	0.000642	0.00427	0.000135
	UPCC101	Fillets without Skin	0.00499	0.000617	0.00109	0.000135
	UPCC102	Fillets without Skin	0.00877	0.000635	0.00187	0.000136
	UPCC103	Fillets without Skin	0.0171	0.000566	0.00412	0.000137
PCB# 42/59/37						
	LACA01	Fillets with Skin	0.0300	0.000484	0.00837	0.000135
	LALB01	Fillets with Skin	0.00767	0.000660	0.00158	0.000137
	*LASF01	Fillets with Skin	0.00189	0.000668	0.000376	0.000133
	LPCA01	Fillets with Skin	0.00578	0.000555	0.00136	0.000131
	LPLB01	Fillets with Skin	0.00285	0.000593	0.000653	0.000136
	LPSB01	Fillets with Skin	0.00426	0.000620	0.000834	0.000122
	*LPSF01	Fillets with Skin	0.000898	0.000733	0.000153	0.000125
	UACA01	Fillets with Skin	0.0333	0.000467	0.00928	0.000130
	UALB01	Fillets with Skin	0.00798	0.000597	0.00178	0.000133
	UASF01	Fillets with Skin	0.00726	0.000644	0.00150	0.000133
	UPCA01	Fillets with Skin	0.00757	0.000435	0.00221	0.000127
	UPLB01	Fillets with Skin	0.00105	0.000654	0.000214	0.000134
	UPSF01	Fillets with Skin	< 0.000669	0.000669	< 0.000131	0.000131
	LAAE01	Fillets without Skin	0.0346	0.000350	0.0128	0.000129
	LABC01	Fillets without Skin	0.0168	0.000614	0.00370	0.000135
	LACC01	Fillets without Skin	0.0241	0.000589	0.00523	0.000128
	LPAE01	Fillets without Skin	0.0155	0.000406	0.00522	0.000137

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	0.00980	0.000485	0.00272	0.000135
	LPBC01	Fillets without Skin	0.0160	0.000608	0.00338	0.000129
	LPBC02	Fillets without Skin	0.00157	0.000711	0.000266	0.000121
	LPBC03	Fillets without Skin	0.00733	0.000564	0.00155	0.000120
	LPBC04	Fillets without Skin	0.0165	0.000590	0.00386	0.000138
	LPCC01	Fillets without Skin	0.0145	0.000724	0.00276	0.000138
	*UAAE01	Fillets without Skin	0.0486	0.000344	0.0182	0.000129
	UABC01	Fillets without Skin	0.0101	0.000630	0.00213	0.000132
	UACC01	Fillets without Skin	0.0245	0.000551	0.00561	0.000126
	UPAE01	Fillets without Skin	0.00584	0.000363	0.00196	0.000122
	UPCC01	Fillets without Skin	0.00950	0.000629	0.00205	0.000135
	UPCC02	Fillets without Skin	0.0105	0.000642	0.00222	0.000135
	UPCC101	Fillets without Skin	0.00320	0.000617	0.000700	0.000135
	UPCC102	Fillets without Skin	0.00688	0.000635	0.00147	0.000136
	UPCC103	Fillets without Skin	0.0150	0.000566	0.00362	0.000137
PCB# 43						
	LACA01	Fillets with Skin	0.00294	0.000484	0.000819	0.000135
	LALB01	Fillets with Skin	< 0.000660	0.000660	< 0.000137	0.000137

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	< 0.000668	0.000668	< 0.000133	0.000133
	LPCA01	Fillets with Skin	< 0.000555	0.000555	< 0.000131	0.000131
	LPLB01	Fillets with Skin	< 0.000593	0.000593	< 0.000136	0.000136
	LPSB01	Fillets with Skin	< 0.000620	0.000620	< 0.000122	0.000122
	*LPSF01	Fillets with Skin	< 0.000733	0.000733	< 0.000125	0.000125
	UACA01	Fillets with Skin	0.00354	0.000467	0.000987	0.000130
	UALB01	Fillets with Skin	0.000886	0.000597	0.000198	0.000133
	UASF01	Fillets with Skin	< 0.000644	0.000644	< 0.000133	0.000133
	UPCA01	Fillets with Skin	< 0.000435	0.000435	< 0.000127	0.000127
	UPLB01	Fillets with Skin	< 0.000654	0.000654	< 0.000134	0.000134
	UPSF01	Fillets with Skin	< 0.000669	0.000669	< 0.000131	0.000131
	LAAE01	Fillets without Skin	< 0.000350	0.000350	< 0.000129	0.000129
	LABC01	Fillets without Skin	0.000798	0.000614	0.000176	0.000135
	LACC01	Fillets without Skin	0.00169	0.000589	0.000367	0.000128
	LPAE01	Fillets without Skin	< 0.000406	0.000406	< 0.000137	0.000137
	LPAE02	Fillets without Skin	< 0.000485	0.000485	< 0.000135	0.000135
	LPBC01	Fillets without Skin	< 0.000608	0.000608	< 0.000129	0.000129
	LPBC02	Fillets without Skin	< 0.000711	0.000711	< 0.000121	0.000121
	LPBC03	Fillets without Skin	< 0.000564	0.000564	< 0.000120	0.000120
	LPBC04	Fillets without Skin	< 0.000590	0.000590	< 0.000138	0.000138
	LPCC01	Fillets without Skin	< 0.000724	0.000724	< 0.000138	0.000138
	UAAE01	Fillets without	< 0.000344	0.000344	< 0.000129	0.000129

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.00122	0.000630	0.000256	0.000132
	UACC01	Fillets without Skin	0.00174	0.000551	0.000398	0.000126
	UPAE01	Fillets without Skin	< 0.000363	0.000363	< 0.000122	0.000122
	UPCC01	Fillets without Skin	< 0.000629	0.000629	< 0.000135	0.000135
	UPCC02	Fillets without Skin	0.00103	0.000642	0.000217	0.000135
	UPCC101	Fillets without Skin	< 0.000617	0.000617	< 0.000135	0.000135
	UPCC102	Fillets without Skin	< 0.000635	0.000635	< 0.000136	0.000136
	UPCC103	Fillets without Skin	< 0.000566	0.000566	< 0.000137	0.000137
PCB# 44						
	*LACA01	Fillets with Skin	0.106	0.000298	0.0297	0.0000830
	LALB01	Fillets with Skin	0.0189	0.000407	0.00390	0.0000840
	*LASF01	Fillets with Skin	0.00406	0.000411	0.000808	0.0000820
	LPCA01	Fillets with Skin	0.0302	0.000342	0.00712	0.0000810
	LPLB01	Fillets with Skin	0.00782	0.000365	0.00179	0.0000840
	LPSB01	Fillets with Skin	0.00768	0.000382	0.00151	0.0000750
	*LPSF01	Fillets with Skin	0.00221	0.000451	0.000377	0.0000770
	*UACA01	Fillets with Skin	0.125	0.000287	0.0348	0.0000800
	UALB01	Fillets with Skin	0.0220	0.000368	0.00490	0.0000820
	UASF01	Fillets with Skin	0.0144	0.000397	0.00296	0.0000820
	UPCA01	Fillets with Skin	0.0439	0.000268	0.0128	0.0000780
	UPLB01	Fillets with Skin	0.00299	0.000403	0.000612	0.0000820
	UPSF01	Fillets with Skin	0.000813	0.000412	0.000159	0.0000810

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LAAE01	Fillets without Skin	0.0662	0.000216	0.0244	0.0000800
	LABC01	Fillets without Skin	0.0275	0.000379	0.00605	0.0000830
	LACC01	Fillets without Skin	0.0615	0.000363	0.0133	0.0000790
	LPAE01	Fillets without Skin	0.0321	0.000250	0.0108	0.0000840
	LPAE02	Fillets without Skin	0.0165	0.000299	0.00458	0.0000830
	LPBC01	Fillets without Skin	0.0345	0.000375	0.00732	0.0000790
	LPBC02	Fillets without Skin	0.00297	0.000438	0.000503	0.0000740
	LPBC03	Fillets without Skin	0.00960	0.000347	0.00204	0.0000740
	LPBC04	Fillets without Skin	0.0374	0.000364	0.00874	0.0000850
	LPCC01	Fillets without Skin	0.0203	0.000446	0.00388	0.0000850
	*UAAE01	Fillets without Skin	0.0970	0.000212	0.0364	0.0000800
	UABC01	Fillets without Skin	0.0317	0.000388	0.00665	0.0000810
	UACC01	Fillets without Skin	0.0740	0.000339	0.0170	0.0000780
	UPAE01	Fillets without Skin	0.0148	0.000223	0.00498	0.0000750
	UPCC01	Fillets without Skin	0.0226	0.000387	0.00486	0.0000830
	UPCC02	Fillets without Skin	0.0284	0.000395	0.00600	0.0000830
	UPCC101	Fillets without Skin	0.0192	0.000380	0.00420	0.0000830

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	0.0189	0.000391	0.00403	0.0000840
	UPCC103	Fillets without Skin	0.0292	0.000349	0.00704	0.0000840
PCB# 45						
	LACA01	Fillets with Skin	0.00889	0.000484	0.00248	0.000135
	LALB01	Fillets with Skin	0.00176	0.000660	0.000363	0.000137
	*LASF01	Fillets with Skin	< 0.000668	0.000668	< 0.000133	0.000133
	LPCA01	Fillets with Skin	0.00110	0.000555	0.000260	0.000131
	LPLB01	Fillets with Skin	< 0.000593	0.000593	< 0.000136	0.000136
	LPSB01	Fillets with Skin	0.000709	0.000620	0.000139	0.000122
	*LPSF01	Fillets with Skin	< 0.000733	0.000733	< 0.000125	0.000125
	UACA01	Fillets with Skin	0.0110	0.000467	0.00306	0.000130
	UALB01	Fillets with Skin	0.00253	0.000597	0.000564	0.000133
	UASF01	Fillets with Skin	0.00108	0.000644	0.000223	0.000133
	UPCA01	Fillets with Skin	0.00168	0.000435	0.000490	0.000127
	UPLB01	Fillets with Skin	< 0.000654	0.000654	< 0.000134	0.000134
	UPSF01	Fillets with Skin	< 0.000669	0.000669	< 0.000131	0.000131
	LAAE01	Fillets without Skin	0.000825	0.000350	0.000304	0.000129
	LABC01	Fillets without Skin	0.000692	0.000614	0.000152	0.000135
	LACC01	Fillets without Skin	0.00320	0.000589	0.000693	0.000128
	LPAE01	Fillets without Skin	< 0.000406	0.000406	< 0.000137	0.000137
	LPAE02	Fillets without Skin	< 0.000485	0.000485	< 0.000135	0.000135
	LPBC01	Fillets without Skin	0.00127	0.000608	0.000268	0.000129
	LPBC02	Fillets without Skin	< 0.000711	0.000711	< 0.000121	0.000121

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	< 0.000564	0.000564	< 0.000120	0.000120
	LPBC04	Fillets without Skin	0.00127	0.000590	0.000297	0.000138
	LPCC01	Fillets without Skin	0.00115	0.000724	0.000219	0.000138
	UAAE01	Fillets without Skin	< 0.000344	0.000344	< 0.000129	0.000129
	UABC01	Fillets without Skin	0.000975	0.000630	0.000205	0.000132
	UACC01	Fillets without Skin	0.00508	0.000551	0.00116	0.000126
	UPAE01	Fillets without Skin	< 0.000363	0.000363	< 0.000122	0.000122
	UPCC01	Fillets without Skin	0.00114	0.000629	0.000244	0.000135
	UPCC02	Fillets without Skin	0.00142	0.000642	0.000299	0.000135
	UPCC101	Fillets without Skin	< 0.000617	0.000617	< 0.000135	0.000135
	UPCC102	Fillets without Skin	0.00105	0.000635	0.000224	0.000136
	UPCC103	Fillets without Skin	0.00185	0.000566	0.000446	0.000137
PCB# 46						
	LACA01	Fillets with Skin	0.00134	0.000484	0.000372	0.000135
	LALB01	Fillets with Skin	0.00103	0.000660	0.000212	0.000137
	*LASF01	Fillets with Skin	< 0.000668	0.000668	< 0.000133	0.000133
	LPCA01	Fillets with Skin	0.000788	0.000555	0.000186	0.000131
	LPLB01	Fillets with Skin	< 0.000593	0.000593	< 0.000136	0.000136
	LPSB01	Fillets with Skin	< 0.000620	0.000620	< 0.000122	0.000122
	*LPSF01	Fillets with Skin	< 0.000733	0.000733	< 0.000125	0.000125
	UACA01	Fillets with Skin	0.00127	0.000467	0.000355	0.000130

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.00106	0.000597	0.000237	0.000133
	UASF01	Fillets with Skin	< 0.000644	0.000644	< 0.000133	0.000133
	UPCA01	Fillets with Skin	0.00114	0.000435	0.000331	0.000127
	UPLB01	Fillets with Skin	< 0.000654	0.000654	< 0.000134	0.000134
	UPSF01	Fillets with Skin	< 0.000669	0.000669	< 0.000131	0.000131
	LAAE01	Fillets without Skin	< 0.000350	0.000350	< 0.000129	0.000129
	LABC01	Fillets without Skin	< 0.000614	0.000614	< 0.000135	0.000135
	LACC01	Fillets without Skin	0.00193	0.000589	0.000418	0.000128
	LPAE01	Fillets without Skin	< 0.000406	0.000406	< 0.000137	0.000137
	LPAE02	Fillets without Skin	< 0.000485	0.000485	< 0.000135	0.000135
	LPBC01	Fillets without Skin	0.000663	0.000608	0.000140	0.000129
	LPBC02	Fillets without Skin	< 0.000711	0.000711	< 0.000121	0.000121
	LPBC03	Fillets without Skin	< 0.000564	0.000564	< 0.000120	0.000120
	LPBC04	Fillets without Skin	< 0.000590	0.000590	< 0.000138	0.000138
	LPCC01	Fillets without Skin	0.000893	0.000724	0.000170	0.000138
	UAAE01	Fillets without Skin	< 0.000344	0.000344	< 0.000129	0.000129
	UABC01	Fillets without Skin	< 0.000630	0.000630	< 0.000132	0.000132
	UACC01	Fillets without Skin	0.00265	0.000551	0.000606	0.000126
	UPAE01	Fillets without Skin	< 0.000363	0.000363	< 0.000122	0.000122

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.000896	0.000629	0.000193	0.000135
	UPCC02	Fillets without Skin	< 0.000642	0.000642	< 0.000135	0.000135
	UPCC101	Fillets without Skin	< 0.000617	0.000617	< 0.000135	0.000135
	UPCC102	Fillets without Skin	< 0.000635	0.000635	< 0.000136	0.000136
	UPCC103	Fillets without Skin	0.00133	0.000566	0.000320	0.000137
PCB# 47/48/75						
	LACA01	Fillets with Skin	0.0995	0.000484	0.0277	0.000135
	LALB01	Fillets with Skin	0.0495	0.000660	0.0102	0.000137
	*LASF01	Fillets with Skin	0.00623	0.000668	0.00124	0.000133
	LPCA01	Fillets with Skin	0.0240	0.000555	0.00565	0.000131
	LPLB01	Fillets with Skin	0.0196	0.000593	0.00447	0.000136
	LPSB01	Fillets with Skin	0.0180	0.000620	0.00354	0.000122
	*LPSF01	Fillets with Skin	0.00629	0.000733	0.00107	0.000125
	UACA01	Fillets with Skin	0.0956	0.000467	0.0267	0.000130
	UALB01	Fillets with Skin	0.0221	0.000597	0.00493	0.000133
	UASF01	Fillets with Skin	0.0183	0.000644	0.00377	0.000133
	UPCA01	Fillets with Skin	0.106	0.000435	0.0309	0.000127
	UPLB01	Fillets with Skin	0.0209	0.000654	0.00428	0.000134
	UPSF01	Fillets with Skin	0.00895	0.000669	0.00175	0.000131
	*LAAE01	Fillets without Skin	0.0627	0.000350	0.0231	0.000129
	LABC01	Fillets without Skin	0.0502	0.000614	0.0110	0.000135
	LACC01	Fillets without Skin	0.0935	0.000589	0.0203	0.000128
	*LPAE01	Fillets without Skin	0.129	0.000406	0.0434	0.000137

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LPAE02	Fillets without Skin	0.603	0.000485	0.168	0.000135
	LPBC01	Fillets without Skin	0.0745	0.000608	0.0158	0.000129
	LPBC02	Fillets without Skin	0.0783	0.000711	0.0133	0.000121
	LPBC03	Fillets without Skin	0.0387	0.000564	0.00821	0.000120
	LPBC04	Fillets without Skin	0.113	0.000590	0.0265	0.000138
	*LPCC01	Fillets without Skin	0.259	0.000724	0.0495	0.000138
	UAAE01	Fillets without Skin	< 0.000344	0.000344	< 0.000129	0.000129
	UABC01	Fillets without Skin	0.0731	0.000630	0.0153	0.000132
	UACC01	Fillets without Skin	0.0775	0.000551	0.0178	0.000126
	*UPAE01	Fillets without Skin	0.255	0.000363	0.0856	0.000122
	UPCC01	Fillets without Skin	0.0772	0.000629	0.0166	0.000135
	UPCC02	Fillets without Skin	0.0344	0.000642	0.00726	0.000135
	UPCC101	Fillets without Skin	0.0232	0.000617	0.00507	0.000135
	UPCC102	Fillets without Skin	0.0234	0.000635	0.00499	0.000136
	*UPCC103	Fillets without Skin	0.134	0.000566	0.0323	0.000137
PCB# 49						
	LACA01	Fillets with Skin	0.115	0.000484	0.0320	0.000135
	LALB01	Fillets with Skin	0.0348	0.000660	0.00720	0.000137

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	0.00633	0.000668	0.00126	0.000133
	LPCA01	Fillets with Skin	0.0257	0.000555	0.00607	0.000131
	LPLB01	Fillets with Skin	0.0139	0.000593	0.00318	0.000136
	LPSB01	Fillets with Skin	0.0150	0.000620	0.00294	0.000122
	*LPSF01	Fillets with Skin	0.00546	0.000733	0.000931	0.000125
	*UACA01	Fillets with Skin	0.106	0.000467	0.0296	0.000130
	UALB01	Fillets with Skin	0.0227	0.000597	0.00506	0.000133
	UASF01	Fillets with Skin	0.0184	0.000644	0.00378	0.000133
	UPCA01	Fillets with Skin	0.0612	0.000435	0.0178	0.000127
	UPLB01	Fillets with Skin	0.0102	0.000654	0.00210	0.000134
	UPSF01	Fillets with Skin	0.00346	0.000669	0.000677	0.000131
	LAAE01	Fillets without Skin	0.0421	0.000350	0.0155	0.000129
	LABC01	Fillets without Skin	0.0463	0.000614	0.0102	0.000135
	LACC01	Fillets without Skin	0.0722	0.000589	0.0156	0.000128
	LPAE01	Fillets without Skin	0.0270	0.000406	0.00910	0.000137
	LPAE02	Fillets without Skin	0.0701	0.000485	0.0195	0.000135
	LPBC01	Fillets without Skin	0.0639	0.000608	0.0135	0.000129
	LPBC02	Fillets without Skin	0.0270	0.000711	0.00457	0.000121
	LPBC03	Fillets without Skin	0.0339	0.000564	0.00719	0.000120
	LPBC04	Fillets without Skin	0.0814	0.000590	0.0190	0.000138
	LPCC01	Fillets without Skin	0.0962	0.000724	0.0184	0.000138
	UAAE01	Fillets without	0.0108	0.000344	0.00406	0.000129

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.0509	0.000630	0.0107	0.000132
	UACC01	Fillets without Skin	0.0630	0.000551	0.0144	0.000126
	UPAE01	Fillets without Skin	0.0272	0.000363	0.00915	0.000122
	UPCC01	Fillets without Skin	0.0411	0.000629	0.00885	0.000135
	UPCC02	Fillets without Skin	0.0333	0.000642	0.00704	0.000135
	UPCC101	Fillets without Skin	0.0139	0.000617	0.00304	0.000135
	UPCC102	Fillets without Skin	0.0178	0.000635	0.00379	0.000136
	UPCC103	Fillets without Skin	0.0752	0.000566	0.0181	0.000137
PCB# 52						
	*LACA01	Fillets with Skin	0.118	0.000484	0.0329	0.000135
	LALB01	Fillets with Skin	0.0395	0.000660	0.00816	0.000137
	*LASF01	Fillets with Skin	0.00897	0.000668	0.00178	0.000133
	LPCA01	Fillets with Skin	0.0335	0.000555	0.00789	0.000131
	LPLB01	Fillets with Skin	0.0174	0.000593	0.00398	0.000136
	LPSB01	Fillets with Skin	0.0170	0.000620	0.00333	0.000122
	*LPSF01	Fillets with Skin	0.00732	0.000733	0.00125	0.000125
	*UACA01	Fillets with Skin	0.146	0.000467	0.0407	0.000130
	UALB01	Fillets with Skin	0.0309	0.000597	0.00689	0.000133
	UASF01	Fillets with Skin	0.0239	0.000644	0.00492	0.000133
	UPCA01	Fillets with Skin	0.0518	0.000435	0.0151	0.000127
	UPLB01	Fillets with Skin	0.0108	0.000654	0.00222	0.000134
	UPSF01	Fillets with Skin	0.00319	0.000669	0.000624	0.000131

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LAAE01	Fillets without Skin	0.110	0.000350	0.0404	0.000129
	LABC01	Fillets without Skin	0.0484	0.000614	0.0106	0.000135
	LACC01	Fillets without Skin	0.0510	0.000589	0.0110	0.000128
	LPAE01	Fillets without Skin	0.107	0.000406	0.0360	0.000137
	LPAE02	Fillets without Skin	0.0794	0.000485	0.0221	0.000135
	LPBC01	Fillets without Skin	0.0701	0.000608	0.0149	0.000129
	LPBC02	Fillets without Skin	0.0160	0.000711	0.00271	0.000121
	LPBC03	Fillets without Skin	0.0294	0.000564	0.00623	0.000120
	LPBC04	Fillets without Skin	0.0727	0.000590	0.0170	0.000138
	LPCC01	Fillets without Skin	0.0343	0.000724	0.00655	0.000138
	*UAAE01	Fillets without Skin	0.159	0.000344	0.0596	0.000129
	UABC01	Fillets without Skin	0.0584	0.000630	0.0122	0.000132
	UACC01	Fillets without Skin	0.0560	0.000551	0.0128	0.000126
	UPAE01	Fillets without Skin	0.0482	0.000363	0.0162	0.000122
	UPCC01	Fillets without Skin	0.0226	0.000629	0.00486	0.000135
	UPCC02	Fillets without Skin	0.0411	0.000642	0.00867	0.000135
	UPCC101	Fillets without Skin	0.0105	0.000617	0.00230	0.000135

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	0.0161	0.000635	0.00344	0.000136
	UPCC103	Fillets without Skin	0.0358	0.000566	0.00863	0.000137
PCB# 56/60						
	LACA01	Fillets with Skin	0.0519	0.000484	0.0145	0.000135
	LALB01	Fillets with Skin	0.00870	0.000660	0.00180	0.000137
	*LASF01	Fillets with Skin	0.00255	0.000668	0.000507	0.000133
	LPCA01	Fillets with Skin	0.00993	0.000555	0.00234	0.000131
	LPLB01	Fillets with Skin	0.00423	0.000593	0.000967	0.000136
	LPSB01	Fillets with Skin	0.00662	0.000620	0.00130	0.000122
	*LPSF01	Fillets with Skin	0.00159	0.000733	0.000271	0.000125
	UACA01	Fillets with Skin	0.0676	0.000467	0.0188	0.000130
	UALB01	Fillets with Skin	0.0100	0.000597	0.00223	0.000133
	UASF01	Fillets with Skin	0.00813	0.000644	0.00167	0.000133
	UPCA01	Fillets with Skin	0.0142	0.000435	0.00413	0.000127
	UPLB01	Fillets with Skin	0.00254	0.000654	0.000520	0.000134
	UPSF01	Fillets with Skin	0.000949	0.000669	0.000186	0.000131
	LAAE01	Fillets without Skin	0.0197	0.000350	0.00728	0.000129
	LABC01	Fillets without Skin	0.0121	0.000614	0.00266	0.000135
	LACC01	Fillets without Skin	0.0170	0.000589	0.00368	0.000128
	LPAE01	Fillets without Skin	0.0167	0.000406	0.00562	0.000137
	LPAE02	Fillets without Skin	0.00542	0.000485	0.00150	0.000135
	LPBC01	Fillets without Skin	0.0177	0.000608	0.00374	0.000129
	LPBC02	Fillets without Skin	0.00899	0.000711	0.00152	0.000121

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	0.0103	0.000564	0.00217	0.000120
	LPBC04	Fillets without Skin	0.0209	0.000590	0.00487	0.000138
	LPCC01	Fillets without Skin	0.00663	0.000724	0.00127	0.000138
	UAAE01	Fillets without Skin	0.0377	0.000344	0.0142	0.000129
	UABC01	Fillets without Skin	0.0172	0.000630	0.00361	0.000132
	UACC01	Fillets without Skin	0.0180	0.000551	0.00412	0.000126
	UPAE01	Fillets without Skin	0.00620	0.000363	0.00208	0.000122
	UPCC01	Fillets without Skin	0.00627	0.000629	0.00135	0.000135
	UPCC02	Fillets without Skin	0.0104	0.000642	0.00219	0.000135
	UPCC101	Fillets without Skin	0.00368	0.000617	0.000806	0.000135
	UPCC102	Fillets without Skin	0.00583	0.000635	0.00124	0.000136
	UPCC103	Fillets without Skin	0.00676	0.000566	0.00163	0.000137
PCB# 66						
	LACA01	Fillets with Skin	0.0507	0.000394	0.0141	0.000110
	LALB01	Fillets with Skin	0.0118	0.000538	0.00244	0.000111
	*LASF01	Fillets with Skin	0.00264	0.000544	0.000526	0.000108
	LPCA01	Fillets with Skin	0.0127	0.000452	0.00300	0.000107
	LPLB01	Fillets with Skin	0.00608	0.000483	0.00139	0.000111
	LPSB01	Fillets with Skin	0.00804	0.000505	0.00158	0.0000990
	*LPSF01	Fillets with Skin	0.00200	0.000597	0.000342	0.000102
	UACA01	Fillets with Skin	0.0733	0.000380	0.0204	0.000106

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.0121	0.000486	0.00270	0.000108
	UASF01	Fillets with Skin	0.0133	0.000525	0.00274	0.000108
	UPCA01	Fillets with Skin	0.0152	0.000354	0.00444	0.000103
	UPLB01	Fillets with Skin	0.00322	0.000533	0.000657	0.000109
	UPSF01	Fillets with Skin	0.00102	0.000545	0.000199	0.000107
	LAAE01	Fillets without Skin	0.0320	0.000285	0.0118	0.000105
	LABC01	Fillets without Skin	0.0251	0.000501	0.00552	0.000110
	LACC01	Fillets without Skin	0.0544	0.000480	0.0118	0.000104
	LPAE01	Fillets without Skin	0.0524	0.000331	0.0177	0.000112
	LPAE02	Fillets without Skin	0.0190	0.000395	0.00528	0.000110
	LPBC01	Fillets without Skin	0.0313	0.000496	0.00664	0.000105
	LPBC02	Fillets without Skin	0.0402	0.000579	0.00682	0.0000980
	LPBC03	Fillets without Skin	0.0233	0.000460	0.00494	0.0000970
	LPBC04	Fillets without Skin	0.0424	0.000481	0.00990	0.000112
	LPCC01	Fillets without Skin	0.0191	0.000590	0.00365	0.000113
	UAAE01	Fillets without Skin	0.0136	0.000281	0.00511	0.000105
	UABC01	Fillets without Skin	0.0482	0.000513	0.0101	0.000108
	UACC01	Fillets without Skin	0.0527	0.000449	0.0121	0.000103
	UPAE01	Fillets without Skin	0.0142	0.000296	0.00477	0.0000990

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.0131	0.000512	0.00282	0.000110
	UPCC02	Fillets without Skin	0.0172	0.000523	0.00362	0.000110
	UPCC101	Fillets without Skin	0.00557	0.000503	0.00122	0.000110
	UPCC102	Fillets without Skin	0.0109	0.000518	0.00233	0.000111
	UPCC103	Fillets without Skin	0.0185	0.000461	0.00446	0.000111
PCB# 7/9						
	LACA01	Fillets with Skin	0.000840	0.000735	0.000234	0.000205
	LALB01	Fillets with Skin	< 0.00100	0.00100	< 0.000207	0.000207
	*LASF01	Fillets with Skin	< 0.00101	0.00101	< 0.000202	0.000202
	LPCA01	Fillets with Skin	< 0.000842	0.000842	< 0.000199	0.000199
	LPLB01	Fillets with Skin	< 0.000900	0.000900	< 0.000206	0.000206
	LPSB01	Fillets with Skin	< 0.000942	0.000942	< 0.000185	0.000185
	*LPSF01	Fillets with Skin	< 0.00111	0.00111	< 0.000190	0.000190
	UACA01	Fillets with Skin	0.00179	0.000708	0.000499	0.000197
	UALB01	Fillets with Skin	< 0.000906	0.000906	< 0.000202	0.000202
	UASF01	Fillets with Skin	< 0.000978	0.000978	< 0.000201	0.000201
	UPCA01	Fillets with Skin	< 0.000660	0.000660	< 0.000192	0.000192
	UPLB01	Fillets with Skin	< 0.000992	0.000992	< 0.000203	0.000203
	UPSF01	Fillets with Skin	< 0.00102	0.00102	< 0.000199	0.000199
	LAAE01	Fillets without Skin	< 0.000531	0.000531	< 0.000196	0.000196
	LABC01	Fillets without Skin	< 0.000933	0.000933	< 0.000205	0.000205
	LACC01	Fillets without Skin	< 0.000895	0.000895	< 0.000194	0.000194
	LPAE01	Fillets without Skin	< 0.000617	0.000617	< 0.000208	0.000208

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 0.000736	0.000736	< 0.000204	0.000204
	LPBC01	Fillets without Skin	< 0.000923	0.000923	< 0.000196	0.000196
	LPBC02	Fillets without Skin	< 0.00108	0.00108	< 0.000183	0.000183
	LPBC03	Fillets without Skin	< 0.000856	0.000856	< 0.000181	0.000181
	LPBC04	Fillets without Skin	< 0.000896	0.000896	< 0.000209	0.000209
	LPCC01	Fillets without Skin	< 0.00110	0.00110	< 0.000210	0.000210
	UAAE01	Fillets without Skin	< 0.000523	0.000523	< 0.000196	0.000196
	UABC01	Fillets without Skin	< 0.000956	0.000956	< 0.000201	0.000201
	UACC01	Fillets without Skin	0.000911	0.000836	0.000209	0.000192
	UPAE01	Fillets without Skin	< 0.000551	0.000551	< 0.000185	0.000185
	UPCC01	Fillets without Skin	< 0.000955	0.000955	< 0.000206	0.000206
	UPCC02	Fillets without Skin	< 0.000974	0.000974	< 0.000206	0.000206
	UPCC101	Fillets without Skin	< 0.000937	0.000937	< 0.000205	0.000205
	UPCC102	Fillets without Skin	< 0.000965	0.000965	< 0.000206	0.000206
	UPCC103	Fillets without Skin	< 0.000860	0.000860	< 0.000207	0.000207
PCB# 70						
	LACA01	Fillets with Skin	0.0881	0.000484	0.0246	0.000135
	LALB01	Fillets with Skin	0.0159	0.000660	0.00329	0.000137

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	0.00482	0.000668	0.000958	0.000133
	LPCA01	Fillets with Skin	0.0178	0.000555	0.00419	0.000131
	LPLB01	Fillets with Skin	0.00756	0.000593	0.00173	0.000136
	LPSB01	Fillets with Skin	0.00863	0.000620	0.00169	0.000122
	*LPSF01	Fillets with Skin	0.00311	0.000733	0.000530	0.000125
	UACA01	Fillets with Skin	0.114	0.000467	0.0317	0.000130
	UALB01	Fillets with Skin	0.0132	0.000597	0.00294	0.000133
	UASF01	Fillets with Skin	0.0151	0.000644	0.00310	0.000133
	UPCA01	Fillets with Skin	0.0305	0.000435	0.00890	0.000127
	UPLB01	Fillets with Skin	0.00524	0.000654	0.00107	0.000134
	UPSF01	Fillets with Skin	0.00129	0.000669	0.000252	0.000131
	LAAE01	Fillets without Skin	0.00648	0.000350	0.00239	0.000129
	LABC01	Fillets without Skin	0.0202	0.000614	0.00444	0.000135
	LACC01	Fillets without Skin	0.00532	0.000589	0.00115	0.000128
	LPAE01	Fillets without Skin	0.00234	0.000406	0.000791	0.000137
	LPAE02	Fillets without Skin	0.00382	0.000485	0.00106	0.000135
	LPBC01	Fillets without Skin	0.0140	0.000608	0.00298	0.000129
	LPBC02	Fillets without Skin	0.00384	0.000711	0.000651	0.000121
	LPBC03	Fillets without Skin	0.00948	0.000564	0.00201	0.000120
	LPBC04	Fillets without Skin	0.0317	0.000590	0.00741	0.000138
	LPCC01	Fillets without Skin	0.00223	0.000724	0.000426	0.000138
	UAAE01	Fillets without	< 0.000344	0.000344	< 0.000129	0.000129

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.0126	0.000630	0.00264	0.000132
	UACC01	Fillets without Skin	0.00429	0.000551	0.000984	0.000126
	UPAE01	Fillets without Skin	0.00356	0.000363	0.00120	0.000122
	UPCC01	Fillets without Skin	0.00364	0.000629	0.000785	0.000135
	UPCC02	Fillets without Skin	0.00802	0.000642	0.00169	0.000135
	UPCC101	Fillets without Skin	< 0.000617	0.000617	< 0.000135	0.000135
	UPCC102	Fillets without Skin	0.00320	0.000635	0.000684	0.000136
	UPCC103	Fillets without Skin	0.00584	0.000566	0.00141	0.000137
PCB# 74/61						
	LACA01	Fillets with Skin	0.0765	0.000484	0.0213	0.000135
	LALB01	Fillets with Skin	0.0122	0.000660	0.00252	0.000137
	*LASF01	Fillets with Skin	0.00246	0.000668	0.000489	0.000133
	LPCA01	Fillets with Skin	0.0172	0.000555	0.00405	0.000131
	LPLB01	Fillets with Skin	0.00502	0.000593	0.00115	0.000136
	LPSB01	Fillets with Skin	0.00816	0.000620	0.00160	0.000122
	*LPSF01	Fillets with Skin	0.00194	0.000733	0.000330	0.000125
	UACA01	Fillets with Skin	0.101	0.000467	0.0281	0.000130
	UALB01	Fillets with Skin	0.0140	0.000597	0.00312	0.000133
	UASF01	Fillets with Skin	0.0103	0.000644	0.00212	0.000133
	UPCA01	Fillets with Skin	0.0182	0.000435	0.00531	0.000127
	UPLB01	Fillets with Skin	0.00396	0.000654	0.000810	0.000134
	UPSF01	Fillets with Skin	0.00102	0.000669	0.000199	0.000131

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	0.0461	0.000350	0.0170	0.000129
	LABC01	Fillets without Skin	0.0243	0.000614	0.00535	0.000135
	LACC01	Fillets without Skin	0.0468	0.000589	0.0101	0.000128
	LPAE01	Fillets without Skin	0.0519	0.000406	0.0175	0.000137
	LPAE02	Fillets without Skin	0.0172	0.000485	0.00478	0.000135
	LPBC01	Fillets without Skin	0.0324	0.000608	0.00687	0.000129
	LPBC02	Fillets without Skin	0.0304	0.000711	0.00515	0.000121
	LPBC03	Fillets without Skin	0.0201	0.000564	0.00425	0.000120
	LPBC04	Fillets without Skin	0.0446	0.000590	0.0104	0.000138
	LPCC01	Fillets without Skin	0.0122	0.000724	0.00234	0.000138
	UAAE01	Fillets without Skin	< 0.000344	0.000344	< 0.000129	0.000129
	UABC01	Fillets without Skin	0.0424	0.000630	0.00890	0.000132
	UACC01	Fillets without Skin	0.0442	0.000551	0.0101	0.000126
	UPAE01	Fillets without Skin	0.0157	0.000363	0.00527	0.000122
	UPCC01	Fillets without Skin	0.0122	0.000629	0.00262	0.000135
	UPCC02	Fillets without Skin	0.0204	0.000642	0.00431	0.000135
	UPCC101	Fillets without Skin	0.00591	0.000617	0.00129	0.000135

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	0.0102	0.000635	0.00219	0.000136
	UPCC103	Fillets without Skin	0.0168	0.000566	0.00406	0.000137
PCB# 77						
	LACA01	Fillets with Skin	0.00484	0.000484	0.00135	0.000135
	LALB01	Fillets with Skin	< 0.000660	0.000660	< 0.000137	0.000137
	*LASF01	Fillets with Skin	< 0.000668	0.000668	< 0.000133	0.000133
	LPCA01	Fillets with Skin	< 0.000555	0.000555	< 0.000131	0.000131
	LPLB01	Fillets with Skin	< 0.000593	0.000593	< 0.000136	0.000136
	LPSB01	Fillets with Skin	< 0.000620	0.000620	< 0.000122	0.000122
	*LPSF01	Fillets with Skin	< 0.000733	0.000733	< 0.000125	0.000125
	UACA01	Fillets with Skin	0.00345	0.000467	0.000962	0.000130
	UALB01	Fillets with Skin	< 0.000597	0.000597	< 0.000133	0.000133
	UASF01	Fillets with Skin	< 0.000644	0.000644	< 0.000133	0.000133
	UPCA01	Fillets with Skin	0.00226	0.000435	0.000657	0.000127
	UPLB01	Fillets with Skin	< 0.000654	0.000654	< 0.000134	0.000134
	UPSF01	Fillets with Skin	< 0.000669	0.000669	< 0.000131	0.000131
	LAAE01	Fillets without Skin	0.000588	0.000350	0.000217	0.000129
	LABC01	Fillets without Skin	< 0.000614	0.000614	< 0.000135	0.000135
	LACC01	Fillets without Skin	0.00192	0.000589	0.000415	0.000128
	LPAE01	Fillets without Skin	< 0.000406	0.000406	< 0.000137	0.000137
	LPAE02	Fillets without Skin	0.000536	0.000485	0.000149	0.000135
	LPBC01	Fillets without Skin	< 0.000608	0.000608	< 0.000129	0.000129
	LPBC02	Fillets without Skin	< 0.000711	0.000711	< 0.000121	0.000121

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	0.00120	0.000564	0.000255	0.000120
	LPBC04	Fillets without Skin	0.00182	0.000590	0.000425	0.000138
	LPCC01	Fillets without Skin	0.000733	0.000724	0.000140	0.000138
	UAAE01	Fillets without Skin	< 0.000344	0.000344	< 0.000129	0.000129
	UABC01	Fillets without Skin	< 0.000630	0.000630	< 0.000132	0.000132
	UACC01	Fillets without Skin	< 0.000551	0.000551	< 0.000126	0.000126
	UPAE01	Fillets without Skin	< 0.000363	0.000363	< 0.000122	0.000122
	UPCC01	Fillets without Skin	< 0.000629	0.000629	< 0.000135	0.000135
	UPCC02	Fillets without Skin	< 0.000642	0.000642	< 0.000135	0.000135
	UPCC101	Fillets without Skin	< 0.000617	0.000617	< 0.000135	0.000135
	UPCC102	Fillets without Skin	< 0.000635	0.000635	< 0.000136	0.000136
	UPCC103	Fillets without Skin	0.00125	0.000566	0.000302	0.000137
PCB# 8/5						
	LACA01	Fillets with Skin	0.00786	0.000735	0.00219	0.000205
	LALB01	Fillets with Skin	0.00127	0.00100	0.000263	0.000207
	*LASF01	Fillets with Skin	0.00118	0.00101	0.000235	0.000202
	LPCA01	Fillets with Skin	< 0.000842	0.000842	< 0.000199	0.000199
	LPLB01	Fillets with Skin	< 0.000900	0.000900	< 0.000206	0.000206
	LPSB01	Fillets with Skin	< 0.000942	0.000942	< 0.000185	0.000185
	*LPSF01	Fillets with Skin	< 0.00111	0.00111	< 0.000190	0.000190
	UACA01	Fillets with Skin	0.0141	0.000708	0.00393	0.000197

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.00266	0.000906	0.000593	0.000202
	UASF01	Fillets with Skin	0.00233	0.000978	0.000480	0.000201
	UPCA01	Fillets with Skin	0.00374	0.000660	0.00109	0.000192
	UPLB01	Fillets with Skin	< 0.000992	0.000992	< 0.000203	0.000203
	UPSF01	Fillets with Skin	0.00244	0.00102	0.000478	0.000199
	LAAE01	Fillets without Skin	< 0.000531	0.000531	< 0.000196	0.000196
	LABC01	Fillets without Skin	0.00458	0.000933	0.00101	0.000205
	LACC01	Fillets without Skin	0.00240	0.000895	0.000520	0.000194
	LPAE01	Fillets without Skin	< 0.000617	0.000617	< 0.000208	0.000208
	LPAE02	Fillets without Skin	< 0.000736	0.000736	< 0.000204	0.000204
	LPBC01	Fillets without Skin	0.00404	0.000923	0.000856	0.000196
	LPBC02	Fillets without Skin	< 0.00108	0.00108	< 0.000183	0.000183
	LPBC03	Fillets without Skin	< 0.000856	0.000856	< 0.000181	0.000181
	LPBC04	Fillets without Skin	0.00293	0.000896	0.000683	0.000209
	LPCC01	Fillets without Skin	0.00440	0.00110	0.000840	0.000210
	UAAE01	Fillets without Skin	0.000608	0.000523	0.000228	0.000196
	UABC01	Fillets without Skin	0.00361	0.000956	0.000757	0.000201
	UACC01	Fillets without Skin	0.00516	0.000836	0.00118	0.000192
	UPAE01	Fillets without Skin	< 0.000551	0.000551	< 0.000185	0.000185

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.00585	0.000955	0.00126	0.000206
	UPCC02	Fillets without Skin	0.00269	0.000974	0.000568	0.000206
	UPCC101	Fillets without Skin	0.00136	0.000937	0.000297	0.000205
	UPCC102	Fillets without Skin	0.00499	0.000965	0.00107	0.000206
	UPCC103	Fillets without Skin	0.00632	0.000860	0.00152	0.000207
PCB# 81						
	LACA01	Fillets with Skin	< 0.000484	0.000484	< 0.000135	0.000135
	LALB01	Fillets with Skin	< 0.000660	0.000660	< 0.000137	0.000137
	*LASF01	Fillets with Skin	< 0.000668	0.000668	< 0.000133	0.000133
	LPCA01	Fillets with Skin	< 0.000555	0.000555	< 0.000131	0.000131
	LPLB01	Fillets with Skin	< 0.000593	0.000593	< 0.000136	0.000136
	LPSB01	Fillets with Skin	< 0.000620	0.000620	< 0.000122	0.000122
	*LPSF01	Fillets with Skin	< 0.000733	0.000733	< 0.000125	0.000125
	UACA01	Fillets with Skin	< 0.000467	0.000467	< 0.000130	0.000130
	UALB01	Fillets with Skin	< 0.000597	0.000597	< 0.000133	0.000133
	UASF01	Fillets with Skin	< 0.000644	0.000644	< 0.000133	0.000133
	UPCA01	Fillets with Skin	< 0.000435	0.000435	< 0.000127	0.000127
	UPLB01	Fillets with Skin	< 0.000654	0.000654	< 0.000134	0.000134
	UPSF01	Fillets with Skin	< 0.000669	0.000669	< 0.000131	0.000131
	LAAE01	Fillets without Skin	< 0.000350	0.000350	< 0.000129	0.000129
	LABC01	Fillets without Skin	< 0.000614	0.000614	< 0.000135	0.000135
	LACC01	Fillets without Skin	< 0.000589	0.000589	< 0.000128	0.000128
	LPAE01	Fillets without Skin	< 0.000406	0.000406	< 0.000137	0.000137

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 0.000485	0.000485	< 0.000135	0.000135
	LPBC01	Fillets without Skin	< 0.000608	0.000608	< 0.000129	0.000129
	LPBC02	Fillets without Skin	< 0.000711	0.000711	< 0.000121	0.000121
	LPBC03	Fillets without Skin	< 0.000564	0.000564	< 0.000120	0.000120
	LPBC04	Fillets without Skin	< 0.000590	0.000590	< 0.000138	0.000138
	LPCC01	Fillets without Skin	0.0112	0.000724	0.00213	0.000138
	UAAE01	Fillets without Skin	< 0.000344	0.000344	< 0.000129	0.000129
	UABC01	Fillets without Skin	< 0.000630	0.000630	< 0.000132	0.000132
	UACC01	Fillets without Skin	< 0.000551	0.000551	< 0.000126	0.000126
	UPAE01	Fillets without Skin	< 0.000363	0.000363	< 0.000122	0.000122
	UPCC01	Fillets without Skin	< 0.000629	0.000629	< 0.000135	0.000135
	UPCC02	Fillets without Skin	< 0.000642	0.000642	< 0.000135	0.000135
	UPCC101	Fillets without Skin	< 0.000617	0.000617	< 0.000135	0.000135
	UPCC102	Fillets without Skin	< 0.000635	0.000635	< 0.000136	0.000136
	UPCC103	Fillets without Skin	< 0.000566	0.000566	< 0.000137	0.000137
PCB# 82						
	LACA01	Fillets with Skin	0.0161	0.000379	0.00449	0.000106
	LALB01	Fillets with Skin	0.00371	0.000518	0.000768	0.000107

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	0.000850	0.000523	0.000169	0.000104
	LPCA01	Fillets with Skin	0.00441	0.000435	0.00104	0.000103
	LPLB01	Fillets with Skin	0.00174	0.000465	0.000399	0.000106
	LPSB01	Fillets with Skin	0.00219	0.000486	0.000429	0.0000950
	*LPSF01	Fillets with Skin	< 0.000574	0.000574	< 0.0000980	0.0000980
	UACA01	Fillets with Skin	0.0210	0.000366	0.00586	0.000102
	UALB01	Fillets with Skin	0.00346	0.000468	0.000771	0.000104
	UASF01	Fillets with Skin	0.00217	0.000505	0.000446	0.000104
	UPCA01	Fillets with Skin	0.00917	0.000341	0.00267	0.0000990
	UPLB01	Fillets with Skin	0.00187	0.000512	0.000382	0.000105
	UPSF01	Fillets with Skin	< 0.000524	0.000524	< 0.000103	0.000103
	LAAE01	Fillets without Skin	0.00648	0.000274	0.00239	0.000101
	LABC01	Fillets without Skin	0.00213	0.000482	0.000468	0.000106
	LACC01	Fillets without Skin	0.00828	0.000462	0.00179	0.000100
	LPAE01	Fillets without Skin	0.00530	0.000318	0.00179	0.000107
	LPAE02	Fillets without Skin	0.00334	0.000380	0.000929	0.000106
	LPBC01	Fillets without Skin	0.00211	0.000477	0.000447	0.000101
	LPBC02	Fillets without Skin	0.00166	0.000557	0.000281	0.0000940
	LPBC03	Fillets without Skin	0.00467	0.000442	0.000990	0.0000940
	LPBC04	Fillets without Skin	0.00502	0.000463	0.00117	0.000108
	LPCC01	Fillets without Skin	0.00383	0.000567	0.000730	0.000108
	UAAE01	Fillets without	0.00560	0.000270	0.00210	0.000101

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.00239	0.000493	0.000501	0.000104
	UACC01	Fillets without Skin	0.00638	0.000432	0.00146	0.0000990
	UPAE01	Fillets without Skin	0.00436	0.000284	0.00146	0.0000950
	UPCC01	Fillets without Skin	0.00245	0.000493	0.000528	0.000106
	UPCC02	Fillets without Skin	0.00191	0.000503	0.000403	0.000106
	UPCC101	Fillets without Skin	0.00165	0.000484	0.000361	0.000106
	UPCC102	Fillets without Skin	0.00210	0.000498	0.000449	0.000106
	UPCC103	Fillets without Skin	0.00306	0.000444	0.000738	0.000107
PCB# 83						
	LACA01	Fillets with Skin	0.00828	0.000379	0.00231	0.000106
	LALB01	Fillets with Skin	0.00264	0.000518	0.000545	0.000107
	*LASF01	Fillets with Skin	< 0.000523	0.000523	< 0.000104	0.000104
	LPCA01	Fillets with Skin	0.00289	0.000435	0.000681	0.000103
	LPLB01	Fillets with Skin	0.00232	0.000465	0.000532	0.000106
	LPSB01	Fillets with Skin	0.00171	0.000486	0.000336	0.0000950
	*LPSF01	Fillets with Skin	< 0.000574	0.000574	< 0.0000980	0.0000980
	UACA01	Fillets with Skin	0.0154	0.000366	0.00429	0.000102
	UALB01	Fillets with Skin	0.00235	0.000468	0.000524	0.000104
	UASF01	Fillets with Skin	0.000976	0.000505	0.000201	0.000104
	UPCA01	Fillets with Skin	0.00627	0.000341	0.00183	0.0000990
	UPLB01	Fillets with Skin	0.00165	0.000512	0.000336	0.000105
	UPSF01	Fillets with Skin	< 0.000524	0.000524	< 0.000103	0.000103

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	< 0.000274	0.000274	< 0.000101	0.000101
	LABC01	Fillets without Skin	0.00388	0.000482	0.000854	0.000106
	LACC01	Fillets without Skin	0.00602	0.000462	0.00130	0.000100
	LPAE01	Fillets without Skin	0.00938	0.000318	0.00316	0.000107
	LPAE02	Fillets without Skin	0.00626	0.000380	0.00174	0.000106
	LPBC01	Fillets without Skin	0.00639	0.000477	0.00135	0.000101
	LPBC02	Fillets without Skin	< 0.000557	0.000557	< 0.0000940	0.0000940
	LPBC03	Fillets without Skin	0.00948	0.000442	0.00201	0.0000940
	LPBC04	Fillets without Skin	0.00806	0.000463	0.00188	0.000108
	LPCC01	Fillets without Skin	0.00574	0.000567	0.00110	0.000108
	UAAE01	Fillets without Skin	0.0160	0.000270	0.00600	0.000101
	UABC01	Fillets without Skin	0.00141	0.000493	0.000297	0.000104
	UACC01	Fillets without Skin	0.00599	0.000432	0.00137	0.0000990
	UPAE01	Fillets without Skin	0.00704	0.000284	0.00236	0.0000950
	UPCC01	Fillets without Skin	0.00466	0.000493	0.00100	0.000106
	UPCC02	Fillets without Skin	0.00342	0.000503	0.000722	0.000106
	UPCC101	Fillets without Skin	0.00170	0.000484	0.000371	0.000106

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	0.00336	0.000498	0.000718	0.000106
	UPCC103	Fillets without Skin	0.00503	0.000444	0.00121	0.000107
PCB# 84						
	LACA01	Fillets with Skin	< 0.000379	0.000379	< 0.000106	0.000106
	LALB01	Fillets with Skin	< 0.000518	0.000518	< 0.000107	0.000107
	*LASF01	Fillets with Skin	< 0.000523	0.000523	< 0.000104	0.000104
	LPCA01	Fillets with Skin	< 0.000435	0.000435	< 0.000103	0.000103
	LPLB01	Fillets with Skin	< 0.000465	0.000465	< 0.000106	0.000106
	LPSB01	Fillets with Skin	< 0.000486	0.000486	< 0.0000950	0.0000950
	*LPSF01	Fillets with Skin	< 0.000574	0.000574	< 0.0000980	0.0000980
	UACA01	Fillets with Skin	< 0.000366	0.000366	< 0.000102	0.000102
	UALB01	Fillets with Skin	< 0.000468	0.000468	< 0.000104	0.000104
	UASF01	Fillets with Skin	< 0.000505	0.000505	< 0.000104	0.000104
	UPCA01	Fillets with Skin	< 0.000341	0.000341	< 0.0000990	0.0000990
	UPLB01	Fillets with Skin	< 0.000512	0.000512	< 0.000105	0.000105
	UPSF01	Fillets with Skin	< 0.000524	0.000524	< 0.000103	0.000103
	LAAE01	Fillets without Skin	< 0.000274	0.000274	< 0.000101	0.000101
	LABC01	Fillets without Skin	< 0.000482	0.000482	< 0.000106	0.000106
	LACC01	Fillets without Skin	< 0.000462	0.000462	< 0.000100	0.000100
	LPAE01	Fillets without Skin	< 0.000318	0.000318	< 0.000107	0.000107
	LPAE02	Fillets without Skin	< 0.000380	0.000380	< 0.000106	0.000106
	LPBC01	Fillets without Skin	< 0.000477	0.000477	< 0.000101	0.000101
	LPBC02	Fillets without Skin	< 0.000557	0.000557	< 0.0000940	0.0000940

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	< 0.000442	0.000442	< 0.0000940	0.0000940
	LPBC04	Fillets without Skin	< 0.000463	0.000463	< 0.000108	0.000108
	LPCC01	Fillets without Skin	< 0.000567	0.000567	< 0.000108	0.000108
	UAAE01	Fillets without Skin	< 0.000270	0.000270	< 0.000101	0.000101
	UABC01	Fillets without Skin	< 0.000493	0.000493	< 0.000104	0.000104
	UACC01	Fillets without Skin	< 0.000432	0.000432	< 0.0000990	0.0000990
	UPAE01	Fillets without Skin	< 0.000284	0.000284	< 0.0000950	0.0000950
	UPCC01	Fillets without Skin	< 0.000493	0.000493	< 0.000106	0.000106
	UPCC02	Fillets without Skin	< 0.000503	0.000503	< 0.000106	0.000106
	UPCC101	Fillets without Skin	< 0.000484	0.000484	< 0.000106	0.000106
	UPCC102	Fillets without Skin	< 0.000498	0.000498	< 0.000106	0.000106
	UPCC103	Fillets without Skin	< 0.000444	0.000444	< 0.000107	0.000107
PCB# 85						
	LACA01	Fillets with Skin	0.0160	0.000379	0.00446	0.000106
	LALB01	Fillets with Skin	0.00728	0.000518	0.00150	0.000107
	*LASF01	Fillets with Skin	0.00123	0.000523	0.000244	0.000104
	LPCA01	Fillets with Skin	0.00541	0.000435	0.00128	0.000103
	LPLB01	Fillets with Skin	0.00333	0.000465	0.000762	0.000106
	LPSB01	Fillets with Skin	0.00384	0.000486	0.000753	0.0000950
	*LPSF01	Fillets with Skin	0.00118	0.000574	0.000200	0.0000980
	UACA01	Fillets with Skin	0.0182	0.000366	0.00508	0.000102

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.00612	0.000468	0.00136	0.000104
	UASF01	Fillets with Skin	0.00428	0.000505	0.000882	0.000104
	UPCA01	Fillets with Skin	0.0132	0.000341	0.00386	0.0000990
	UPLB01	Fillets with Skin	0.00501	0.000512	0.00102	0.000105
	UPSF01	Fillets with Skin	0.000949	0.000524	0.000186	0.000103
	LAAE01	Fillets without Skin	0.0149	0.000274	0.00550	0.000101
	LABC01	Fillets without Skin	0.0135	0.000482	0.00296	0.000106
	LACC01	Fillets without Skin	0.0258	0.000462	0.00560	0.000100
	LPAE01	Fillets without Skin	0.0386	0.000318	0.0130	0.000107
	LPAE02	Fillets without Skin	0.0141	0.000380	0.00392	0.000106
	LPBC01	Fillets without Skin	0.0151	0.000477	0.00320	0.000101
	LPBC02	Fillets without Skin	0.0237	0.000557	0.00401	0.0000940
	LPBC03	Fillets without Skin	0.0216	0.000442	0.00458	0.0000940
	LPBC04	Fillets without Skin	0.0293	0.000463	0.00683	0.000108
	LPCC01	Fillets without Skin	0.0111	0.000567	0.00212	0.000108
	UAAE01	Fillets without Skin	0.0173	0.000270	0.00648	0.000101
	UABC01	Fillets without Skin	0.0169	0.000493	0.00355	0.000104
	UACC01	Fillets without Skin	0.0191	0.000432	0.00438	0.0000990
	UPAE01	Fillets without Skin	0.0153	0.000284	0.00514	0.0000950

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.00681	0.000493	0.00147	0.000106
	UPCC02	Fillets without Skin	0.00948	0.000503	0.00200	0.000106
	UPCC101	Fillets without Skin	0.00552	0.000484	0.00121	0.000106
	UPCC102	Fillets without Skin	0.00730	0.000498	0.00156	0.000106
	UPCC103	Fillets without Skin	0.0122	0.000444	0.00293	0.000107
PCB# 86						
	LACA01	Fillets with Skin	< 0.000379	0.000379	< 0.000106	0.000106
	LALB01	Fillets with Skin	< 0.000518	0.000518	< 0.000107	0.000107
	*LASF01	Fillets with Skin	< 0.000523	0.000523	< 0.000104	0.000104
	LPCA01	Fillets with Skin	< 0.000435	0.000435	< 0.000103	0.000103
	LPLB01	Fillets with Skin	< 0.000465	0.000465	< 0.000106	0.000106
	LPSB01	Fillets with Skin	< 0.000486	0.000486	< 0.0000950	0.0000950
	*LPSF01	Fillets with Skin	< 0.000574	0.000574	< 0.0000980	0.0000980
	UACA01	Fillets with Skin	< 0.000366	0.000366	< 0.000102	0.000102
	UALB01	Fillets with Skin	< 0.000468	0.000468	< 0.000104	0.000104
	UASF01	Fillets with Skin	< 0.000505	0.000505	< 0.000104	0.000104
	UPCA01	Fillets with Skin	< 0.000341	0.000341	< 0.0000990	0.0000990
	UPLB01	Fillets with Skin	< 0.000512	0.000512	< 0.000105	0.000105
	UPSF01	Fillets with Skin	< 0.000524	0.000524	< 0.000103	0.000103
	LAAE01	Fillets without Skin	< 0.000274	0.000274	< 0.000101	0.000101
	LABC01	Fillets without Skin	< 0.000482	0.000482	< 0.000106	0.000106
	LACC01	Fillets without Skin	< 0.000462	0.000462	< 0.000100	0.000100
	LPAE01	Fillets without Skin	< 0.000318	0.000318	< 0.000107	0.000107

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 0.000380	0.000380	< 0.000106	0.000106
	LPBC01	Fillets without Skin	< 0.000477	0.000477	< 0.000101	0.000101
	LPBC02	Fillets without Skin	< 0.000557	0.000557	< 0.0000940	0.0000940
	LPBC03	Fillets without Skin	< 0.000442	0.000442	< 0.0000940	0.0000940
	LPBC04	Fillets without Skin	< 0.000463	0.000463	< 0.000108	0.000108
	LPCC01	Fillets without Skin	< 0.000567	0.000567	< 0.000108	0.000108
	UAAE01	Fillets without Skin	< 0.000270	0.000270	< 0.000101	0.000101
	UABC01	Fillets without Skin	< 0.000493	0.000493	< 0.000104	0.000104
	UACC01	Fillets without Skin	< 0.000432	0.000432	< 0.0000990	0.0000990
	UPAE01	Fillets without Skin	< 0.000284	0.000284	< 0.0000950	0.0000950
	UPCC01	Fillets without Skin	< 0.000493	0.000493	< 0.000106	0.000106
	UPCC02	Fillets without Skin	< 0.000503	0.000503	< 0.000106	0.000106
	UPCC101	Fillets without Skin	< 0.000484	0.000484	< 0.000106	0.000106
	UPCC102	Fillets without Skin	< 0.000498	0.000498	< 0.000106	0.000106
	UPCC103	Fillets without Skin	< 0.000444	0.000444	< 0.000107	0.000107
PCB# 87/115						
	LACA01	Fillets with Skin	0.0489	0.000507	0.0136	0.000141
	LALB01	Fillets with Skin	0.0155	0.000691	0.00320	0.000143

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	0.00326	0.000698	0.000648	0.000139
	LPCA01	Fillets with Skin	0.0171	0.000581	0.00404	0.000137
	LPLB01	Fillets with Skin	0.00840	0.000621	0.00192	0.000142
	LPSB01	Fillets with Skin	0.00928	0.000649	0.00182	0.000127
	*LPSF01	Fillets with Skin	0.00304	0.000767	0.000518	0.000131
	UACA01	Fillets with Skin	0.0696	0.000488	0.0194	0.000136
	UALB01	Fillets with Skin	0.0121	0.000624	0.00271	0.000139
	UASF01	Fillets with Skin	0.00846	0.000674	0.00174	0.000139
	UPCA01	Fillets with Skin	0.0406	0.000455	0.0118	0.000133
	UPLB01	Fillets with Skin	0.00965	0.000684	0.00197	0.000140
	UPSF01	Fillets with Skin	0.00190	0.000700	0.000372	0.000137
	LAAE01	Fillets without Skin	0.0244	0.000366	0.00901	0.000135
	LABC01	Fillets without Skin	0.0213	0.000643	0.00468	0.000141
	LACC01	Fillets without Skin	0.0461	0.000617	0.00999	0.000134
	LPAE01	Fillets without Skin	0.0406	0.000425	0.0137	0.000143
	LPAE02	Fillets without Skin	0.0213	0.000507	0.00593	0.000141
	LPBC01	Fillets without Skin	0.0256	0.000636	0.00541	0.000135
	LPBC02	Fillets without Skin	0.00524	0.000744	0.000888	0.000126
	LPBC03	Fillets without Skin	0.0313	0.000590	0.00663	0.000125
	LPBC04	Fillets without Skin	0.0527	0.000618	0.0123	0.000144
	LPCC01	Fillets without Skin	0.0268	0.000757	0.00512	0.000145
	UAAE01	Fillets without	0.0368	0.000360	0.0138	0.000135

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.0172	0.000659	0.00361	0.000138
	UACC01	Fillets without Skin	0.0248	0.000577	0.00569	0.000132
	UPAE01	Fillets without Skin	0.0242	0.000380	0.00811	0.000127
	UPCC01	Fillets without Skin	0.0157	0.000658	0.00338	0.000142
	UPCC02	Fillets without Skin	0.0148	0.000671	0.00312	0.000142
	UPCC101	Fillets without Skin	0.00775	0.000646	0.00170	0.000141
	UPCC102	Fillets without Skin	0.0172	0.000665	0.00368	0.000142
	UPCC103	Fillets without Skin	0.0237	0.000592	0.00572	0.000143
PCB# 88						
	LACA01	Fillets with Skin	0.0947	0.000379	0.0264	0.000106
	LALB01	Fillets with Skin	0.0262	0.000518	0.00541	0.000107
	*LASF01	Fillets with Skin	0.00246	0.000523	0.000489	0.000104
	LPCA01	Fillets with Skin	0.0318	0.000435	0.00751	0.000103
	LPLB01	Fillets with Skin	0.0101	0.000465	0.00231	0.000106
	LPSB01	Fillets with Skin	0.00780	0.000486	0.00153	0.0000950
	*LPSF01	Fillets with Skin	< 0.000574	0.000574	< 0.0000980	0.0000980
	UACA01	Fillets with Skin	0.107	0.000366	0.0298	0.000102
	UALB01	Fillets with Skin	0.0170	0.000468	0.00379	0.000104
	UASF01	Fillets with Skin	0.00840	0.000505	0.00173	0.000104
	UPCA01	Fillets with Skin	0.0798	0.000341	0.0233	0.0000990
	UPLB01	Fillets with Skin	0.00853	0.000512	0.00174	0.000105
	UPSF01	Fillets with Skin	0.00217	0.000524	0.000425	0.000103

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	0.0991	0.000274	0.0366	0.000101
	LABC01	Fillets without Skin	0.0346	0.000482	0.00762	0.000106
	LACC01	Fillets without Skin	0.0768	0.000462	0.0166	0.000100
	LPAE01	Fillets without Skin	0.0509	0.000318	0.0172	0.000107
	LPAE02	Fillets without Skin	0.0788	0.000380	0.0219	0.000106
	LPBC01	Fillets without Skin	0.0595	0.000477	0.0126	0.000101
	LPBC02	Fillets without Skin	0.0172	0.000557	0.00292	0.0000940
	LPBC03	Fillets without Skin	0.0362	0.000442	0.00766	0.0000940
	LPBC04	Fillets without Skin	0.0752	0.000463	0.0176	0.000108
	LPCC01	Fillets without Skin	0.0684	0.000567	0.0131	0.000108
	UAAE01	Fillets without Skin	0.121	0.000270	0.0455	0.000101
	UABC01	Fillets without Skin	0.0539	0.000493	0.0113	0.000104
	UACC01	Fillets without Skin	0.0609	0.000432	0.0139	0.0000990
	UPAE01	Fillets without Skin	0.0330	0.000284	0.0111	0.0000950
	UPCC01	Fillets without Skin	0.0321	0.000493	0.00691	0.000106
	UPCC02	Fillets without Skin	0.0367	0.000503	0.00774	0.000106
	UPCC101	Fillets without Skin	0.0235	0.000484	0.00516	0.000106

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	0.0165	0.000498	0.00353	0.000106
	UPCC103	Fillets without Skin	0.0472	0.000444	0.0114	0.000107
PCB# 92						
	LACA01	Fillets with Skin	< 0.000379	0.000379	< 0.000106	0.000106
	LALB01	Fillets with Skin	0.0223	0.000518	0.00460	0.000107
	*LASF01	Fillets with Skin	0.00571	0.000523	0.00114	0.000104
	LPCA01	Fillets with Skin	0.0911	0.000435	0.0215	0.000103
	LPLB01	Fillets with Skin	0.0222	0.000465	0.00508	0.000106
	LPSB01	Fillets with Skin	0.0115	0.000486	0.00225	0.0000950
	*LPSF01	Fillets with Skin	0.00594	0.000574	0.00101	0.0000980
	*UACA01	Fillets with Skin	0.153	0.000366	0.0427	0.000102
	UALB01	Fillets with Skin	0.0430	0.000468	0.00959	0.000104
	UASF01	Fillets with Skin	0.0237	0.000505	0.00489	0.000104
	UPCA01	Fillets with Skin	0.108	0.000341	0.0315	0.0000990
	UPLB01	Fillets with Skin	0.0147	0.000512	0.00301	0.000105
	UPSF01	Fillets with Skin	0.00414	0.000524	0.000810	0.000103
	*LAAE01	Fillets without Skin	0.236	0.000274	0.0870	0.000101
	LABC01	Fillets without Skin	0.0906	0.000482	0.0199	0.000106
	LACC01	Fillets without Skin	0.156	0.000462	0.0338	0.000100
	*LPAE01	Fillets without Skin	0.133	0.000318	0.0448	0.000107
	LPAE02	Fillets without Skin	0.114	0.000380	0.0316	0.000106
	LPBC01	Fillets without Skin	< 0.000477	0.000477	< 0.000101	0.000101
	LPBC02	Fillets without Skin	0.0601	0.000557	0.0102	0.0000940

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	0.0702	0.000442	0.0149	0.0000940
	LPBC04	Fillets without Skin	0.149	0.000463	0.0349	0.000108
	LPCC01	Fillets without Skin	0.0714	0.000567	0.0136	0.000108
	*UAAE01	Fillets without Skin	0.382	0.000270	0.143	0.000101
	UABC01	Fillets without Skin	0.146	0.000493	0.0307	0.000104
	UACC01	Fillets without Skin	0.250	0.000432	0.0573	0.0000990
	UPAE01	Fillets without Skin	0.0796	0.000284	0.0267	0.0000950
	UPCC01	Fillets without Skin	0.0496	0.000493	0.0107	0.000106
	UPCC02	Fillets without Skin	0.0656	0.000503	0.0138	0.000106
	UPCC101	Fillets without Skin	0.0416	0.000484	0.00911	0.000106
	UPCC102	Fillets without Skin	0.0360	0.000498	0.00769	0.000106
	UPCC103	Fillets without Skin	0.0523	0.000444	0.0126	0.000107
PCB# 95						
	LACA01	Fillets with Skin	0.104	0.000379	0.0291	0.000106
	LALB01	Fillets with Skin	0.0283	0.000518	0.00586	0.000107
	*LASF01	Fillets with Skin	0.00505	0.000523	0.00100	0.000104
	LPCA01	Fillets with Skin	0.0346	0.000435	0.00815	0.000103
	LPLB01	Fillets with Skin	0.0141	0.000465	0.00322	0.000106
	LPSB01	Fillets with Skin	0.0138	0.000486	0.00271	0.0000950
	*LPSF01	Fillets with Skin	0.00456	0.000574	0.000777	0.0000980
	*UACA01	Fillets with Skin	0.115	0.000366	0.0320	0.000102

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.0212	0.000468	0.00472	0.000104
	UASF01	Fillets with Skin	0.00938	0.000505	0.00193	0.000104
	UPCA01	Fillets with Skin	0.0643	0.000341	0.0187	0.0000990
	UPLB01	Fillets with Skin	0.0132	0.000512	0.00271	0.000105
	UPSF01	Fillets with Skin	0.00271	0.000524	0.000531	0.000103
	LAAE01	Fillets without Skin	0.0488	0.000274	0.0180	0.000101
	LABC01	Fillets without Skin	0.0441	0.000482	0.00970	0.000106
	LACC01	Fillets without Skin	0.0259	0.000462	0.00561	0.000100
	LPAE01	Fillets without Skin	0.0361	0.000318	0.0122	0.000107
	LPAE02	Fillets without Skin	0.0420	0.000380	0.0117	0.000106
	LPBC01	Fillets without Skin	0.0409	0.000477	0.00867	0.000101
	LPBC02	Fillets without Skin	0.00960	0.000557	0.00163	0.0000940
	LPBC03	Fillets without Skin	0.0409	0.000442	0.00866	0.0000940
	LPBC04	Fillets without Skin	0.0639	0.000463	0.0149	0.000108
	LPCC01	Fillets without Skin	0.0406	0.000567	0.00774	0.000108
	UAAE01	Fillets without Skin	0.0809	0.000270	0.0303	0.000101
	UABC01	Fillets without Skin	0.0255	0.000493	0.00534	0.000104
	UACC01	Fillets without Skin	0.0307	0.000432	0.00703	0.0000990
	UPAE01	Fillets without Skin	0.0320	0.000284	0.0108	0.0000950

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.0287	0.000493	0.00618	0.000106
	UPCC02	Fillets without Skin	0.0287	0.000503	0.00606	0.000106
	UPCC101	Fillets without Skin	0.0106	0.000484	0.00231	0.000106
	UPCC102	Fillets without Skin	0.0193	0.000498	0.00413	0.000106
	UPCC103	Fillets without Skin	0.0440	0.000444	0.0106	0.000107
PCB# 97						
	LACA01	Fillets with Skin	0.0350	0.000379	0.00974	0.000106
	LALB01	Fillets with Skin	0.0137	0.000518	0.00283	0.000107
	*LASF01	Fillets with Skin	0.00269	0.000523	0.000535	0.000104
	LPCA01	Fillets with Skin	0.0194	0.000435	0.00457	0.000103
	LPLB01	Fillets with Skin	0.00708	0.000465	0.00162	0.000106
	LPSB01	Fillets with Skin	0.00774	0.000486	0.00152	0.0000950
	*LPSF01	Fillets with Skin	0.00242	0.000574	0.000412	0.0000980
	UACA01	Fillets with Skin	0.0545	0.000366	0.0152	0.000102
	UALB01	Fillets with Skin	0.0131	0.000468	0.00293	0.000104
	UASF01	Fillets with Skin	0.00759	0.000505	0.00156	0.000104
	UPCA01	Fillets with Skin	0.0382	0.000341	0.0111	0.0000990
	UPLB01	Fillets with Skin	0.00935	0.000512	0.00191	0.000105
	UPSF01	Fillets with Skin	0.00149	0.000524	0.000292	0.000103
	LAAE01	Fillets without Skin	0.0210	0.000274	0.00774	0.000101
	LABC01	Fillets without Skin	0.0316	0.000482	0.00695	0.000106
	LACC01	Fillets without Skin	0.0376	0.000462	0.00815	0.000100
	LPAE01	Fillets without Skin	0.0265	0.000318	0.00894	0.000107

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	0.0213	0.000380	0.00593	0.000106
	LPBC01	Fillets without Skin	0.0343	0.000477	0.00727	0.000101
	LPBC02	Fillets without Skin	0.00375	0.000557	0.000636	0.0000940
	LPBC03	Fillets without Skin	0.0337	0.000442	0.00714	0.0000940
	LPBC04	Fillets without Skin	0.0344	0.000463	0.00805	0.000108
	LPCC01	Fillets without Skin	0.0291	0.000567	0.00555	0.000108
	UAAE01	Fillets without Skin	0.0277	0.000270	0.0104	0.000101
	UABC01	Fillets without Skin	0.0190	0.000493	0.00398	0.000104
	UACC01	Fillets without Skin	0.0291	0.000432	0.00668	0.0000990
	UPAE01	Fillets without Skin	0.0152	0.000284	0.00512	0.0000950
	UPCC01	Fillets without Skin	0.0192	0.000493	0.00413	0.000106
	UPCC02	Fillets without Skin	0.0157	0.000503	0.00331	0.000106
	UPCC101	Fillets without Skin	0.00833	0.000484	0.00182	0.000106
	UPCC102	Fillets without Skin	0.0151	0.000498	0.00323	0.000106
	UPCC103	Fillets without Skin	0.0284	0.000444	0.00684	0.000107
PCB# 99						
	LACA01	Fillets with Skin	0.0723	0.000379	0.0202	0.000106
	LALB01	Fillets with Skin	0.0367	0.000518	0.00758	0.000107

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	0.00505	0.000523	0.00100	0.000104
	LPCA01	Fillets with Skin	0.0264	0.000435	0.00623	0.000103
	LPLB01	Fillets with Skin	0.0157	0.000465	0.00359	0.000106
	LPSB01	Fillets with Skin	0.0115	0.000486	0.00225	0.0000950
	*LPSF01	Fillets with Skin	0.00560	0.000574	0.000954	0.0000980
	UACA01	Fillets with Skin	0.111	0.000366	0.0310	0.000102
	UALB01	Fillets with Skin	0.0265	0.000468	0.00590	0.000104
	UASF01	Fillets with Skin	0.0163	0.000505	0.00336	0.000104
	UPCA01	Fillets with Skin	0.0619	0.000341	0.0180	0.0000990
	UPLB01	Fillets with Skin	0.0304	0.000512	0.00621	0.000105
	UPSF01	Fillets with Skin	0.00596	0.000524	0.00117	0.000103
	*LAAE01	Fillets without Skin	0.0731	0.000274	0.0270	0.000101
	LABC01	Fillets without Skin	0.263	0.000482	0.0578	0.000106
	LACC01	Fillets without Skin	0.119	0.000462	0.0257	0.000100
	*LPAE01	Fillets without Skin	0.228	0.000318	0.0770	0.000107
	*LPAE02	Fillets without Skin	0.146	0.000380	0.0407	0.000106
	LPBC01	Fillets without Skin	0.0757	0.000477	0.0160	0.000101
	LPBC02	Fillets without Skin	0.143	0.000557	0.0242	0.0000940
	*LPBC03	Fillets without Skin	0.156	0.000442	0.0330	0.0000940
	LPBC04	Fillets without Skin	0.142	0.000463	0.0332	0.000108
	LPCC01	Fillets without Skin	0.0972	0.000567	0.0186	0.000108
	*UAAE01	Fillets without	0.103	0.000270	0.0388	0.000101

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.0927	0.000493	0.0195	0.000104
	UACC01	Fillets without Skin	0.0870	0.000432	0.0200	0.0000990
	*UPAE01	Fillets without Skin	0.120	0.000284	0.0405	0.0000950
	UPCC01	Fillets without Skin	0.0588	0.000493	0.0127	0.000106
	UPCC02	Fillets without Skin	0.0565	0.000503	0.0119	0.000106
	UPCC101	Fillets without Skin	0.0272	0.000484	0.00595	0.000106
	UPCC102	Fillets without Skin	0.0435	0.000498	0.00930	0.000106
	UPCC103	Fillets without Skin	0.0829	0.000444	0.0200	0.000107
PCB-1242						
	LACA01	Fillets with Skin	0.284	0.0367	0.0792	0.0102
	LALB01	Fillets with Skin	< 0.0501	0.0501	< 0.0104	0.0104
	LASF01	Fillets with Skin	< 0.0506	0.0506	< 0.0101	0.0101
	LPCA01	Fillets with Skin	< 0.0421	0.0421	< 0.00992	0.00992
	LPLB01	Fillets with Skin	< 0.0450	0.0450	< 0.0103	0.0103
	LPSB01	Fillets with Skin	< 0.0470	0.0470	< 0.00922	0.00922
	LPSF01	Fillets with Skin	< 0.0556	0.0556	< 0.00948	0.00948
	UACA01	Fillets with Skin	< 0.0354	0.0354	< 0.00987	0.00987
	UALB01	Fillets with Skin	0.382	0.0453	0.0852	0.0101
	UASF01	Fillets with Skin	< 0.0488	0.0488	< 0.0101	0.0101
	UPCA01	Fillets with Skin	< 0.0330	0.0330	< 0.00961	0.00961
	UPLB01	Fillets with Skin	< 0.0496	0.0496	< 0.0101	0.0101
	UPSF01	Fillets with Skin	< 0.0508	0.0508	< 0.00994	0.00994

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	< 0.0265	0.0265	< 0.00979	0.00979
	LABC01	Fillets without Skin	< 0.0466	0.0466	< 0.0103	0.0103
	LACC01	Fillets without Skin	< 0.0447	0.0447	< 0.00968	0.00968
	LPAE01	Fillets without Skin	< 0.0308	0.0308	< 0.0104	0.0104
	LPAE02	Fillets without Skin	< 0.0368	0.0368	< 0.0102	0.0102
	LPBC01	Fillets without Skin	< 0.0461	0.0461	< 0.00978	0.00978
	LPBC02	Fillets without Skin	< 0.0539	0.0539	< 0.00914	0.00914
	LPBC03	Fillets without Skin	< 0.0428	0.0428	< 0.00906	0.00906
	LPBC04	Fillets without Skin	< 0.0448	0.0448	< 0.0105	0.0105
	LPCC01	Fillets without Skin	< 0.0549	0.0549	< 0.0105	0.0105
	UAAE01	Fillets without Skin	< 0.0261	0.0261	< 0.00979	0.00979
	UABC01	Fillets without Skin	< 0.0478	0.0478	< 0.0100	0.0100
	UACC01	Fillets without Skin	< 0.0418	0.0418	< 0.00958	0.00958
	UPAE01	Fillets without Skin	< 0.0275	0.0275	< 0.00924	0.00924
	UPCC01	Fillets without Skin	< 0.0477	0.0477	< 0.0103	0.0103
	UPCC02	Fillets without Skin	< 0.0487	0.0487	< 0.0103	0.0103
	UPCC101	Fillets without Skin	< 0.0468	0.0468	< 0.0103	0.0103

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	< 0.0482	0.0482	< 0.0103	0.0103
	UPCC103	Fillets without Skin	< 0.0429	0.0429	< 0.0104	0.0104
PCB-1248						
	LACA01	Fillets with Skin	1.14	0.0367	0.317	0.0102
	LALB01	Fillets with Skin	0.900	0.0501	0.186	0.0104
	LASF01	Fillets with Skin	0.0714	0.0506	0.0142	0.0101
	LPCA01	Fillets with Skin	0.188	0.0421	0.0444	0.00992
	LPLB01	Fillets with Skin	0.0795	0.0450	0.0182	0.0103
	LPSB01	Fillets with Skin	0.0734	0.0470	0.0144	0.00922
	LPSF01	Fillets with Skin	0.217	0.0556	0.0369	0.00948
	UACA01	Fillets with Skin	1.56	0.0354	0.435	0.00987
	UALB01	Fillets with Skin	0.491	0.0453	0.110	0.0101
	UASF01	Fillets with Skin	0.250	0.0488	0.0515	0.0101
	UPCA01	Fillets with Skin	0.307	0.0330	0.0896	0.00961
	UPLB01	Fillets with Skin	0.664	0.0496	0.136	0.0101
	UPSF01	Fillets with Skin	< 0.0508	0.0508	< 0.00994	0.00994
	LAAE01	Fillets without Skin	0.405	0.0265	0.149	0.00979
	LABC01	Fillets without Skin	< 0.0466	0.0466	< 0.0103	0.0103
	LACC01	Fillets without Skin	0.889	0.0447	0.193	0.00968
	LPAE01	Fillets without Skin	< 0.0308	0.0308	< 0.0104	0.0104
	LPAE02	Fillets without Skin	< 0.0368	0.0368	< 0.0102	0.0102
	LPBC01	Fillets without Skin	< 0.0461	0.0461	< 0.00978	0.00978
	LPBC02	Fillets without Skin	< 0.0539	0.0539	< 0.00914	0.00914

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	< 0.0428	0.0428	< 0.00906	0.00906
	LPBC04	Fillets without Skin	< 0.0448	0.0448	< 0.0105	0.0105
	LPCC01	Fillets without Skin	< 0.0549	0.0549	< 0.0105	0.0105
	UAAE01	Fillets without Skin	0.587	0.0261	0.220	0.00979
	UABC01	Fillets without Skin	0.577	0.0478	0.121	0.0100
	UACC01	Fillets without Skin	0.705	0.0418	0.162	0.00958
	UPAE01	Fillets without Skin	< 0.0275	0.0275	< 0.00924	0.00924
	UPCC01	Fillets without Skin	< 0.0477	0.0477	< 0.0103	0.0103
	UPCC02	Fillets without Skin	0.237	0.0487	0.0501	0.0103
	UPCC101	Fillets without Skin	< 0.0468	0.0468	< 0.0103	0.0103
	UPCC102	Fillets without Skin	< 0.0482	0.0482	< 0.0103	0.0103
	UPCC103	Fillets without Skin	< 0.0429	0.0429	< 0.0104	0.0104
PCB-1254						
	LACA01	Fillets with Skin	1.42	0.0367	0.396	0.0102
	LALB01	Fillets with Skin	1.35	0.0501	0.279	0.0104
	LASF01	Fillets with Skin	0.119	0.0506	0.0237	0.0101
	LPCA01	Fillets with Skin	1.13	0.0421	0.266	0.00992
	LPLB01	Fillets with Skin	0.397	0.0450	0.0909	0.0103
	LPSB01	Fillets with Skin	0.514	0.0470	0.101	0.00922
	LPSF01	Fillets with Skin	0.0619	0.0556	0.0106	0.00948
	UACA01	Fillets with Skin	1.56	0.0354	0.435	0.00987

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.218	0.0453	0.0487	0.0101
	UASF01	Fillets with Skin	0.375	0.0488	0.0773	0.0101
	UPCA01	Fillets with Skin	1.54	0.0330	0.448	0.00961
	UPLB01	Fillets with Skin	0.664	0.0496	0.136	0.0101
	UPSF01	Fillets with Skin	0.156	0.0508	0.0306	0.00994
	LAAE01	Fillets without Skin	2.43	0.0265	0.895	0.00979
	LABC01	Fillets without Skin	2.19	0.0466	0.481	0.0103
	LACC01	Fillets without Skin	2.22	0.0447	0.482	0.00968
	LPAE01	Fillets without Skin	4.74	0.0308	1.60	0.0104
	LPAE02	Fillets without Skin	3.29	0.0368	0.913	0.0102
	LPBC01	Fillets without Skin	1.97	0.0461	0.417	0.00978
	LPBC02	Fillets without Skin	1.94	0.0539	0.329	0.00914
	LPBC03	Fillets without Skin	2.76	0.0428	0.585	0.00906
	LPBC04	Fillets without Skin	2.85	0.0448	0.666	0.0105
	LPCC01	Fillets without Skin	3.24	0.0549	0.619	0.0105
	UAAE01	Fillets without Skin	2.35	0.0261	0.881	0.00979
	UABC01	Fillets without Skin	1.59	0.0478	0.333	0.0100
	UACC01	Fillets without Skin	1.94	0.0418	0.445	0.00958
	UPAE01	Fillets without Skin	2.59	0.0275	0.871	0.00924

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	1.17	0.0477	0.252	0.0103
	UPCC02	Fillets without Skin	1.42	0.0487	0.301	0.0103
	UPCC101	Fillets without Skin	0.686	0.0468	0.150	0.0103
	UPCC102	Fillets without Skin	1.09	0.0482	0.232	0.0103
	UPCC103	Fillets without Skin	1.75	0.0429	0.422	0.0104
PCB-1260						
	LACA01	Fillets with Skin	< 0.0367	0.0367	< 0.0102	0.0102
	LALB01	Fillets with Skin	< 0.0501	0.0501	< 0.0104	0.0104
	LASF01	Fillets with Skin	< 0.0506	0.0506	< 0.0101	0.0101
	LPCA01	Fillets with Skin	0.564	0.0421	0.133	0.00992
	LPLB01	Fillets with Skin	0.318	0.0450	0.0727	0.0103
	LPSB01	Fillets with Skin	0.147	0.0470	0.0288	0.00922
	LPSF01	Fillets with Skin	< 0.0556	0.0556	< 0.00948	0.00948
	UACA01	Fillets with Skin	0.390	0.0354	0.109	0.00987
	UALB01	Fillets with Skin	< 0.0453	0.0453	< 0.0101	0.0101
	UASF01	Fillets with Skin	< 0.0488	0.0488	< 0.0101	0.0101
	UPCA01	Fillets with Skin	1.23	0.0330	0.358	0.00961
	UPLB01	Fillets with Skin	< 0.0496	0.0496	< 0.0101	0.0101
	UPSF01	Fillets with Skin	0.156	0.0508	0.0306	0.00994
	LAAE01	Fillets without Skin	1.21	0.0265	0.448	0.00979
	LABC01	Fillets without Skin	0.729	0.0466	0.160	0.0103
	LACC01	Fillets without Skin	1.33	0.0447	0.289	0.00968
	LPAE01	Fillets without Skin	7.11	0.0308	2.40	0.0104

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	4.93	0.0368	1.37	0.0102
	LPBC01	Fillets without Skin	1.31	0.0461	0.278	0.00978
	LPBC02	Fillets without Skin	2.91	0.0539	0.493	0.00914
	LPBC03	Fillets without Skin	3.38	0.0428	0.715	0.00906
	LPBC04	Fillets without Skin	2.85	0.0448	0.666	0.0105
	LPCC01	Fillets without Skin	2.16	0.0549	0.412	0.0105
	UAAE01	Fillets without Skin	< 0.0261	0.0261	< 0.00979	0.00979
	UABC01	Fillets without Skin	0.721	0.0478	0.151	0.0100
	UACC01	Fillets without Skin	0.882	0.0418	0.202	0.00958
	UPAE01	Fillets without Skin	3.89	0.0275	1.31	0.00924
	UPCC01	Fillets without Skin	1.17	0.0477	0.252	0.0103
	UPCC02	Fillets without Skin	0.949	0.0487	0.200	0.0103
	UPCC101	Fillets without Skin	0.561	0.0468	0.123	0.0103
	UPCC102	Fillets without Skin	1.09	0.0482	0.232	0.0103
	UPCC103	Fillets without Skin	1.75	0.0429	0.422	0.0104
PCB-TOTAL						
	*LACA01	Fillets with Skin	2.84	0.0126	0.792	0.00352
	LALB01	Fillets with Skin	2.25	0.0172	0.465	0.00356

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	0.238	0.0174	0.0473	0.00347
	LPCA01	Fillets with Skin	1.88	0.0145	0.444	0.00342
	LPLB01	Fillets with Skin	0.795	0.0155	0.182	0.00354
	LPSB01	Fillets with Skin	0.734	0.0162	0.144	0.00317
	*LPSF01	Fillets with Skin	0.310	0.0191	0.0528	0.00326
	*UACA01	Fillets with Skin	3.90	0.0122	1.09	0.00340
	UALB01	Fillets with Skin	1.09	0.0156	0.243	0.00347
	UASF01	Fillets with Skin	0.625	0.0168	0.129	0.00346
	*UPCA01	Fillets with Skin	3.07	0.0114	0.896	0.00331
	UPLB01	Fillets with Skin	1.33	0.0171	0.272	0.00349
	UPSF01	Fillets with Skin	0.312	0.0175	0.0612	0.00342
	*LAAE01	Fillets without Skin	4.05	0.00914	1.49	0.00337
	LABC01	Fillets without Skin	2.91	0.0160	0.641	0.00353
	*LACC01	Fillets without Skin	4.44	0.0154	0.963	0.00333
	*LPAE01	Fillets without Skin	11.9	0.0106	4.00	0.00358
	*LPAE02	Fillets without Skin	8.22	0.0127	2.28	0.00351
	LPBC01	Fillets without Skin	3.28	0.0159	0.695	0.00336
	*LPBC02	Fillets without Skin	4.85	0.0186	0.822	0.00315
	*LPBC03	Fillets without Skin	6.14	0.0147	1.30	0.00312
	*LPBC04	Fillets without Skin	5.70	0.0154	1.33	0.00360
	*LPCC01	Fillets without Skin	5.40	0.0189	1.03	0.00361
	*UAAE01	Fillets without	2.94	0.00899	1.10	0.00337

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	*UABC01	Fillets without Skin	2.89	0.0164	0.605	0.00345
	*UACC01	Fillets without Skin	3.53	0.0144	0.808	0.00330
	*UPAE01	Fillets without Skin	6.48	0.00947	2.18	0.00318
	UPCC01	Fillets without Skin	2.34	0.0164	0.503	0.00354
	UPCC02	Fillets without Skin	2.37	0.0167	0.501	0.00354
	UPCC101	Fillets without Skin	1.25	0.0161	0.273	0.00353
	UPCC102	Fillets without Skin	2.17	0.0166	0.464	0.00354
	*UPCC103	Fillets without Skin	3.50	0.0148	0.845	0.00356
Pentachlorobenzene						
	LACA01	Fillets with Skin	0.00466	0.000365	0.00130	0.000102
	LALB01	Fillets with Skin	0.00494	0.000499	0.00102	0.000103
	*LASF01	Fillets with Skin	0.00458	0.000504	0.000911	0.000100
	LPCA01	Fillets with Skin	0.00462	0.000419	0.00109	0.0000990
	LPLB01	Fillets with Skin	0.00375	0.000448	0.000858	0.000102
	LPSB01	Fillets with Skin	0.00337	0.000468	0.000661	0.0000920
	*LPSF01	Fillets with Skin	0.00463	0.000553	0.000789	0.0000940
	UACA01	Fillets with Skin	0.00525	0.000352	0.00146	0.0000980
	UALB01	Fillets with Skin	0.00421	0.000450	0.000939	0.000100
	UASF01	Fillets with Skin	0.00553	0.000486	0.00114	0.000100
	UPCA01	Fillets with Skin	0.00442	0.000328	0.00129	0.0000960
	UPLB01	Fillets with Skin	0.00426	0.000493	0.000872	0.000101
	UPSF01	Fillets with Skin	0.00515	0.000505	0.00101	0.0000990

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	0.00626	0.000264	0.00231	0.0000970
	LABC01	Fillets without Skin	0.00431	0.000464	0.000948	0.000102
	LACC01	Fillets without Skin	0.00527	0.000445	0.00114	0.0000960
	LPAE01	Fillets without Skin	0.00243	0.000307	0.000819	0.000103
	LPAE02	Fillets without Skin	0.00494	0.000366	0.00137	0.000102
	LPBC01	Fillets without Skin	0.00464	0.000459	0.000983	0.0000970
	LPBC02	Fillets without Skin	0.00454	0.000537	0.000770	0.0000910
	LPBC03	Fillets without Skin	0.00253	0.000426	0.000536	0.0000900
	LPBC04	Fillets without Skin	0.00524	0.000446	0.00122	0.000104
	LPCC01	Fillets without Skin	0.00504	0.000546	0.000962	0.000104
	UAAE01	Fillets without Skin	0.00445	0.000260	0.00167	0.0000970
	UABC01	Fillets without Skin	0.00712	0.000475	0.00149	0.000100
	UACC01	Fillets without Skin	0.00555	0.000416	0.00127	0.0000950
	UPAE01	Fillets without Skin	0.00436	0.000274	0.00146	0.0000920
	UPCC01	Fillets without Skin	0.00639	0.000475	0.00138	0.000102
	UPCC02	Fillets without Skin	0.00592	0.000484	0.00125	0.000102
	UPCC101	Fillets without Skin	0.00480	0.000466	0.00105	0.000102

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	0.00410	0.000480	0.000875	0.000102
	UPCC103	Fillets without Skin	0.00411	0.000427	0.000990	0.000103
Total DDT's						
	*LACA01	Fillets with Skin	0.500	0.00267	0.139	0.000745
	LALB01	Fillets with Skin	0.225	0.00365	0.0466	0.000754
	*LASF01	Fillets with Skin	0.0295	0.00369	0.00586	0.000734
	LPCA01	Fillets with Skin	0.385	0.00306	0.0907	0.000723
	LPLB01	Fillets with Skin	0.165	0.00328	0.0377	0.000750
	LPSB01	Fillets with Skin	0.101	0.00342	0.0199	0.000672
	*LPSF01	Fillets with Skin	0.0423	0.00405	0.00721	0.000690
	*UACA01	Fillets with Skin	0.546	0.00258	0.152	0.000718
	UALB01	Fillets with Skin	0.155	0.00330	0.0345	0.000735
	UASF01	Fillets with Skin	0.0888	0.00356	0.0183	0.000732
	*UPCA01	Fillets with Skin	0.463	0.00240	0.135	0.000700
	UPLB01	Fillets with Skin	0.154	0.00361	0.0315	0.000738
	UPSF01	Fillets with Skin	0.0285	0.00370	0.00559	0.000724
	*LAAE01	Fillets without Skin	0.944	0.00193	0.348	0.000713
	LABC01	Fillets without Skin	0.544	0.00339	0.120	0.000747
	*LACC01	Fillets without Skin	0.639	0.00325	0.138	0.000705
	*LPAE01	Fillets without Skin	1.73	0.00224	0.584	0.000757
	*LPAE02	Fillets without Skin	0.529	0.00268	0.147	0.000744
	LPBC01	Fillets without Skin	0.591	0.00336	0.125	0.000712
	*LPBC02	Fillets without Skin	0.720	0.00393	0.122	0.000666

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LPBC03	Fillets without Skin	0.907	0.00312	0.192	0.000660
	*LPBC04	Fillets without Skin	0.964	0.00326	0.225	0.000761
	LPCC01	Fillets without Skin	0.281	0.00400	0.0537	0.000763
	*UAAE01	Fillets without Skin	0.559	0.00190	0.210	0.000713
	*UABC01	Fillets without Skin	0.535	0.00348	0.112	0.000729
	*UACC01	Fillets without Skin	0.453	0.00304	0.104	0.000697
	*UPAE01	Fillets without Skin	0.849	0.00200	0.285	0.000673
	UPCC01	Fillets without Skin	0.350	0.00347	0.0753	0.000748
	UPCC02	Fillets without Skin	0.404	0.00354	0.0853	0.000748
	UPCC101	Fillets without Skin	0.246	0.00341	0.0539	0.000747
	UPCC102	Fillets without Skin	0.294	0.00351	0.0627	0.000750
	*UPCC103	Fillets without Skin	0.383	0.00313	0.0924	0.000754
acenaphthalene						
	LACA01	Fillets with Skin	0.0108	0.00143	0.00300	0.000398
	LALB01	Fillets with Skin	< 0.00195	0.00195	< 0.000403	0.000403
	LASF01	Fillets with Skin	< 0.00197	0.00197	< 0.000392	0.000392
	LPCA01	Fillets with Skin	0.00594	0.00164	0.00140	0.000386
	LPLB01	Fillets with Skin	< 0.00175	0.00175	< 0.000401	0.000401
	LPSB01	Fillets with Skin	< 0.00183	0.00183	< 0.000359	0.000359
	LPSF01	Fillets with Skin	< 0.00216	0.00216	< 0.000369	0.000369
	UACA01	Fillets with Skin	0.00753	0.00138	0.00210	0.000384

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.00179	0.00176	0.000400	0.000393
	UASF01	Fillets with Skin	< 0.00190	0.00190	< 0.000392	0.000392
	UPCA01	Fillets with Skin	0.0299	0.00128	0.00870	0.000374
	UPLB01	Fillets with Skin	< 0.00193	0.00193	< 0.000395	0.000395
	UPSF01	Fillets with Skin	< 0.00198	0.00198	< 0.000387	0.000387
	LAAE01	Fillets without Skin	0.00380	0.00103	0.00140	0.000381
	LABC01	Fillets without Skin	0.00954	0.00182	0.00210	0.000399
	LACC01	Fillets without Skin	0.0102	0.00174	0.00220	0.000377
	LPAE01	Fillets without Skin	0.00356	0.00120	0.00120	0.000405
	LPAE02	Fillets without Skin	0.00216	0.00143	0.000600	0.000398
	LPBC01	Fillets without Skin	0.00991	0.00180	0.00210	0.000381
	LPBC02	Fillets without Skin	0.00472	0.00210	0.000800	0.000356
	LPBC03	Fillets without Skin	0.00566	0.00167	0.00120	0.000353
	LPBC04	Fillets without Skin	0.00942	0.00174	0.00220	0.000407
	LPCC01	Fillets without Skin	0.00367	0.00214	0.000700	0.000408
	UAAE01	Fillets without Skin	0.00240	0.00102	0.000900	0.000381
	UABC01	Fillets without Skin	0.00810	0.00186	0.00170	0.000390
	UACC01	Fillets without Skin	0.00436	0.00163	0.00100	0.000373
	UPAE01	Fillets without Skin	0.00387	0.00107	0.00130	0.000360

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.00557	0.00186	0.00120	0.000400
	UPCC02	Fillets without Skin	0.00711	0.00190	0.00150	0.000400
	UPCC101	Fillets without Skin	0.00411	0.00182	0.000900	0.000399
	UPCC102	Fillets without Skin	0.00281	0.00188	0.000600	0.000401
	UPCC103	Fillets without Skin	0.00830	0.00167	0.00200	0.000403
acenaphthene						
	LACA01	Fillets with Skin	0.107	0.00144	0.0298	0.000400
	LALB01	Fillets with Skin	0.00677	0.00196	0.00140	0.000405
	LASF01	Fillets with Skin	0.00452	0.00198	0.000900	0.000394
	LPCA01	Fillets with Skin	0.0136	0.00165	0.00320	0.000388
	LPLB01	Fillets with Skin	0.00262	0.00176	0.000600	0.000403
	LPSB01	Fillets with Skin	< 0.00184	0.00184	< 0.000361	0.000361
	LPSF01	Fillets with Skin	< 0.00217	0.00217	< 0.000371	0.000371
	UACA01	Fillets with Skin	0.0362	0.00138	0.0101	0.000386
	UALB01	Fillets with Skin	0.00672	0.00177	0.00150	0.000395
	UASF01	Fillets with Skin	0.00728	0.00191	0.00150	0.000393
	UPCA01	Fillets with Skin	0.214	0.00129	0.0623	0.000376
	UPLB01	Fillets with Skin	0.0122	0.00194	0.00250	0.000397
	UPSF01	Fillets with Skin	0.00204	0.00199	0.000400	0.000389
	LAAE01	Fillets without Skin	0.0762	0.00104	0.0281	0.000383
	LABC01	Fillets without Skin	0.0109	0.00182	0.00240	0.000401
	LACC01	Fillets without Skin	0.0503	0.00175	0.0109	0.000379
	LPAE01	Fillets without Skin	0.00771	0.00121	0.00260	0.000407

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	0.00432	0.00144	0.00120	0.000400
	LPBC01	Fillets without Skin	0.0170	0.00180	0.00360	0.000382
	LPBC02	Fillets without Skin	< 0.00211	0.00211	< 0.000358	0.000358
	LPBC03	Fillets without Skin	< 0.00167	0.00167	< 0.000355	0.000355
	LPBC04	Fillets without Skin	0.00770	0.00175	0.00180	0.000409
	LPCC01	Fillets without Skin	0.00681	0.00215	0.00130	0.000410
	UAAE01	Fillets without Skin	0.0355	0.00102	0.0133	0.000382
	UABC01	Fillets without Skin	0.0291	0.00187	0.00610	0.000392
	UACC01	Fillets without Skin	0.0131	0.00164	0.00300	0.000375
	UPAE01	Fillets without Skin	0.0140	0.00108	0.00470	0.000362
	UPCC01	Fillets without Skin	0.0274	0.00187	0.00590	0.000402
	UPCC02	Fillets without Skin	0.0213	0.00190	0.00450	0.000402
	UPCC101	Fillets without Skin	0.0575	0.00183	0.0126	0.000401
	UPCC102	Fillets without Skin	0.0403	0.00189	0.00860	0.000403
	UPCC103	Fillets without Skin	0.00912	0.00168	0.00220	0.000405
alpha BHC						
	LACA01	Fillets with Skin	< 0.000988	0.000988	< 0.000275	0.000275
	LALB01	Fillets with Skin	< 0.00135	0.00135	< 0.000279	0.000279

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	< 0.00136	0.00136	< 0.000271	0.000271
	LPCA01	Fillets with Skin	< 0.00113	0.00113	< 0.000267	0.000267
	LPLB01	Fillets with Skin	< 0.00121	0.00121	< 0.000277	0.000277
	LPSB01	Fillets with Skin	< 0.00127	0.00127	< 0.000248	0.000248
	*LPSF01	Fillets with Skin	< 0.00150	0.00150	< 0.000255	0.000255
	UACA01	Fillets with Skin	< 0.000952	0.000952	< 0.000266	0.000266
	UALB01	Fillets with Skin	< 0.00122	0.00122	< 0.000272	0.000272
	UASF01	Fillets with Skin	< 0.00131	0.00131	< 0.000271	0.000271
	UPCA01	Fillets with Skin	< 0.000888	0.000888	< 0.000259	0.000259
	UPLB01	Fillets with Skin	< 0.00133	0.00133	< 0.000273	0.000273
	UPSF01	Fillets with Skin	< 0.00137	0.00137	< 0.000268	0.000268
	LAAE01	Fillets without Skin	< 0.000714	0.000714	< 0.000264	0.000264
	LABC01	Fillets without Skin	< 0.00125	0.00125	< 0.000276	0.000276
	LACC01	Fillets without Skin	< 0.00120	0.00120	< 0.000261	0.000261
	LPAE01	Fillets without Skin	< 0.000829	0.000829	< 0.000280	0.000280
	LPAE02	Fillets without Skin	< 0.000989	0.000989	< 0.000275	0.000275
	LPBC01	Fillets without Skin	< 0.00124	0.00124	< 0.000263	0.000263
	LPBC02	Fillets without Skin	< 0.00145	0.00145	< 0.000246	0.000246
	LPBC03	Fillets without Skin	< 0.00115	0.00115	< 0.000244	0.000244
	LPBC04	Fillets without Skin	< 0.00120	0.00120	< 0.000281	0.000281
	LPCC01	Fillets without Skin	< 0.00148	0.00148	< 0.000282	0.000282
	UAAE01	Fillets without	< 0.000703	0.000703	< 0.000264	0.000264

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	< 0.00128	0.00128	< 0.000270	0.000270
	UACC01	Fillets without Skin	< 0.00112	0.00112	< 0.000258	0.000258
	UPAE01	Fillets without Skin	< 0.000740	0.000740	< 0.000249	0.000249
	UPCC01	Fillets without Skin	< 0.00128	0.00128	< 0.000276	0.000276
	UPCC02	Fillets without Skin	< 0.00131	0.00131	< 0.000276	0.000276
	UPCC101	Fillets without Skin	< 0.00126	0.00126	< 0.000276	0.000276
	UPCC102	Fillets without Skin	< 0.00130	0.00130	< 0.000277	0.000277
	UPCC103	Fillets without Skin	< 0.00116	0.00116	< 0.000279	0.000279
alpha chlordane						
	*LACA01	Fillets with Skin	0.253	0.000347	0.0705	0.0000970
	LALB01	Fillets with Skin	0.0507	0.000473	0.0105	0.0000980
	*LASF01	Fillets with Skin	0.00581	0.000478	0.00116	0.0000950
	LPCA01	Fillets with Skin	0.119	0.000397	0.0282	0.0000940
	LPLB01	Fillets with Skin	0.0300	0.000425	0.00686	0.0000970
	LPSB01	Fillets with Skin	0.0145	0.000444	0.00285	0.0000870
	*LPSF01	Fillets with Skin	0.00491	0.000525	0.000836	0.0000890
	*UACA01	Fillets with Skin	0.291	0.000334	0.0812	0.0000930
	UALB01	Fillets with Skin	0.0622	0.000427	0.0139	0.0000950
	UASF01	Fillets with Skin	0.0199	0.000461	0.00411	0.0000950
	*UPCA01	Fillets with Skin	0.188	0.000311	0.0546	0.0000910
	UPLB01	Fillets with Skin	0.00800	0.000468	0.00164	0.0000960
	UPSF01	Fillets with Skin	0.00271	0.000479	0.000531	0.0000940

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LAAE01	Fillets without Skin	0.358	0.000251	0.132	0.0000920
	LABC01	Fillets without Skin	0.168	0.000440	0.0370	0.0000970
	*LACC01	Fillets without Skin	0.204	0.000422	0.0441	0.0000910
	*LPAE01	Fillets without Skin	0.308	0.000291	0.104	0.0000980
	LPAE02	Fillets without Skin	0.0923	0.000347	0.0256	0.0000960
	LPBC01	Fillets without Skin	0.231	0.000435	0.0489	0.0000920
	LPBC02	Fillets without Skin	0.140	0.000509	0.0238	0.0000860
	LPBC03	Fillets without Skin	0.0937	0.000404	0.0198	0.0000860
	*LPBC04	Fillets without Skin	0.258	0.000423	0.0602	0.0000990
	LPCC01	Fillets without Skin	0.0423	0.000518	0.00808	0.0000990
	*UAAE01	Fillets without Skin	0.498	0.000247	0.187	0.0000920
	*UABC01	Fillets without Skin	0.167	0.000451	0.0349	0.0000950
	*UACC01	Fillets without Skin	0.191	0.000394	0.0437	0.0000900
	*UPAE01	Fillets without Skin	0.106	0.000260	0.0355	0.0000870
	UPCC01	Fillets without Skin	0.0827	0.000450	0.0178	0.0000970
	UPCC02	Fillets without Skin	0.129	0.000459	0.0273	0.0000970
	UPCC101	Fillets without Skin	0.0972	0.000442	0.0213	0.0000970

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	0.0754	0.000455	0.0161	0.0000970
	UPCC103	Fillets without Skin	0.0902	0.000405	0.0218	0.0000980
anthracene						
	LACA01	Fillets with Skin	0.0172	0.000876	0.00480	0.000244
	LALB01	Fillets with Skin	0.00194	0.00120	0.000400	0.000247
	LASF01	Fillets with Skin	0.00151	0.00121	0.000300	0.000240
	LPCA01	Fillets with Skin	0.00466	0.00100	0.00110	0.000237
	LPLB01	Fillets with Skin	< 0.00107	0.00107	< 0.000246	0.000246
	LPSB01	Fillets with Skin	< 0.00112	0.00112	< 0.000220	0.000220
	LPSF01	Fillets with Skin	< 0.00133	0.00133	< 0.000226	0.000226
	UACA01	Fillets with Skin	0.0104	0.000844	0.00290	0.000235
	UALB01	Fillets with Skin	0.00179	0.00108	0.000400	0.000241
	UASF01	Fillets with Skin	0.00243	0.00116	0.000500	0.000240
	UPCA01	Fillets with Skin	0.0141	0.000787	0.00410	0.000229
	UPLB01	Fillets with Skin	< 0.00118	0.00118	< 0.000242	0.000242
	UPSF01	Fillets with Skin	< 0.00121	0.00121	< 0.000237	0.000237
	LAAE01	Fillets without Skin	0.00271	0.000633	0.00100	0.000234
	LABC01	Fillets without Skin	0.0105	0.00111	0.00230	0.000245
	LACC01	Fillets without Skin	0.0157	0.00107	0.00340	0.000231
	LPAE01	Fillets without Skin	< 0.000735	0.000735	< 0.000248	0.000248
	LPAE02	Fillets without Skin	< 0.000877	0.000877	< 0.000244	0.000244
	LPBC01	Fillets without Skin	0.00944	0.00110	0.00200	0.000233
	LPBC02	Fillets without Skin	0.00295	0.00129	0.000500	0.000218

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	0.00378	0.00102	0.000800	0.000216
	LPBC04	Fillets without Skin	0.00599	0.00107	0.00140	0.000250
	LPCC01	Fillets without Skin	0.00314	0.00131	0.000600	0.000250
	UAAE01	Fillets without Skin	0.00213	0.000622	0.000800	0.000233
	UABC01	Fillets without Skin	0.00906	0.00114	0.00190	0.000239
	UACC01	Fillets without Skin	0.00611	0.000997	0.00140	0.000229
	UPAE01	Fillets without Skin	0.00119	0.000656	0.000400	0.000220
	UPCC01	Fillets without Skin	0.00557	0.00114	0.00120	0.000245
	UPCC02	Fillets without Skin	0.00568	0.00116	0.00120	0.000245
	UPCC101	Fillets without Skin	0.00822	0.00112	0.00180	0.000245
	UPCC102	Fillets without Skin	0.00562	0.00115	0.00120	0.000246
	UPCC103	Fillets without Skin	0.00498	0.00102	0.00120	0.000247
benzo(a)pyrene						
	LACA01	Fillets with Skin	< 0.00156	0.00156	< 0.000436	0.000436
	LALB01	Fillets with Skin	< 0.00213	0.00213	< 0.000441	0.000441
	LASF01	Fillets with Skin	< 0.00216	0.00216	< 0.000429	0.000429
	LPCA01	Fillets with Skin	< 0.00179	0.00179	< 0.000422	0.000422
	LPLB01	Fillets with Skin	< 0.00192	0.00192	< 0.000438	0.000438
	LPSB01	Fillets with Skin	< 0.00200	0.00200	< 0.000393	0.000393
	LPSF01	Fillets with Skin	< 0.00236	0.00236	< 0.000403	0.000403
	UACA01	Fillets with Skin	< 0.00151	0.00151	< 0.000420	0.000420

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	< 0.00193	0.00193	< 0.000430	0.000430
	UASF01	Fillets with Skin	< 0.00208	0.00208	< 0.000428	0.000428
	UPCA01	Fillets with Skin	< 0.00140	0.00140	< 0.000409	0.000409
	UPLB01	Fillets with Skin	< 0.00211	0.00211	< 0.000431	0.000431
	UPSF01	Fillets with Skin	< 0.00216	0.00216	< 0.000423	0.000423
	LAAE01	Fillets without Skin	< 0.00113	0.00113	< 0.000417	0.000417
	LABC01	Fillets without Skin	< 0.00198	0.00198	< 0.000436	0.000436
	LACC01	Fillets without Skin	< 0.00190	0.00190	< 0.000412	0.000412
	LPAE01	Fillets without Skin	< 0.00131	0.00131	< 0.000442	0.000442
	LPAE02	Fillets without Skin	< 0.00156	0.00156	< 0.000435	0.000435
	LPBC01	Fillets without Skin	< 0.00196	0.00196	< 0.000416	0.000416
	LPBC02	Fillets without Skin	< 0.00230	0.00230	< 0.000389	0.000389
	LPBC03	Fillets without Skin	< 0.00182	0.00182	< 0.000386	0.000386
	LPBC04	Fillets without Skin	< 0.00190	0.00190	< 0.000445	0.000445
	LPCC01	Fillets without Skin	< 0.00234	0.00234	< 0.000446	0.000446
	UAAE01	Fillets without Skin	< 0.00111	0.00111	< 0.000416	0.000416
	UABC01	Fillets without Skin	< 0.00203	0.00203	< 0.000426	0.000426
	UACC01	Fillets without Skin	< 0.00178	0.00178	< 0.000408	0.000408
	UPAE01	Fillets without Skin	< 0.00117	0.00117	< 0.000393	0.000393

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	< 0.00203	0.00203	< 0.000437	0.000437
	UPCC02	Fillets without Skin	< 0.00207	0.00207	< 0.000437	0.000437
	UPCC101	Fillets without Skin	< 0.00199	0.00199	< 0.000436	0.000436
	UPCC102	Fillets without Skin	< 0.00205	0.00205	< 0.000438	0.000438
	UPCC103	Fillets without Skin	< 0.00183	0.00183	< 0.000441	0.000441
benzo(b)fluoranthene						
	LACA01	Fillets with Skin	< 0.00117	0.00117	< 0.000326	0.000326
	LALB01	Fillets with Skin	< 0.00160	0.00160	< 0.000330	0.000330
	LASF01	Fillets with Skin	< 0.00161	0.00161	< 0.000321	0.000321
	LPCA01	Fillets with Skin	< 0.00134	0.00134	< 0.000316	0.000316
	LPLB01	Fillets with Skin	< 0.00143	0.00143	< 0.000328	0.000328
	LPSB01	Fillets with Skin	< 0.00150	0.00150	< 0.000294	0.000294
	LPSF01	Fillets with Skin	< 0.00177	0.00177	< 0.000302	0.000302
	UACA01	Fillets with Skin	< 0.00113	0.00113	< 0.000315	0.000315
	UALB01	Fillets with Skin	< 0.00144	0.00144	< 0.000322	0.000322
	UASF01	Fillets with Skin	< 0.00156	0.00156	< 0.000321	0.000321
	UPCA01	Fillets with Skin	< 0.00105	0.00105	< 0.000306	0.000306
	UPLB01	Fillets with Skin	< 0.00158	0.00158	< 0.000323	0.000323
	UPSF01	Fillets with Skin	< 0.00162	0.00162	< 0.000317	0.000317
	LAAE01	Fillets without Skin	< 0.000846	0.000846	< 0.000312	0.000312
	LABC01	Fillets without Skin	< 0.00149	0.00149	< 0.000327	0.000327
	LACC01	Fillets without Skin	< 0.00142	0.00142	< 0.000309	0.000309
	LPAE01	Fillets without Skin	< 0.000982	0.000982	< 0.000331	0.000331

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 0.00117	0.00117	< 0.000326	0.000326
	LPBC01	Fillets without Skin	< 0.00147	0.00147	< 0.000312	0.000312
	LPBC02	Fillets without Skin	< 0.00172	0.00172	< 0.000291	0.000291
	LPBC03	Fillets without Skin	< 0.00136	0.00136	< 0.000289	0.000289
	LPBC04	Fillets without Skin	< 0.00143	0.00143	< 0.000333	0.000333
	LPCC01	Fillets without Skin	< 0.00175	0.00175	< 0.000334	0.000334
	UAAE01	Fillets without Skin	< 0.000831	0.000831	< 0.000312	0.000312
	UABC01	Fillets without Skin	< 0.00152	0.00152	< 0.000319	0.000319
	UACC01	Fillets without Skin	< 0.00133	0.00133	< 0.000305	0.000305
	UPAE01	Fillets without Skin	< 0.000877	0.000877	< 0.000295	0.000295
	UPCC01	Fillets without Skin	< 0.00152	0.00152	< 0.000327	0.000327
	UPCC02	Fillets without Skin	< 0.00155	0.00155	< 0.000327	0.000327
	UPCC101	Fillets without Skin	< 0.00149	0.00149	< 0.000327	0.000327
	UPCC102	Fillets without Skin	< 0.00154	0.00154	< 0.000328	0.000328
	UPCC103	Fillets without Skin	< 0.00137	0.00137	< 0.000330	0.000330
benzo(e)pyrene						
	LACA01	Fillets with Skin	< 0.00168	0.00168	< 0.000467	0.000467
	LALB01	Fillets with Skin	< 0.00228	0.00228	< 0.000472	0.000472

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LASF01	Fillets with Skin	< 0.00231	0.00231	< 0.000460	0.000460
	LPCA01	Fillets with Skin	< 0.00192	0.00192	< 0.000453	0.000453
	LPLB01	Fillets with Skin	< 0.00205	0.00205	< 0.000470	0.000470
	LPSB01	Fillets with Skin	< 0.00215	0.00215	< 0.000421	0.000421
	LPSF01	Fillets with Skin	< 0.00254	0.00254	< 0.000432	0.000432
	UACA01	Fillets with Skin	< 0.00161	0.00161	< 0.000450	0.000450
	UALB01	Fillets with Skin	< 0.00206	0.00206	< 0.000461	0.000461
	UASF01	Fillets with Skin	< 0.00223	0.00223	< 0.000459	0.000459
	UPCA01	Fillets with Skin	< 0.00150	0.00150	< 0.000439	0.000439
	UPLB01	Fillets with Skin	< 0.00226	0.00226	< 0.000462	0.000462
	UPSF01	Fillets with Skin	< 0.00232	0.00232	< 0.000454	0.000454
	LAAE01	Fillets without Skin	< 0.00121	0.00121	< 0.000447	0.000447
	LABC01	Fillets without Skin	< 0.00213	0.00213	< 0.000468	0.000468
	LACC01	Fillets without Skin	< 0.00204	0.00204	< 0.000442	0.000442
	LPAE01	Fillets without Skin	< 0.00140	0.00140	< 0.000474	0.000474
	LPAE02	Fillets without Skin	< 0.00168	0.00168	< 0.000466	0.000466
	LPBC01	Fillets without Skin	< 0.00210	0.00210	< 0.000446	0.000446
	LPBC02	Fillets without Skin	< 0.00246	0.00246	< 0.000417	0.000417
	LPBC03	Fillets without Skin	< 0.00195	0.00195	< 0.000413	0.000413
	LPBC04	Fillets without Skin	< 0.00204	0.00204	< 0.000477	0.000477
	LPCC01	Fillets without Skin	< 0.00250	0.00250	< 0.000478	0.000478
	UAAE01	Fillets without	< 0.00119	0.00119	< 0.000446	0.000446

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	< 0.00218	0.00218	< 0.000457	0.000457
	UACC01	Fillets without Skin	< 0.00191	0.00191	< 0.000437	0.000437
	UPAE01	Fillets without Skin	< 0.00126	0.00126	< 0.000422	0.000422
	UPCC01	Fillets without Skin	< 0.00218	0.00218	< 0.000469	0.000469
	UPCC02	Fillets without Skin	< 0.00222	0.00222	< 0.000469	0.000469
	UPCC101	Fillets without Skin	< 0.00214	0.00214	< 0.000468	0.000468
	UPCC102	Fillets without Skin	< 0.00220	0.00220	< 0.000470	0.000470
	UPCC103	Fillets without Skin	< 0.00196	0.00196	< 0.000472	0.000472
benzo(g,h,i)perylene						
	LACA01	Fillets with Skin	< 0.00188	0.00188	< 0.000525	0.000525
	LALB01	Fillets with Skin	< 0.00257	0.00257	< 0.000532	0.000532
	LASF01	Fillets with Skin	< 0.00260	0.00260	< 0.000517	0.000517
	LPCA01	Fillets with Skin	< 0.00216	0.00216	< 0.000509	0.000509
	LPLB01	Fillets with Skin	< 0.00231	0.00231	< 0.000528	0.000528
	LPSB01	Fillets with Skin	< 0.00242	0.00242	< 0.000474	0.000474
	LPSF01	Fillets with Skin	< 0.00285	0.00285	< 0.000486	0.000486
	UACA01	Fillets with Skin	< 0.00182	0.00182	< 0.000507	0.000507
	UALB01	Fillets with Skin	< 0.00232	0.00232	< 0.000518	0.000518
	UASF01	Fillets with Skin	< 0.00251	0.00251	< 0.000516	0.000516
	UPCA01	Fillets with Skin	< 0.00169	0.00169	< 0.000494	0.000494
	UPLB01	Fillets with Skin	< 0.00255	0.00255	< 0.000520	0.000520
	UPSF01	Fillets with Skin	< 0.00261	0.00261	< 0.000510	0.000510

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	< 0.00136	0.00136	< 0.000503	0.000503
	LABC01	Fillets without Skin	< 0.00239	0.00239	< 0.000526	0.000526
	LACC01	Fillets without Skin	< 0.00230	0.00230	< 0.000497	0.000497
	LPAE01	Fillets without Skin	< 0.00158	0.00158	< 0.000534	0.000534
	LPAE02	Fillets without Skin	< 0.00189	0.00189	< 0.000524	0.000524
	LPBC01	Fillets without Skin	< 0.00237	0.00237	< 0.000502	0.000502
	LPBC02	Fillets without Skin	< 0.00277	0.00277	< 0.000469	0.000469
	LPBC03	Fillets without Skin	< 0.00220	0.00220	< 0.000465	0.000465
	LPBC04	Fillets without Skin	< 0.00230	0.00230	< 0.000537	0.000537
	LPCC01	Fillets without Skin	< 0.00282	0.00282	< 0.000538	0.000538
	UAAE01	Fillets without Skin	< 0.00134	0.00134	< 0.000502	0.000502
	UABC01	Fillets without Skin	< 0.00245	0.00245	< 0.000514	0.000514
	UACC01	Fillets without Skin	< 0.00215	0.00215	< 0.000492	0.000492
	UPAE01	Fillets without Skin	< 0.00141	0.00141	< 0.000474	0.000474
	UPCC01	Fillets without Skin	< 0.00245	0.00245	< 0.000527	0.000527
	UPCC02	Fillets without Skin	< 0.00250	0.00250	< 0.000527	0.000527
	UPCC101	Fillets without Skin	< 0.00240	0.00240	< 0.000526	0.000526

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	< 0.00247	0.00247	< 0.000528	0.000528
	UPCC103	Fillets without Skin	< 0.00220	0.00220	< 0.000532	0.000532
benzo(k)fluoranthene						
	LACA01	Fillets with Skin	< 0.00145	0.00145	< 0.000404	0.000404
	LALB01	Fillets with Skin	< 0.00198	0.00198	< 0.000409	0.000409
	LASF01	Fillets with Skin	< 0.00200	0.00200	< 0.000398	0.000398
	LPCA01	Fillets with Skin	< 0.00166	0.00166	< 0.000392	0.000392
	LPLB01	Fillets with Skin	< 0.00178	0.00178	< 0.000407	0.000407
	LPSB01	Fillets with Skin	< 0.00186	0.00186	< 0.000364	0.000364
	LPSF01	Fillets with Skin	< 0.00220	0.00220	< 0.000374	0.000374
	UACA01	Fillets with Skin	< 0.00140	0.00140	< 0.000390	0.000390
	UALB01	Fillets with Skin	< 0.00179	0.00179	< 0.000399	0.000399
	UASF01	Fillets with Skin	< 0.00193	0.00193	< 0.000397	0.000397
	UPCA01	Fillets with Skin	< 0.00130	0.00130	< 0.000380	0.000380
	UPLB01	Fillets with Skin	< 0.00196	0.00196	< 0.000400	0.000400
	UPSF01	Fillets with Skin	< 0.00200	0.00200	< 0.000393	0.000393
	LAAE01	Fillets without Skin	< 0.00105	0.00105	< 0.000387	0.000387
	LABC01	Fillets without Skin	< 0.00184	0.00184	< 0.000405	0.000405
	LACC01	Fillets without Skin	< 0.00177	0.00177	< 0.000383	0.000383
	LPAE01	Fillets without Skin	< 0.00122	0.00122	< 0.000411	0.000411
	LPAE02	Fillets without Skin	< 0.00145	0.00145	< 0.000404	0.000404
	LPBC01	Fillets without Skin	< 0.00182	0.00182	< 0.000386	0.000386
	LPBC02	Fillets without Skin	< 0.00213	0.00213	< 0.000361	0.000361

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	< 0.00169	0.00169	< 0.000358	0.000358
	LPBC04	Fillets without Skin	< 0.00177	0.00177	< 0.000413	0.000413
	LPCC01	Fillets without Skin	< 0.00217	0.00217	< 0.000414	0.000414
	UAAE01	Fillets without Skin	< 0.00103	0.00103	< 0.000386	0.000386
	UABC01	Fillets without Skin	< 0.00189	0.00189	< 0.000396	0.000396
	UACC01	Fillets without Skin	< 0.00165	0.00165	< 0.000378	0.000378
	UPAE01	Fillets without Skin	< 0.00109	0.00109	< 0.000365	0.000365
	UPCC01	Fillets without Skin	< 0.00188	0.00188	< 0.000406	0.000406
	UPCC02	Fillets without Skin	< 0.00192	0.00192	< 0.000406	0.000406
	UPCC101	Fillets without Skin	< 0.00185	0.00185	< 0.000405	0.000405
	UPCC102	Fillets without Skin	< 0.00190	0.00190	< 0.000407	0.000407
	UPCC103	Fillets without Skin	< 0.00170	0.00170	< 0.000409	0.000409
beta BHC						
	LACA01	Fillets with Skin	< 0.000909	0.000909	< 0.000253	0.000253
	LALB01	Fillets with Skin	< 0.00124	0.00124	< 0.000256	0.000256
	*LASF01	Fillets with Skin	< 0.00125	0.00125	< 0.000249	0.000249
	LPCA01	Fillets with Skin	< 0.00104	0.00104	< 0.000246	0.000246
	LPLB01	Fillets with Skin	< 0.00111	0.00111	< 0.000255	0.000255
	LPSB01	Fillets with Skin	< 0.00116	0.00116	< 0.000228	0.000228
	*LPSF01	Fillets with Skin	< 0.00138	0.00138	< 0.000235	0.000235
	UACA01	Fillets with Skin	< 0.000876	0.000876	< 0.000244	0.000244

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	< 0.00112	0.00112	< 0.000250	0.000250
	UASF01	Fillets with Skin	< 0.00121	0.00121	< 0.000249	0.000249
	UPCA01	Fillets with Skin	< 0.000817	0.000817	< 0.000238	0.000238
	UPLB01	Fillets with Skin	< 0.00123	0.00123	< 0.000251	0.000251
	UPSF01	Fillets with Skin	< 0.00126	0.00126	< 0.000246	0.000246
	LAAE01	Fillets without Skin	< 0.000657	0.000657	< 0.000242	0.000242
	LABC01	Fillets without Skin	< 0.00115	0.00115	< 0.000254	0.000254
	LACC01	Fillets without Skin	< 0.00111	0.00111	< 0.000240	0.000240
	LPAE01	Fillets without Skin	< 0.000763	0.000763	< 0.000257	0.000257
	LPAE02	Fillets without Skin	< 0.000910	0.000910	< 0.000253	0.000253
	LPBC01	Fillets without Skin	< 0.00114	0.00114	< 0.000242	0.000242
	LPBC02	Fillets without Skin	< 0.00133	0.00133	< 0.000226	0.000226
	LPBC03	Fillets without Skin	< 0.00106	0.00106	< 0.000224	0.000224
	LPBC04	Fillets without Skin	< 0.00111	0.00111	< 0.000259	0.000259
	LPCC01	Fillets without Skin	< 0.00136	0.00136	< 0.000259	0.000259
	UAAE01	Fillets without Skin	0.00102	0.000646	0.000384	0.000242
	UABC01	Fillets without Skin	< 0.00118	0.00118	< 0.000248	0.000248
	UACC01	Fillets without Skin	< 0.00103	0.00103	< 0.000237	0.000237
	UPAE01	Fillets without Skin	< 0.000681	0.000681	< 0.000229	0.000229

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	< 0.00118	0.00118	< 0.000254	0.000254
	UPCC02	Fillets without Skin	< 0.00120	0.00120	< 0.000254	0.000254
	UPCC101	Fillets without Skin	< 0.00116	0.00116	< 0.000254	0.000254
	UPCC102	Fillets without Skin	< 0.00119	0.00119	< 0.000255	0.000255
	UPCC103	Fillets without Skin	< 0.00106	0.00106	< 0.000256	0.000256
biphenyl						
	LACA01	Fillets with Skin	0.0140	0.00260	0.00390	0.000725
	LALB01	Fillets with Skin	0.00387	0.00355	0.000800	0.000733
	LASF01	Fillets with Skin	< 0.00358	0.00358	< 0.000713	0.000713
	LPCA01	Fillets with Skin	0.00509	0.00298	0.00120	0.000703
	LPLB01	Fillets with Skin	0.00393	0.00319	0.000900	0.000729
	LPSB01	Fillets with Skin	< 0.00333	0.00333	< 0.000653	0.000653
	LPSF01	Fillets with Skin	< 0.00394	0.00394	< 0.000671	0.000671
	UACA01	Fillets with Skin	0.0100	0.00251	0.00280	0.000699
	UALB01	Fillets with Skin	< 0.00320	0.00320	< 0.000715	0.000715
	UASF01	Fillets with Skin	< 0.00346	0.00346	< 0.000712	0.000712
	UPCA01	Fillets with Skin	0.0192	0.00234	0.00560	0.000681
	UPLB01	Fillets with Skin	< 0.00351	0.00351	< 0.000718	0.000718
	UPSF01	Fillets with Skin	0.00408	0.00359	0.000800	0.000704
	LAAE01	Fillets without Skin	0.00271	0.00188	0.00100	0.000693
	LABC01	Fillets without Skin	0.00546	0.00330	0.00120	0.000726
	LACC01	Fillets without Skin	0.00784	0.00316	0.00170	0.000686
	LPAE01	Fillets without Skin	< 0.00218	0.00218	< 0.000736	0.000736

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	0.00324	0.00260	0.000900	0.000723
	LPBC01	Fillets without Skin	0.0189	0.00327	0.00400	0.000692
	LPBC02	Fillets without Skin	0.00413	0.00382	0.000700	0.000647
	LPBC03	Fillets without Skin	0.00519	0.00303	0.00110	0.000642
	LPBC04	Fillets without Skin	0.00642	0.00317	0.00150	0.000741
	LPCC01	Fillets without Skin	0.00524	0.00389	0.00100	0.000742
	UAAE01	Fillets without Skin	0.00267	0.00185	0.00100	0.000692
	UABC01	Fillets without Skin	0.00763	0.00338	0.00160	0.000709
	UACC01	Fillets without Skin	0.00698	0.00296	0.00160	0.000678
	UPAE01	Fillets without Skin	0.00447	0.00195	0.00150	0.000654
	UPCC01	Fillets without Skin	0.00928	0.00338	0.00200	0.000727
	UPCC02	Fillets without Skin	0.0118	0.00345	0.00250	0.000727
	UPCC101	Fillets without Skin	0.00913	0.00332	0.00200	0.000726
	UPCC102	Fillets without Skin	0.00702	0.00341	0.00150	0.000729
	UPCC103	Fillets without Skin	0.00581	0.00304	0.00140	0.000733
chlorpyrifos						
	LACA01	Fillets with Skin	0.0175	0.000830	0.00488	0.000231
	LALB01	Fillets with Skin	0.00220	0.00113	0.000454	0.000234

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	0.00142	0.00114	0.000282	0.000228
	LPCA01	Fillets with Skin	0.00384	0.000951	0.000904	0.000224
	LPLB01	Fillets with Skin	0.00137	0.00102	0.000314	0.000233
	LPSB01	Fillets with Skin	< 0.00106	0.00106	< 0.000208	0.000208
	*LPSF01	Fillets with Skin	< 0.00126	0.00126	< 0.000214	0.000214
	UACA01	Fillets with Skin	0.0180	0.000800	0.00501	0.000223
	UALB01	Fillets with Skin	0.00350	0.00102	0.000781	0.000228
	UASF01	Fillets with Skin	0.00347	0.00110	0.000714	0.000227
	UPCA01	Fillets with Skin	0.00719	0.000745	0.00210	0.000217
	UPLB01	Fillets with Skin	< 0.00112	0.00112	< 0.000229	0.000229
	UPSF01	Fillets with Skin	< 0.00115	0.00115	< 0.000225	0.000225
	LAAE01	Fillets without Skin	0.0300	0.000600	0.0111	0.000221
	LABC01	Fillets without Skin	0.00378	0.00105	0.000831	0.000232
	LACC01	Fillets without Skin	0.00663	0.00101	0.00144	0.000219
	LPAE01	Fillets without Skin	0.0106	0.000696	0.00358	0.000235
	LPAE02	Fillets without Skin	0.00325	0.000831	0.000903	0.000231
	LPBC01	Fillets without Skin	0.00578	0.00104	0.00123	0.000221
	LPBC02	Fillets without Skin	< 0.00122	0.00122	< 0.000207	0.000207
	LPBC03	Fillets without Skin	0.00182	0.000967	0.000385	0.000205
	LPBC04	Fillets without Skin	0.00546	0.00101	0.00128	0.000236
	LPCC01	Fillets without Skin	< 0.00124	0.00124	< 0.000237	0.000237
	UAAE01	Fillets without	0.0791	0.000590	0.0297	0.000221

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.00688	0.00108	0.00144	0.000226
	UACC01	Fillets without Skin	0.00789	0.000944	0.00181	0.000216
	UPAE01	Fillets without Skin	0.00284	0.000622	0.000954	0.000209
	UPCC01	Fillets without Skin	0.00323	0.00108	0.000695	0.000232
	UPCC02	Fillets without Skin	0.00582	0.00110	0.00123	0.000232
	UPCC101	Fillets without Skin	0.00576	0.00106	0.00126	0.000232
	UPCC102	Fillets without Skin	0.00310	0.00109	0.000662	0.000233
	UPCC103	Fillets without Skin	0.00185	0.000970	0.000446	0.000234
chrysene						
	LACA01	Fillets with Skin	0.00538	0.00165	0.00150	0.000461
	LALB01	Fillets with Skin	< 0.00226	0.00226	< 0.000466	0.000466
	LASF01	Fillets with Skin	0.00352	0.00228	0.000700	0.000454
	LPCA01	Fillets with Skin	0.00297	0.00190	0.000700	0.000447
	LPLB01	Fillets with Skin	< 0.00203	0.00203	< 0.000464	0.000464
	LPSB01	Fillets with Skin	< 0.00212	0.00212	< 0.000415	0.000415
	LPSF01	Fillets with Skin	< 0.00250	0.00250	< 0.000427	0.000427
	UACA01	Fillets with Skin	0.00430	0.00159	0.00120	0.000444
	UALB01	Fillets with Skin	< 0.00204	0.00204	< 0.000455	0.000455
	UASF01	Fillets with Skin	< 0.00220	0.00220	< 0.000453	0.000453
	UPCA01	Fillets with Skin	0.00309	0.00149	0.000900	0.000433
	UPLB01	Fillets with Skin	< 0.00223	0.00223	< 0.000456	0.000456
	UPSF01	Fillets with Skin	< 0.00229	0.00229	< 0.000448	0.000448

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	0.00569	0.00120	0.00210	0.000441
	LABC01	Fillets without Skin	0.00954	0.00210	0.00210	0.000462
	LACC01	Fillets without Skin	0.0175	0.00201	0.00380	0.000436
	LPAE01	Fillets without Skin	0.00208	0.00139	0.000700	0.000468
	LPAE02	Fillets without Skin	0.00180	0.00166	0.000500	0.000460
	LPBC01	Fillets without Skin	0.0151	0.00208	0.00320	0.000440
	LPBC02	Fillets without Skin	< 0.00243	0.00243	< 0.000412	0.000412
	LPBC03	Fillets without Skin	0.00283	0.00193	0.000600	0.000408
	LPBC04	Fillets without Skin	0.00514	0.00202	0.00120	0.000471
	LPCC01	Fillets without Skin	0.00733	0.00247	0.00140	0.000472
	UAAE01	Fillets without Skin	0.00160	0.00117	0.000600	0.000440
	UABC01	Fillets without Skin	0.00667	0.00215	0.00140	0.000451
	UACC01	Fillets without Skin	0.00916	0.00188	0.00210	0.000431
	UPAE01	Fillets without Skin	0.00238	0.00124	0.000800	0.000416
	UPCC01	Fillets without Skin	0.00464	0.00215	0.00100	0.000463
	UPCC02	Fillets without Skin	0.00426	0.00219	0.000900	0.000463
	UPCC101	Fillets without Skin	0.00639	0.00211	0.00140	0.000462

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	0.00328	0.00217	0.000700	0.000464
	UPCC103	Fillets without Skin	0.00373	0.00193	0.000900	0.000466
cis-nonachlor						
	LACA01	Fillets with Skin	0.0817	0.000477	0.0228	0.000133
	LALB01	Fillets with Skin	0.0244	0.000651	0.00504	0.000135
	*LASF01	Fillets with Skin	0.00392	0.000658	0.000780	0.000131
	LPCA01	Fillets with Skin	0.0342	0.000547	0.00808	0.000129
	LPLB01	Fillets with Skin	0.0114	0.000585	0.00260	0.000134
	LPSB01	Fillets with Skin	0.00946	0.000612	0.00185	0.000120
	*LPSF01	Fillets with Skin	0.00373	0.000722	0.000636	0.000123
	UACA01	Fillets with Skin	0.100	0.000460	0.0280	0.000128
	UALB01	Fillets with Skin	0.0222	0.000588	0.00495	0.000131
	UASF01	Fillets with Skin	0.0128	0.000635	0.00264	0.000131
	UPCA01	Fillets with Skin	0.0604	0.000429	0.0176	0.000125
	UPLB01	Fillets with Skin	0.0102	0.000645	0.00208	0.000132
	UPSF01	Fillets with Skin	0.00237	0.000660	0.000465	0.000129
	*LAAE01	Fillets without Skin	0.124	0.000345	0.0457	0.000127
	LABC01	Fillets without Skin	0.0484	0.000606	0.0107	0.000133
	LACC01	Fillets without Skin	0.0997	0.000581	0.0216	0.000126
	*LPAE01	Fillets without Skin	0.158	0.000401	0.0534	0.000135
	LPAE02	Fillets without Skin	0.0589	0.000478	0.0164	0.000133
	LPBC01	Fillets without Skin	0.0665	0.000600	0.0141	0.000127
	LPBC02	Fillets without Skin	0.0676	0.000701	0.0115	0.000119

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	0.0669	0.000556	0.0142	0.000118
	LPBC04	Fillets without Skin	0.114	0.000582	0.0267	0.000136
	LPCC01	Fillets without Skin	0.0247	0.000714	0.00472	0.000136
	*UAAE01	Fillets without Skin	0.124	0.000340	0.0465	0.000127
	UABC01	Fillets without Skin	0.0691	0.000621	0.0145	0.000130
	UACC01	Fillets without Skin	0.0813	0.000543	0.0186	0.000125
	UPAE01	Fillets without Skin	0.0704	0.000358	0.0236	0.000120
	UPCC01	Fillets without Skin	0.0283	0.000620	0.00609	0.000134
	UPCC02	Fillets without Skin	0.0357	0.000633	0.00753	0.000134
	UPCC101	Fillets without Skin	0.0232	0.000609	0.00507	0.000133
	UPCC102	Fillets without Skin	0.0268	0.000627	0.00572	0.000134
	UPCC103	Fillets without Skin	0.0368	0.000558	0.00886	0.000135
delta BHC						
	LACA01	Fillets with Skin	< 0.00100	0.00100	< 0.000280	0.000280
	LALB01	Fillets with Skin	< 0.00137	0.00137	< 0.000283	0.000283
	*LASF01	Fillets with Skin	< 0.00138	0.00138	< 0.000276	0.000276
	LPCA01	Fillets with Skin	< 0.00115	0.00115	< 0.000271	0.000271
	LPLB01	Fillets with Skin	< 0.00123	0.00123	< 0.000282	0.000282
	LPSB01	Fillets with Skin	< 0.00129	0.00129	< 0.000252	0.000252
	*LPSF01	Fillets with Skin	< 0.00152	0.00152	< 0.000259	0.000259
	UACA01	Fillets with Skin	< 0.000968	0.000968	< 0.000270	0.000270

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	< 0.00124	0.00124	< 0.000276	0.000276
	UASF01	Fillets with Skin	< 0.00134	0.00134	< 0.000275	0.000275
	UPCA01	Fillets with Skin	< 0.000902	0.000902	< 0.000263	0.000263
	UPLB01	Fillets with Skin	< 0.00136	0.00136	< 0.000277	0.000277
	UPSF01	Fillets with Skin	< 0.00139	0.00139	< 0.000272	0.000272
	LAAE01	Fillets without Skin	< 0.000726	0.000726	< 0.000268	0.000268
	LABC01	Fillets without Skin	< 0.00128	0.00128	< 0.000280	0.000280
	LACC01	Fillets without Skin	< 0.00122	0.00122	< 0.000265	0.000265
	LPAE01	Fillets without Skin	< 0.000843	0.000843	< 0.000284	0.000284
	LPAE02	Fillets without Skin	< 0.00101	0.00101	< 0.000279	0.000279
	LPBC01	Fillets without Skin	< 0.00126	0.00126	< 0.000267	0.000267
	LPBC02	Fillets without Skin	< 0.00148	0.00148	< 0.000250	0.000250
	LPBC03	Fillets without Skin	< 0.00117	0.00117	< 0.000248	0.000248
	LPBC04	Fillets without Skin	< 0.00122	0.00122	< 0.000286	0.000286
	LPCC01	Fillets without Skin	< 0.00150	0.00150	< 0.000287	0.000287
	UAAE01	Fillets without Skin	< 0.000714	0.000714	< 0.000268	0.000268
	UABC01	Fillets without Skin	< 0.00131	0.00131	< 0.000274	0.000274
	UACC01	Fillets without Skin	< 0.00114	0.00114	< 0.000262	0.000262
	UPAE01	Fillets without Skin	< 0.000752	0.000752	< 0.000253	0.000253

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	< 0.00130	0.00130	< 0.000281	0.000281
	UPCC02	Fillets without Skin	< 0.00133	0.00133	< 0.000281	0.000281
	UPCC101	Fillets without Skin	< 0.00128	0.00128	< 0.000280	0.000280
	UPCC102	Fillets without Skin	< 0.00132	0.00132	< 0.000282	0.000282
	UPCC103	Fillets without Skin	< 0.00118	0.00118	< 0.000283	0.000283
dibenzothiophene						
	LACA01	Fillets with Skin	0.0100	0.00120	0.00280	0.000334
	LALB01	Fillets with Skin	< 0.00164	0.00164	< 0.000338	0.000338
	LASF01	Fillets with Skin	< 0.00165	0.00165	< 0.000329	0.000329
	LPCA01	Fillets with Skin	0.00551	0.00137	0.00130	0.000324
	LPLB01	Fillets with Skin	< 0.00147	0.00147	< 0.000336	0.000336
	LPSB01	Fillets with Skin	< 0.00154	0.00154	< 0.000301	0.000301
	LPSF01	Fillets with Skin	< 0.00181	0.00181	< 0.000309	0.000309
	UACA01	Fillets with Skin	0.00753	0.00116	0.00210	0.000322
	UALB01	Fillets with Skin	< 0.00148	0.00148	< 0.000329	0.000329
	UASF01	Fillets with Skin	0.00194	0.00159	0.000400	0.000328
	UPCA01	Fillets with Skin	0.0154	0.00108	0.00450	0.000314
	UPLB01	Fillets with Skin	< 0.00162	0.00162	< 0.000331	0.000331
	UPSF01	Fillets with Skin	< 0.00166	0.00166	< 0.000324	0.000324
	LAAE01	Fillets without Skin	0.00163	0.000866	0.000600	0.000320
	LABC01	Fillets without Skin	0.00318	0.00152	0.000700	0.000335
	LACC01	Fillets without Skin	0.00600	0.00146	0.00130	0.000316
	LPAE01	Fillets without Skin	< 0.00101	0.00101	< 0.000339	0.000339

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 0.00120	0.00120	< 0.000333	0.000333
	LPBC01	Fillets without Skin	0.00283	0.00151	0.000600	0.000319
	LPBC02	Fillets without Skin	< 0.00176	0.00176	< 0.000298	0.000298
	LPBC03	Fillets without Skin	< 0.00140	0.00140	< 0.000296	0.000296
	LPBC04	Fillets without Skin	0.00214	0.00146	0.000500	0.000341
	LPCC01	Fillets without Skin	0.00314	0.00179	0.000600	0.000342
	UAAE01	Fillets without Skin	0.00160	0.000851	0.000600	0.000319
	UABC01	Fillets without Skin	0.00286	0.00156	0.000600	0.000327
	UACC01	Fillets without Skin	0.00349	0.00136	0.000800	0.000313
	UPAE01	Fillets without Skin	< 0.000898	0.000898	< 0.000302	0.000302
	UPCC01	Fillets without Skin	0.00371	0.00156	0.000800	0.000335
	UPCC02	Fillets without Skin	0.00284	0.00159	0.000600	0.000335
	UPCC101	Fillets without Skin	0.00776	0.00153	0.00170	0.000335
	UPCC102	Fillets without Skin	0.00468	0.00157	0.00100	0.000336
	UPCC103	Fillets without Skin	0.00207	0.00140	0.000500	0.000338
dieldrin						
	LACA01	Fillets with Skin	0.0738	0.00133	0.0206	0.000371
	LALB01	Fillets with Skin	0.0129	0.00182	0.00268	0.000375

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	0.00420	0.00184	0.000836	0.000365
	LPCA01	Fillets with Skin	0.0391	0.00152	0.00923	0.000360
	LPLB01	Fillets with Skin	0.00882	0.00163	0.00202	0.000373
	LPSB01	Fillets with Skin	0.00745	0.00170	0.00146	0.000334
	*LPSF01	Fillets with Skin	0.00373	0.00201	0.000636	0.000343
	UACA01	Fillets with Skin	0.0751	0.00128	0.0209	0.000358
	UALB01	Fillets with Skin	0.0136	0.00164	0.00304	0.000366
	UASF01	Fillets with Skin	0.0122	0.00177	0.00252	0.000365
	UPCA01	Fillets with Skin	0.0908	0.00120	0.0264	0.000348
	UPLB01	Fillets with Skin	0.00396	0.00180	0.000810	0.000367
	UPSF01	Fillets with Skin	0.00292	0.00184	0.000571	0.000360
	*LAAE01	Fillets without Skin	0.126	0.000962	0.0465	0.000355
	LABC01	Fillets without Skin	0.0588	0.00169	0.0129	0.000372
	LACC01	Fillets without Skin	0.0450	0.00162	0.00976	0.000351
	LPAE01	Fillets without Skin	0.102	0.00112	0.0344	0.000377
	LPAE02	Fillets without Skin	0.0315	0.00133	0.00874	0.000370
	LPBC01	Fillets without Skin	0.0373	0.00167	0.00790	0.000354
	LPBC02	Fillets without Skin	0.00637	0.00195	0.00108	0.000331
	LPBC03	Fillets without Skin	0.0111	0.00155	0.00235	0.000329
	LPBC04	Fillets without Skin	0.0560	0.00162	0.0131	0.000379
	LPCC01	Fillets without Skin	0.00893	0.00199	0.00170	0.000380
	*UAAE01	Fillets without	0.293	0.000947	0.110	0.000355

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.0404	0.00173	0.00847	0.000363
	UACC01	Fillets without Skin	0.0465	0.00152	0.0107	0.000347
	UPAE01	Fillets without Skin	0.101	0.000997	0.0341	0.000335
	UPCC01	Fillets without Skin	0.0290	0.00173	0.00624	0.000372
	UPCC02	Fillets without Skin	0.0288	0.00176	0.00609	0.000372
	UPCC101	Fillets without Skin	0.0395	0.00170	0.00866	0.000372
	UPCC102	Fillets without Skin	0.0187	0.00175	0.00399	0.000373
	UPCC103	Fillets without Skin	0.0244	0.00156	0.00589	0.000375
endosulfan I						
	LACA01	Fillets with Skin	< 0.00142	0.00142	< 0.000395	0.000395
	LALB01	Fillets with Skin	< 0.00193	0.00193	< 0.000399	0.000399
	*LASF01	Fillets with Skin	< 0.00195	0.00195	< 0.000389	0.000389
	LPCA01	Fillets with Skin	< 0.00162	0.00162	< 0.000383	0.000383
	LPLB01	Fillets with Skin	< 0.00174	0.00174	< 0.000397	0.000397
	LPSB01	Fillets with Skin	< 0.00181	0.00181	< 0.000356	0.000356
	*LPSF01	Fillets with Skin	< 0.00214	0.00214	< 0.000365	0.000365
	UACA01	Fillets with Skin	< 0.00136	0.00136	< 0.000381	0.000381
	UALB01	Fillets with Skin	< 0.00174	0.00174	< 0.000389	0.000389
	UASF01	Fillets with Skin	< 0.00188	0.00188	< 0.000388	0.000388
	UPCA01	Fillets with Skin	< 0.00127	0.00127	< 0.000371	0.000371
	UPLB01	Fillets with Skin	< 0.00191	0.00191	< 0.000391	0.000391
	UPSF01	Fillets with Skin	< 0.00196	0.00196	< 0.000384	0.000384

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	< 0.00102	0.00102	< 0.000378	0.000378
	LABC01	Fillets without Skin	< 0.00180	0.00180	< 0.000396	0.000396
	LACC01	Fillets without Skin	< 0.00172	0.00172	< 0.000374	0.000374
	LPAE01	Fillets without Skin	< 0.00119	0.00119	< 0.000401	0.000401
	LPAE02	Fillets without Skin	< 0.00142	0.00142	< 0.000394	0.000394
	LPBC01	Fillets without Skin	< 0.00178	0.00178	< 0.000377	0.000377
	LPBC02	Fillets without Skin	< 0.00208	0.00208	< 0.000353	0.000353
	LPBC03	Fillets without Skin	< 0.00165	0.00165	< 0.000350	0.000350
	LPBC04	Fillets without Skin	< 0.00173	0.00173	< 0.000403	0.000403
	LPCC01	Fillets without Skin	< 0.00212	0.00212	< 0.000404	0.000404
	UAAE01	Fillets without Skin	< 0.00101	0.00101	< 0.000378	0.000378
	UABC01	Fillets without Skin	< 0.00184	0.00184	< 0.000386	0.000386
	UACC01	Fillets without Skin	< 0.00161	0.00161	< 0.000369	0.000369
	UPAE01	Fillets without Skin	< 0.00106	0.00106	< 0.000356	0.000356
	UPCC01	Fillets without Skin	< 0.00184	0.00184	< 0.000396	0.000396
	UPCC02	Fillets without Skin	< 0.00188	0.00188	< 0.000396	0.000396
	UPCC101	Fillets without Skin	< 0.00181	0.00181	< 0.000396	0.000396

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	< 0.00186	0.00186	< 0.000397	0.000397
	UPCC103	Fillets without Skin	< 0.00166	0.00166	< 0.000399	0.000399
endosulfan II						
	LACA01	Fillets with Skin	< 0.00135	0.00135	< 0.000376	0.000376
	LALB01	Fillets with Skin	< 0.00184	0.00184	< 0.000380	0.000380
	*LASF01	Fillets with Skin	< 0.00186	0.00186	< 0.000370	0.000370
	LPCA01	Fillets with Skin	< 0.00154	0.00154	< 0.000364	0.000364
	LPLB01	Fillets with Skin	< 0.00165	0.00165	< 0.000378	0.000378
	LPSB01	Fillets with Skin	< 0.00173	0.00173	< 0.000339	0.000339
	*LPSF01	Fillets with Skin	< 0.00204	0.00204	< 0.000348	0.000348
	UACA01	Fillets with Skin	< 0.00130	0.00130	< 0.000362	0.000362
	UALB01	Fillets with Skin	0.00838	0.00166	0.00187	0.000371
	UASF01	Fillets with Skin	< 0.00179	0.00179	< 0.000369	0.000369
	UPCA01	Fillets with Skin	< 0.00121	0.00121	< 0.000353	0.000353
	UPLB01	Fillets with Skin	< 0.00182	0.00182	< 0.000372	0.000372
	UPSF01	Fillets with Skin	< 0.00186	0.00186	< 0.000365	0.000365
	LAAE01	Fillets without Skin	< 0.000975	0.000975	< 0.000360	0.000360
	LABC01	Fillets without Skin	< 0.00171	0.00171	< 0.000376	0.000376
	LACC01	Fillets without Skin	< 0.00164	0.00164	< 0.000356	0.000356
	LPAE01	Fillets without Skin	< 0.00113	0.00113	< 0.000382	0.000382
	LPAE02	Fillets without Skin	< 0.00135	0.00135	< 0.000375	0.000375
	LPBC01	Fillets without Skin	< 0.00169	0.00169	< 0.000359	0.000359
	LPBC02	Fillets without Skin	< 0.00198	0.00198	< 0.000336	0.000336

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	< 0.00157	0.00157	< 0.000333	0.000333
	LPBC04	Fillets without Skin	< 0.00164	0.00164	< 0.000384	0.000384
	LPCC01	Fillets without Skin	< 0.00202	0.00202	< 0.000385	0.000385
	UAAE01	Fillets without Skin	< 0.000959	0.000959	< 0.000360	0.000360
	UABC01	Fillets without Skin	< 0.00175	0.00175	< 0.000368	0.000368
	UACC01	Fillets without Skin	< 0.00153	0.00153	< 0.000352	0.000352
	UPAE01	Fillets without Skin	< 0.00101	0.00101	< 0.000339	0.000339
	UPCC01	Fillets without Skin	< 0.00175	0.00175	< 0.000377	0.000377
	UPCC02	Fillets without Skin	< 0.00179	0.00179	< 0.000377	0.000377
	UPCC101	Fillets without Skin	< 0.00172	0.00172	< 0.000376	0.000376
	UPCC102	Fillets without Skin	< 0.00177	0.00177	< 0.000378	0.000378
	UPCC103	Fillets without Skin	< 0.00158	0.00158	< 0.000380	0.000380
endosulfan sulfate						
	LACA01	Fillets with Skin	0.0287	0.00148	0.00801	0.000414
	LALB01	Fillets with Skin	0.0236	0.00203	0.00488	0.000419
	*LASF01	Fillets with Skin	0.00326	0.00205	0.000648	0.000407
	LPCA01	Fillets with Skin	< 0.00170	0.00170	< 0.000401	0.000401
	LPLB01	Fillets with Skin	< 0.00182	0.00182	< 0.000416	0.000416
	LPSB01	Fillets with Skin	< 0.00190	0.00190	< 0.000373	0.000373
	*LPSF01	Fillets with Skin	< 0.00225	0.00225	< 0.000383	0.000383
	UACA01	Fillets with Skin	0.0413	0.00143	0.0115	0.000399

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	< 0.00183	0.00183	< 0.000408	0.000408
	UASF01	Fillets with Skin	0.00829	0.00198	0.00171	0.000407
	UPCA01	Fillets with Skin	< 0.00133	0.00133	< 0.000389	0.000389
	UPLB01	Fillets with Skin	< 0.00200	0.00200	< 0.000410	0.000410
	UPSF01	Fillets with Skin	0.00508	0.00205	0.000996	0.000402
	LAAE01	Fillets without Skin	0.0412	0.00107	0.0152	0.000396
	LABC01	Fillets without Skin	0.0214	0.00188	0.00472	0.000415
	LACC01	Fillets without Skin	0.0200	0.00181	0.00434	0.000392
	LPAE01	Fillets without Skin	< 0.00125	0.00125	< 0.000420	0.000420
	LPAE02	Fillets without Skin	< 0.00149	0.00149	< 0.000413	0.000413
	LPBC01	Fillets without Skin	< 0.00186	0.00186	< 0.000395	0.000395
	LPBC02	Fillets without Skin	< 0.00218	0.00218	< 0.000370	0.000370
	LPBC03	Fillets without Skin	< 0.00173	0.00173	< 0.000367	0.000367
	LPBC04	Fillets without Skin	< 0.00181	0.00181	< 0.000423	0.000423
	LPCC01	Fillets without Skin	< 0.00222	0.00222	< 0.000424	0.000424
	UAAE01	Fillets without Skin	0.0494	0.00106	0.0185	0.000396
	UABC01	Fillets without Skin	0.0303	0.00193	0.00636	0.000405
	UACC01	Fillets without Skin	0.0311	0.00169	0.00713	0.000387
	UPAE01	Fillets without Skin	< 0.00111	0.00111	< 0.000374	0.000374

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.0120	0.00193	0.00258	0.000415
	UPCC02	Fillets without Skin	0.0196	0.00197	0.00414	0.000415
	UPCC101	Fillets without Skin	0.00780	0.00189	0.00171	0.000415
	UPCC102	Fillets without Skin	0.0109	0.00195	0.00232	0.000416
	UPCC103	Fillets without Skin	0.0268	0.00174	0.00646	0.000419
endrin						
	LACA01	Fillets with Skin	< 0.00162	0.00162	< 0.000451	0.000451
	LALB01	Fillets with Skin	< 0.00221	0.00221	< 0.000457	0.000457
	*LASF01	Fillets with Skin	< 0.00223	0.00223	< 0.000444	0.000444
	LPCA01	Fillets with Skin	< 0.00186	0.00186	< 0.000438	0.000438
	LPLB01	Fillets with Skin	< 0.00198	0.00198	< 0.000454	0.000454
	LPSB01	Fillets with Skin	< 0.00208	0.00208	< 0.000407	0.000407
	*LPSF01	Fillets with Skin	< 0.00245	0.00245	< 0.000418	0.000418
	UACA01	Fillets with Skin	< 0.00156	0.00156	< 0.000435	0.000435
	UALB01	Fillets with Skin	< 0.00200	0.00200	< 0.000445	0.000445
	UASF01	Fillets with Skin	< 0.00215	0.00215	< 0.000444	0.000444
	UPCA01	Fillets with Skin	< 0.00146	0.00146	< 0.000424	0.000424
	UPLB01	Fillets with Skin	< 0.00219	0.00219	< 0.000447	0.000447
	UPSF01	Fillets with Skin	< 0.00224	0.00224	< 0.000439	0.000439
	LAAE01	Fillets without Skin	< 0.00117	0.00117	< 0.000432	0.000432
	LABC01	Fillets without Skin	< 0.00206	0.00206	< 0.000452	0.000452
	LACC01	Fillets without Skin	< 0.00197	0.00197	< 0.000427	0.000427
	LPAE01	Fillets without Skin	< 0.00136	0.00136	< 0.000459	0.000459

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 0.00162	0.00162	< 0.000451	0.000451
	LPBC01	Fillets without Skin	< 0.00204	0.00204	< 0.000431	0.000431
	LPBC02	Fillets without Skin	< 0.00238	0.00238	< 0.000403	0.000403
	LPBC03	Fillets without Skin	< 0.00189	0.00189	< 0.000400	0.000400
	LPBC04	Fillets without Skin	< 0.00198	0.00198	< 0.000461	0.000461
	LPCC01	Fillets without Skin	< 0.00242	0.00242	< 0.000462	0.000462
	UAAE01	Fillets without Skin	< 0.00115	0.00115	< 0.000432	0.000432
	UABC01	Fillets without Skin	< 0.00211	0.00211	< 0.000442	0.000442
	UACC01	Fillets without Skin	< 0.00184	0.00184	< 0.000423	0.000423
	UPAE01	Fillets without Skin	0.00248	0.00121	0.000833	0.000408
	UPCC01	Fillets without Skin	< 0.00210	0.00210	< 0.000453	0.000453
	UPCC02	Fillets without Skin	< 0.00215	0.00215	< 0.000453	0.000453
	UPCC101	Fillets without Skin	< 0.00206	0.00206	< 0.000452	0.000452
	UPCC102	Fillets without Skin	< 0.00213	0.00213	< 0.000454	0.000454
	UPCC103	Fillets without Skin	< 0.00189	0.00189	< 0.000457	0.000457
fluoranthene						
	LACA01	Fillets with Skin	0.0341	0.00109	0.00950	0.000303
	LALB01	Fillets with Skin	0.00629	0.00148	0.00130	0.000306

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LASF01	Fillets with Skin	0.0131	0.00150	0.00260	0.000298
	LPCA01	Fillets with Skin	0.0221	0.00124	0.00520	0.000294
	LPLB01	Fillets with Skin	0.00568	0.00133	0.00130	0.000305
	LPSB01	Fillets with Skin	0.00255	0.00139	0.000500	0.000273
	LPSF01	Fillets with Skin	0.00704	0.00164	0.00120	0.000280
	UACA01	Fillets with Skin	0.0445	0.00105	0.0124	0.000292
	UALB01	Fillets with Skin	0.00314	0.00134	0.000700	0.000299
	UASF01	Fillets with Skin	0.0102	0.00144	0.00210	0.000298
	UPCA01	Fillets with Skin	0.0323	0.000976	0.00940	0.000284
	UPLB01	Fillets with Skin	0.00294	0.00147	0.000600	0.000300
	UPSF01	Fillets with Skin	0.00664	0.00150	0.00130	0.000294
	LAAE01	Fillets without Skin	0.0247	0.000785	0.00910	0.000290
	LABC01	Fillets without Skin	0.0273	0.00138	0.00600	0.000303
	LACC01	Fillets without Skin	0.0323	0.00132	0.00700	0.000287
	LPAE01	Fillets without Skin	0.0127	0.000911	0.00430	0.000308
	LPAE02	Fillets without Skin	0.00972	0.00109	0.00270	0.000302
	LPBC01	Fillets without Skin	0.0175	0.00136	0.00370	0.000289
	LPBC02	Fillets without Skin	0.00236	0.00160	0.000400	0.000271
	LPBC03	Fillets without Skin	0.00566	0.00127	0.00120	0.000268
	LPBC04	Fillets without Skin	0.0128	0.00132	0.00300	0.000309
	LPCC01	Fillets without Skin	0.0236	0.00162	0.00450	0.000310
	UAAE01	Fillets without	0.0160	0.000771	0.00600	0.000289

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.00953	0.00141	0.00200	0.000296
	UACC01	Fillets without Skin	0.0249	0.00124	0.00570	0.000283
	UPAE01	Fillets without Skin	0.0164	0.000814	0.00550	0.000273
	UPCC01	Fillets without Skin	0.0172	0.00141	0.00370	0.000304
	UPCC02	Fillets without Skin	0.00758	0.00144	0.00160	0.000304
	UPCC101	Fillets without Skin	0.0237	0.00138	0.00520	0.000303
	UPCC102	Fillets without Skin	0.0136	0.00143	0.00290	0.000305
	UPCC103	Fillets without Skin	0.0182	0.00127	0.00440	0.000306
fluorene						
	LACA01	Fillets with Skin	0.0524	0.00145	0.0146	0.000404
	LALB01	Fillets with Skin	0.00677	0.00198	0.00140	0.000409
	LASF01	Fillets with Skin	0.00402	0.00200	0.000800	0.000398
	LPCA01	Fillets with Skin	0.0161	0.00166	0.00380	0.000392
	LPLB01	Fillets with Skin	0.00393	0.00178	0.000900	0.000407
	LPSB01	Fillets with Skin	0.00204	0.00186	0.000400	0.000364
	LPSF01	Fillets with Skin	0.00293	0.00220	0.000500	0.000374
	UACA01	Fillets with Skin	0.0273	0.00140	0.00760	0.000390
	UALB01	Fillets with Skin	0.00583	0.00179	0.00130	0.000399
	UASF01	Fillets with Skin	0.00728	0.00193	0.00150	0.000397
	UPCA01	Fillets with Skin	0.0580	0.00130	0.0169	0.000380
	UPLB01	Fillets with Skin	0.00440	0.00196	0.000900	0.000400
	UPSF01	Fillets with Skin	0.00306	0.00200	0.000600	0.000393

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	0.00895	0.00105	0.00330	0.000387
	LABC01	Fillets without Skin	0.0118	0.00184	0.00260	0.000405
	LACC01	Fillets without Skin	0.0300	0.00177	0.00650	0.000383
	LPAE01	Fillets without Skin	0.00326	0.00122	0.00110	0.000411
	LPAE02	Fillets without Skin	0.00252	0.00145	0.000700	0.000404
	LPBC01	Fillets without Skin	0.0170	0.00182	0.00360	0.000386
	LPBC02	Fillets without Skin	0.00236	0.00213	0.000400	0.000361
	LPBC03	Fillets without Skin	0.00283	0.00169	0.000600	0.000358
	LPBC04	Fillets without Skin	0.00899	0.00177	0.00210	0.000413
	LPCC01	Fillets without Skin	0.00890	0.00217	0.00170	0.000414
	UAAE01	Fillets without Skin	0.00640	0.00103	0.00240	0.000386
	UABC01	Fillets without Skin	0.0143	0.00189	0.00300	0.000396
	UACC01	Fillets without Skin	0.0127	0.00165	0.00290	0.000378
	UPAE01	Fillets without Skin	0.00417	0.00109	0.00140	0.000365
	UPCC01	Fillets without Skin	0.0158	0.00188	0.00340	0.000406
	UPCC02	Fillets without Skin	0.0204	0.00192	0.00430	0.000406
	UPCC101	Fillets without Skin	0.0265	0.00185	0.00580	0.000405

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	0.0154	0.00190	0.00330	0.000407
	UPCC103	Fillets without Skin	0.0108	0.00170	0.00260	0.000409
gamma BHC						
	LACA01	Fillets with Skin	< 0.000488	0.000488	< 0.000136	0.000136
	LALB01	Fillets with Skin	< 0.000666	0.000666	< 0.000138	0.000138
	*LASF01	Fillets with Skin	< 0.000673	0.000673	< 0.000134	0.000134
	LPCA01	Fillets with Skin	< 0.000559	0.000559	< 0.000132	0.000132
	LPLB01	Fillets with Skin	< 0.000598	0.000598	< 0.000137	0.000137
	LPSB01	Fillets with Skin	< 0.000625	0.000625	< 0.000123	0.000123
	*LPSF01	Fillets with Skin	< 0.000739	0.000739	< 0.000126	0.000126
	UACA01	Fillets with Skin	0.000597	0.000470	0.000166	0.000131
	UALB01	Fillets with Skin	< 0.000602	0.000602	< 0.000134	0.000134
	UASF01	Fillets with Skin	< 0.000649	0.000649	< 0.000134	0.000134
	UPCA01	Fillets with Skin	< 0.000439	0.000439	< 0.000128	0.000128
	UPLB01	Fillets with Skin	< 0.000659	0.000659	< 0.000135	0.000135
	UPSF01	Fillets with Skin	< 0.000675	0.000675	< 0.000132	0.000132
	LAAE01	Fillets without Skin	0.000703	0.000353	0.000259	0.000130
	LABC01	Fillets without Skin	0.000905	0.000620	0.000199	0.000136
	LACC01	Fillets without Skin	< 0.000594	0.000594	< 0.000129	0.000129
	LPAE01	Fillets without Skin	0.000699	0.000410	0.000236	0.000138
	LPAE02	Fillets without Skin	0.00749	0.000489	0.00208	0.000136
	LPBC01	Fillets without Skin	< 0.000613	0.000613	< 0.000130	0.000130
	LPBC02	Fillets without Skin	< 0.000717	0.000717	< 0.000122	0.000122

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	< 0.000569	0.000569	< 0.000121	0.000121
	LPBC04	Fillets without Skin	0.000607	0.000595	0.000142	0.000139
	LPCC01	Fillets without Skin	< 0.000730	0.000730	< 0.000139	0.000139
	UAAE01	Fillets without Skin	0.00547	0.000347	0.00205	0.000130
	UABC01	Fillets without Skin	< 0.000635	0.000635	< 0.000133	0.000133
	UACC01	Fillets without Skin	< 0.000556	0.000556	< 0.000127	0.000127
	UPAE01	Fillets without Skin	0.000440	0.000366	0.000148	0.000123
	UPCC01	Fillets without Skin	< 0.000634	0.000634	< 0.000137	0.000137
	UPCC02	Fillets without Skin	< 0.000647	0.000647	< 0.000137	0.000137
	UPCC101	Fillets without Skin	< 0.000622	0.000622	< 0.000136	0.000136
	UPCC102	Fillets without Skin	< 0.000641	0.000641	< 0.000137	0.000137
	UPCC103	Fillets without Skin	< 0.000571	0.000571	< 0.000138	0.000138
gamma chlordane						
	*LACA01	Fillets with Skin	0.194	0.000398	0.0541	0.000111
	LALB01	Fillets with Skin	0.0190	0.000543	0.00393	0.000112
	*LASF01	Fillets with Skin	0.00132	0.000549	0.000263	0.000109
	LPCA01	Fillets with Skin	0.0863	0.000456	0.0204	0.000108
	LPLB01	Fillets with Skin	0.0109	0.000487	0.00250	0.000112
	LPSB01	Fillets with Skin	0.00538	0.000510	0.00106	0.000100
	*LPSF01	Fillets with Skin	0.00118	0.000602	0.000200	0.000103
	*UACA01	Fillets with Skin	0.207	0.000383	0.0577	0.000107

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.0272	0.000490	0.00606	0.000109
	UASF01	Fillets with Skin	0.00526	0.000529	0.00108	0.000109
	*UPCA01	Fillets with Skin	0.121	0.000357	0.0353	0.000104
	UPLB01	Fillets with Skin	0.00247	0.000537	0.000505	0.000110
	UPSF01	Fillets with Skin	0.000678	0.000550	0.000133	0.000108
	*LAAE01	Fillets without Skin	0.218	0.000288	0.0805	0.000106
	LABC01	Fillets without Skin	0.118	0.000505	0.0260	0.000111
	*LACC01	Fillets without Skin	0.132	0.000484	0.0285	0.000105
	*LPAE01	Fillets without Skin	0.0849	0.000334	0.0287	0.000113
	LPAE02	Fillets without Skin	0.0289	0.000398	0.00802	0.000111
	LPBC01	Fillets without Skin	0.178	0.000500	0.0378	0.000106
	LPBC02	Fillets without Skin	0.0708	0.000584	0.0120	0.0000990
	LPBC03	Fillets without Skin	0.0343	0.000463	0.00728	0.0000980
	LPBC04	Fillets without Skin	0.166	0.000485	0.0388	0.000113
	LPCC01	Fillets without Skin	0.0249	0.000595	0.00475	0.000114
	*UAAE01	Fillets without Skin	0.251	0.000283	0.0942	0.000106
	UABC01	Fillets without Skin	0.159	0.000517	0.0333	0.000109
	UACC01	Fillets without Skin	0.159	0.000453	0.0363	0.000104
	UPAE01	Fillets without Skin	0.0365	0.000298	0.0123	0.000100

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.0479	0.000517	0.0103	0.000111
	UPCC02	Fillets without Skin	0.0862	0.000527	0.0182	0.000111
	UPCC101	Fillets without Skin	0.0581	0.000507	0.0127	0.000111
	UPCC102	Fillets without Skin	0.0459	0.000522	0.00980	0.000112
	UPCC103	Fillets without Skin	0.0549	0.000465	0.0132	0.000112
heptachlor epoxide						
	LACA01	Fillets with Skin	0.0276	0.00106	0.00768	0.000295
	LALB01	Fillets with Skin	0.00176	0.00145	0.000363	0.000299
	*LASF01	Fillets with Skin	< 0.00146	0.00146	< 0.000291	0.000291
	LPCA01	Fillets with Skin	0.00772	0.00122	0.00182	0.000286
	LPLB01	Fillets with Skin	0.00169	0.00130	0.000387	0.000297
	LPSB01	Fillets with Skin	< 0.00136	0.00136	< 0.000266	0.000266
	*LPSF01	Fillets with Skin	< 0.00160	0.00160	< 0.000273	0.000273
	UACA01	Fillets with Skin	0.0294	0.00102	0.00821	0.000285
	UALB01	Fillets with Skin	0.00399	0.00131	0.000890	0.000291
	UASF01	Fillets with Skin	0.00282	0.00141	0.000580	0.000290
	UPCA01	Fillets with Skin	0.0212	0.000952	0.00616	0.000277
	UPLB01	Fillets with Skin	< 0.00143	0.00143	< 0.000293	0.000293
	UPSF01	Fillets with Skin	< 0.00146	0.00146	< 0.000287	0.000287
	*LAAE01	Fillets without Skin	0.0796	0.000766	0.0294	0.000283
	LABC01	Fillets without Skin	0.00846	0.00134	0.00186	0.000296
	LACC01	Fillets without Skin	0.00941	0.00129	0.00204	0.000280
	LPAE01	Fillets without Skin	0.0198	0.000889	0.00667	0.000300

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	0.00678	0.00106	0.00188	0.000295
	LPBC01	Fillets without Skin	0.00796	0.00133	0.00169	0.000282
	LPBC02	Fillets without Skin	0.00253	0.00156	0.000429	0.000264
	LPBC03	Fillets without Skin	0.00227	0.00124	0.000481	0.000262
	LPBC04	Fillets without Skin	0.0114	0.00129	0.00267	0.000302
	LPCC01	Fillets without Skin	0.00191	0.00158	0.000365	0.000302
	*UAAE01	Fillets without Skin	0.163	0.000754	0.0611	0.000283
	UABC01	Fillets without Skin	0.00834	0.00138	0.00175	0.000289
	UACC01	Fillets without Skin	0.0148	0.00121	0.00340	0.000276
	UPAE01	Fillets without Skin	0.0205	0.000794	0.00689	0.000267
	UPCC01	Fillets without Skin	0.00986	0.00138	0.00212	0.000297
	UPCC02	Fillets without Skin	0.00523	0.00140	0.00110	0.000297
	UPCC101	Fillets without Skin	0.0234	0.00135	0.00513	0.000296
	UPCC102	Fillets without Skin	0.00772	0.00139	0.00165	0.000297
	UPCC103	Fillets without Skin	0.00435	0.00124	0.00105	0.000299
indeno(1,2,3-cd)pyrene						
	LACA01	Fillets with Skin	< 0.00244	0.00244	< 0.000680	0.000680
	LALB01	Fillets with Skin	< 0.00333	0.00333	< 0.000688	0.000688

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LASF01	Fillets with Skin	< 0.00336	0.00336	< 0.000669	0.000669
	LPCA01	Fillets with Skin	< 0.00280	0.00280	< 0.000659	0.000659
	LPLB01	Fillets with Skin	< 0.00299	0.00299	< 0.000684	0.000684
	LPSB01	Fillets with Skin	< 0.00312	0.00312	< 0.000613	0.000613
	LPSF01	Fillets with Skin	< 0.00369	0.00369	< 0.000629	0.000629
	UACA01	Fillets with Skin	< 0.00235	0.00235	< 0.000655	0.000655
	UALB01	Fillets with Skin	< 0.00300	0.00300	< 0.000671	0.000671
	UASF01	Fillets with Skin	< 0.00324	0.00324	< 0.000668	0.000668
	UPCA01	Fillets with Skin	< 0.00219	0.00219	< 0.000639	0.000639
	UPLB01	Fillets with Skin	< 0.00329	0.00329	< 0.000673	0.000673
	UPSF01	Fillets with Skin	< 0.00337	0.00337	< 0.000660	0.000660
	LAAE01	Fillets without Skin	< 0.00176	0.00176	< 0.000650	0.000650
	LABC01	Fillets without Skin	< 0.00310	0.00310	< 0.000681	0.000681
	LACC01	Fillets without Skin	< 0.00297	0.00297	< 0.000643	0.000643
	LPAE01	Fillets without Skin	< 0.00205	0.00205	< 0.000690	0.000690
	LPAE02	Fillets without Skin	< 0.00244	0.00244	< 0.000678	0.000678
	LPBC01	Fillets without Skin	< 0.00306	0.00306	< 0.000649	0.000649
	LPBC02	Fillets without Skin	< 0.00358	0.00358	< 0.000607	0.000607
	LPBC03	Fillets without Skin	< 0.00284	0.00284	< 0.000602	0.000602
	LPBC04	Fillets without Skin	< 0.00297	0.00297	< 0.000695	0.000695
	LPCC01	Fillets without Skin	< 0.00365	0.00365	< 0.000696	0.000696
	UAAE01	Fillets without	< 0.00173	0.00173	< 0.000649	0.000649

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	< 0.00317	0.00317	< 0.000665	0.000665
	UACC01	Fillets without Skin	< 0.00278	0.00278	< 0.000636	0.000636
	UPAE01	Fillets without Skin	< 0.00183	0.00183	< 0.000614	0.000614
	UPCC01	Fillets without Skin	< 0.00317	0.00317	< 0.000682	0.000682
	UPCC02	Fillets without Skin	< 0.00323	0.00323	< 0.000682	0.000682
	UPCC101	Fillets without Skin	< 0.00311	0.00311	< 0.000681	0.000681
	UPCC102	Fillets without Skin	< 0.00320	0.00320	< 0.000684	0.000684
	UPCC103	Fillets without Skin	< 0.00285	0.00285	< 0.000688	0.000688
mirex						
	LACA01	Fillets with Skin	0.00111	0.000342	0.000309	0.0000950
	LALB01	Fillets with Skin	< 0.000467	0.000467	< 0.0000970	0.0000970
	*LASF01	Fillets with Skin	< 0.000472	0.000472	< 0.0000940	0.0000940
	LPCA01	Fillets with Skin	0.000420	0.000392	0.0000990	0.0000930
	LPLB01	Fillets with Skin	< 0.000419	0.000419	< 0.0000960	0.0000960
	LPSB01	Fillets with Skin	< 0.000439	0.000439	< 0.0000860	0.0000860
	*LPSF01	Fillets with Skin	< 0.000518	0.000518	< 0.0000880	0.0000880
	UACA01	Fillets with Skin	0.00179	0.000330	0.000499	0.0000920
	UALB01	Fillets with Skin	< 0.000422	0.000422	< 0.0000940	0.0000940
	UASF01	Fillets with Skin	< 0.000455	0.000455	< 0.0000940	0.0000940
	UPCA01	Fillets with Skin	0.000673	0.000308	0.000196	0.0000900
	UPLB01	Fillets with Skin	< 0.000462	0.000462	< 0.0000940	0.0000940
	UPSF01	Fillets with Skin	< 0.000473	0.000473	< 0.0000930	0.0000930

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	0.00229	0.000248	0.000846	0.0000910
	LABC01	Fillets without Skin	0.00176	0.000435	0.000386	0.0000960
	LACC01	Fillets without Skin	0.00216	0.000417	0.000469	0.0000900
	LPAE01	Fillets without Skin	0.00576	0.000287	0.00194	0.0000970
	LPAE02	Fillets without Skin	0.000942	0.000343	0.000262	0.0000950
	LPBC01	Fillets without Skin	0.00108	0.000430	0.000230	0.0000910
	LPBC02	Fillets without Skin	0.00122	0.000503	0.000207	0.0000850
	LPBC03	Fillets without Skin	0.00136	0.000399	0.000289	0.0000850
	LPBC04	Fillets without Skin	0.00171	0.000417	0.000400	0.0000970
	LPCC01	Fillets without Skin	< 0.000512	0.000512	< 0.0000980	0.0000980
	UAAE01	Fillets without Skin	0.000704	0.000243	0.000264	0.0000910
	UABC01	Fillets without Skin	0.00102	0.000445	0.000215	0.0000930
	UACC01	Fillets without Skin	0.00204	0.000390	0.000467	0.0000890
	UPAE01	Fillets without Skin	0.00172	0.000256	0.000578	0.0000860
	UPCC01	Fillets without Skin	0.000597	0.000445	0.000129	0.0000960
	UPCC02	Fillets without Skin	0.000538	0.000454	0.000114	0.0000960
	UPCC101	Fillets without Skin	< 0.000436	0.000436	< 0.0000960	0.0000960

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	0.000893	0.000449	0.000191	0.0000960
	UPCC103	Fillets without Skin	0.000644	0.000400	0.000155	0.0000970
naphthalene						
	LACA01	Fillets with Skin	0.0334	0.00351	0.00930	0.000979
	LALB01	Fillets with Skin	0.00532	0.00479	0.00110	0.000990
	LASF01	Fillets with Skin	< 0.00484	0.00484	< 0.000963	0.000963
	LPCA01	Fillets with Skin	0.0119	0.00402	0.00280	0.000949
	LPLB01	Fillets with Skin	< 0.00430	0.00430	< 0.000984	0.000984
	LPSB01	Fillets with Skin	< 0.00450	0.00450	< 0.000882	0.000882
	LPSF01	Fillets with Skin	< 0.00531	0.00531	< 0.000906	0.000906
	UACA01	Fillets with Skin	0.0104	0.00338	0.00290	0.000944
	UALB01	Fillets with Skin	0.00448	0.00433	0.00100	0.000965
	UASF01	Fillets with Skin	0.00631	0.00467	0.00130	0.000962
	UPCA01	Fillets with Skin	0.0470	0.00316	0.0137	0.000919
	UPLB01	Fillets with Skin	< 0.00474	0.00474	< 0.000969	0.000969
	UPSF01	Fillets with Skin	< 0.00485	0.00485	< 0.000951	0.000951
	LAAE01	Fillets without Skin	0.0106	0.00254	0.00390	0.000936
	LABC01	Fillets without Skin	0.00954	0.00446	0.00210	0.000980
	LACC01	Fillets without Skin	0.0152	0.00427	0.00330	0.000926
	LPAE01	Fillets without Skin	0.0113	0.00295	0.00380	0.000994
	LPAE02	Fillets without Skin	0.0122	0.00352	0.00340	0.000977
	LPBC01	Fillets without Skin	0.0109	0.00441	0.00230	0.000935
	LPBC02	Fillets without Skin	< 0.00516	0.00516	< 0.000874	0.000874

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	0.00566	0.00409	0.00120	0.000867
	LPBC04	Fillets without Skin	0.0107	0.00428	0.00250	0.00100
	LPCC01	Fillets without Skin	0.00995	0.00525	0.00190	0.00100
	UAAE01	Fillets without Skin	0.0155	0.00249	0.00580	0.000935
	UABC01	Fillets without Skin	0.0153	0.00457	0.00320	0.000958
	UACC01	Fillets without Skin	0.0100	0.00400	0.00230	0.000916
	UPAE01	Fillets without Skin	0.0134	0.00263	0.00450	0.000884
	UPCC01	Fillets without Skin	0.0111	0.00456	0.00240	0.000982
	UPCC02	Fillets without Skin	0.0128	0.00465	0.00270	0.000982
	UPCC101	Fillets without Skin	0.0228	0.00448	0.00500	0.000980
	UPCC102	Fillets without Skin	0.0131	0.00461	0.00280	0.000984
	UPCC103	Fillets without Skin	0.0120	0.00411	0.00290	0.000990
o,p'-DDD						
	LACA01	Fillets with Skin	0.0247	0.000685	0.00689	0.000191
	LALB01	Fillets with Skin	0.0295	0.000934	0.00610	0.000193
	*LASF01	Fillets with Skin	0.00104	0.000944	0.000207	0.000188
	LPCA01	Fillets with Skin	0.0101	0.000785	0.00238	0.000185
	LPLB01	Fillets with Skin	0.0117	0.000839	0.00268	0.000192
	LPSB01	Fillets with Skin	0.00934	0.000877	0.00183	0.000172
	*LPSF01	Fillets with Skin	0.00304	0.00104	0.000518	0.000177
	UACA01	Fillets with Skin	0.0255	0.000660	0.00710	0.000184

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.00678	0.000844	0.00151	0.000188
	UASF01	Fillets with Skin	0.00222	0.000911	0.000457	0.000188
	UPCA01	Fillets with Skin	0.0243	0.000615	0.00708	0.000179
	UPLB01	Fillets with Skin	0.00860	0.000925	0.00176	0.000189
	UPSF01	Fillets with Skin	0.00203	0.000946	0.000398	0.000185
	LAAE01	Fillets without Skin	0.0158	0.000495	0.00583	0.000183
	LABC01	Fillets without Skin	0.0133	0.000869	0.00293	0.000191
	LACC01	Fillets without Skin	0.0239	0.000833	0.00519	0.000181
	LPAE01	Fillets without Skin	0.0375	0.000575	0.0126	0.000194
	LPAE02	Fillets without Skin	0.0997	0.000686	0.0277	0.000190
	LPBC01	Fillets without Skin	0.0168	0.000860	0.00356	0.000182
	LPBC02	Fillets without Skin	0.0344	0.00100	0.00583	0.000171
	LPBC03	Fillets without Skin	0.0439	0.000798	0.00931	0.000169
	LPBC04	Fillets without Skin	0.0327	0.000835	0.00765	0.000195
	LPCC01	Fillets without Skin	0.0535	0.00102	0.0102	0.000195
	UAAE01	Fillets without Skin	< 0.000487	0.000487	< 0.000183	0.000183
	UABC01	Fillets without Skin	0.0140	0.000891	0.00294	0.000187
	UACC01	Fillets without Skin	0.0167	0.000779	0.00382	0.000179
	UPAE01	Fillets without Skin	0.0372	0.000513	0.0125	0.000172

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.0204	0.000889	0.00440	0.000192
	UPCC02	Fillets without Skin	0.0143	0.000908	0.00301	0.000192
	UPCC101	Fillets without Skin	0.00886	0.000873	0.00194	0.000191
	UPCC102	Fillets without Skin	0.0107	0.000899	0.00228	0.000192
	UPCC103	Fillets without Skin	0.0304	0.000801	0.00733	0.000193
o,p'-DDE						
	LACA01	Fillets with Skin	0.00183	0.000325	0.000511	0.0000900
	LALB01	Fillets with Skin	0.00117	0.000443	0.000242	0.0000920
	*LASF01	Fillets with Skin	< 0.000448	0.000448	< 0.0000890	0.0000890
	LPCA01	Fillets with Skin	0.00173	0.000372	0.000409	0.0000880
	LPLB01	Fillets with Skin	0.000951	0.000398	0.000218	0.0000910
	LPSB01	Fillets with Skin	0.000650	0.000416	0.000128	0.0000820
	*LPSF01	Fillets with Skin	< 0.000491	0.000491	< 0.0000840	0.0000840
	UACA01	Fillets with Skin	0.00247	0.000313	0.000688	0.0000870
	UALB01	Fillets with Skin	0.000797	0.000400	0.000178	0.0000890
	UASF01	Fillets with Skin	0.000705	0.000432	0.000145	0.0000890
	UPCA01	Fillets with Skin	0.000967	0.000292	0.000282	0.0000850
	UPLB01	Fillets with Skin	0.000523	0.000438	0.000107	0.0000900
	UPSF01	Fillets with Skin	< 0.000449	0.000449	< 0.0000880	0.0000880
	LAAE01	Fillets without Skin	0.00104	0.000235	0.000383	0.0000870
	LABC01	Fillets without Skin	0.000639	0.000412	0.000140	0.0000910
	LACC01	Fillets without Skin	0.00249	0.000395	0.000540	0.0000860
	LPAE01	Fillets without Skin	< 0.000272	0.000272	< 0.0000920	0.0000920

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 0.000325	0.000325	< 0.0000900	0.0000900
	LPBC01	Fillets without Skin	< 0.000408	0.000408	< 0.0000860	0.0000860
	LPBC02	Fillets without Skin	< 0.000477	0.000477	< 0.0000810	0.0000810
	LPBC03	Fillets without Skin	< 0.000378	0.000378	< 0.0000800	0.0000800
	LPBC04	Fillets without Skin	< 0.000396	0.000396	< 0.0000920	0.0000920
	LPCC01	Fillets without Skin	0.000829	0.000485	0.000158	0.0000930
	UAAE01	Fillets without Skin	0.00278	0.000231	0.00104	0.0000870
	UABC01	Fillets without Skin	0.00151	0.000422	0.000317	0.0000890
	UACC01	Fillets without Skin	0.00208	0.000370	0.000477	0.0000850
	UPAE01	Fillets without Skin	0.000360	0.000243	0.000121	0.0000820
	UPCC01	Fillets without Skin	0.00143	0.000422	0.000309	0.0000910
	UPCC02	Fillets without Skin	0.000440	0.000430	0.0000930	0.0000910
	UPCC101	Fillets without Skin	0.00165	0.000414	0.000361	0.0000910
	UPCC102	Fillets without Skin	0.00131	0.000426	0.000280	0.0000910
	UPCC103	Fillets without Skin	0.00217	0.000380	0.000524	0.0000920
o,p'-DDT						
	LACA01	Fillets with Skin	0.00920	0.000511	0.00256	0.000142
	LALB01	Fillets with Skin	0.0198	0.000697	0.00409	0.000144

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	0.00113	0.000705	0.000225	0.000140
	LPCA01	Fillets with Skin	0.0279	0.000586	0.00659	0.000138
	LPLB01	Fillets with Skin	0.00972	0.000626	0.00222	0.000143
	LPSB01	Fillets with Skin	0.00940	0.000655	0.00184	0.000128
	*LPSF01	Fillets with Skin	0.00318	0.000773	0.000542	0.000132
	UACA01	Fillets with Skin	0.0123	0.000493	0.00343	0.000137
	UALB01	Fillets with Skin	0.00381	0.000630	0.000850	0.000140
	UASF01	Fillets with Skin	0.00173	0.000680	0.000357	0.000140
	UPCA01	Fillets with Skin	0.0231	0.000459	0.00674	0.000134
	UPLB01	Fillets with Skin	0.00830	0.000690	0.00170	0.000141
	UPSF01	Fillets with Skin	0.00210	0.000706	0.000412	0.000138
	LAAE01	Fillets without Skin	0.0174	0.000369	0.00643	0.000136
	LABC01	Fillets without Skin	0.0494	0.000649	0.0109	0.000143
	LACC01	Fillets without Skin	0.0182	0.000622	0.00395	0.000135
	LPAE01	Fillets without Skin	0.0448	0.000429	0.0151	0.000145
	LPAE02	Fillets without Skin	0.106	0.000512	0.0294	0.000142
	LPBC01	Fillets without Skin	0.0183	0.000642	0.00388	0.000136
	LPBC02	Fillets without Skin	0.0329	0.000750	0.00558	0.000127
	LPBC03	Fillets without Skin	0.0354	0.000595	0.00750	0.000126
	LPBC04	Fillets without Skin	0.0402	0.000623	0.00939	0.000146
	LPCC01	Fillets without Skin	0.0481	0.000764	0.00919	0.000146
	UAAE01	Fillets without	< 0.000363	0.000363	< 0.000136	0.000136

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.0112	0.000665	0.00234	0.000139
	UACC01	Fillets without Skin	0.0128	0.000582	0.00294	0.000133
	UPAE01	Fillets without Skin	0.0443	0.000383	0.0149	0.000129
	UPCC01	Fillets without Skin	0.0143	0.000664	0.00309	0.000143
	UPCC02	Fillets without Skin	0.00802	0.000677	0.00169	0.000143
	UPCC101	Fillets without Skin	0.00736	0.000652	0.00161	0.000143
	UPCC102	Fillets without Skin	0.0102	0.000671	0.00218	0.000143
	UPCC103	Fillets without Skin	0.0234	0.000598	0.00565	0.000144
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	LACA01	Fillets with Skin	0.0348	0.000517	0.00969	0.000144
	LALB01	Fillets with Skin	0.0122	0.000706	0.00252	0.000146
	*LASF01	Fillets with Skin	0.00581	0.000713	0.00116	0.000142
	LPCA01	Fillets with Skin	0.0137	0.000593	0.00323	0.000140
	LPLB01	Fillets with Skin	0.00555	0.000634	0.00127	0.000145
	LPSB01	Fillets with Skin	0.00703	0.000663	0.00138	0.000130
	*LPSF01	Fillets with Skin	0.00477	0.000783	0.000813	0.000134
	UACA01	Fillets with Skin	0.0442	0.000499	0.0123	0.000139
	UALB01	Fillets with Skin	0.0114	0.000638	0.00254	0.000142
	UASF01	Fillets with Skin	0.0165	0.000688	0.00340	0.000142
	UPCA01	Fillets with Skin	0.0226	0.000465	0.00659	0.000135
	UPLB01	Fillets with Skin	0.00613	0.000699	0.00125	0.000143
	UPSF01	Fillets with Skin	0.00251	0.000715	0.000491	0.000140

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LAAE01	Fillets without Skin	0.0917	0.000374	0.0338	0.000138
	LABC01	Fillets without Skin	0.0122	0.000657	0.00269	0.000144
	LACC01	Fillets without Skin	0.0242	0.000630	0.00524	0.000136
	LPAE01	Fillets without Skin	0.0698	0.000434	0.0235	0.000146
	LPAE02	Fillets without Skin	0.0230	0.000518	0.00638	0.000144
	LPBC01	Fillets without Skin	0.0180	0.000650	0.00380	0.000138
	LPBC02	Fillets without Skin	0.0120	0.000760	0.00203	0.000129
	LPBC03	Fillets without Skin	0.00889	0.000603	0.00188	0.000128
	LPBC04	Fillets without Skin	0.0288	0.000631	0.00673	0.000147
	LPCC01	Fillets without Skin	0.0113	0.000774	0.00216	0.000148
	*UAAE01	Fillets without Skin	0.137	0.000368	0.0512	0.000138
	UABC01	Fillets without Skin	0.0292	0.000673	0.00612	0.000141
	UACC01	Fillets without Skin	0.0289	0.000589	0.00662	0.000135
	UPAE01	Fillets without Skin	0.0433	0.000388	0.0145	0.000130
	UPCC01	Fillets without Skin	0.0101	0.000672	0.00217	0.000145
	UPCC02	Fillets without Skin	0.0128	0.000686	0.00269	0.000145
	UPCC101	Fillets without Skin	0.0136	0.000660	0.00297	0.000144

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	0.00735	0.000679	0.00157	0.000145
	UPCC103	Fillets without Skin	0.00942	0.000605	0.00227	0.000146
p,p'-DDD						
	*LACA01	Fillets with Skin	0.181	0.000687	0.0504	0.000191
	LALB01	Fillets with Skin	0.0390	0.000937	0.00807	0.000194
	*LASF01	Fillets with Skin	0.00722	0.000947	0.00144	0.000189
	LPCA01	Fillets with Skin	0.0786	0.000787	0.0185	0.000186
	LPLB01	Fillets with Skin	0.0204	0.000842	0.00468	0.000193
	LPSB01	Fillets with Skin	0.0132	0.000880	0.00260	0.000173
	*LPSF01	Fillets with Skin	0.00774	0.00104	0.00132	0.000177
	*UACA01	Fillets with Skin	0.180	0.000662	0.0502	0.000185
	UALB01	Fillets with Skin	0.0347	0.000847	0.00774	0.000189
	UASF01	Fillets with Skin	0.0215	0.000914	0.00442	0.000188
	*UPCA01	Fillets with Skin	0.112	0.000617	0.0326	0.000180
	UPLB01	Fillets with Skin	0.0133	0.000928	0.00272	0.000190
	UPSF01	Fillets with Skin	0.00441	0.000950	0.000863	0.000186
	*LAAE01	Fillets without Skin	0.219	0.000497	0.0808	0.000183
	LABC01	Fillets without Skin	0.120	0.000872	0.0263	0.000192
	*LACC01	Fillets without Skin	0.122	0.000836	0.0264	0.000181
	*LPAE01	Fillets without Skin	0.238	0.000577	0.0804	0.000195
	LPAE02	Fillets without Skin	0.0746	0.000688	0.0207	0.000191
	LPBC01	Fillets without Skin	0.141	0.000863	0.0299	0.000183
	LPBC02	Fillets without Skin	0.107	0.00101	0.0181	0.000171

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	0.110	0.000801	0.0234	0.000170
	*LPBC04	Fillets without Skin	0.161	0.000838	0.0376	0.000196
	LPCC01	Fillets without Skin	0.0307	0.00103	0.00586	0.000196
	*UAAE01	Fillets without Skin	0.156	0.000489	0.0585	0.000183
	UABC01	Fillets without Skin	0.170	0.000894	0.0357	0.000187
	UACC01	Fillets without Skin	0.130	0.000782	0.0298	0.000179
	*UPAE01	Fillets without Skin	0.111	0.000515	0.0372	0.000173
	UPCC01	Fillets without Skin	0.0622	0.000892	0.0134	0.000192
	UPCC02	Fillets without Skin	0.0995	0.000911	0.0210	0.000192
	UPCC101	Fillets without Skin	0.0458	0.000876	0.0100	0.000192
	UPCC102	Fillets without Skin	0.0431	0.000902	0.00921	0.000193
	UPCC103	Fillets without Skin	0.0748	0.000804	0.0180	0.000194
p,p'-DDE						
	*LACA01	Fillets with Skin	0.233	0.000340	0.0649	0.0000950
	LALB01	Fillets with Skin	0.124	0.000464	0.0256	0.0000960
	*LASF01	Fillets with Skin	0.0168	0.000469	0.00334	0.0000930
	LPCA01	Fillets with Skin	0.248	0.000390	0.0585	0.0000920
	LPLB01	Fillets with Skin	0.111	0.000417	0.0253	0.0000950
	LPSB01	Fillets with Skin	0.0655	0.000436	0.0129	0.0000860
	*LPSF01	Fillets with Skin	0.0252	0.000515	0.00429	0.0000880
	*UACA01	Fillets with Skin	0.287	0.000328	0.0799	0.0000910

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.0982	0.000419	0.0219	0.0000940
	UASF01	Fillets with Skin	0.0541	0.000453	0.0111	0.0000930
	*UPCA01	Fillets with Skin	0.280	0.000306	0.0816	0.0000890
	UPLB01	Fillets with Skin	0.114	0.000460	0.0233	0.0000940
	UPSF01	Fillets with Skin	0.0184	0.000470	0.00360	0.0000920
	*LAAE01	Fillets without Skin	0.561	0.000246	0.207	0.0000910
	LABC01	Fillets without Skin	0.323	0.000432	0.0710	0.0000950
	*LACC01	Fillets without Skin	0.413	0.000414	0.0896	0.0000900
	*LPAE01	Fillets without Skin	1.31	0.000286	0.443	0.0000960
	*LPAE02	Fillets without Skin	0.230	0.000341	0.0638	0.0000950
	LPBC01	Fillets without Skin	0.375	0.000428	0.0795	0.0000910
	*LPBC02	Fillets without Skin	0.506	0.000500	0.0858	0.0000850
	*LPBC03	Fillets without Skin	0.685	0.000397	0.145	0.0000840
	*LPBC04	Fillets without Skin	0.669	0.000415	0.156	0.0000970
	LPCC01	Fillets without Skin	0.142	0.000509	0.0271	0.0000970
	*UAAE01	Fillets without Skin	0.253	0.000242	0.0947	0.0000910
	*UABC01	Fillets without Skin	0.292	0.000443	0.0614	0.0000930
	*UACC01	Fillets without Skin	0.255	0.000387	0.0584	0.0000890
	*UPAE01	Fillets without Skin	0.608	0.000255	0.204	0.0000860

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.221	0.000442	0.0476	0.0000950
	UPCC02	Fillets without Skin	0.251	0.000451	0.0530	0.0000950
	UPCC101	Fillets without Skin	0.141	0.000434	0.0309	0.0000950
	UPCC102	Fillets without Skin	0.204	0.000447	0.0435	0.0000950
	*UPCC103	Fillets without Skin	0.229	0.000398	0.0553	0.0000960
p,p'-DDT						
	LACA01	Fillets with Skin	0.00160	0.000364	0.000447	0.000101
	LALB01	Fillets with Skin	0.00366	0.000496	0.000757	0.000103
	*LASF01	Fillets with Skin	0.000944	0.000501	0.000188	0.000100
	LPCA01	Fillets with Skin	0.00404	0.000417	0.000954	0.0000980
	LPLB01	Fillets with Skin	0.00560	0.000446	0.00128	0.000102
	LPSB01	Fillets with Skin	0.00319	0.000466	0.000626	0.0000910
	*LPSF01	Fillets with Skin	0.00131	0.000550	0.000224	0.0000940
	UACA01	Fillets with Skin	0.00167	0.000350	0.000466	0.0000980
	UALB01	Fillets with Skin	0.00226	0.000448	0.000504	0.000100
	UASF01	Fillets with Skin	0.00211	0.000484	0.000435	0.000100
	UPCA01	Fillets with Skin	0.00324	0.000327	0.000944	0.0000950
	UPLB01	Fillets with Skin	0.00584	0.000491	0.00119	0.000100
	UPSF01	Fillets with Skin	0.00149	0.000503	0.000292	0.0000980
	LAAE01	Fillets without Skin	0.0991	0.000263	0.0366	0.0000970
	LABC01	Fillets without Skin	0.0114	0.000462	0.00252	0.000102
	LACC01	Fillets without Skin	0.0230	0.000443	0.00498	0.0000960
	LPAE01	Fillets without Skin	0.0676	0.000305	0.0228	0.000103

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	0.0194	0.000364	0.00539	0.000101
	LPBC01	Fillets without Skin	0.0145	0.000457	0.00308	0.0000970
	LPBC02	Fillets without Skin	0.0107	0.000534	0.00182	0.0000910
	LPBC03	Fillets without Skin	0.0113	0.000424	0.00239	0.0000900
	LPBC04	Fillets without Skin	0.0216	0.000443	0.00505	0.000104
	LPCC01	Fillets without Skin	0.00625	0.000544	0.00119	0.000104
	*UAAE01	Fillets without Skin	0.148	0.000259	0.0553	0.0000970
	UABC01	Fillets without Skin	0.00946	0.000473	0.00198	0.0000990
	UACC01	Fillets without Skin	0.00967	0.000414	0.00222	0.0000950
	UPAE01	Fillets without Skin	0.0486	0.000272	0.0163	0.0000920
	UPCC01	Fillets without Skin	0.0218	0.000472	0.00470	0.000102
	UPCC02	Fillets without Skin	0.00640	0.000482	0.00135	0.000102
	UPCC101	Fillets without Skin	0.0413	0.000464	0.00905	0.000102
	UPCC102	Fillets without Skin	0.0153	0.000477	0.00328	0.000102
	UPCC103	Fillets without Skin	0.0119	0.000425	0.00286	0.000103
pentachloro-anisole						
	LACA01	Fillets with Skin	0.00576	0.000374	0.00161	0.000104
	LALB01	Fillets with Skin	< 0.000510	0.000510	< 0.000105	0.000105

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	< 0.000516	0.000516	< 0.000103	0.000103
	LPCA01	Fillets with Skin	0.00609	0.000429	0.00144	0.000101
	LPLB01	Fillets with Skin	0.000634	0.000458	0.000145	0.000105
	LPSB01	Fillets with Skin	0.000828	0.000479	0.000162	0.0000940
	*LPSF01	Fillets with Skin	0.000622	0.000566	0.000106	0.0000970
	UACA01	Fillets with Skin	0.00955	0.000361	0.00266	0.000101
	UALB01	Fillets with Skin	0.000532	0.000461	0.000119	0.000103
	UASF01	Fillets with Skin	0.00114	0.000498	0.000234	0.000102
	UPCA01	Fillets with Skin	0.00610	0.000336	0.00178	0.0000980
	UPLB01	Fillets with Skin	< 0.000505	0.000505	< 0.000103	0.000103
	UPSF01	Fillets with Skin	< 0.000517	0.000517	< 0.000101	0.000101
	LAAE01	Fillets without Skin	0.00654	0.000270	0.00241	0.000100
	LABC01	Fillets without Skin	0.0154	0.000475	0.00339	0.000104
	LACC01	Fillets without Skin	0.00320	0.000455	0.000693	0.0000990
	LPAE01	Fillets without Skin	0.00518	0.000314	0.00175	0.000106
	LPAE02	Fillets without Skin	0.00146	0.000375	0.000406	0.000104
	LPBC01	Fillets without Skin	0.00554	0.000470	0.00118	0.000100
	LPBC02	Fillets without Skin	0.00157	0.000549	0.000266	0.0000930
	LPBC03	Fillets without Skin	0.00117	0.000436	0.000248	0.0000920
	LPBC04	Fillets without Skin	0.00718	0.000456	0.00168	0.000107
	LPCC01	Fillets without Skin	0.00147	0.000559	0.000280	0.000107
	UAAE01	Fillets without	0.00330	0.000266	0.00124	0.000100

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.00488	0.000486	0.00102	0.000102
	UACC01	Fillets without Skin	0.00607	0.000426	0.00139	0.0000980
	UPAE01	Fillets without Skin	0.00344	0.000280	0.00116	0.0000940
	UPCC01	Fillets without Skin	0.00251	0.000486	0.000540	0.000105
	UPCC02	Fillets without Skin	0.00279	0.000496	0.000588	0.000105
	UPCC101	Fillets without Skin	0.00291	0.000477	0.000636	0.000104
	UPCC102	Fillets without Skin	0.00200	0.000491	0.000426	0.000105
	UPCC103	Fillets without Skin	0.00302	0.000438	0.000728	0.000105
perylene						
	LACA01	Fillets with Skin	< 0.00226	0.00226	< 0.000631	0.000631
	LALB01	Fillets with Skin	< 0.00309	0.00309	< 0.000638	0.000638
	LASF01	Fillets with Skin	< 0.00312	0.00312	< 0.000621	0.000621
	LPCA01	Fillets with Skin	< 0.00259	0.00259	< 0.000612	0.000612
	LPLB01	Fillets with Skin	< 0.00277	0.00277	< 0.000635	0.000635
	LPSB01	Fillets with Skin	< 0.00290	0.00290	< 0.000569	0.000569
	LPSF01	Fillets with Skin	0.00411	0.00343	0.000700	0.000584
	UACA01	Fillets with Skin	< 0.00218	0.00218	< 0.000608	0.000608
	UALB01	Fillets with Skin	< 0.00279	0.00279	< 0.000622	0.000622
	UASF01	Fillets with Skin	< 0.00301	0.00301	< 0.000620	0.000620
	UPCA01	Fillets with Skin	< 0.00203	0.00203	< 0.000593	0.000593
	UPLB01	Fillets with Skin	< 0.00306	0.00306	< 0.000625	0.000625
	UPSF01	Fillets with Skin	< 0.00313	0.00313	< 0.000613	0.000613

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	< 0.00164	0.00164	< 0.000604	0.000604
	LABC01	Fillets without Skin	< 0.00287	0.00287	< 0.000632	0.000632
	LACC01	Fillets without Skin	< 0.00276	0.00276	< 0.000597	0.000597
	LPAE01	Fillets without Skin	< 0.00190	0.00190	< 0.000641	0.000641
	LPAE02	Fillets without Skin	< 0.00227	0.00227	< 0.000630	0.000630
	LPBC01	Fillets without Skin	0.00330	0.00284	0.000700	0.000603
	LPBC02	Fillets without Skin	< 0.00332	0.00332	< 0.000564	0.000564
	LPBC03	Fillets without Skin	< 0.00264	0.00264	< 0.000559	0.000559
	LPBC04	Fillets without Skin	< 0.00276	0.00276	< 0.000645	0.000645
	LPCC01	Fillets without Skin	< 0.00338	0.00338	< 0.000646	0.000646
	UAAE01	Fillets without Skin	< 0.00161	0.00161	< 0.000603	0.000603
	UABC01	Fillets without Skin	< 0.00294	0.00294	< 0.000618	0.000618
	UACC01	Fillets without Skin	< 0.00258	0.00258	< 0.000590	0.000590
	UPAE01	Fillets without Skin	< 0.00170	0.00170	< 0.000570	0.000570
	UPCC01	Fillets without Skin	< 0.00294	0.00294	< 0.000633	0.000633
	UPCC02	Fillets without Skin	< 0.00300	0.00300	< 0.000633	0.000633
	UPCC101	Fillets without Skin	< 0.00289	0.00289	< 0.000632	0.000632

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	< 0.00297	0.00297	< 0.000635	0.000635
	UPCC103	Fillets without Skin	< 0.00265	0.00265	< 0.000638	0.000638
phenanthrene						
	LACA01	Fillets with Skin	0.0538	0.00104	0.0150	0.000291
	LALB01	Fillets with Skin	0.00919	0.00142	0.00190	0.000294
	LASF01	Fillets with Skin	0.00804	0.00144	0.00160	0.000287
	LPCA01	Fillets with Skin	0.0322	0.00120	0.00760	0.000282
	LPLB01	Fillets with Skin	0.00743	0.00128	0.00170	0.000293
	LPSB01	Fillets with Skin	0.00561	0.00134	0.00110	0.000262
	LPSF01	Fillets with Skin	0.00762	0.00158	0.00130	0.000269
	UACA01	Fillets with Skin	0.0330	0.00101	0.00920	0.000281
	UALB01	Fillets with Skin	0.00583	0.00129	0.00130	0.000287
	UASF01	Fillets with Skin	0.00874	0.00139	0.00180	0.000286
	UPCA01	Fillets with Skin	0.0590	0.000938	0.0172	0.000273
	UPLB01	Fillets with Skin	0.00636	0.00141	0.00130	0.000288
	UPSF01	Fillets with Skin	0.00817	0.00144	0.00160	0.000283
	LAAE01	Fillets without Skin	0.0125	0.000755	0.00460	0.000279
	LABC01	Fillets without Skin	0.0186	0.00132	0.00410	0.000292
	LACC01	Fillets without Skin	0.0392	0.00127	0.00850	0.000275
	LPAE01	Fillets without Skin	0.00711	0.000876	0.00240	0.000296
	LPAE02	Fillets without Skin	0.00504	0.00105	0.00140	0.000290
	LPBC01	Fillets without Skin	0.0156	0.00131	0.00330	0.000278
	LPBC02	Fillets without Skin	0.00472	0.00153	0.000800	0.000260

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	0.00425	0.00122	0.000900	0.000258
	LPBC04	Fillets without Skin	0.0146	0.00127	0.00340	0.000297
	LPCC01	Fillets without Skin	0.0225	0.00156	0.00430	0.000298
	UAAE01	Fillets without Skin	0.0144	0.000741	0.00540	0.000278
	UABC01	Fillets without Skin	0.00953	0.00136	0.00200	0.000285
	UACC01	Fillets without Skin	0.0166	0.00119	0.00380	0.000272
	UPAE01	Fillets without Skin	0.00953	0.000782	0.00320	0.000263
	UPCC01	Fillets without Skin	0.0218	0.00136	0.00470	0.000292
	UPCC02	Fillets without Skin	0.0223	0.00138	0.00470	0.000292
	UPCC101	Fillets without Skin	0.0384	0.00133	0.00840	0.000292
	UPCC102	Fillets without Skin	0.0220	0.00137	0.00470	0.000293
	UPCC103	Fillets without Skin	0.0149	0.00122	0.00360	0.000294
pyrene						
	LACA01	Fillets with Skin	0.0136	0.00141	0.00380	0.000393
	LALB01	Fillets with Skin	0.00339	0.00192	0.000700	0.000397
	LASF01	Fillets with Skin	0.00452	0.00194	0.000900	0.000387
	LPCA01	Fillets with Skin	0.00891	0.00161	0.00210	0.000381
	LPLB01	Fillets with Skin	0.00218	0.00173	0.000500	0.000395
	LPSB01	Fillets with Skin	< 0.00180	0.00180	< 0.000354	0.000354
	LPSF01	Fillets with Skin	0.00293	0.00213	0.000500	0.000363
	UACA01	Fillets with Skin	0.0212	0.00136	0.00590	0.000379

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.00179	0.00174	0.000400	0.000387
	UASF01	Fillets with Skin	0.00340	0.00187	0.000700	0.000386
	UPCA01	Fillets with Skin	0.0165	0.00127	0.00480	0.000369
	UPLB01	Fillets with Skin	0.00196	0.00190	0.000400	0.000389
	UPSF01	Fillets with Skin	0.00204	0.00195	0.000400	0.000381
	LAAE01	Fillets without Skin	0.00895	0.00102	0.00330	0.000376
	LABC01	Fillets without Skin	0.00954	0.00179	0.00210	0.000393
	LACC01	Fillets without Skin	0.00969	0.00172	0.00210	0.000372
	LPAE01	Fillets without Skin	0.00445	0.00118	0.00150	0.000399
	LPAE02	Fillets without Skin	0.00360	0.00141	0.00100	0.000392
	LPBC01	Fillets without Skin	0.00425	0.00177	0.000900	0.000375
	LPBC02	Fillets without Skin	< 0.00207	0.00207	< 0.000351	0.000351
	LPBC03	Fillets without Skin	0.00236	0.00164	0.000500	0.000348
	LPBC04	Fillets without Skin	0.00428	0.00172	0.00100	0.000401
	LPCC01	Fillets without Skin	0.00838	0.00211	0.00160	0.000402
	UAAE01	Fillets without Skin	0.00453	0.00100	0.00170	0.000375
	UABC01	Fillets without Skin	0.00286	0.00183	0.000600	0.000384
	UACC01	Fillets without Skin	0.00960	0.00160	0.00220	0.000367
	UPAE01	Fillets without Skin	0.00625	0.00106	0.00210	0.000354

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.00604	0.00183	0.00130	0.000394
	UPCC02	Fillets without Skin	0.00426	0.00187	0.000900	0.000394
	UPCC101	Fillets without Skin	0.00913	0.00180	0.00200	0.000393
	UPCC102	Fillets without Skin	0.00655	0.00185	0.00140	0.000395
	UPCC103	Fillets without Skin	0.00705	0.00165	0.00170	0.000397
toxaphene						
	LACA01	Fillets with Skin	< 0.0350	0.0350	< 0.00977	0.00977
	LALB01	Fillets with Skin	< 0.0478	0.0478	< 0.00988	0.00988
	*LASF01	Fillets with Skin	< 0.0483	0.0483	< 0.00962	0.00962
	LPCA01	Fillets with Skin	< 0.0402	0.0402	< 0.00947	0.00947
	LPLB01	Fillets with Skin	< 0.0429	0.0429	< 0.00982	0.00982
	LPSB01	Fillets with Skin	< 0.0449	0.0449	< 0.00880	0.00880
	*LPSF01	Fillets with Skin	< 0.0530	0.0530	< 0.00904	0.00904
	UACA01	Fillets with Skin	< 0.0338	0.0338	< 0.00942	0.00942
	UALB01	Fillets with Skin	< 0.0432	0.0432	< 0.00963	0.00963
	UASF01	Fillets with Skin	< 0.0466	0.0466	< 0.00960	0.00960
	UPCA01	Fillets with Skin	< 0.0315	0.0315	< 0.00917	0.00917
	UPLB01	Fillets with Skin	< 0.0473	0.0473	< 0.00967	0.00967
	UPSF01	Fillets with Skin	< 0.0484	0.0484	< 0.00949	0.00949
	LAAE01	Fillets without Skin	< 0.0253	0.0253	< 0.00935	0.00935
	LABC01	Fillets without Skin	< 0.0445	0.0445	< 0.00978	0.00978
	LACC01	Fillets without Skin	< 0.0426	0.0426	< 0.00924	0.00924
	LPAE01	Fillets without Skin	< 0.0294	0.0294	< 0.00992	0.00992

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 0.0351	0.0351	< 0.00975	0.00975
	LPBC01	Fillets without Skin	< 0.0440	0.0440	< 0.00933	0.00933
	LPBC02	Fillets without Skin	< 0.0514	0.0514	< 0.00873	0.00873
	LPBC03	Fillets without Skin	< 0.0408	0.0408	< 0.00865	0.00865
	LPBC04	Fillets without Skin	< 0.0427	0.0427	< 0.00998	0.00998
	LPCC01	Fillets without Skin	< 0.0524	0.0524	< 0.0100	0.0100
	UAAE01	Fillets without Skin	< 0.0249	0.0249	< 0.00935	0.00935
	UABC01	Fillets without Skin	< 0.0456	0.0456	< 0.00956	0.00956
	UACC01	Fillets without Skin	< 0.0399	0.0399	< 0.00914	0.00914
	UPAE01	Fillets without Skin	< 0.0263	0.0263	< 0.00882	0.00882
	UPCC01	Fillets without Skin	< 0.0455	0.0455	< 0.00980	0.00980
	UPCC02	Fillets without Skin	< 0.0464	0.0464	< 0.00980	0.00980
	UPCC101	Fillets without Skin	< 0.0447	0.0447	< 0.00978	0.00978
	UPCC102	Fillets without Skin	< 0.0460	0.0460	< 0.00982	0.00982
	UPCC103	Fillets without Skin	< 0.0410	0.0410	< 0.00988	0.00988
trans-nonachlor						
	*LACA01	Fillets with Skin	0.149	0.000381	0.0416	0.000106
	LALB01	Fillets with Skin	0.0639	0.000520	0.0132	0.000108

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	*LASF01	Fillets with Skin	0.0103	0.000526	0.00205	0.000105
	LPCA01	Fillets with Skin	0.0990	0.000437	0.0233	0.000103
	LPLB01	Fillets with Skin	0.0345	0.000467	0.00788	0.000107
	LPSB01	Fillets with Skin	0.0280	0.000488	0.00548	0.0000960
	*LPSF01	Fillets with Skin	0.00981	0.000577	0.00167	0.0000980
	*UACA01	Fillets with Skin	0.206	0.000368	0.0574	0.000102
	UALB01	Fillets with Skin	0.0675	0.000470	0.0151	0.000105
	UASF01	Fillets with Skin	0.0427	0.000507	0.00879	0.000104
	*UPCA01	Fillets with Skin	0.133	0.000343	0.0389	0.000100
	UPLB01	Fillets with Skin	0.0309	0.000515	0.00632	0.000105
	UPSF01	Fillets with Skin	0.00590	0.000527	0.00116	0.000103
	*LAAE01	Fillets without Skin	0.445	0.000276	0.164	0.000102
	LABC01	Fillets without Skin	0.141	0.000484	0.0311	0.000106
	*LACC01	Fillets without Skin	0.192	0.000464	0.0416	0.000101
	*LPAE01	Fillets without Skin	0.510	0.000320	0.172	0.000108
	LPAE02	Fillets without Skin	0.131	0.000382	0.0363	0.000106
	LPBC01	Fillets without Skin	0.180	0.000479	0.0382	0.000102
	LPBC02	Fillets without Skin	0.171	0.000560	0.0291	0.0000950
	LPBC03	Fillets without Skin	0.130	0.000444	0.0276	0.0000940
	*LPBC04	Fillets without Skin	0.240	0.000465	0.0561	0.000109
	LPCC01	Fillets without Skin	0.0416	0.000570	0.00795	0.000109
	*UAAE01	Fillets without	0.525	0.000271	0.197	0.000102

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	0.173	0.000496	0.0363	0.000104
	*UACC01	Fillets without Skin	0.167	0.000434	0.0384	0.0000990
	*UPAE01	Fillets without Skin	0.210	0.000286	0.0706	0.0000960
	UPCC01	Fillets without Skin	0.0750	0.000495	0.0161	0.000107
	UPCC02	Fillets without Skin	0.0836	0.000505	0.0177	0.000107
	UPCC101	Fillets without Skin	0.0729	0.000486	0.0160	0.000106
	UPCC102	Fillets without Skin	0.0805	0.000500	0.0172	0.000107
	UPCC103	Fillets without Skin	0.0824	0.000446	0.0199	0.000108

* See "Laboratory Notes" section.

5. Procedural Blanks

Analyte	Lab Sample Number	Lab Sample Matrix	Result Total UG	** BEC (ppm/%)	Basis
1,2,3,4-Tetrachlorobenzene					
	ENV1850A	Animal Tissue	0.000500	< 0.0000930	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000930	Wet
1,2,4,5-Tetrachlorobenzene					
	ENV1850A	Animal Tissue	0.00110	< 0.000184	Wet
	ENV1851A	Animal Tissue	0.00110	< 0.000184	Wet
1,6,7-Trimethyl-naphthalene					
	ENV1850A	Animal Tissue	0.00220	< 0.000366	Wet
	ENV1851A	Animal Tissue	0.00220	< 0.000366	Wet
1-methylnaphthalene					
	ENV1850A	Animal Tissue	0.00380	< 0.000623	Wet
	ENV1851A	Animal Tissue	0.00380	< 0.000623	Wet
1-methylphenanthrene					
	ENV1850A	Animal Tissue	0.00260	< 0.000420	Wet
	ENV1851A	Animal Tissue	0.00260	< 0.000420	Wet
2,6-dimethylnaphthalene					
	ENV1850A	Animal Tissue	0.00330	< 0.000536	Wet
	ENV1851A	Animal Tissue	0.00330	< 0.000536	Wet
2-methylnaphthalene					
	ENV1850A	Animal Tissue	0.00410	< 0.000672	Wet
	ENV1851A	Animal Tissue	0.00410	< 0.000672	Wet
Aldrin					
	ENV1850A	Animal Tissue	0.000500	< 0.0000880	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000880	Wet
BDE# 1					
	ENV1858A	Animal Tissue	0.0322	< 0.00248	Wet
	ENV1859A	Animal Tissue	0.0322	< 0.00248	Wet
BDE# 10					
	ENV1858A	Animal Tissue	0.0322	< 0.00248	Wet
	ENV1859A	Animal Tissue	0.0322	< 0.00248	Wet

Analyte	Lab Sample Number	Lab Sample Matrix	Result Total UG	** BEC (ppm/%)	Basis
BDE# 100					
	ENV1858A	Animal Tissue	0.0229	< 0.00176	Wet
	ENV1859A	Animal Tissue	0.0229	< 0.00176	Wet
BDE# 11					
	ENV1858A	Animal Tissue	0.0322	< 0.00248	Wet
	ENV1859A	Animal Tissue	0.0322	< 0.00248	Wet
BDE# 116					
	ENV1858A	Animal Tissue	0.0229	< 0.00176	Wet
	ENV1859A	Animal Tissue	0.0229	< 0.00176	Wet
BDE# 118					
	ENV1858A	Animal Tissue	0.0229	< 0.00176	Wet
	ENV1859A	Animal Tissue	0.0229	< 0.00176	Wet
BDE# 119					
	ENV1858A	Animal Tissue	0.0229	< 0.00176	Wet
	ENV1859A	Animal Tissue	0.0229	< 0.00176	Wet
BDE# 12					
	ENV1858A	Animal Tissue	0.0322	< 0.00248	Wet
	ENV1859A	Animal Tissue	0.0322	< 0.00248	Wet
BDE# 126					
	ENV1858A	Animal Tissue	0.0229	< 0.00176	Wet
	ENV1859A	Animal Tissue	0.0229	< 0.00176	Wet
BDE# 13					
	ENV1858A	Animal Tissue	0.0322	< 0.00248	Wet
	ENV1859A	Animal Tissue	0.0322	< 0.00248	Wet
BDE# 138					
	ENV1858A	Animal Tissue	0.0402	< 0.00309	Wet
	ENV1859A	Animal Tissue	0.0402	< 0.00309	Wet
BDE# 15					
	ENV1858A	Animal Tissue	0.0322	< 0.00248	Wet
	ENV1859A	Animal Tissue	0.0322	< 0.00248	Wet
BDE# 153					
	ENV1858A	Animal Tissue	0.0217	< 0.00167	Wet
	ENV1859A	Animal Tissue	0.0217	< 0.00167	Wet

Analyte	Lab Sample Number	Lab Sample Matrix	Result Total UG	** BEC (ppm/%)	Basis
BDE# 154					
	ENV1858A	Animal Tissue	0.0257	< 0.00198	Wet
	ENV1859A	Animal Tissue	0.0257	< 0.00198	Wet
BDE# 155					
	ENV1858A	Animal Tissue	0.0257	< 0.00198	Wet
	ENV1859A	Animal Tissue	0.0257	< 0.00198	Wet
BDE# 166					
	ENV1858A	Animal Tissue	0.0257	< 0.00198	Wet
	ENV1859A	Animal Tissue	0.0257	< 0.00198	Wet
BDE# 17					
	ENV1858A	Animal Tissue	0.0322	< 0.00248	Wet
	ENV1859A	Animal Tissue	0.0322	< 0.00248	Wet
BDE# 181					
	ENV1858A	Animal Tissue	0.0286	< 0.00220	Wet
	ENV1859A	Animal Tissue	0.0286	< 0.00220	Wet
BDE# 183					
	ENV1858A	Animal Tissue	0.0286	< 0.00220	Wet
	ENV1859A	Animal Tissue	0.0286	< 0.00220	Wet
BDE# 190					
	ENV1858A	Animal Tissue	0.0285	< 0.00219	Wet
	ENV1859A	Animal Tissue	0.0285	< 0.00219	Wet
BDE# 2					
	ENV1858A	Animal Tissue	0.0322	< 0.00248	Wet
	ENV1859A	Animal Tissue	0.0322	< 0.00248	Wet
BDE# 25					
	ENV1858A	Animal Tissue	0.0322	< 0.00248	Wet
	ENV1859A	Animal Tissue	0.0322	< 0.00248	Wet
BDE# 28					
	ENV1858A	Animal Tissue	0.0151	< 0.00116	Wet
	ENV1859A	Animal Tissue	0.0195	0.00150	Wet
BDE# 3					
	ENV1858A	Animal Tissue	0.0322	< 0.00248	Wet
	ENV1859A	Animal Tissue	0.0322	< 0.00248	Wet

Analyte	Lab Sample Number	Lab Sample Matrix	Result Total UG	** BEC (ppm/%)	Basis
BDE# 30					
	ENV1858A	Animal Tissue	0.0322	< 0.00248	Wet
	ENV1859A	Animal Tissue	0.0322	< 0.00248	Wet
BDE# 32					
	ENV1858A	Animal Tissue	0.0322	< 0.00248	Wet
	ENV1859A	Animal Tissue	0.0322	< 0.00248	Wet
BDE# 33					
	ENV1858A	Animal Tissue	0.0322	< 0.00248	Wet
	ENV1859A	Animal Tissue	0.0322	< 0.00248	Wet
BDE# 35					
	ENV1858A	Animal Tissue	0.0322	< 0.00248	Wet
	ENV1859A	Animal Tissue	0.0322	< 0.00248	Wet
BDE# 37					
	ENV1858A	Animal Tissue	0.0322	< 0.00248	Wet
	ENV1859A	Animal Tissue	0.0322	< 0.00248	Wet
BDE# 47					
	ENV1858A	Animal Tissue	0.0165	< 0.00127	Wet
	ENV1859A	Animal Tissue	0.0165	< 0.00127	Wet
BDE# 49/71					
	ENV1858A	Animal Tissue	0.0178	< 0.00137	Wet
	ENV1859A	Animal Tissue	0.0178	< 0.00137	Wet
BDE# 66					
	ENV1858A	Animal Tissue	0.0199	< 0.00153	Wet
	ENV1859A	Animal Tissue	0.0199	< 0.00153	Wet
BDE# 7					
	ENV1858A	Animal Tissue	0.0322	< 0.00248	Wet
	ENV1859A	Animal Tissue	0.0322	< 0.00248	Wet
BDE# 75					
	ENV1858A	Animal Tissue	0.0178	< 0.00137	Wet
	ENV1859A	Animal Tissue	0.0178	< 0.00137	Wet
BDE# 77					
	ENV1858A	Animal Tissue	0.0178	< 0.00137	Wet
	ENV1859A	Animal Tissue	0.0178	< 0.00137	Wet

Analyte	Lab Sample Number	Lab Sample Matrix	Result Total UG	** BEC (ppm/%)	Basis
BDE# 8					
	ENV1858A	Animal Tissue	0.0322	< 0.00248	Wet
	ENV1859A	Animal Tissue	0.0322	< 0.00248	Wet
BDE# 85					
	ENV1858A	Animal Tissue	0.0194	< 0.00149	Wet
	ENV1859A	Animal Tissue	0.0194	< 0.00149	Wet
BDE# 99					
	ENV1858A	Animal Tissue	0.0152	< 0.00117	Wet
	ENV1859A	Animal Tissue	0.0152	< 0.00117	Wet
BHC (Total)					
	ENV1850A	Animal Tissue	0.00400	< 0.000685	Wet
	ENV1851A	Animal Tissue	0.00400	< 0.000685	Wet
Benzo(a)anthracene					
	ENV1850A	Animal Tissue	0.00190	< 0.000311	Wet
	ENV1851A	Animal Tissue	0.00190	< 0.000311	Wet
C1-Fluoranthenes & Pyrenes					
	ENV1850A	Animal Tissue	0.00310	< 0.000507	Wet
	ENV1851A	Animal Tissue	0.00310	< 0.000507	Wet
C1-Phenanthrenes & Anthracenes					
	ENV1850A	Animal Tissue	0.00300	< 0.000489	Wet
	ENV1851A	Animal Tissue	0.00300	< 0.000489	Wet
C1-chrysenes					
	ENV1850A	Animal Tissue	0.00470	< 0.000775	Wet
	ENV1851A	Animal Tissue	0.00470	< 0.000775	Wet
C1-dibenzothiophenes					
	ENV1850A	Animal Tissue	0.00340	< 0.000559	Wet
	ENV1851A	Animal Tissue	0.00340	< 0.000559	Wet
C1-fluorenes					
	ENV1850A	Animal Tissue	0.00420	< 0.000680	Wet
	ENV1851A	Animal Tissue	0.00420	< 0.000680	Wet
C1-naphthalenes					
	ENV1850A	Animal Tissue	0.00790	< 0.00129	Wet
	ENV1851A	Animal Tissue	0.00790	< 0.00129	Wet

Analyte	Lab Sample Number	Lab Sample Matrix	Result Total UG	** BEC (ppm/%)	Basis
C2-Phenanthrenes & Anthracenes					
	ENV1850A	Animal Tissue	0.00300	< 0.000489	Wet
	ENV1851A	Animal Tissue	0.00300	< 0.000489	Wet
C2-chrysenes					
	ENV1850A	Animal Tissue	0.00470	< 0.000775	Wet
	ENV1851A	Animal Tissue	0.00470	< 0.000775	Wet
C2-dibenzothiophenes					
	ENV1850A	Animal Tissue	0.00340	< 0.000559	Wet
	ENV1851A	Animal Tissue	0.00340	< 0.000559	Wet
C2-fluorenes					
	ENV1850A	Animal Tissue	0.00420	< 0.000680	Wet
	ENV1851A	Animal Tissue	0.00420	< 0.000680	Wet
C2-naphthalenes					
	ENV1850A	Animal Tissue	0.0100	< 0.00164	Wet
	ENV1851A	Animal Tissue	0.0100	< 0.00164	Wet
C3-Phenanthrenes & Anthracenes					
	ENV1850A	Animal Tissue	0.00300	< 0.000489	Wet
	ENV1851A	Animal Tissue	0.00300	< 0.000489	Wet
C3-chrysenes					
	ENV1850A	Animal Tissue	0.00470	< 0.000775	Wet
	ENV1851A	Animal Tissue	0.00470	< 0.000775	Wet
C3-dibenzothiophenes					
	ENV1850A	Animal Tissue	0.00340	< 0.000559	Wet
	ENV1851A	Animal Tissue	0.00340	< 0.000559	Wet
C3-fluorenes					
	ENV1850A	Animal Tissue	0.00420	< 0.000680	Wet
	ENV1851A	Animal Tissue	0.00420	< 0.000680	Wet
C3-naphthalenes					
	ENV1850A	Animal Tissue	0.0100	< 0.00164	Wet
	ENV1851A	Animal Tissue	0.0100	< 0.00164	Wet
C4-Phenanthrenes & Anthracenes					
	ENV1850A	Animal Tissue	0.00300	< 0.000489	Wet
	ENV1851A	Animal Tissue	0.00300	< 0.000489	Wet

Analyte	Lab Sample Number	Lab Sample Matrix	Result Total UG	** BEC (ppm/%)	Basis
C4-chrysenes					
	ENV1850A	Animal Tissue	0.00470	< 0.000775	Wet
	ENV1851A	Animal Tissue	0.00470	< 0.000775	Wet
C4-naphthalenes					
	ENV1850A	Animal Tissue	0.0100	< 0.00164	Wet
	ENV1851A	Animal Tissue	0.0100	< 0.00164	Wet
DDMU					
	ENV1850A	Animal Tissue	0.000700	< 0.000118	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000118	Wet
Dibenz(a,h)anthracene					
	ENV1850A	Animal Tissue	0.00220	< 0.000354	Wet
	ENV1851A	Animal Tissue	0.00220	< 0.000354	Wet
HCB					
	ENV1850A	Animal Tissue	0.00130	< 0.000225	Wet
	ENV1851A	Animal Tissue	0.00130	< 0.000225	Wet
Heptachlor					
	ENV1850A	Animal Tissue	0.000400	< 0.0000730	Wet
	ENV1851A	Animal Tissue	0.000400	< 0.0000730	Wet
PCB# 1					
	ENV1850A	Animal Tissue	0.00100	< 0.000178	Wet
	ENV1851A	Animal Tissue	0.00100	< 0.000178	Wet
PCB# 101/90					
	ENV1850A	Animal Tissue	0.000500	< 0.0000920	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000920	Wet
PCB# 105					
	ENV1850A	Animal Tissue	0.00100	< 0.000162	Wet
	ENV1851A	Animal Tissue	0.00100	< 0.000162	Wet
PCB# 107					
	ENV1850A	Animal Tissue	0.000500	< 0.0000920	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000920	Wet
PCB# 110/77					
	ENV1850A	Animal Tissue	0.000600	< 0.0000990	Wet
	ENV1851A	Animal Tissue	0.000600	< 0.0000990	Wet

Analyte	Lab Sample Number	Lab Sample Matrix	Result Total UG	** BEC (ppm/%)	Basis
PCB# 114/131/122					
	ENV1850A	Animal Tissue	0.000500	< 0.0000920	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000920	Wet
PCB# 118					
	ENV1850A	Animal Tissue	0.000700	< 0.000117	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000117	Wet
PCB# 126					
	ENV1850A	Animal Tissue	0.000500	< 0.0000920	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000920	Wet
PCB# 128					
	ENV1850A	Animal Tissue	0.000500	< 0.0000830	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000830	Wet
PCB# 129					
	ENV1850A	Animal Tissue	0.000500	< 0.0000880	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000880	Wet
PCB# 136					
	ENV1850A	Animal Tissue	0.000500	< 0.0000880	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000880	Wet
PCB# 138/160					
	ENV1850A	Animal Tissue	0.00150	0.000256	Wet
	ENV1851A	Animal Tissue	0.00150	0.000263	Wet
PCB# 141/179					
	ENV1850A	Animal Tissue	0.000500	< 0.0000880	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000880	Wet
PCB# 146					
	ENV1850A	Animal Tissue	0.000500	< 0.0000880	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000880	Wet
PCB# 149/123					
	ENV1850A	Animal Tissue	0.000500	< 0.0000880	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000880	Wet
PCB# 15					
	ENV1850A	Animal Tissue	0.00100	< 0.000178	Wet
	ENV1851A	Animal Tissue	0.00100	< 0.000178	Wet

Analyte	Lab Sample Number	Lab Sample Matrix	Result Total UG	** BEC (ppm/%)	Basis
PCB# 151					
	ENV1850A	Animal Tissue	0.000500	< 0.0000880	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000880	Wet
PCB# 153/132					
	ENV1850A	Animal Tissue	0.000700	< 0.000116	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000116	Wet
PCB# 156/171/202					
	ENV1850A	Animal Tissue	0.000500	< 0.0000880	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000880	Wet
PCB# 158					
	ENV1850A	Animal Tissue	0.000500	< 0.0000880	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000880	Wet
PCB# 16/32					
	ENV1850A	Animal Tissue	0.000700	< 0.000124	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000124	Wet
PCB# 166					
	ENV1850A	Animal Tissue	0.000500	< 0.0000880	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000880	Wet
PCB# 167					
	ENV1850A	Animal Tissue	0.000500	< 0.0000880	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000880	Wet
PCB# 169					
	ENV1850A	Animal Tissue	0.000500	< 0.0000880	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000880	Wet
PCB# 170/190					
	ENV1850A	Animal Tissue	0.000900	< 0.000153	Wet
	ENV1851A	Animal Tissue	0.000900	< 0.000153	Wet
PCB# 172					
	ENV1850A	Animal Tissue	0.000700	< 0.000116	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000116	Wet
PCB# 174					
	ENV1850A	Animal Tissue	0.000700	< 0.000116	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000116	Wet

Analyte	Lab Sample Number	Lab Sample Matrix	Result Total UG	** BEC (ppm/%)	Basis
PCB# 176/137					
	ENV1850A	Animal Tissue	0.000700	< 0.000116	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000116	Wet
PCB# 177					
	ENV1850A	Animal Tissue	0.000700	< 0.000116	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000116	Wet
PCB# 178					
	ENV1850A	Animal Tissue	0.000700	< 0.000116	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000116	Wet
PCB# 18					
	ENV1850A	Animal Tissue	0.000700	< 0.000124	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000124	Wet
PCB# 180					
	ENV1850A	Animal Tissue	0.000700	< 0.000116	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000116	Wet
PCB# 183					
	ENV1850A	Animal Tissue	0.000700	< 0.000116	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000116	Wet
PCB# 185					
	ENV1850A	Animal Tissue	0.000700	< 0.000116	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000116	Wet
PCB# 187					
	ENV1850A	Animal Tissue	0.000400	< 0.0000720	Wet
	ENV1851A	Animal Tissue	0.000400	< 0.0000720	Wet
PCB# 189					
	ENV1850A	Animal Tissue	0.000700	< 0.000116	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000116	Wet
PCB# 191					
	ENV1850A	Animal Tissue	0.000700	< 0.000116	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000116	Wet
PCB# 194					
	ENV1850A	Animal Tissue	0.000500	< 0.0000900	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000900	Wet

Analyte	Lab Sample Number	Lab Sample Matrix	Result Total UG	** BEC (ppm/%)	Basis
PCB# 195/208					
	ENV1850A	Animal Tissue	0.000500	< 0.0000900	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000900	Wet
PCB# 196/203					
	ENV1850A	Animal Tissue	0.000500	< 0.0000900	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000900	Wet
PCB# 199					
	ENV1850A	Animal Tissue	0.000500	< 0.0000900	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000900	Wet
PCB# 200/157/173					
	ENV1850A	Animal Tissue	0.000400	< 0.0000750	Wet
	ENV1851A	Animal Tissue	0.000400	< 0.0000750	Wet
PCB# 201					
	ENV1850A	Animal Tissue	0.000500	< 0.0000900	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000900	Wet
PCB# 205					
	ENV1850A	Animal Tissue	0.000500	< 0.0000900	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000900	Wet
PCB# 206					
	ENV1850A	Animal Tissue	0.000500	< 0.0000810	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000810	Wet
PCB# 209					
	ENV1850A	Animal Tissue	0.000500	< 0.0000830	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000830	Wet
PCB# 22/51					
	ENV1850A	Animal Tissue	0.000700	< 0.000124	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000124	Wet
PCB# 24/27					
	ENV1850A	Animal Tissue	0.000700	< 0.000124	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000124	Wet
PCB# 25					
	ENV1850A	Animal Tissue	0.000700	< 0.000124	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000124	Wet

Analyte	Lab Sample Number	Lab Sample Matrix	Result Total UG	** BEC (ppm/%)	Basis
PCB# 26					
	ENV1850A	Animal Tissue	0.000700	< 0.000124	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000124	Wet
PCB# 28					
	ENV1850A	Animal Tissue	0.000600	< 0.0000950	Wet
	ENV1851A	Animal Tissue	0.000600	< 0.0000950	Wet
PCB# 29					
	ENV1850A	Animal Tissue	0.000500	< 0.0000770	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000770	Wet
PCB# 31					
	ENV1850A	Animal Tissue	0.000700	< 0.000124	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000124	Wet
PCB# 33/53/20					
	ENV1850A	Animal Tissue	0.000700	< 0.000124	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000124	Wet
PCB# 40					
	ENV1850A	Animal Tissue	0.000700	< 0.000117	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000117	Wet
PCB# 41/64					
	ENV1850A	Animal Tissue	0.000700	< 0.000117	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000117	Wet
PCB# 42/59/37					
	ENV1850A	Animal Tissue	0.000700	< 0.000117	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000117	Wet
PCB# 43					
	ENV1850A	Animal Tissue	0.000700	< 0.000117	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000117	Wet
PCB# 44					
	ENV1850A	Animal Tissue	0.000400	< 0.0000720	Wet
	ENV1851A	Animal Tissue	0.000400	< 0.0000720	Wet
PCB# 45					
	ENV1850A	Animal Tissue	0.000700	< 0.000117	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000117	Wet

Analyte	Lab Sample Number	Lab Sample Matrix	Result Total UG	** BEC (ppm/%)	Basis
PCB# 46					
	ENV1850A	Animal Tissue	0.000700	< 0.000117	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000117	Wet
PCB# 47/48/75					
	ENV1850A	Animal Tissue	0.000700	< 0.000117	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000117	Wet
PCB# 49					
	ENV1850A	Animal Tissue	0.000700	< 0.000117	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000117	Wet
PCB# 52					
	ENV1850A	Animal Tissue	0.000700	< 0.000117	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000117	Wet
PCB# 56/60					
	ENV1850A	Animal Tissue	0.000700	< 0.000117	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000117	Wet
PCB# 66					
	ENV1850A	Animal Tissue	0.000600	< 0.0000960	Wet
	ENV1851A	Animal Tissue	0.000600	< 0.0000960	Wet
PCB# 7/9					
	ENV1850A	Animal Tissue	0.00100	< 0.000178	Wet
	ENV1851A	Animal Tissue	0.00100	< 0.000178	Wet
PCB# 70					
	ENV1850A	Animal Tissue	0.000700	< 0.000117	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000117	Wet
PCB# 74/61					
	ENV1850A	Animal Tissue	0.000700	< 0.000117	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000117	Wet
PCB# 77					
	ENV1850A	Animal Tissue	0.000700	< 0.000117	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000117	Wet
PCB# 8/5					
	ENV1850A	Animal Tissue	0.00100	< 0.000178	Wet
	ENV1851A	Animal Tissue	0.00100	< 0.000178	Wet

Analyte	Lab Sample Number	Lab Sample Matrix	Result Total UG	** BEC (ppm/%)	Basis
PCB# 81					
	ENV1850A	Animal Tissue	0.000700	< 0.000117	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000117	Wet
PCB# 82					
	ENV1850A	Animal Tissue	0.000500	< 0.0000920	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000920	Wet
PCB# 83					
	ENV1850A	Animal Tissue	0.000500	< 0.0000920	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000920	Wet
PCB# 84					
	ENV1850A	Animal Tissue	0.000500	< 0.0000920	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000920	Wet
PCB# 85					
	ENV1850A	Animal Tissue	0.000500	< 0.0000920	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000920	Wet
PCB# 86					
	ENV1850A	Animal Tissue	0.000500	< 0.0000920	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000920	Wet
PCB# 87/115					
	ENV1850A	Animal Tissue	0.000700	< 0.000123	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000123	Wet
PCB# 88					
	ENV1850A	Animal Tissue	0.000500	< 0.0000920	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000920	Wet
PCB# 92					
	ENV1850A	Animal Tissue	0.000500	< 0.0000920	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000920	Wet
PCB# 95					
	ENV1850A	Animal Tissue	0.000500	< 0.0000920	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000920	Wet
PCB# 97					
	ENV1850A	Animal Tissue	0.000500	< 0.0000920	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000920	Wet

Analyte	Lab Sample Number	Lab Sample Matrix	Result Total UG	** BEC (ppm/%)	Basis
PCB# 99					
	ENV1850A	Animal Tissue	0.000500	< 0.0000920	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000920	Wet
PCB-1242					
	ENV1850A	Animal Tissue	0.0524	< 0.00890	Wet
	ENV1851A	Animal Tissue	0.0524	< 0.00890	Wet
PCB-1248					
	ENV1850A	Animal Tissue	0.0524	< 0.00890	Wet
	ENV1851A	Animal Tissue	0.0524	< 0.00890	Wet
PCB-1254					
	ENV1850A	Animal Tissue	0.0524	< 0.00890	Wet
	ENV1851A	Animal Tissue	0.0524	< 0.00890	Wet
PCB-1260					
	ENV1850A	Animal Tissue	0.0524	< 0.00890	Wet
	ENV1851A	Animal Tissue	0.0524	< 0.00890	Wet
PCB-TOTAL					
	ENV1850A	Animal Tissue	0.0180	< 0.00306	Wet
	ENV1851A	Animal Tissue	0.0180	< 0.00306	Wet
Pentachlorobenzene					
	ENV1850A	Animal Tissue	0.00290	0.000498	Wet
	ENV1851A	Animal Tissue	0.00150	0.000250	Wet
Total DDT's					
	ENV1850A	Animal Tissue	0.00380	< 0.000648	Wet
	ENV1851A	Animal Tissue	0.00380	< 0.000648	Wet
acenaphthalene					
	ENV1850A	Animal Tissue	0.00200	< 0.000334	Wet
	ENV1851A	Animal Tissue	0.00200	< 0.000334	Wet
acenaphthene					
	ENV1850A	Animal Tissue	0.00210	< 0.000336	Wet
	ENV1851A	Animal Tissue	0.00210	< 0.000336	Wet
alpha BHC					
	ENV1850A	Animal Tissue	0.00140	< 0.000239	Wet
	ENV1851A	Animal Tissue	0.00140	< 0.000239	Wet

Analyte	Lab Sample Number	Lab Sample Matrix	Result Total UG	** BEC (ppm/%)	Basis
alpha chlordane					
	ENV1850A	Animal Tissue	0.000500	< 0.0000840	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000840	Wet
anthracene					
	ENV1850A	Animal Tissue	0.00130	< 0.000205	Wet
	ENV1851A	Animal Tissue	0.00130	< 0.000205	Wet
benzo(a)pyrene					
	ENV1850A	Animal Tissue	0.00220	< 0.000366	Wet
	ENV1851A	Animal Tissue	0.00220	< 0.000366	Wet
benzo(b)fluoranthene					
	ENV1850A	Animal Tissue	0.00170	< 0.000274	Wet
	ENV1851A	Animal Tissue	0.00170	< 0.000274	Wet
benzo(e)pyrene					
	ENV1850A	Animal Tissue	0.00240	< 0.000392	Wet
	ENV1851A	Animal Tissue	0.00240	< 0.000392	Wet
benzo(g,h,i)perylene					
	ENV1850A	Animal Tissue	0.00270	< 0.000441	Wet
	ENV1851A	Animal Tissue	0.00270	< 0.000441	Wet
benzo(k)fluoranthene					
	ENV1850A	Animal Tissue	0.00210	< 0.000339	Wet
	ENV1851A	Animal Tissue	0.00210	< 0.000339	Wet
beta BHC					
	ENV1850A	Animal Tissue	0.00130	< 0.000220	Wet
	ENV1851A	Animal Tissue	0.00130	< 0.000220	Wet
biphenyl					
	ENV1850A	Animal Tissue	0.00370	< 0.000608	Wet
	ENV1851A	Animal Tissue	0.00370	< 0.000608	Wet
chlorpyrifos					
	ENV1850A	Animal Tissue	0.00120	< 0.000201	Wet
	ENV1851A	Animal Tissue	0.00120	< 0.000201	Wet
chrysene					
	ENV1850A	Animal Tissue	0.00240	< 0.000387	Wet
	ENV1851A	Animal Tissue	0.00240	< 0.000387	Wet

Analyte	Lab Sample Number	Lab Sample Matrix	Result Total UG	** BEC (ppm/%)	Basis
cis-nonachlor					
	ENV1850A	Animal Tissue	0.000700	< 0.000116	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000116	Wet
delta BHC					
	ENV1850A	Animal Tissue	0.00140	< 0.000243	Wet
	ENV1851A	Animal Tissue	0.00140	< 0.000243	Wet
dibenzothiophene					
	ENV1850A	Animal Tissue	0.00170	< 0.000280	Wet
	ENV1851A	Animal Tissue	0.00170	< 0.000280	Wet
dieldrin					
	ENV1850A	Animal Tissue	0.00190	< 0.000322	Wet
	ENV1851A	Animal Tissue	0.00190	< 0.000322	Wet
endosulfan I					
	ENV1850A	Animal Tissue	0.00200	< 0.000343	Wet
	ENV1851A	Animal Tissue	0.00200	< 0.000343	Wet
endosulfan II					
	ENV1850A	Animal Tissue	0.00190	< 0.000327	Wet
	ENV1851A	Animal Tissue	0.00190	< 0.000327	Wet
endosulfan sulfate					
	ENV1850A	Animal Tissue	0.00210	< 0.000360	Wet
	ENV1851A	Animal Tissue	0.00210	< 0.000360	Wet
endrin					
	ENV1850A	Animal Tissue	0.00230	< 0.000392	Wet
	ENV1851A	Animal Tissue	0.00230	< 0.000392	Wet
fluoranthene					
	ENV1850A	Animal Tissue	0.00150	< 0.000254	Wet
	ENV1851A	Animal Tissue	0.00150	< 0.000254	Wet
fluorene					
	ENV1850A	Animal Tissue	0.00210	< 0.000339	Wet
	ENV1851A	Animal Tissue	0.00210	< 0.000339	Wet
gamma BHC					
	ENV1850A	Animal Tissue	0.000700	< 0.000118	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000118	Wet

Analyte	Lab Sample Number	Lab Sample Matrix	Result Total UG	** BEC (ppm/%)	Basis
gamma chlordane					
	ENV1850A	Animal Tissue	0.000600	< 0.0000960	Wet
	ENV1851A	Animal Tissue	0.000600	< 0.0000960	Wet
heptachlor epoxide					
	ENV1850A	Animal Tissue	0.00150	< 0.000257	Wet
	ENV1851A	Animal Tissue	0.00150	< 0.000257	Wet
indeno(1,2,3-cd)pyrene					
	ENV1850A	Animal Tissue	0.00350	< 0.000570	Wet
	ENV1851A	Animal Tissue	0.00350	< 0.000570	Wet
mirex					
	ENV1850A	Animal Tissue	0.000500	< 0.0000830	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000830	Wet
naphthalene					
	ENV1850A	Animal Tissue	0.00500	< 0.000821	Wet
	ENV1851A	Animal Tissue	0.00500	< 0.000821	Wet
o,p'-DDD					
	ENV1850A	Animal Tissue	0.00100	< 0.000166	Wet
	ENV1851A	Animal Tissue	0.00100	< 0.000166	Wet
o,p'-DDE					
	ENV1850A	Animal Tissue	0.000500	< 0.0000790	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000790	Wet
o,p'-DDT					
	ENV1850A	Animal Tissue	0.000700	< 0.000124	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000124	Wet
oxychlordane					
	ENV1850A	Animal Tissue	0.000700	< 0.000125	Wet
	ENV1851A	Animal Tissue	0.000700	< 0.000125	Wet
p,p'-DDD					
	ENV1850A	Animal Tissue	0.00100	< 0.000166	Wet
	ENV1851A	Animal Tissue	0.00100	< 0.000166	Wet
p,p'-DDE					
	ENV1850A	Animal Tissue	0.000500	< 0.0000820	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000820	Wet

Analyte	Lab Sample Number	Lab Sample Matrix	Result Total UG	** BEC (ppm/%)	Basis
p,p'-DDT					
	ENV1850A	Animal Tissue	0.000500	< 0.0000880	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000880	Wet
pentachloro-anisole					
	ENV1850A	Animal Tissue	0.000500	< 0.0000910	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000910	Wet
perylene					
	ENV1850A	Animal Tissue	0.00320	< 0.000530	Wet
	ENV1851A	Animal Tissue	0.00320	< 0.000530	Wet
phenanthrene					
	ENV1850A	Animal Tissue	0.00180	0.000300	Wet
	ENV1851A	Animal Tissue	0.00150	< 0.000244	Wet
pyrene					
	ENV1850A	Animal Tissue	0.00200	< 0.000330	Wet
	ENV1851A	Animal Tissue	0.00200	< 0.000330	Wet
toxaphene					
	ENV1850A	Animal Tissue	0.0500	< 0.00849	Wet
	ENV1851A	Animal Tissue	0.0500	< 0.00849	Wet
trans-nonachlor					
	ENV1850A	Animal Tissue	0.000500	< 0.0000920	Wet
	ENV1851A	Animal Tissue	0.000500	< 0.0000920	Wet

** Blank Equivalent Concentration

6. Duplicates

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
% Lipid							
	UALB01	Fillets with Skin	Percent	0.920	0.980	0.950	6.32
	UPLB01	Fillets with Skin	Percent	0.720	0.760	0.740	5.41
% Moisture							
	UALB01	Fillets with Skin	Percent	77.7	77.7	77.7	0.000
	UPLB01	Fillets with Skin	Percent	79.6	79.6	79.6	0.000
1,2,3,4-Tetrachlorobenzene							
	UALB01	Fillets with Skin	Wet	< 0.000105	< 0.000106	0.0000528	0.950
	UPLB01	Fillets with Skin	Wet	< 0.000106	< 0.000102	0.0000520	3.85
1,2,4,5-Tetrachlorobenzene							
	UALB01	Fillets with Skin	Wet	0.000267	0.000257	0.000262	3.82
	UPLB01	Fillets with Skin	Wet	0.000291	0.000261	0.000276	10.9
1,6,7-Trimethyl-naphthalene							
	UALB01	Fillets with Skin	Wet	0.000600	0.000600	0.000600	0.000
	UPLB01	Fillets with Skin	Wet	< 0.000431	< 0.000414	0.000211	4.02
1-methylnaphthalene							
	UALB01	Fillets with Skin	Wet	0.000800	0.000800	0.000800	0.000
	UPLB01	Fillets with Skin	Wet	< 0.000735	< 0.000706	0.000360	4.02
1-methylphenanthrene							
	UALB01	Fillets with	Wet	< 0.000493	< 0.000495	0.000247	0.400

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
		Skin					
	UPLB01	Fillets with Skin	Wet	< 0.000495	< 0.000476	0.000243	3.91
2,6-dimethylnaphthalene							
	UALB01	Fillets with Skin	Wet	0.000900	0.000900	0.000900	0.000
	UPLB01	Fillets with Skin	Wet	< 0.000632	< 0.000608	0.000310	3.87
2-methylnaphthalene							
	UALB01	Fillets with Skin	Wet	0.000900	0.000900	0.000900	0.000
	UPLB01	Fillets with Skin	Wet	0.000800	0.000800	0.000800	0.000
Aldrin							
	UALB01	Fillets with Skin	Wet	< 0.000100	< 0.000101	0.0000502	1.00
	UPLB01	Fillets with Skin	Wet	< 0.000101	< 0.0000970	0.0000495	4.04
BDE# 1							
	UALB01	Fillets with Skin	Wet	0.00800	0.00790	0.00795	1.26
	UPLB01	Fillets with Skin	Wet	< 0.00640	< 0.00645	0.00321	0.790
BDE# 10							
	UALB01	Fillets with Skin	Wet	< 0.00618	< 0.00603	0.00305	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00640	< 0.00645	0.00321	0.790
BDE# 100							
	UALB01	Fillets with Skin	Wet	< 0.00438	< 0.00428	0.00217	2.45
	UPLB01	Fillets with Skin	Wet	< 0.00454	< 0.00458	0.00228	0.790
BDE# 11							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	< 0.00618	< 0.00603	0.00305	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00640	< 0.00645	0.00321	0.790
BDE# 116							
	UALB01	Fillets with Skin	Wet	< 0.00438	< 0.00428	0.00217	2.45
	UPLB01	Fillets with Skin	Wet	< 0.00454	< 0.00458	0.00228	0.790
BDE# 118							
	UALB01	Fillets with Skin	Wet	< 0.00438	< 0.00428	0.00217	2.45
	UPLB01	Fillets with Skin	Wet	< 0.00454	< 0.00458	0.00228	0.790
BDE# 119							
	UALB01	Fillets with Skin	Wet	< 0.00438	< 0.00428	0.00217	2.45
	UPLB01	Fillets with Skin	Wet	< 0.00454	< 0.00458	0.00228	0.790
BDE# 12							
	UALB01	Fillets with Skin	Wet	< 0.00618	< 0.00603	0.00305	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00640	< 0.00645	0.00321	0.790
BDE# 126							
	UALB01	Fillets with Skin	Wet	< 0.00438	< 0.00428	0.00217	2.45
	UPLB01	Fillets with Skin	Wet	< 0.00454	< 0.00458	0.00228	0.790
BDE# 13							
	UALB01	Fillets with Skin	Wet	< 0.00618	< 0.00603	0.00305	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00640	< 0.00645	0.00321	0.790
BDE# 138							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	< 0.00770	< 0.00751	0.00380	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00797	< 0.00803	0.00400	0.800
BDE# 15							
	UALB01	Fillets with Skin	Wet	< 0.00618	< 0.00603	0.00305	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00640	< 0.00645	0.00321	0.790
BDE# 153							
	UALB01	Fillets with Skin	Wet	< 0.00416	< 0.00406	0.00205	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00431	< 0.00434	0.00216	0.790
BDE# 154							
	UALB01	Fillets with Skin	Wet	< 0.00493	< 0.00481	0.00244	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00511	< 0.00515	0.00256	0.800
BDE# 155							
	UALB01	Fillets with Skin	Wet	< 0.00493	< 0.00481	0.00244	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00511	< 0.00515	0.00256	0.800
BDE# 166							
	UALB01	Fillets with Skin	Wet	< 0.00493	< 0.00481	0.00244	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00511	< 0.00515	0.00256	0.800
BDE# 17							
	UALB01	Fillets with Skin	Wet	< 0.00618	< 0.00603	0.00305	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00640	< 0.00645	0.00321	0.790
BDE# 181							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	< 0.00548	< 0.00535	0.00271	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00568	< 0.00572	0.00285	0.790
BDE# 183							
	UALB01	Fillets with Skin	Wet	< 0.00548	< 0.00535	0.00271	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00568	< 0.00572	0.00285	0.790
BDE# 190							
	UALB01	Fillets with Skin	Wet	< 0.00545	< 0.00532	0.00269	2.47
	UPLB01	Fillets with Skin	Wet	< 0.00565	< 0.00569	0.00284	0.790
BDE# 2							
	UALB01	Fillets with Skin	Wet	< 0.00618	< 0.00603	0.00305	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00640	< 0.00645	0.00321	0.790
BDE# 25							
	UALB01	Fillets with Skin	Wet	< 0.00618	< 0.00603	0.00305	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00640	< 0.00645	0.00321	0.790
BDE# 28							
	UALB01	Fillets with Skin	Wet	< 0.00289	0.00320	0.00232	75.6
	UPLB01	Fillets with Skin	Wet	< 0.00299	< 0.00302	0.00150	0.800
BDE# 3							
	UALB01	Fillets with Skin	Wet	< 0.00618	< 0.00603	0.00305	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00640	< 0.00645	0.00321	0.790
BDE# 30							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	< 0.00618	< 0.00603	0.00305	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00640	< 0.00645	0.00321	0.790
BDE# 32							
	UALB01	Fillets with Skin	Wet	< 0.00618	< 0.00603	0.00305	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00640	< 0.00645	0.00321	0.790
BDE# 33							
	UALB01	Fillets with Skin	Wet	< 0.00618	< 0.00603	0.00305	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00640	< 0.00645	0.00321	0.790
BDE# 35							
	UALB01	Fillets with Skin	Wet	< 0.00618	< 0.00603	0.00305	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00640	< 0.00645	0.00321	0.790
BDE# 37							
	UALB01	Fillets with Skin	Wet	< 0.00618	< 0.00603	0.00305	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00640	< 0.00645	0.00321	0.790
BDE# 47							
	UALB01	Fillets with Skin	Wet	0.0131	0.0132	0.0132	0.760
	UPLB01	Fillets with Skin	Wet	< 0.00328	0.0132	0.00742	156
BDE# 49/71							
	UALB01	Fillets with Skin	Wet	< 0.00341	< 0.00333	0.00169	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00353	< 0.00356	0.00177	0.790
BDE# 66							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	< 0.00381	< 0.00372	0.00188	2.44
	UPLB01	Fillets with Skin	Wet	< 0.00395	< 0.00398	0.00198	0.810
BDE# 7							
	UALB01	Fillets with Skin	Wet	< 0.00618	< 0.00603	0.00305	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00640	< 0.00645	0.00321	0.790
BDE# 75							
	UALB01	Fillets with Skin	Wet	< 0.00341	< 0.00333	0.00169	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00353	< 0.00356	0.00177	0.790
BDE# 77							
	UALB01	Fillets with Skin	Wet	< 0.00341	< 0.00333	0.00169	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00353	< 0.00356	0.00177	0.790
BDE# 8							
	UALB01	Fillets with Skin	Wet	< 0.00618	< 0.00603	0.00305	2.46
	UPLB01	Fillets with Skin	Wet	< 0.00640	< 0.00645	0.00321	0.790
BDE# 85							
	UALB01	Fillets with Skin	Wet	< 0.00371	< 0.00362	0.00183	2.45
	UPLB01	Fillets with Skin	Wet	< 0.00384	< 0.00387	0.00193	0.800
BDE# 99							
	UALB01	Fillets with Skin	Wet	0.00570	0.00540	0.00555	5.41
	UPLB01	Fillets with Skin	Wet	0.00620	0.00680	0.00650	9.23
BHC (Total)							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	< 0.000777	< 0.000780	0.000389	0.390
	UPLB01	Fillets with Skin	Wet	< 0.000780	< 0.000750	0.000383	3.92
Benzo(a)anthracene							
	UALB01	Fillets with Skin	Wet	< 0.000366	< 0.000368	0.000184	0.540
	UPLB01	Fillets with Skin	Wet	< 0.000368	< 0.000353	0.000180	4.16
C1-Fluoranthenes & Pyrenes							
	UALB01	Fillets with Skin	Wet	< 0.000595	< 0.000598	0.000298	0.500
	UPLB01	Fillets with Skin	Wet	< 0.000598	< 0.000574	0.000293	4.10
C1-Phenanthrenes & Anthracenes							
	UALB01	Fillets with Skin	Wet	< 0.000574	< 0.000576	0.000288	0.350
	UPLB01	Fillets with Skin	Wet	0.000600	0.000600	0.000600	0.000
C1-chrysenes							
	UALB01	Fillets with Skin	Wet	< 0.000911	< 0.000915	0.000456	0.440
	UPLB01	Fillets with Skin	Wet	< 0.000915	< 0.000879	0.000448	4.01
C1-dibenzothiophenes							
	UALB01	Fillets with Skin	Wet	< 0.000657	< 0.000660	0.000329	0.460
	UPLB01	Fillets with Skin	Wet	< 0.000660	< 0.000634	0.000324	4.02
C1-fluorenes							
	UALB01	Fillets with Skin	Wet	0.00170	0.00160	0.00165	6.06
	UPLB01	Fillets with Skin	Wet	0.00100	0.00100	0.00100	0.000
C1-naphthalenes							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	< 0.00152	< 0.00153	0.000762	0.390
	UPLB01	Fillets with Skin	Wet	< 0.00153	< 0.00147	0.000748	3.94
C2-Phenanthrenes & Anthracenes							
	UALB01	Fillets with Skin	Wet	< 0.000574	< 0.000576	0.000288	0.350
	UPLB01	Fillets with Skin	Wet	0.000900	0.000900	0.000900	0.000
C2-chrysenes							
	UALB01	Fillets with Skin	Wet	< 0.000911	< 0.000915	0.000456	0.440
	UPLB01	Fillets with Skin	Wet	< 0.000915	< 0.000879	0.000448	4.01
C2-dibenzothiophenes							
	UALB01	Fillets with Skin	Wet	< 0.000657	< 0.000660	0.000329	0.460
	UPLB01	Fillets with Skin	Wet	< 0.000660	< 0.000634	0.000324	4.02
C2-fluorenes							
	UALB01	Fillets with Skin	Wet	< 0.000800	< 0.000803	0.000401	0.370
	UPLB01	Fillets with Skin	Wet	< 0.000803	< 0.000771	0.000393	4.07
C2-naphthalenes							
	UALB01	Fillets with Skin	Wet	0.00230	0.00240	0.00235	4.26
	UPLB01	Fillets with Skin	Wet	0.00250	0.00260	0.00255	3.92
C3-Phenanthrenes & Anthracenes							
	UALB01	Fillets with Skin	Wet	< 0.000574	< 0.000576	0.000288	0.350
	UPLB01	Fillets with Skin	Wet	0.00170	0.00160	0.00165	6.06
C3-chrysenes							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	< 0.000911	< 0.000915	0.000456	0.440
	UPLB01	Fillets with Skin	Wet	< 0.000915	< 0.000879	0.000448	4.01
C3-dibenzothiophenes							
	UALB01	Fillets with Skin	Wet	< 0.000657	< 0.000660	0.000329	0.460
	UPLB01	Fillets with Skin	Wet	< 0.000660	< 0.000634	0.000324	4.02
C3-fluorenes							
	UALB01	Fillets with Skin	Wet	< 0.000800	< 0.000803	0.000401	0.370
	UPLB01	Fillets with Skin	Wet	< 0.000803	< 0.000771	0.000393	4.07
C3-naphthalenes							
	UALB01	Fillets with Skin	Wet	0.00340	0.00340	0.00340	0.000
	UPLB01	Fillets with Skin	Wet	0.00300	0.00290	0.00295	3.39
C4-Phenanthrenes & Anthracenes							
	UALB01	Fillets with Skin	Wet	< 0.000574	< 0.000576	0.000288	0.350
	UPLB01	Fillets with Skin	Wet	< 0.000576	< 0.000554	0.000282	3.89
C4-chrysenes							
	UALB01	Fillets with Skin	Wet	< 0.000911	< 0.000915	0.000456	0.440
	UPLB01	Fillets with Skin	Wet	< 0.000915	< 0.000879	0.000448	4.01
C4-naphthalenes							
	UALB01	Fillets with Skin	Wet	0.00430	0.00450	0.00440	4.55
	UPLB01	Fillets with Skin	Wet	< 0.00194	< 0.00186	0.000951	4.00
DDMU							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	0.00181	0.00176	0.00178	2.75
	UPLB01	Fillets with Skin	Wet	0.000657	0.000663	0.000660	0.910
Dibenz(a,h)anthracene							
	UALB01	Fillets with Skin	Wet	< 0.000416	< 0.000418	0.000208	0.480
	UPLB01	Fillets with Skin	Wet	< 0.000418	< 0.000401	0.000205	4.15
HCB							
	UALB01	Fillets with Skin	Wet	0.000741	0.000854	0.000798	14.2
	UPLB01	Fillets with Skin	Wet	< 0.000256	< 0.000246	0.000126	3.98
Heptachlor							
	UALB01	Fillets with Skin	Wet	< 0.0000820	< 0.0000830	0.0000412	1.21
	UPLB01	Fillets with Skin	Wet	< 0.0000830	< 0.0000790	0.0000405	4.94
PCB# 1							
	UALB01	Fillets with Skin	Wet	< 0.000202	< 0.000203	0.000101	0.490
	UPLB01	Fillets with Skin	Wet	< 0.000203	< 0.000195	0.0000995	4.02
PCB# 101/90							
	UALB01	Fillets with Skin	Wet	0.0107	0.0107	0.0107	0.0800
	UPLB01	Fillets with Skin	Wet	0.0119	0.0111	0.0115	7.26
PCB# 105							
	UALB01	Fillets with Skin	Wet	0.00306	0.00330	0.00318	7.83
	UPLB01	Fillets with Skin	Wet	0.00298	0.00315	0.00307	5.51
PCB# 107							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	0.000346	0.000381	0.000364	9.63
	UPLB01	Fillets with Skin	Wet	< 0.000105	< 0.000101	0.0000515	3.88
PCB# 110/77							
	UALB01	Fillets with Skin	Wet	0.00740	0.00735	0.00738	0.750
	UPLB01	Fillets with Skin	Wet	0.00468	0.00444	0.00456	5.20
PCB# 114/131/122							
	UALB01	Fillets with Skin	Wet	< 0.000104	< 0.000105	0.0000522	0.960
	UPLB01	Fillets with Skin	Wet	< 0.000105	< 0.000101	0.0000515	3.88
PCB# 118							
	UALB01	Fillets with Skin	Wet	0.00910	0.00880	0.00895	3.29
	UPLB01	Fillets with Skin	Wet	0.00884	0.00815	0.00849	8.10
PCB# 126							
	UALB01	Fillets with Skin	Wet	< 0.000104	< 0.000105	0.0000522	0.960
	UPLB01	Fillets with Skin	Wet	< 0.000105	< 0.000101	0.0000515	3.88
PCB# 128							
	UALB01	Fillets with Skin	Wet	0.00171	0.00180	0.00176	5.18
	UPLB01	Fillets with Skin	Wet	0.00210	0.00205	0.00207	2.17
PCB# 129							
	UALB01	Fillets with Skin	Wet	0.000366	0.000350	0.000358	4.47
	UPLB01	Fillets with Skin	Wet	0.000413	0.000379	0.000396	8.59
PCB# 136							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	< 0.000100	< 0.000101	0.0000502	1.00
	UPLB01	Fillets with Skin	Wet	< 0.000101	< 0.0000970	0.0000495	4.04
PCB# 138/160							
	UALB01	Fillets with Skin	Wet	0.0168	0.0163	0.0165	2.54
	UPLB01	Fillets with Skin	Wet	0.0241	0.0222	0.0231	8.02
PCB# 141/179							
	UALB01	Fillets with Skin	Wet	0.00231	0.00239	0.00235	3.19
	UPLB01	Fillets with Skin	Wet	0.00367	0.00344	0.00355	6.62
PCB# 146							
	UALB01	Fillets with Skin	Wet	0.00293	0.00298	0.00295	1.66
	UPLB01	Fillets with Skin	Wet	0.00498	0.00470	0.00484	5.82
PCB# 149/123							
	UALB01	Fillets with Skin	Wet	0.00658	0.00677	0.00668	2.83
	UPLB01	Fillets with Skin	Wet	0.00850	0.00781	0.00815	8.51
PCB# 15							
	UALB01	Fillets with Skin	Wet	0.00205	0.00221	0.00213	7.84
	UPLB01	Fillets with Skin	Wet	0.000367	0.000344	0.000356	6.47
PCB# 151							
	UALB01	Fillets with Skin	Wet	0.00250	0.00266	0.00258	6.01
	UPLB01	Fillets with Skin	Wet	0.00384	0.00353	0.00368	8.36
PCB# 153/132							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	0.0213	0.0212	0.0212	0.470
	UPLB01	Fillets with Skin	Wet	0.0330	0.0305	0.0317	7.84
PCB# 156/171/202							
	UALB01	Fillets with Skin	Wet	0.00201	0.00195	0.00198	3.09
	UPLB01	Fillets with Skin	Wet	0.00249	0.00242	0.00245	3.06
PCB# 158							
	UALB01	Fillets with Skin	Wet	0.00177	0.00186	0.00182	5.12
	UPLB01	Fillets with Skin	Wet	0.00262	0.00248	0.00255	5.46
PCB# 16/32							
	UALB01	Fillets with Skin	Wet	0.00200	0.00211	0.00205	5.50
	UPLB01	Fillets with Skin	Wet	< 0.000141	< 0.000136	0.0000692	3.61
PCB# 166							
	UALB01	Fillets with Skin	Wet	0.000168	0.000165	0.000166	1.80
	UPLB01	Fillets with Skin	Wet	0.000138	0.000107	0.000122	25.3
PCB# 167							
	UALB01	Fillets with Skin	Wet	0.000484	0.000474	0.000479	2.09
	UPLB01	Fillets with Skin	Wet	0.000627	0.000557	0.000592	11.8
PCB# 169							
	UALB01	Fillets with Skin	Wet	< 0.000100	< 0.000101	0.0000502	1.00
	UPLB01	Fillets with Skin	Wet	< 0.000101	< 0.0000970	0.0000495	4.04
PCB# 170/190							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	0.00452	0.00438	0.00445	2.99
	UPLB01	Fillets with Skin	Wet	0.00578	0.00532	0.00555	8.31
PCB# 172							
	UALB01	Fillets with Skin	Wet	0.000712	0.000710	0.000711	0.280
	UPLB01	Fillets with Skin	Wet	0.000933	0.000841	0.000887	10.4
PCB# 174							
	UALB01	Fillets with Skin	Wet	0.00181	0.00188	0.00185	4.06
	UPLB01	Fillets with Skin	Wet	0.00191	0.00175	0.00183	8.62
PCB# 176/137							
	UALB01	Fillets with Skin	Wet	0.000455	0.000443	0.000449	2.67
	UPLB01	Fillets with Skin	Wet	0.000596	0.000557	0.000576	6.76
PCB# 177							
	UALB01	Fillets with Skin	Wet	0.00134	0.00131	0.00132	2.12
	UPLB01	Fillets with Skin	Wet	0.00180	0.00167	0.00174	7.71
PCB# 178							
	UALB01	Fillets with Skin	Wet	0.000781	0.000813	0.000797	4.02
	UPLB01	Fillets with Skin	Wet	0.00121	0.00115	0.00118	5.01
PCB# 18							
	UALB01	Fillets with Skin	Wet	0.00167	0.00178	0.00173	6.37
	UPLB01	Fillets with Skin	Wet	< 0.000141	< 0.000136	0.0000692	3.61
PCB# 180							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	0.0140	0.0132	0.0136	5.65
	UPLB01	Fillets with Skin	Wet	0.0172	0.0158	0.0165	8.34
PCB# 183							
	UALB01	Fillets with Skin	Wet	0.00245	0.00255	0.00250	4.04
	UPLB01	Fillets with Skin	Wet	0.00364	0.00339	0.00351	7.14
PCB# 185							
	UALB01	Fillets with Skin	Wet	0.000386	0.000412	0.000399	6.52
	UPLB01	Fillets with Skin	Wet	0.000535	0.000450	0.000492	17.3
PCB# 187							
	UALB01	Fillets with Skin	Wet	0.00701	0.00724	0.00712	3.20
	UPLB01	Fillets with Skin	Wet	0.0113	0.0104	0.0109	8.21
PCB# 189							
	UALB01	Fillets with Skin	Wet	< 0.000132	< 0.000132	0.0000660	0.000
	UPLB01	Fillets with Skin	Wet	< 0.000132	< 0.000127	0.0000648	3.86
PCB# 191							
	UALB01	Fillets with Skin	Wet	0.000168	0.000206	0.000187	20.3
	UPLB01	Fillets with Skin	Wet	0.000260	0.000237	0.000248	9.26
PCB# 194							
	UALB01	Fillets with Skin	Wet	0.00141	0.00140	0.00141	1.00
	UPLB01	Fillets with Skin	Wet	0.00179	0.00166	0.00172	7.60
PCB# 195/208							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	0.000732	0.000741	0.000736	1.22
	UPLB01	Fillets with Skin	Wet	0.00102	0.000971	0.000998	5.31
PCB# 196/203							
	UALB01	Fillets with Skin	Wet	0.00209	0.00206	0.00207	1.30
	UPLB01	Fillets with Skin	Wet	0.00271	0.00251	0.00261	7.44
PCB# 199							
	UALB01	Fillets with Skin	Wet	0.00195	0.00202	0.00198	3.58
	UPLB01	Fillets with Skin	Wet	0.00229	0.00230	0.00230	0.170
PCB# 200/157/173							
	UALB01	Fillets with Skin	Wet	0.000178	0.000185	0.000182	3.86
	UPLB01	Fillets with Skin	Wet	0.000275	0.000237	0.000256	14.8
PCB# 201							
	UALB01	Fillets with Skin	Wet	< 0.000102	< 0.000102	0.0000510	0.000
	UPLB01	Fillets with Skin	Wet	< 0.000102	< 0.0000980	0.0000500	4.00
PCB# 205							
	UALB01	Fillets with Skin	Wet	0.000119	0.000123	0.000121	3.31
	UPLB01	Fillets with Skin	Wet	0.000153	0.000119	0.000136	25.0
PCB# 206							
	UALB01	Fillets with Skin	Wet	0.000504	0.000515	0.000510	2.16
	UPLB01	Fillets with Skin	Wet	0.000612	0.000521	0.000566	16.1
PCB# 209							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	0.000188	0.000185	0.000186	1.61
	UPLB01	Fillets with Skin	Wet	0.000229	0.000213	0.000221	7.24
PCB# 22/51							
	UALB01	Fillets with Skin	Wet	0.000702	0.000782	0.000742	10.8
	UPLB01	Fillets with Skin	Wet	< 0.000141	< 0.000136	0.0000692	3.61
PCB# 24/27							
	UALB01	Fillets with Skin	Wet	0.000504	0.000556	0.000530	9.81
	UPLB01	Fillets with Skin	Wet	< 0.000141	< 0.000136	0.0000692	3.61
PCB# 25							
	UALB01	Fillets with Skin	Wet	< 0.000141	< 0.000141	0.0000705	0.000
	UPLB01	Fillets with Skin	Wet	< 0.000141	< 0.000136	0.0000692	3.61
PCB# 26							
	UALB01	Fillets with Skin	Wet	0.000732	0.000679	0.000706	7.51
	UPLB01	Fillets with Skin	Wet	< 0.000141	< 0.000136	0.0000692	3.61
PCB# 28							
	UALB01	Fillets with Skin	Wet	0.00383	0.00408	0.00395	6.33
	UPLB01	Fillets with Skin	Wet	0.000352	0.000296	0.000324	17.3
PCB# 29							
	UALB01	Fillets with Skin	Wet	< 0.0000870	< 0.0000870	0.0000435	0.000
	UPLB01	Fillets with Skin	Wet	< 0.0000870	< 0.0000840	0.0000427	3.51
PCB# 31							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	0.00192	0.00206	0.00199	7.09
	UPLB01	Fillets with Skin	Wet	0.000199	0.000189	0.000194	5.15
PCB# 33/53/20							
	UALB01	Fillets with Skin	Wet	0.000692	0.000731	0.000712	5.48
	UPLB01	Fillets with Skin	Wet	< 0.000141	< 0.000136	0.0000692	3.61
PCB# 40							
	UALB01	Fillets with Skin	Wet	0.000820	0.000700	0.000760	15.8
	UPLB01	Fillets with Skin	Wet	< 0.000134	< 0.000128	0.0000655	4.58
PCB# 41/64							
	UALB01	Fillets with Skin	Wet	0.00356	0.00360	0.00358	1.23
	UPLB01	Fillets with Skin	Wet	0.000382	0.000403	0.000392	5.35
PCB# 42/59/37							
	UALB01	Fillets with Skin	Wet	0.00178	0.00182	0.00180	2.33
	UPLB01	Fillets with Skin	Wet	0.000214	0.000178	0.000196	18.4
PCB# 43							
	UALB01	Fillets with Skin	Wet	0.000198	0.000175	0.000186	12.3
	UPLB01	Fillets with Skin	Wet	< 0.000134	< 0.000128	0.0000655	4.58
PCB# 44							
	UALB01	Fillets with Skin	Wet	0.00490	0.00526	0.00508	7.03
	UPLB01	Fillets with Skin	Wet	0.000612	0.000545	0.000578	11.6
PCB# 45							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	0.000564	0.000607	0.000586	7.34
	UPLB01	Fillets with Skin	Wet	< 0.000134	< 0.000128	0.0000655	4.58
PCB# 46							
	UALB01	Fillets with Skin	Wet	0.000237	0.000278	0.000257	15.9
	UPLB01	Fillets with Skin	Wet	< 0.000134	< 0.000128	0.0000655	4.58
PCB# 47/48/75							
	UALB01	Fillets with Skin	Wet	0.00493	0.00518	0.00506	4.85
	UPLB01	Fillets with Skin	Wet	0.00428	0.00419	0.00424	2.05
PCB# 49							
	UALB01	Fillets with Skin	Wet	0.00506	0.00531	0.00519	4.82
	UPLB01	Fillets with Skin	Wet	0.00210	0.00193	0.00201	8.15
PCB# 52							
	UALB01	Fillets with Skin	Wet	0.00689	0.00716	0.00703	3.90
	UPLB01	Fillets with Skin	Wet	0.00222	0.00205	0.00213	7.83
PCB# 56/60							
	UALB01	Fillets with Skin	Wet	0.00223	0.00214	0.00219	4.25
	UPLB01	Fillets with Skin	Wet	0.000520	0.000498	0.000509	4.32
PCB# 66							
	UALB01	Fillets with Skin	Wet	0.00270	0.00288	0.00279	6.56
	UPLB01	Fillets with Skin	Wet	0.000657	0.000616	0.000636	6.44
PCB# 7/9							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	< 0.000202	< 0.000203	0.000101	0.490
	UPLB01	Fillets with Skin	Wet	< 0.000203	< 0.000195	0.0000995	4.02
PCB# 70							
	UALB01	Fillets with Skin	Wet	0.00294	0.00312	0.00303	6.04
	UPLB01	Fillets with Skin	Wet	0.00107	0.000960	0.00102	10.8
PCB# 74/61							
	UALB01	Fillets with Skin	Wet	0.00312	0.00313	0.00313	0.160
	UPLB01	Fillets with Skin	Wet	0.000810	0.000687	0.000748	16.4
PCB# 77							
	UALB01	Fillets with Skin	Wet	< 0.000133	< 0.000134	0.0000668	0.750
	UPLB01	Fillets with Skin	Wet	< 0.000134	< 0.000128	0.0000655	4.58
PCB# 8/5							
	UALB01	Fillets with Skin	Wet	0.000593	0.000607	0.000600	2.33
	UPLB01	Fillets with Skin	Wet	< 0.000203	< 0.000195	0.0000995	4.02
PCB# 81							
	UALB01	Fillets with Skin	Wet	< 0.000133	< 0.000134	0.0000668	0.750
	UPLB01	Fillets with Skin	Wet	< 0.000134	< 0.000128	0.0000655	4.58
PCB# 82							
	UALB01	Fillets with Skin	Wet	0.000771	0.000793	0.000782	2.81
	UPLB01	Fillets with Skin	Wet	0.000382	0.000332	0.000357	14.0
PCB# 83							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	0.000524	0.000577	0.000550	9.63
	UPLB01	Fillets with Skin	Wet	0.000336	0.000284	0.000310	16.8
PCB# 84							
	UALB01	Fillets with Skin	Wet	< 0.000104	< 0.000105	0.0000522	0.960
	UPLB01	Fillets with Skin	Wet	< 0.000105	< 0.000101	0.0000515	3.88
PCB# 85							
	UALB01	Fillets with Skin	Wet	0.00136	0.00134	0.00135	1.92
	UPLB01	Fillets with Skin	Wet	0.00102	0.000983	0.00100	4.09
PCB# 86							
	UALB01	Fillets with Skin	Wet	< 0.000104	< 0.000105	0.0000522	0.960
	UPLB01	Fillets with Skin	Wet	< 0.000105	< 0.000101	0.0000515	3.88
PCB# 87/115							
	UALB01	Fillets with Skin	Wet	0.00271	0.00272	0.00271	0.330
	UPLB01	Fillets with Skin	Wet	0.00197	0.00214	0.00206	8.31
PCB# 88							
	UALB01	Fillets with Skin	Wet	0.00379	0.00364	0.00372	3.82
	UPLB01	Fillets with Skin	Wet	0.00174	0.00161	0.00168	7.87
PCB# 92							
	UALB01	Fillets with Skin	Wet	0.00959	0.00948	0.00954	1.13
	UPLB01	Fillets with Skin	Wet	0.00301	0.00327	0.00314	8.21
PCB# 95							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	0.00472	0.00512	0.00492	7.95
	UPLB01	Fillets with Skin	Wet	0.00271	0.00258	0.00264	4.65
PCB# 97							
	UALB01	Fillets with Skin	Wet	0.00293	0.00298	0.00296	2.00
	UPLB01	Fillets with Skin	Wet	0.00191	0.00181	0.00186	5.32
PCB# 99							
	UALB01	Fillets with Skin	Wet	0.00590	0.00593	0.00592	0.460
	UPLB01	Fillets with Skin	Wet	0.00621	0.00582	0.00601	6.50
PCB-1242							
	UALB01	Fillets with Skin	Wet	0.0852	< 0.0101	0.0451	178
	UPLB01	Fillets with Skin	Wet	< 0.0101	< 0.00974	0.00497	3.99
PCB-1248							
	UALB01	Fillets with Skin	Wet	0.110	0.0852	0.0974	24.9
	UPLB01	Fillets with Skin	Wet	0.136	< 0.00974	0.0703	186
PCB-1254							
	UALB01	Fillets with Skin	Wet	0.0487	0.110	0.0791	77.0
	UPLB01	Fillets with Skin	Wet	0.136	0.126	0.131	7.52
PCB-1260							
	UALB01	Fillets with Skin	Wet	< 0.0101	0.0487	0.0269	162
	UPLB01	Fillets with Skin	Wet	< 0.0101	0.126	0.0655	185
PCB-TOTAL							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	0.243	0.244	0.243	0.0600
	UPLB01	Fillets with Skin	Wet	0.272	0.252	0.262	7.52
Pentachlorobenzene							
	UALB01	Fillets with Skin	Wet	0.000939	0.000885	0.000912	5.92
	UPLB01	Fillets with Skin	Wet	0.000872	0.000770	0.000821	12.4
Total DDT's							
	UALB01	Fillets with Skin	Wet	0.0345	0.0340	0.0342	1.49
	UPLB01	Fillets with Skin	Wet	0.0315	0.0301	0.0308	4.55
acenaphthalene							
	UALB01	Fillets with Skin	Wet	0.000400	0.000400	0.000400	0.000
	UPLB01	Fillets with Skin	Wet	< 0.000395	< 0.000379	0.000194	4.13
acenaphthene							
	UALB01	Fillets with Skin	Wet	0.00150	0.00150	0.00150	0.000
	UPLB01	Fillets with Skin	Wet	0.00250	0.00250	0.00250	0.000
alpha BHC							
	UALB01	Fillets with Skin	Wet	< 0.000272	< 0.000273	0.000136	0.370
	UPLB01	Fillets with Skin	Wet	< 0.000273	< 0.000262	0.000134	4.11
alpha chlordane							
	UALB01	Fillets with Skin	Wet	0.0139	0.0137	0.0138	0.930
	UPLB01	Fillets with Skin	Wet	0.00164	0.00162	0.00163	0.800
anthracene							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	0.000400	0.000400	0.000400	0.000
	UPLB01	Fillets with Skin	Wet	< 0.000242	< 0.000232	0.000119	4.22
benzo(a)pyrene							
	UALB01	Fillets with Skin	Wet	< 0.000430	< 0.000431	0.000215	0.230
	UPLB01	Fillets with Skin	Wet	< 0.000431	< 0.000414	0.000211	4.02
benzo(b)fluoranthene							
	UALB01	Fillets with Skin	Wet	< 0.000322	< 0.000323	0.000161	0.310
	UPLB01	Fillets with Skin	Wet	< 0.000323	< 0.000310	0.000158	4.11
benzo(e)pyrene							
	UALB01	Fillets with Skin	Wet	< 0.000461	< 0.000462	0.000231	0.220
	UPLB01	Fillets with Skin	Wet	< 0.000462	< 0.000444	0.000226	3.97
benzo(g,h,i)perylene							
	UALB01	Fillets with Skin	Wet	< 0.000518	< 0.000520	0.000259	0.390
	UPLB01	Fillets with Skin	Wet	< 0.000520	< 0.000500	0.000255	3.92
benzo(k)fluoranthene							
	UALB01	Fillets with Skin	Wet	< 0.000399	< 0.000400	0.000200	0.250
	UPLB01	Fillets with Skin	Wet	< 0.000400	< 0.000385	0.000196	3.82
beta BHC							
	UALB01	Fillets with Skin	Wet	< 0.000250	< 0.000251	0.000125	0.400
	UPLB01	Fillets with Skin	Wet	< 0.000251	< 0.000241	0.000123	4.07
biphenyl							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	< 0.000715	< 0.000718	0.000358	0.420
	UPLB01	Fillets with Skin	Wet	< 0.000718	0.000700	0.000530	64.4
chlorpyrifos							
	UALB01	Fillets with Skin	Wet	0.000781	0.000741	0.000761	5.26
	UPLB01	Fillets with Skin	Wet	< 0.000229	< 0.000220	0.000112	4.01
chrysene							
	UALB01	Fillets with Skin	Wet	< 0.000455	< 0.000456	0.000228	0.220
	UPLB01	Fillets with Skin	Wet	< 0.000456	< 0.000439	0.000224	3.80
cis-nonachlor							
	UALB01	Fillets with Skin	Wet	0.00495	0.00526	0.00511	6.01
	UPLB01	Fillets with Skin	Wet	0.00208	0.00200	0.00204	3.82
delta BHC							
	UALB01	Fillets with Skin	Wet	< 0.000276	< 0.000277	0.000138	0.360
	UPLB01	Fillets with Skin	Wet	< 0.000277	< 0.000266	0.000136	4.05
dibenzothiophene							
	UALB01	Fillets with Skin	Wet	< 0.000329	< 0.000331	0.000165	0.610
	UPLB01	Fillets with Skin	Wet	< 0.000331	< 0.000318	0.000162	4.01
dieldrin							
	UALB01	Fillets with Skin	Wet	0.00304	0.00322	0.00313	5.98
	UPLB01	Fillets with Skin	Wet	0.000810	0.000900	0.000855	10.5
endosulfan I							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	< 0.000389	< 0.000391	0.000195	0.510
	UPLB01	Fillets with Skin	Wet	< 0.000391	< 0.000376	0.000192	3.91
endosulfan II							
	UALB01	Fillets with Skin	Wet	0.00187	0.00192	0.00190	2.95
	UPLB01	Fillets with Skin	Wet	< 0.000372	< 0.000358	0.000182	3.84
endosulfan sulfate							
	UALB01	Fillets with Skin	Wet	< 0.000408	< 0.000410	0.000204	0.490
	UPLB01	Fillets with Skin	Wet	< 0.000410	< 0.000394	0.000201	3.98
endrin							
	UALB01	Fillets with Skin	Wet	< 0.000445	< 0.000447	0.000223	0.450
	UPLB01	Fillets with Skin	Wet	< 0.000447	< 0.000430	0.000219	3.88
fluoranthene							
	UALB01	Fillets with Skin	Wet	0.000700	0.000700	0.000700	0.000
	UPLB01	Fillets with Skin	Wet	0.000600	0.000600	0.000600	0.000
fluorene							
	UALB01	Fillets with Skin	Wet	0.00130	0.00130	0.00130	0.000
	UPLB01	Fillets with Skin	Wet	0.000900	0.000900	0.000900	0.000
gamma BHC							
	UALB01	Fillets with Skin	Wet	< 0.000134	< 0.000135	0.0000673	0.740
	UPLB01	Fillets with Skin	Wet	< 0.000135	< 0.000129	0.0000660	4.55
gamma chlordane							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	0.00606	0.00603	0.00605	0.460
	UPLB01	Fillets with Skin	Wet	0.000505	0.000474	0.000490	6.33
heptachlor epoxide							
	UALB01	Fillets with Skin	Wet	0.000890	0.000906	0.000898	1.78
	UPLB01	Fillets with Skin	Wet	< 0.000293	< 0.000281	0.000144	4.18
indeno(1,2,3-cd)pyrene							
	UALB01	Fillets with Skin	Wet	< 0.000671	< 0.000673	0.000336	0.300
	UPLB01	Fillets with Skin	Wet	< 0.000673	< 0.000647	0.000330	3.94
mirex							
	UALB01	Fillets with Skin	Wet	< 0.0000940	< 0.0000940	0.0000470	0.000
	UPLB01	Fillets with Skin	Wet	< 0.0000940	< 0.0000910	0.0000462	3.24
naphthalene							
	UALB01	Fillets with Skin	Wet	0.00100	0.00100	0.00100	0.000
	UPLB01	Fillets with Skin	Wet	< 0.000969	< 0.000931	0.000475	4.00
o,p'-DDD							
	UALB01	Fillets with Skin	Wet	0.00151	0.00155	0.00153	2.67
	UPLB01	Fillets with Skin	Wet	0.00176	0.00198	0.00187	11.8
o,p'-DDE							
	UALB01	Fillets with Skin	Wet	0.000178	0.000175	0.000176	1.70
	UPLB01	Fillets with Skin	Wet	0.000107	< 0.0000860	0.0000750	85.3
o,p'-DDT							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	0.000850	0.000896	0.000873	5.27
	UPLB01	Fillets with Skin	Wet	0.00170	0.00174	0.00172	2.56
oxychlordane							
	UALB01	Fillets with Skin	Wet	0.00254	0.00268	0.00261	5.18
	UPLB01	Fillets with Skin	Wet	0.00125	0.00107	0.00116	16.2
p,p'-DDD							
	UALB01	Fillets with Skin	Wet	0.00774	0.00716	0.00745	7.73
	UPLB01	Fillets with Skin	Wet	0.00272	0.00255	0.00263	6.64
p,p'-DDE							
	UALB01	Fillets with Skin	Wet	0.0219	0.0220	0.0219	0.320
	UPLB01	Fillets with Skin	Wet	0.0233	0.0219	0.0226	6.21
p,p'-DDT							
	UALB01	Fillets with Skin	Wet	0.000504	0.000463	0.000484	8.48
	UPLB01	Fillets with Skin	Wet	0.00119	0.00112	0.00116	5.87
pentachloro-anisole							
	UALB01	Fillets with Skin	Wet	0.000119	0.000134	0.000126	11.9
	UPLB01	Fillets with Skin	Wet	< 0.000103	< 0.0000990	0.0000505	3.96
perylene							
	UALB01	Fillets with Skin	Wet	< 0.000622	< 0.000625	0.000312	0.480
	UPLB01	Fillets with Skin	Wet	< 0.000625	< 0.000600	0.000306	4.08
phenanthrene							

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UALB01	Fillets with Skin	Wet	0.00130	0.00120	0.00125	8.00
	UPLB01	Fillets with Skin	Wet	0.00130	0.00130	0.00130	0.000
pyrene							
	UALB01	Fillets with Skin	Wet	0.000400	0.000400	0.000400	0.000
	UPLB01	Fillets with Skin	Wet	0.000400	0.000400	0.000400	0.000
toxaphene							
	UALB01	Fillets with Skin	Wet	< 0.00963	< 0.00967	0.00483	0.380
	UPLB01	Fillets with Skin	Wet	< 0.00967	< 0.00929	0.00474	3.98
trans-nonachlor							
	UALB01	Fillets with Skin	Wet	0.0151	0.0156	0.0154	3.85
	UPLB01	Fillets with Skin	Wet	0.00632	0.00596	0.00614	5.80

7. Spike Recoveries

Analyte	Sample Number	Sample Matrix	Basis	Spike Level (ppm/%)	Amount Recovered (ppm/%)	*** Spike Background	Percent Recovery
1,2,3,4-Tetrachlorobenzene							
	LALB01	Fillets with Skin	Wet	0.00750	0.00612	139	81.6
	LPSF01	Fillets with Skin	Wet	0.00770	0.00612	156	79.5
1,2,4,5-Tetrachlorobenzene							
	LALB01	Fillets with Skin	Wet	0.00750	0.00676	32.3	90.1
	LPSF01	Fillets with Skin	Wet	0.00770	0.00676	21.1	87.8
1,6,7-Trimethyl-naphthalene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0180	20.9	95.7
	LPSF01	Fillets with Skin	Wet	0.0194	0.0180	96.3	92.8
1-methylnaphthalene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0191	23.5	102
	LPSF01	Fillets with Skin	Wet	0.0194	0.0182	56.5	93.6
1-methylphenanthrene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0155	74.3	82.7
	LPSF01	Fillets with Skin	Wet	0.0194	0.0139	83.8	71.5
2,6-dimethylnaphthalene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0184	26.9	97.9
	LPSF01	Fillets with Skin	Wet	0.0194	0.0186	65.6	95.9
2-methylnaphthalene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0195	20.9	104
	LPSF01	Fillets with Skin	Wet	0.0194	0.0195	52.4	101
Aldrin							
	LALB01	Fillets with Skin	Wet	0.00750	0.00575	146	76.6
	LPSF01	Fillets with Skin	Wet	0.00770	0.00643	164	83.5
BDE# 100							
	LALB01	Fillets with Skin	Wet	0.0164	0.0160	9.42	97.3
	LPSF01	Fillets with Skin	Wet	0.0198	0.0223	8.97	113
BDE# 138							
	LALB01	Fillets with Skin	Wet	0.0164	0.0142	5.36	86.8

Analyte	Sample Number	Sample Matrix	Basis	Spike Level (ppm/%)	Amount Recovered (ppm/%)	*** Spike Background	Percent Recovery
	LPSF01	Fillets with Skin	Wet	0.0198	0.0156	5.11	78.9
BDE# 153							
	LALB01	Fillets with Skin	Wet	0.0164	0.0179	9.93	109
	LPSF01	Fillets with Skin	Wet	0.0198	0.0211	9.45	107
BDE# 154							
	LALB01	Fillets with Skin	Wet	0.0164	0.0180	8.37	110.
	LPSF01	Fillets with Skin	Wet	0.0198	0.0211	7.97	107
BDE# 17							
	LALB01	Fillets with Skin	Wet	0.0164	0.0172	6.68	105
	LPSF01	Fillets with Skin	Wet	0.0198	0.0212	6.36	107
BDE# 183							
	LALB01	Fillets with Skin	Wet	0.0164	0.0142	7.54	86.7
	LPSF01	Fillets with Skin	Wet	0.0198	0.0171	7.17	86.6
BDE# 190							
	LALB01	Fillets with Skin	Wet	0.0164	0.0113	7.57	69.1
	LPSF01	Fillets with Skin	Wet	0.0198	0.0140	7.21	70.5
BDE# 28							
	LALB01	Fillets with Skin	Wet	0.0164	0.0179	14.3	109
	LPSF01	Fillets with Skin	Wet	0.0198	0.0217	13.6	110.
BDE# 47							
	LALB01	Fillets with Skin	Wet	0.0164	0.0136	1.04	82.9
	LPSF01	Fillets with Skin	Wet	0.0198	0.0244	12.4	123
BDE# 49/71							
	LALB01	Fillets with Skin	Wet	0.0164	0.0185	12.1	113
	LPSF01	Fillets with Skin	Wet	0.0198	0.0228	11.5	115
BDE# 66							
	LALB01	Fillets with Skin	Wet	0.0164	0.0165	10.8	101
	LPSF01	Fillets with Skin	Wet	0.0198	0.0214	10.3	108
BDE# 85							
	LALB01	Fillets with Skin	Wet	0.0164	0.0151	11.1	92.2
	LPSF01	Fillets with Skin	Wet	0.0198	0.0192	10.6	97.1
BDE# 99							

Analyte	Sample Number	Sample Matrix	Basis	Spike Level (ppm/%)	Amount Recovered (ppm/%)	*** Spike Background	Percent Recovery
	LALB01	Fillets with Skin	Wet	0.0164	0.0153	2.02	93.3
	LPSF01	Fillets with Skin	Wet	0.0198	0.0238	13.5	120.
Benzo(a)anthracene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0184	100.	97.9
	LPSF01	Fillets with Skin	Wet	0.0194	0.0181	113	93.4
DDMU							
	LALB01	Fillets with Skin	Wet	0.00750	0.00530	4.50	70.7
	LPSF01	Fillets with Skin	Wet	0.00770	0.00715	26.2	92.8
Dibenz(a,h)anthracene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0216	88.1	115
	LPSF01	Fillets with Skin	Wet	0.0194	0.0225	99.2	116
HCB							
	LALB01	Fillets with Skin	Wet	0.00750	0.00674	15.2	89.8
	LPSF01	Fillets with Skin	Wet	0.00770	0.00717	64.4	93.1
Heptachlor							
	LALB01	Fillets with Skin	Wet	0.00750	0.00671	179	89.5
	LPSF01	Fillets with Skin	Wet	0.00770	0.00641	200.	83.2
PCB# 101/90							
	LALB01	Fillets with Skin	Wet	0.00750	0.00834	0.460	111
	LPSF01	Fillets with Skin	Wet	0.00770	0.00743	3.22	96.4
PCB# 105							
	LALB01	Fillets with Skin	Wet	0.00750	0.00628	2.23	83.8
	LPSF01	Fillets with Skin	Wet	0.00770	0.00756	14.2	98.2
PCB# 110/77							
	LALB01	Fillets with Skin	Wet	0.00750	0.00621	1.02	82.8
	LPSF01	Fillets with Skin	Wet	0.00770	0.00742	5.45	96.3
PCB# 118							
	LALB01	Fillets with Skin	Wet	0.00750	0.00650	0.910	86.7
	LPSF01	Fillets with Skin	Wet	0.00770	0.00744	5.27	96.6
PCB# 128							
	LALB01	Fillets with Skin	Wet	0.00750	0.00650	2.89	86.7
	LPSF01	Fillets with Skin	Wet	0.00770	0.00726	31.2	94.2

Analyte	Sample Number	Sample Matrix	Basis	Spike Level (ppm/%)	Amount Recovered (ppm/%)	*** Spike Background	Percent Recovery
PCB# 138/160							
	LALB01	Fillets with Skin	Wet	0.00750	0.00611	0.220	81.5
	LPSF01	Fillets with Skin	Wet	0.00770	0.00634	1.84	82.4
PCB# 153/132							
	LALB01	Fillets with Skin	Wet	0.00750	0.000641	0.190	8.55
	LPSF01	Fillets with Skin	Wet	0.00770	0.00734	1.51	95.3
PCB# 170/190							
	LALB01	Fillets with Skin	Wet	0.00750	0.00475	0.460	63.3
	LPSF01	Fillets with Skin	Wet	0.00770	0.00756	6.81	98.2
PCB# 18							
	LALB01	Fillets with Skin	Wet	0.00750	0.00680	6.04	90.6
	LPSF01	Fillets with Skin	Wet	0.00770	0.00716	50.3	93.0
PCB# 180							
	LALB01	Fillets with Skin	Wet	0.00750	0.00799	0.200	107
	LPSF01	Fillets with Skin	Wet	0.00770	0.00705	2.59	91.6
PCB# 187							
	LALB01	Fillets with Skin	Wet	0.00750	0.00523	0.260	69.7
	LPSF01	Fillets with Skin	Wet	0.00770	0.00754	3.57	98.0
PCB# 195/208							
	LALB01	Fillets with Skin	Wet	0.00750	0.00569	2.14	75.8
	LPSF01	Fillets with Skin	Wet	0.00770	0.00761	32.6	98.8
PCB# 199							
	LALB01	Fillets with Skin	Wet	0.00750	0.00623	0.880	83.0
	LPSF01	Fillets with Skin	Wet	0.00770	0.00804	8.60	104
PCB# 206							
	LALB01	Fillets with Skin	Wet	0.00750	0.00586	4.42	78.2
	LPSF01	Fillets with Skin	Wet	0.00770	0.00717	50.3	93.1
PCB# 209							
	LALB01	Fillets with Skin	Wet	0.00750	0.00628	41.2	83.7
	LPSF01	Fillets with Skin	Wet	0.00770	0.00772	173	100.
PCB# 28							
	LALB01	Fillets with Skin	Wet	0.00750	0.00708	2.52	94.4

Analyte	Sample Number	Sample Matrix	Basis	Spike Level (ppm/%)	Amount Recovered (ppm/%)	*** Spike Background	Percent Recovery
	LPSF01	Fillets with Skin	Wet	0.00770	0.00730	23.3	94.8
PCB# 29							
	LALB01	Fillets with Skin	Wet	0.00750	0.00712	169	94.9
	LPSF01	Fillets with Skin	Wet	0.00770	0.00733	188	95.2
PCB# 44							
	LALB01	Fillets with Skin	Wet	0.00750	0.00676	1.92	90.1
	LPSF01	Fillets with Skin	Wet	0.00770	0.00762	20.4	99.0
PCB# 52							
	LALB01	Fillets with Skin	Wet	0.00750	0.00625	0.920	83.3
	LPSF01	Fillets with Skin	Wet	0.00770	0.00754	6.16	97.9
PCB# 66							
	LALB01	Fillets with Skin	Wet	0.00750	0.00581	3.08	77.4
	LPSF01	Fillets with Skin	Wet	0.00770	0.00618	22.5	80.3
PCB# 8/5							
	LALB01	Fillets with Skin	Wet	0.00750	0.00745	28.5	99.3
	LPSF01	Fillets with Skin	Wet	0.00770	0.00800	81.0	104
PCB# 87/115							
	LALB01	Fillets with Skin	Wet	0.00750	0.00629	2.34	83.9
	LPSF01	Fillets with Skin	Wet	0.00770	0.00749	14.9	97.3
Pentachlorobenzene							
	LALB01	Fillets with Skin	Wet	0.00750	0.00617	7.35	82.3
	LPSF01	Fillets with Skin	Wet	0.00770	0.00648	9.76	84.1
acenaphthalene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0173	93.3	92.0
	LPSF01	Fillets with Skin	Wet	0.0194	0.0171	105	88.2
acenaphthene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0178	13.4	94.7
	LPSF01	Fillets with Skin	Wet	0.0194	0.0175	105	90.3
alpha BHC							
	LALB01	Fillets with Skin	Wet	0.00750	0.00550	53.8	73.4
	LPSF01	Fillets with Skin	Wet	0.00770	0.00620	60.4	80.5
alpha chlordane							

Analyte	Sample Number	Sample Matrix	Basis	Spike Level (ppm/%)	Amount Recovered (ppm/%)	*** Spike Background	Percent Recovery
	LALB01	Fillets with Skin	Wet	0.00750	0.00709	0.720	94.6
	LPSF01	Fillets with Skin	Wet	0.00770	0.00743	9.21	96.5
anthracene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0163	47.0	86.7
	LPSF01	Fillets with Skin	Wet	0.0194	0.0135	172	69.5
benzo(a)pyrene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0197	85.3	105
	LPSF01	Fillets with Skin	Wet	0.0194	0.0200	96.3	103
benzo(b)fluoranthene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0217	114	116
	LPSF01	Fillets with Skin	Wet	0.0194	0.0225	128	116
benzo(e)pyrene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0221	79.7	117
	LPSF01	Fillets with Skin	Wet	0.0194	0.0227	89.8	117
benzo(g,h,i)perylene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0220	70.7	117
	LPSF01	Fillets with Skin	Wet	0.0194	0.0223	79.8	115
benzo(k)fluoranthene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0221	91.9	118
	LPSF01	Fillets with Skin	Wet	0.0194	0.0228	104	118
beta BHC							
	LALB01	Fillets with Skin	Wet	0.00750	0.00576	58.6	76.8
	LPSF01	Fillets with Skin	Wet	0.00770	0.00643	65.5	83.5
biphenyl							
	LALB01	Fillets with Skin	Wet	0.0188	0.0184	23.5	97.9
	LPSF01	Fillets with Skin	Wet	0.0194	0.0185	57.8	95.2
chlorpyrifos							
	LALB01	Fillets with Skin	Wet	0.00750	0.00374	16.5	49.9
	LPSF01	Fillets with Skin	Wet	0.00770	0.00407	72.0	52.8
chrysene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0169	80.7	89.7
	LPSF01	Fillets with Skin	Wet	0.0194	0.0200	90.9	103

Analyte	Sample Number	Sample Matrix	Basis	Spike Level (ppm/%)	Amount Recovered (ppm/%)	*** Spike Background	Percent Recovery
cis-nonachlor							
	LALB01	Fillets with Skin	Wet	0.00750	0.00626	1.49	83.5
	LPSF01	Fillets with Skin	Wet	0.00770	0.00704	12.1	91.4
delta BHC							
	LALB01	Fillets with Skin	Wet	0.00750	0.00543	53.0	72.4
	LPSF01	Fillets with Skin	Wet	0.00770	0.00629	59.5	81.7
dibenzothiophene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0153	111	81.6
	LPSF01	Fillets with Skin	Wet	0.0194	0.0136	126	70.3
dieldrin							
	LALB01	Fillets with Skin	Wet	0.00750	0.00587	2.80	78.3
	LPSF01	Fillets with Skin	Wet	0.00770	0.00636	12.1	82.6
endosulfan II							
	LALB01	Fillets with Skin	Wet	0.00750	0.00495	39.5	66.0
	LPSF01	Fillets with Skin	Wet	0.00770	0.000449	44.2	5.83
endosulfan sulfate							
	LALB01	Fillets with Skin	Wet	0.00750	0.00856	1.54	114
	LPSF01	Fillets with Skin	Wet	0.00770	0.00787	40.2	102
endrin							
	LALB01	Fillets with Skin	Wet	0.00750	0.00683	32.8	91.1
	LPSF01	Fillets with Skin	Wet	0.00770	0.00728	36.8	94.6
fluoranthene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0199	14.5	106
	LPSF01	Fillets with Skin	Wet	0.0194	0.0181	16.2	93.3
fluorene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0173	13.4	92.0
	LPSF01	Fillets with Skin	Wet	0.0194	0.0175	38.8	90.2
gamma BHC							
	LALB01	Fillets with Skin	Wet	0.00750	0.00566	109	75.4
	LPSF01	Fillets with Skin	Wet	0.00770	0.00638	122	82.9
gamma chlordane							
	LALB01	Fillets with Skin	Wet	0.00750	0.00679	1.91	90.5

Analyte	Sample Number	Sample Matrix	Basis	Spike Level (ppm/%)	Amount Recovered (ppm/%)	*** Spike Background	Percent Recovery
	LPSF01	Fillets with Skin	Wet	0.00770	0.00631	38.5	82.0
heptachlor epoxide							
	LALB01	Fillets with Skin	Wet	0.00750	0.00574	20.7	76.5
	LPSF01	Fillets with Skin	Wet	0.00770	0.00621	56.4	80.7
indeno(1,2,3-cd)pyrene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0204	54.6	108
	LPSF01	Fillets with Skin	Wet	0.0194	0.0218	61.7	112
mirex							
	LALB01	Fillets with Skin	Wet	0.00750	0.00612	155	81.5
	LPSF01	Fillets with Skin	Wet	0.00770	0.00673	175	87.4
naphthalene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0196	17.1	104
	LPSF01	Fillets with Skin	Wet	0.0194	0.0188	42.8	97.2
o,p'-DDD							
	LALB01	Fillets with Skin	Wet	0.00750	0.00634	1.23	84.6
	LPSF01	Fillets with Skin	Wet	0.00770	0.00728	14.9	94.5
o,p'-DDE							
	LALB01	Fillets with Skin	Wet	0.00750	0.00628	31.0	83.7
	LPSF01	Fillets with Skin	Wet	0.00770	0.00715	183	92.9
o,p'-DDT							
	LALB01	Fillets with Skin	Wet	0.00750	0.00574	1.83	76.6
	LPSF01	Fillets with Skin	Wet	0.00770	0.00730	14.2	94.8
oxychlordane							
	LALB01	Fillets with Skin	Wet	0.00750	0.00605	2.98	80.7
	LPSF01	Fillets with Skin	Wet	0.00770	0.00628	9.47	81.5
p,p'-DDD							
	LALB01	Fillets with Skin	Wet	0.00750	0.00481	0.930	64.1
	LPSF01	Fillets with Skin	Wet	0.00770	0.00666	5.84	86.6
p,p'-DDE							
	LALB01	Fillets with Skin	Wet	0.00750	0.00421	0.290	56.1
	LPSF01	Fillets with Skin	Wet	0.00770	0.00771	1.80	100.
p,p'-DDT							

Analyte	Sample Number	Sample Matrix	Basis	Spike Level (ppm/%)	Amount Recovered (ppm/%)	*** Spike Background	Percent Recovery
	LALB01	Fillets with Skin	Wet	0.00750	0.00586	9.91	78.1
	LPSF01	Fillets with Skin	Wet	0.00770	0.00715	34.4	92.8
pentachloro-anisole							
	LALB01	Fillets with Skin	Wet	0.00750	0.00690	143	91.9
	LPSF01	Fillets with Skin	Wet	0.00770	0.00738	72.6	95.9
perylene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0179	58.9	95.1
	LPSF01	Fillets with Skin	Wet	0.0194	0.0161	27.7	83.0
phenanthrene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0152	9.89	80.8
	LPSF01	Fillets with Skin	Wet	0.0194	0.0146	14.9	75.3
pyrene							
	LALB01	Fillets with Skin	Wet	0.0188	0.0165	26.9	87.8
	LPSF01	Fillets with Skin	Wet	0.0194	0.0141	38.8	72.7
trans-nonachlor							
	LALB01	Fillets with Skin	Wet	0.00750	0.00625	0.570	83.3
	LPSF01	Fillets with Skin	Wet	0.00770	0.00743	4.60	96.5

*** For a spike to be a valid measure of method accuracy, this ratio must be higher than 1.0.

8. Reference Materials

Analyte	Lab Sample Number	S.R.M. ID	Basis	Certified Reference Value	95% Confidence Interval	Result (ppm/%)	Percent Recovery
% Lipid							
	ENV1850B	NIST 1974b	Percent			0.520	
	ENV1851B	NIST 1974b	Percent			0.570	
% Moisture							
	ENV1850B	NIST 1974b	Percent			89.9	
	ENV1851B	NIST 1974b	Percent			89.9	
1,2,3,4-Tetrachlorobenzene							
	ENV1850B	NIST 1974b	Wet			< 0.000107	
	ENV1851B	NIST 1974b	Wet			< 0.000109	
1,2,4,5-Tetrachlorobenzene							
	ENV1850B	NIST 1974b	Wet			< 0.000212	
	ENV1851B	NIST 1974b	Wet			< 0.000217	
1,6,7-Trimethyl-naphthalene							
	ENV1850B	NIST 1974b	Wet	0.0004	0.000032	< 0.000435	
	ENV1851B	NIST 1974b	Wet	0.0004	0.000032	< 0.000446	
1-methylnaphthalene							
	ENV1850B	NIST 1974b	Wet	0.000614	0.00005	< 0.000741	
	ENV1851B	NIST 1974b	Wet	0.000614	0.00005	< 0.000760	
1-methylphenanthrene							
	ENV1850B	NIST 1974b	Wet	0.00098	0.00013	0.000700	71.4
	ENV1851B	NIST 1974b	Wet	0.00098	0.00013	0.000800	81.6
2,6-dimethylnaphthalene							
	ENV1850B	NIST 1974b	Wet	0.00033	0.00016	< 0.000637	
	ENV1851B	NIST 1974b	Wet	0.00033	0.00016	< 0.000654	
2-methylnaphthalene							
	ENV1850B	NIST 1974b	Wet	0.00125	0.00009	< 0.000799	
	ENV1851B	NIST 1974b	Wet	0.00125	0.00009	< 0.000820	
Aldrin							
	ENV1850B	NIST 1974b	Wet			< 0.000101	

Analyte	Lab Sample Number	S.R.M. ID	Basis	Certified Reference Value	95% Confidence Interval	Result (ppm/%)	Percent Recovery
	ENV1851B	NIST 1974b	Wet			< 0.000104	
BHC (Total)							
	ENV1850B	NIST 1974b	Wet			< 0.000786	
	ENV1851B	NIST 1974b	Wet			< 0.000807	
Benzo(a)anthracene							
	ENV1850B	NIST 1974b	Wet	0.00474	0.00053	0.00520	110.
	ENV1851B	NIST 1974b	Wet	0.00474	0.00053	0.00410	86.5
C1-Fluoranthenes & Pyrenes							
	ENV1850B	NIST 1974b	Wet			0.00990	
	ENV1851B	NIST 1974b	Wet			0.0108	
C1-Phenanthrenes & Anthracenes							
	ENV1850B	NIST 1974b	Wet			0.00320	
	ENV1851B	NIST 1974b	Wet			0.00290	
C1-chrysenes							
	ENV1850B	NIST 1974b	Wet			0.00560	
	ENV1851B	NIST 1974b	Wet			0.00510	
C1-dibenzothiophenes							
	ENV1850B	NIST 1974b	Wet			0.00110	
	ENV1851B	NIST 1974b	Wet			0.00120	
C1-fluorenes							
	ENV1850B	NIST 1974b	Wet			0.00170	
	ENV1851B	NIST 1974b	Wet			0.00130	
C1-naphthalenes							
	ENV1850B	NIST 1974b	Wet			< 0.00154	
	ENV1851B	NIST 1974b	Wet			< 0.00158	
C2-Phenanthrenes & Anthracenes							
	ENV1850B	NIST 1974b	Wet			0.00910	
	ENV1851B	NIST 1974b	Wet			0.00930	
C2-chrysenes							
	ENV1850B	NIST 1974b	Wet			0.00300	
	ENV1851B	NIST 1974b	Wet			0.00240	
C2-dibenzothiophenes							

Analyte	Lab Sample Number	S.R.M. ID	Basis	Certified Reference Value	95% Confidence Interval	Result (ppm/%)	Percent Recovery
	ENV1850B	NIST 1974b	Wet			0.00370	
	ENV1851B	NIST 1974b	Wet			0.00390	
C2-fluorenes							
	ENV1850B	NIST 1974b	Wet			0.00440	
	ENV1851B	NIST 1974b	Wet			0.00420	
C2-naphthalenes							
	ENV1850B	NIST 1974b	Wet			< 0.00196	
	ENV1851B	NIST 1974b	Wet			< 0.00201	
C3-Phenanthrenes & Anthracenes							
	ENV1850B	NIST 1974b	Wet			0.0127	
	ENV1851B	NIST 1974b	Wet			0.0126	
C3-chrysenes							
	ENV1850B	NIST 1974b	Wet			0.00110	
	ENV1851B	NIST 1974b	Wet			< 0.000946	
C3-dibenzothiophenes							
	ENV1850B	NIST 1974b	Wet			0.00490	
	ENV1851B	NIST 1974b	Wet			0.00530	
C3-fluorenes							
	ENV1850B	NIST 1974b	Wet			0.00850	
	ENV1851B	NIST 1974b	Wet			0.00830	
C3-naphthalenes							
	ENV1850B	NIST 1974b	Wet			0.00290	
	ENV1851B	NIST 1974b	Wet			0.00330	
C4-Phenanthrenes & Anthracenes							
	ENV1850B	NIST 1974b	Wet			0.00650	
	ENV1851B	NIST 1974b	Wet			0.00700	
C4-chrysenes							
	ENV1850B	NIST 1974b	Wet			< 0.000922	
	ENV1851B	NIST 1974b	Wet			< 0.000946	
C4-naphthalenes							
	ENV1850B	NIST 1974b	Wet			< 0.00196	
	ENV1851B	NIST 1974b	Wet			0.00280	

Analyte	Lab Sample Number	S.R.M. ID	Basis	Certified Reference Value	95% Confidence Interval	Result (ppm/%)	Percent Recovery
DDMU							
	ENV1850B	NIST 1974b	Wet			< 0.000135	
	ENV1851B	NIST 1974b	Wet			< 0.000138	
Dibenz(a,h)anthracene							
	ENV1850B	NIST 1974b	Wet	0.000327	0.000031	< 0.000421	
	ENV1851B	NIST 1974b	Wet	0.000327	0.000031	< 0.000432	
HCB							
	ENV1850B	NIST 1974b	Wet			< 0.000258	
	ENV1851B	NIST 1974b	Wet			< 0.000265	
Heptachlor							
	ENV1850B	NIST 1974b	Wet	0.000212	0.000084	< 0.0000830	
	ENV1851B	NIST 1974b	Wet	0.000212	0.000084	< 0.0000860	
PCB# 1							
	ENV1850B	NIST 1974b	Wet			< 0.000204	
	ENV1851B	NIST 1974b	Wet			< 0.000210	
PCB# 101/90							
	ENV1850B	NIST 1974b	Wet			0.00806	
	ENV1851B	NIST 1974b	Wet			0.00815	
PCB# 105							
	ENV1850B	NIST 1974b	Wet	0.004	0.00018	0.00332	82.9
	ENV1851B	NIST 1974b	Wet	0.004	0.00018	0.00283	70.8
PCB# 107							
	ENV1850B	NIST 1974b	Wet	0.00103	0.00012	0.000695	67.5
	ENV1851B	NIST 1974b	Wet	0.00103	0.00012	0.000621	60.3
PCB# 110/77							
	ENV1850B	NIST 1974b	Wet			0.00721	
	ENV1851B	NIST 1974b	Wet			0.00716	
PCB# 114/131/122							
	ENV1850B	NIST 1974b	Wet			< 0.000106	
	ENV1851B	NIST 1974b	Wet			< 0.000108	
PCB# 118							
	ENV1850B	NIST 1974b	Wet	0.0103	0.0004	0.00736	71.4

Analyte	Lab Sample Number	S.R.M. ID	Basis	Certified Reference Value	95% Confidence Interval	Result (ppm/%)	Percent Recovery
	ENV1851B	NIST 1974b	Wet	0.0103	0.0004	0.00762	74.0
PCB# 126							
	ENV1850B	NIST 1974b	Wet			< 0.000106	
	ENV1851B	NIST 1974b	Wet			< 0.000108	
PCB# 128							
	ENV1850B	NIST 1974b	Wet	0.00179	0.00012	0.00128	71.6
	ENV1851B	NIST 1974b	Wet	0.00179	0.00012	0.00119	66.5
PCB# 129							
	ENV1850B	NIST 1974b	Wet			< 0.000101	
	ENV1851B	NIST 1974b	Wet			< 0.000104	
PCB# 136							
	ENV1850B	NIST 1974b	Wet			0.000505	
	ENV1851B	NIST 1974b	Wet			0.000461	
PCB# 138/160							
	ENV1850B	NIST 1974b	Wet			0.00917	
	ENV1851B	NIST 1974b	Wet			0.00884	
PCB# 141/179							
	ENV1850B	NIST 1974b	Wet			< 0.000101	
	ENV1851B	NIST 1974b	Wet			< 0.000104	
PCB# 146							
	ENV1850B	NIST 1974b	Wet	0.00192	0.00016	0.00134	70.0
	ENV1851B	NIST 1974b	Wet	0.00192	0.00016	0.00135	70.1
PCB# 149/123							
	ENV1850B	NIST 1974b	Wet			0.00477	
	ENV1851B	NIST 1974b	Wet			0.00491	
PCB# 15							
	ENV1850B	NIST 1974b	Wet			0.00169	
	ENV1851B	NIST 1974b	Wet			0.00183	
PCB# 151							
	ENV1850B	NIST 1974b	Wet	0.00186	0.00016	0.00131	70.2
	ENV1851B	NIST 1974b	Wet	0.00186	0.00016	0.00133	71.7
PCB# 153/132							

Analyte	Lab Sample Number	S.R.M. ID	Basis	Certified Reference Value	95% Confidence Interval	Result (ppm/%)	Percent Recovery
	ENV1850B	NIST 1974b	Wet			0.0118	
	ENV1851B	NIST 1974b	Wet			0.0117	
PCB# 156/171/202							
	ENV1850B	NIST 1974b	Wet			0.000838	
	ENV1851B	NIST 1974b	Wet			0.000873	
PCB# 158							
	ENV1850B	NIST 1974b	Wet	0.000999	0.000096	0.00111	111
	ENV1851B	NIST 1974b	Wet	0.000999	0.000096	0.00113	113
PCB# 16/32							
	ENV1850B	NIST 1974b	Wet			0.00117	
	ENV1851B	NIST 1974b	Wet			0.00121	
PCB# 166							
	ENV1850B	NIST 1974b	Wet			< 0.000101	
	ENV1851B	NIST 1974b	Wet			< 0.000104	
PCB# 167							
	ENV1850B	NIST 1974b	Wet			0.000246	
	ENV1851B	NIST 1974b	Wet			0.000315	
PCB# 169							
	ENV1850B	NIST 1974b	Wet			< 0.000101	
	ENV1851B	NIST 1974b	Wet			< 0.000104	
PCB# 170/190							
	ENV1850B	NIST 1974b	Wet			0.000234	
	ENV1851B	NIST 1974b	Wet			0.000243	
PCB# 172							
	ENV1850B	NIST 1974b	Wet			< 0.000133	
	ENV1851B	NIST 1974b	Wet			< 0.000137	
PCB# 174							
	ENV1850B	NIST 1974b	Wet			< 0.000133	
	ENV1851B	NIST 1974b	Wet			< 0.000137	
PCB# 176/137							
	ENV1850B	NIST 1974b	Wet			< 0.000133	
	ENV1851B	NIST 1974b	Wet			< 0.000137	

Analyte	Lab Sample Number	S.R.M. ID	Basis	Certified Reference Value	95% Confidence Interval	Result (ppm/%)	Percent Recovery
PCB# 177							
	ENV1850B	NIST 1974b	Wet			0.000752	
	ENV1851B	NIST 1974b	Wet			0.000776	
PCB# 178							
	ENV1850B	NIST 1974b	Wet			0.000308	
	ENV1851B	NIST 1974b	Wet			0.000315	
PCB# 18							
	ENV1850B	NIST 1974b	Wet	0.00084	0.00013	0.000838	99.8
	ENV1851B	NIST 1974b	Wet	0.00084	0.00013	0.000910	108
PCB# 180							
	ENV1850B	NIST 1974b	Wet	0.00117	0.0001	0.00149	127
	ENV1851B	NIST 1974b	Wet	0.00117	0.0001	0.00150	129
PCB# 183							
	ENV1850B	NIST 1974b	Wet	0.00125	0.00003	0.000949	75.9
	ENV1851B	NIST 1974b	Wet	0.00125	0.00003	0.000982	78.6
PCB# 185							
	ENV1850B	NIST 1974b	Wet			< 0.000133	
	ENV1851B	NIST 1974b	Wet			< 0.000137	
PCB# 187							
	ENV1850B	NIST 1974b	Wet	0.00294	0.00015	0.00213	72.5
	ENV1851B	NIST 1974b	Wet	0.00294	0.00015	0.00222	75.5
PCB# 189							
	ENV1850B	NIST 1974b	Wet			< 0.000133	
	ENV1851B	NIST 1974b	Wet			< 0.000137	
PCB# 191							
	ENV1850B	NIST 1974b	Wet			< 0.000133	
	ENV1851B	NIST 1974b	Wet			< 0.000137	
PCB# 194							
	ENV1850B	NIST 1974b	Wet			< 0.000103	
	ENV1851B	NIST 1974b	Wet			< 0.000105	
PCB# 195/208							
	ENV1850B	NIST 1974b	Wet			< 0.000103	

Analyte	Lab Sample Number	S.R.M. ID	Basis	Certified Reference Value	95% Confidence Interval	Result (ppm/%)	Percent Recovery
	ENV1851B	NIST 1974b	Wet			< 0.000105	
PCB# 196/203							
	ENV1850B	NIST 1974b	Wet			< 0.000103	
	ENV1851B	NIST 1974b	Wet			< 0.000105	
PCB# 199							
	ENV1850B	NIST 1974b	Wet			< 0.000103	
	ENV1851B	NIST 1974b	Wet			< 0.000105	
PCB# 200/157/173							
	ENV1850B	NIST 1974b	Wet			< 0.0000860	
	ENV1851B	NIST 1974b	Wet			< 0.0000890	
PCB# 201							
	ENV1850B	NIST 1974b	Wet			< 0.000103	
	ENV1851B	NIST 1974b	Wet			< 0.000105	
PCB# 205							
	ENV1850B	NIST 1974b	Wet			< 0.000103	
	ENV1851B	NIST 1974b	Wet			< 0.000105	
PCB# 206							
	ENV1850B	NIST 1974b	Wet			< 0.0000930	
	ENV1851B	NIST 1974b	Wet			< 0.0000960	
PCB# 209							
	ENV1850B	NIST 1974b	Wet			< 0.0000950	
	ENV1851B	NIST 1974b	Wet			< 0.0000980	
PCB# 22/51							
	ENV1850B	NIST 1974b	Wet			0.000468	
	ENV1851B	NIST 1974b	Wet			0.000437	
PCB# 24/27							
	ENV1850B	NIST 1974b	Wet			0.000271	
	ENV1851B	NIST 1974b	Wet			0.000352	
PCB# 25							
	ENV1850B	NIST 1974b	Wet			0.000579	
	ENV1851B	NIST 1974b	Wet			0.000497	
PCB# 26							

Analyte	Lab Sample Number	S.R.M. ID	Basis	Certified Reference Value	95% Confidence Interval	Result (ppm/%)	Percent Recovery
	ENV1850B	NIST 1974b	Wet			0.000739	
	ENV1851B	NIST 1974b	Wet			0.000594	
PCB# 28							
	ENV1850B	NIST 1974b	Wet	0.00343	0.00025	0.00272	79.4
	ENV1851B	NIST 1974b	Wet	0.00343	0.00025	0.00290	84.5
PCB# 29							
	ENV1850B	NIST 1974b	Wet			< 0.0000880	
	ENV1851B	NIST 1974b	Wet			< 0.0000900	
PCB# 31							
	ENV1850B	NIST 1974b	Wet	0.00288	0.00023	0.00213	74.0
	ENV1851B	NIST 1974b	Wet	0.00288	0.00023	0.00204	70.8
PCB# 33/53/20							
	ENV1850B	NIST 1974b	Wet			0.000333	
	ENV1851B	NIST 1974b	Wet			0.000328	
PCB# 40							
	ENV1850B	NIST 1974b	Wet			0.000505	
	ENV1851B	NIST 1974b	Wet			0.000509	
PCB# 41/64							
	ENV1850B	NIST 1974b	Wet			0.00244	
	ENV1851B	NIST 1974b	Wet			0.00283	
PCB# 42/59/37							
	ENV1850B	NIST 1974b	Wet			0.00200	
	ENV1851B	NIST 1974b	Wet			0.00181	
PCB# 43							
	ENV1850B	NIST 1974b	Wet			0.000296	
	ENV1851B	NIST 1974b	Wet			0.000315	
PCB# 44							
	ENV1850B	NIST 1974b	Wet	0.00385	0.0002	0.00292	75.8
	ENV1851B	NIST 1974b	Wet	0.00385	0.0002	0.00301	78.1
PCB# 45							
	ENV1850B	NIST 1974b	Wet	0.0005	0.00018	0.000345	69.0
	ENV1851B	NIST 1974b	Wet	0.0005	0.00018	0.000352	70.4

Analyte	Lab Sample Number	S.R.M. ID	Basis	Certified Reference Value	95% Confidence Interval	Result (ppm/%)	Percent Recovery
PCB# 46							
	ENV1850B	NIST 1974b	Wet			0.000185	
	ENV1851B	NIST 1974b	Wet			0.000170	
PCB# 47/48/75							
	ENV1850B	NIST 1974b	Wet			0.00474	
	ENV1851B	NIST 1974b	Wet			0.00492	
PCB# 49							
	ENV1850B	NIST 1974b	Wet	0.00566	0.00023	0.00467	82.5
	ENV1851B	NIST 1974b	Wet	0.00566	0.00023	0.00463	81.9
PCB# 52							
	ENV1850B	NIST 1974b	Wet	0.00626	0.00037	0.00518	82.7
	ENV1851B	NIST 1974b	Wet	0.00626	0.00037	0.00525	83.9
PCB# 56/60							
	ENV1850B	NIST 1974b	Wet			0.00277	
	ENV1851B	NIST 1974b	Wet			0.00261	
PCB# 66							
	ENV1850B	NIST 1974b	Wet	0.00637	0.00037	0.00436	68.5
	ENV1851B	NIST 1974b	Wet	0.00637	0.00037	0.00438	68.8
PCB# 7/9							
	ENV1850B	NIST 1974b	Wet			< 0.000204	
	ENV1851B	NIST 1974b	Wet			< 0.000210	
PCB# 70							
	ENV1850B	NIST 1974b	Wet	0.00601	0.00022	0.00482	80.2
	ENV1851B	NIST 1974b	Wet	0.00601	0.00022	0.00475	79.1
PCB# 74/61							
	ENV1850B	NIST 1974b	Wet			0.00276	
	ENV1851B	NIST 1974b	Wet			0.00276	
PCB# 77							
	ENV1850B	NIST 1974b	Wet	0.000563	0.000023	< 0.000135	
	ENV1851B	NIST 1974b	Wet	0.000563	0.000023	< 0.000138	
PCB# 8/5							
	ENV1850B	NIST 1974b	Wet			0.000579	

Analyte	Lab Sample Number	S.R.M. ID	Basis	Certified Reference Value	95% Confidence Interval	Result (ppm/%)	Percent Recovery
	ENV1851B	NIST 1974b	Wet			0.000437	
PCB# 81							
	ENV1850B	NIST 1974b	Wet			< 0.000135	
	ENV1851B	NIST 1974b	Wet			< 0.000138	
PCB# 82							
	ENV1850B	NIST 1974b	Wet	0.00116	0.00014	0.000887	76.5
	ENV1851B	NIST 1974b	Wet	0.00116	0.00014	0.000922	79.5
PCB# 83							
	ENV1850B	NIST 1974b	Wet			0.000690	
	ENV1851B	NIST 1974b	Wet			0.000728	
PCB# 84							
	ENV1850B	NIST 1974b	Wet			0.00159	
	ENV1851B	NIST 1974b	Wet			0.00161	
PCB# 85							
	ENV1850B	NIST 1974b	Wet			0.00153	
	ENV1851B	NIST 1974b	Wet			0.00150	
PCB# 86							
	ENV1850B	NIST 1974b	Wet			< 0.000106	
	ENV1851B	NIST 1974b	Wet			< 0.000108	
PCB# 87/115							
	ENV1850B	NIST 1974b	Wet			0.00293	
	ENV1851B	NIST 1974b	Wet			0.00303	
PCB# 88							
	ENV1850B	NIST 1974b	Wet			0.00139	
	ENV1851B	NIST 1974b	Wet			0.00137	
PCB# 92							
	ENV1850B	NIST 1974b	Wet	0.00276	0.00058	0.00203	73.7
	ENV1851B	NIST 1974b	Wet	0.00276	0.00058	0.00207	75.1
PCB# 95							
	ENV1850B	NIST 1974b	Wet	0.00604	0.00036	0.00578	95.7
	ENV1851B	NIST 1974b	Wet	0.00604	0.00036	0.00627	104
PCB# 97							

Analyte	Lab Sample Number	S.R.M. ID	Basis	Certified Reference Value	95% Confidence Interval	Result (ppm/%)	Percent Recovery
	ENV1850B	NIST 1974b	Wet			0.00280	
	ENV1851B	NIST 1974b	Wet			0.00280	
PCB# 99							
	ENV1850B	NIST 1974b	Wet	0.00592	0.00027	0.00492	83.0
	ENV1851B	NIST 1974b	Wet	0.00592	0.00027	0.00492	83.2
PCB-TOTAL							
	ENV1850B	NIST 1974b	Wet	0.205	0.042	0.139	67.9
	ENV1851B	NIST 1974b	Wet	0.205	0.042	0.140	68.2
Pentachlorobenzene							
	ENV1850B	NIST 1974b	Wet			0.000764	
	ENV1851B	NIST 1974b	Wet			0.000837	
Total DDT's							
	ENV1850B	NIST 1974b	Wet			0.00724	
	ENV1851B	NIST 1974b	Wet			0.00725	
acenaphthalene							
	ENV1850B	NIST 1974b	Wet	0.00048	0.00012	0.000500	104
	ENV1851B	NIST 1974b	Wet	0.00048	0.00012	0.000500	104
acenaphthene							
	ENV1850B	NIST 1974b	Wet	0.000274	0.000054	< 0.000400	
	ENV1851B	NIST 1974b	Wet	0.000274	0.000054	< 0.000410	
alpha BHC							
	ENV1850B	NIST 1974b	Wet			< 0.000275	
	ENV1851B	NIST 1974b	Wet			< 0.000282	
alpha chlordane							
	ENV1850B	NIST 1974b	Wet	0.00136	0.0001	0.000896	65.9
	ENV1851B	NIST 1974b	Wet	0.00136	0.0001	0.000844	62.1
anthracene							
	ENV1850B	NIST 1974b	Wet	0.000527	0.000071	0.000500	94.9
	ENV1851B	NIST 1974b	Wet	0.000527	0.000071	0.000400	75.9
benzo(a)pyrene							
	ENV1850B	NIST 1974b	Wet	0.0028	0.00038	0.00250	89.3
	ENV1851B	NIST 1974b	Wet	0.0028	0.00038	0.00220	78.6

Analyte	Lab Sample Number	S.R.M. ID	Basis	Certified Reference Value	95% Confidence Interval	Result (ppm/%)	Percent Recovery
benzo(b)fluoranthene							
	ENV1850B	NIST 1974b	Wet	0.00646	0.00059	0.00700	108
	ENV1851B	NIST 1974b	Wet	0.00646	0.00059	0.00810	125
benzo(e)pyrene							
	ENV1850B	NIST 1974b	Wet	0.0103	0.0011	0.0105	102
	ENV1851B	NIST 1974b	Wet	0.0103	0.0011	0.0120	116
benzo(g,h,i)perylene							
	ENV1850B	NIST 1974b	Wet	0.00312	0.00033	0.00330	106
	ENV1851B	NIST 1974b	Wet	0.00312	0.00033	0.00360	115
benzo(k)fluoranthene							
	ENV1850B	NIST 1974b	Wet	0.00316	0.00018	0.00330	104
	ENV1851B	NIST 1974b	Wet	0.00316	0.00018	0.00350	111
beta BHC							
	ENV1850B	NIST 1974b	Wet			< 0.000253	
	ENV1851B	NIST 1974b	Wet			< 0.000259	
biphenyl							
	ENV1850B	NIST 1974b	Wet	0.00061	0.00014	< 0.000723	
	ENV1851B	NIST 1974b	Wet	0.00061	0.00014	0.000800	131
chlorpyrifos							
	ENV1850B	NIST 1974b	Wet			< 0.000231	
	ENV1851B	NIST 1974b	Wet			< 0.000237	
chrysene							
	ENV1850B	NIST 1974b	Wet	0.0063	0.001	0.00960	152
	ENV1851B	NIST 1974b	Wet	0.0063	0.001	0.00820	130.
cis-nonachlor							
	ENV1850B	NIST 1974b	Wet	0.00064	0.00016	0.000567	88.6
	ENV1851B	NIST 1974b	Wet	0.00064	0.00016	0.000631	98.6
delta BHC							
	ENV1850B	NIST 1974b	Wet			< 0.000279	
	ENV1851B	NIST 1974b	Wet			< 0.000287	
dibenzothiophene							
	ENV1850B	NIST 1974b	Wet			< 0.000333	

Analyte	Lab Sample Number	S.R.M. ID	Basis	Certified Reference Value	95% Confidence Interval	Result (ppm/%)	Percent Recovery
	ENV1851B	NIST 1974b	Wet			< 0.000342	
dieldrin							
	ENV1850B	NIST 1974b	Wet	0.00062	0.00013	0.000444	71.6
	ENV1851B	NIST 1974b	Wet	0.00062	0.00013	< 0.000380	
endosulfan I							
	ENV1850B	NIST 1974b	Wet			< 0.000394	
	ENV1851B	NIST 1974b	Wet			< 0.000404	
endosulfan II							
	ENV1850B	NIST 1974b	Wet			0.00156	
	ENV1851B	NIST 1974b	Wet			0.00148	
endosulfan sulfate							
	ENV1850B	NIST 1974b	Wet			< 0.000413	
	ENV1851B	NIST 1974b	Wet			< 0.000424	
endrin							
	ENV1850B	NIST 1974b	Wet			< 0.000451	
	ENV1851B	NIST 1974b	Wet			< 0.000462	
fluoranthene							
	ENV1850B	NIST 1974b	Wet	0.0171	0.0007	0.0165	96.5
	ENV1851B	NIST 1974b	Wet	0.0171	0.0007	0.0190	111
fluorene							
	ENV1850B	NIST 1974b	Wet	0.000494	0.000036	0.000600	121
	ENV1851B	NIST 1974b	Wet	0.000494	0.000036	0.000600	121
gamma BHC							
	ENV1850B	NIST 1974b	Wet			< 0.000136	
	ENV1851B	NIST 1974b	Wet			< 0.000139	
gamma chlordane							
	ENV1850B	NIST 1974b	Wet			0.000701	
	ENV1851B	NIST 1974b	Wet			0.000701	
heptachlor epoxide							
	ENV1850B	NIST 1974b	Wet			< 0.000295	
	ENV1851B	NIST 1974b	Wet			< 0.000302	
indeno(1,2,3-cd)pyrene							

Analyte	Lab Sample Number	S.R.M. ID	Basis	Certified Reference Value	95% Confidence Interval	Result (ppm/%)	Percent Recovery
	ENV1850B	NIST 1974b	Wet	0.00214	0.00011	0.00200	93.5
	ENV1851B	NIST 1974b	Wet	0.00214	0.00011	0.00200	93.5
mirex							
	ENV1850B	NIST 1974b	Wet			< 0.0000950	
	ENV1851B	NIST 1974b	Wet			< 0.0000980	
naphthalene							
	ENV1850B	NIST 1974b	Wet	0.00243	0.00012	0.00110	45.3
	ENV1851B	NIST 1974b	Wet	0.00243	0.00012	< 0.00100	
o,p'-DDD							
	ENV1850B	NIST 1974b	Wet	0.00109	0.00016	0.000924	84.8
	ENV1851B	NIST 1974b	Wet	0.00109	0.00016	0.00107	97.9
o,p'-DDE							
	ENV1850B	NIST 1974b	Wet	0.000336	0.000044	0.000271	80.6
	ENV1851B	NIST 1974b	Wet	0.000336	0.000044	0.000318	94.6
o,p'-DDT							
	ENV1850B	NIST 1974b	Wet	0.000894	0.000057	0.000665	74.4
	ENV1851B	NIST 1974b	Wet	0.000894	0.000057	0.000582	65.1
oxychlordane							
	ENV1850B	NIST 1974b	Wet	0.000362	0.000072	0.000382	106
	ENV1851B	NIST 1974b	Wet	0.000362	0.000072	0.000364	101
p,p'-DDD							
	ENV1850B	NIST 1974b	Wet	0.00334	0.00022	0.00244	73.0
	ENV1851B	NIST 1974b	Wet	0.00334	0.00022	0.00226	67.5
p,p'-DDE							
	ENV1850B	NIST 1974b	Wet	0.00415	0.00038	0.00268	64.7
	ENV1851B	NIST 1974b	Wet	0.00415	0.00038	0.00275	66.2
p,p'-DDT							
	ENV1850B	NIST 1974b	Wet	0.000396	0.000096	0.000259	65.4
	ENV1851B	NIST 1974b	Wet	0.000396	0.000096	0.000279	70.4
pentachloro-anisole							
	ENV1850B	NIST 1974b	Wet			< 0.000104	
	ENV1851B	NIST 1974b	Wet			< 0.000107	

Analyte	Lab Sample Number	S.R.M. ID	Basis	Certified Reference Value	95% Confidence Interval	Result (ppm/%)	Percent Recovery
perylene							
	ENV1850B	NIST 1974b	Wet	0.00099	0.00014	0.000900	90.9
	ENV1851B	NIST 1974b	Wet	0.00099	0.00014	0.000900	90.9
phenanthrene							
	ENV1850B	NIST 1974b	Wet	0.00258	0.00011	0.00200	77.5
	ENV1851B	NIST 1974b	Wet	0.00258	0.00011	0.00200	77.5
pyrene							
	ENV1850B	NIST 1974b	Wet	0.01804	0.0006	0.0136	75.4
	ENV1851B	NIST 1974b	Wet	0.01804	0.0006	0.0155	85.9
toxaphene							
	ENV1850B	NIST 1974b	Wet			< 0.00975	
	ENV1851B	NIST 1974b	Wet			< 0.0100	
trans-nonachlor							
	ENV1850B	NIST 1974b	Wet	0.0013	0.00014	0.000773	59.5
	ENV1851B	NIST 1974b	Wet	0.0013	0.00014	0.000860	66.2

S.R.M Names

SRM ID	SRM Name
NIST 1974b	Organics in Mussel Tissue

9. Laboratory Notes

Analyte	Sample Number	Result Modifier
1,2,3,4-Tetrachlorobenzene		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
1,2,4,5-Tetrachlorobenzene		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
Aldrin		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
BHC (Total)		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
DDMU		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
HCB		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
Heptachlor		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in

		the sum of the total PCBs
PCB# 1		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 101/90		
	LAAE01	analyte diluted
	LACA01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	M analyte diluted
	LPAE02	analyte diluted
	LPBC04	analyte diluted
	LPCC01	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	analyte diluted
	UACA01	analyte diluted
	UPAE01	M analyte diluted
	UPCA01	analyte diluted
PCB# 105		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 107		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 110/77		
	LAAE01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs

	LPAE01	M analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	M analyte diluted
	UACA01	analyte diluted
	UPAE01	M analyte diluted
PCB# 114/131/122		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 118		
	LAAE01	analyte diluted
	LACC01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	M analyte diluted
	LPAE02	analyte diluted
	LPBC03	analyte diluted
	LPBC04	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	analyte diluted
	UACA01	analyte diluted
	UACC01	analyte diluted
	UPAE01	M analyte diluted
PCB# 126		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 128		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	analyte diluted

	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 129		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 136		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 138/160		
	LAAE01	M analyte diluted
	LACA01	analyte diluted
	LACC01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	M analyte diluted
	LPAE02	analyte diluted
	LPBC02	analyte diluted
	LPBC03	analyte diluted
	LPBC04	analyte diluted
	LPCC01	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	analyte diluted
	UABC01	analyte diluted
	UACA01	analyte diluted
	UACC01	analyte diluted
	UPAE01	M analyte diluted
	UPCA01	analyte diluted
	UPCC103	analyte diluted
PCB# 141/179		

	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 146		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	analyte diluted
	LPAE02	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UPAE01	analyte diluted
PCB# 149/123		
	LAAE01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	analyte diluted
	LPAE02	analyte diluted
	LPBC03	analyte diluted
	LPBC04	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	analyte diluted
	UPAE01	analyte diluted
PCB# 15		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 151		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs

PCB# 153/132		
	LAAE01	M analyte diluted
	LACA01	analyte diluted
	LACC01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	M analyte diluted
	LPAE02	analyte diluted
	LPBC02	analyte diluted
	LPBC03	analyte diluted
	LPBC04	analyte diluted
	LPCC01	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	analyte diluted
	UABC01	analyte diluted
	UACA01	analyte diluted
	UACC01	analyte diluted
	UPAE01	M analyte diluted
	UPCA01	analyte diluted
	UPCC103	analyte diluted
PCB# 156/171/202		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 158		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 16/32		

	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 166		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 167		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 169		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 170/190		
	LAAE01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	analyte diluted
	LPAE02	analyte diluted
	LPBC03	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UPAE01	analyte diluted
PCB# 172		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 174		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs

	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 176/137		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 177		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE02	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 178		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 18		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 180		
	LAAE01	M analyte diluted
	LACA01	analyte diluted
	LACC01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	analyte diluted
	LPAE02	analyte diluted
	LPBC02	analyte diluted
	LPBC03	analyte diluted
	LPBC04	analyte diluted
	LPCC01	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in

		the sum of the total PCBs
	UABC01	analyte diluted
	UACA01	analyte diluted
	UACC01	analyte diluted
	UPAE01	analyte diluted
	UPCA01	analyte diluted
	UPCC103	analyte diluted
PCB# 183		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	analyte diluted
	LPAE02	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 185		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 187		
	LAAE01	M analyte diluted
	LACC01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	analyte diluted
	LPAE02	analyte diluted
	LPBC02	analyte diluted
	LPBC03	analyte diluted
	LPBC04	analyte diluted
	LPCC01	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	analyte diluted
	UPAE01	analyte diluted

PCB# 189		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 191		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 194		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 195/208		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 196/203		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 199		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 200/157/173		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 201		

	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 205		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 206		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 209		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 22/51		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 24/27		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 25		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 26		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in

		the sum of the total PCBs
PCB# 28		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 29		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 31		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 33/53/20		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 40		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 41/64		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 42/59/37		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	analyte diluted

PCB# 43		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 44		
	LAAE01	analyte diluted
	LACA01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	M analyte diluted
	UACA01	analyte diluted
PCB# 45		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 46		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 47/48/75		
	LAAE01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	analyte diluted
	LPAE02	analyte diluted
	LPCC01	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UPAE01	analyte diluted
	UPCC103	analyte diluted
PCB# 49		

	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UACA01	analyte diluted
PCB# 52		
	LAAE01	analyte diluted
	LACA01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	M analyte diluted
	UACA01	analyte diluted
PCB# 56/60		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 66		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 7/9		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 70		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 74/61		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs

	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 77		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 8/5		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 81		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 82		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 83		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 84		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 85		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 86		

	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 87/115		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 88		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 92		
	LAAE01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	analyte diluted
	UACA01	analyte diluted
PCB# 95		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UACA01	analyte diluted
PCB# 97		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
PCB# 99		
	LAAE01	analyte diluted

	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	analyte diluted
	LPAE02	analyte diluted
	LPBC03	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	analyte diluted
	UPAE01	analyte diluted
PCB-TOTAL		
	LAAE01	analyte diluted
	LACA01	analyte diluted
	LACC01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	analyte diluted
	LPAE02	analyte diluted
	LPBC02	analyte diluted
	LPBC03	analyte diluted
	LPBC04	analyte diluted
	LPCC01	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	analyte diluted
	UABC01	analyte diluted
	UACA01	analyte diluted
	UACC01	analyte diluted
	UPAE01	analyte diluted
	UPCA01	analyte diluted
	UPCC103	analyte diluted
Pentachlorobenzene		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs

	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
Total DDT's		
	LAAE01	analyte diluted
	LACA01	analyte diluted
	LACC01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	analyte diluted
	LPAE02	analyte diluted
	LPBC02	analyte diluted
	LPBC03	analyte diluted
	LPBC04	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	analyte diluted
	UABC01	analyte diluted
	UACA01	analyte diluted
	UACC01	analyte diluted
	UPAE01	analyte diluted
	UPCA01	analyte diluted
	UPCC103	analyte diluted
alpha BHC		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
alpha chlordane		
	LAAE01	analyte diluted
	LACA01	analyte diluted
	LACC01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	analyte diluted

	LPBC04	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	M analyte diluted
	UABC01	analyte diluted
	UACA01	analyte diluted
	UACC01	analyte diluted
	UPAE01	analyte diluted
	UPCA01	analyte diluted
beta BHC		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
chlorpyrifos		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
cis-nonachlor		
	LAAE01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	analyte diluted
delta BHC		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
dieldrin		
	LAAE01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in

		the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	analyte diluted
endosulfan I		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
endosulfan II		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
endosulfan sulfate		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
endrin		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
gamma BHC		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
gamma chlordane		
	LAAE01	analyte diluted
	LACA01	analyte diluted
	LACC01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	analyte diluted

	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	analyte diluted
	UACA01	analyte diluted
	UPCA01	analyte diluted
heptachlor epoxide		
	LAAE01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	analyte diluted
mirex		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
o,p'-DDD		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
o,p'-DDE		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
o,p'-DDT		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
oxychlordane		
	LAAE01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs

	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	analyte diluted
p,p'-DDD		
	LAAE01	analyte diluted
	LACA01	analyte diluted
	LACC01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	analyte diluted
	LPBC04	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	analyte diluted
	UACA01	analyte diluted
	UPAE01	analyte diluted
	UPCA01	analyte diluted
p,p'-DDE		
	LAAE01	analyte diluted
	LACA01	analyte diluted
	LACC01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	M analyte diluted
	LPAE02	analyte diluted
	LPBC02	analyte diluted
	LPBC03	analyte diluted
	LPBC04	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	analyte diluted
	UABC01	analyte diluted
	UACA01	analyte diluted

	UACC01	analyte diluted
	UPAE01	M analyte diluted
	UPCA01	analyte diluted
	UPCC103	analyte diluted
p,p'-DDT		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	analyte diluted
pentachloro-anisole		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
toxaphene		
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
trans-nonachlor		
	LAAE01	M analyte diluted
	LACA01	analyte diluted
	LACC01	analyte diluted
	LASF01	.00947 ppm (Aroclor-1260) was used in the sum of the total PCBs
	LPAE01	analyte diluted
	LPBC04	analyte diluted
	LPSF01	.00528 ppm (Aroclor-1242) was used in the sum of the total PCBs
	UAAE01	analyte diluted
	UACA01	analyte diluted
	UACC01	analyte diluted
	UPAE01	analyte diluted
	UPCA01	analyte diluted

Code List

If appropriate, labs are instructed to use the following codes when entering laboratory notes. The labs may use one or more of the codes in each note displayed above.

Code	Comment
A	Values reported based on Aldrin response factor.
C	Sample possibly compromised due to improper handling / packaging.
D	Sample was deleted from the catalog by the submitter.
H	Due to sample characteristics it was difficult to obtain adequate sample homogeneity - precision was impacted.
I	Interferences occurred during analysis.
L	Sample compromised or destroyed during shipment - sample not analyzed.
M	Compound identity was confirmed by GC/MS.
N	Sample was not analyzed.
P	Sample destroyed during preparation at lab - sample not analyzed.
Q	Insufficient sample quantity to perform requested analysis.
R	Sample is highly decomposed - results may be impacted.
S	Sample was substituted by the submitter.
T	Retention time relative to Aldrin.
U	GC/MS identifies the unknown compound to be _____ (fill in analyte).
W	Insufficient sample quantity to perform duplicate / spike analyses.
Y	Sample was analyzed but results may be impacted (see 'C')

10. QAQC Summary

1. Procedural Blank Summary

Procedural Blank Summary of Blank Equivalent Concentration (BEC) Data

Within a lab sample matrix, there must be three or more Blank results for a given analyte in order to generate a report.

10.2. Duplicate Summary

Duplicate Summary of Relative Percent Difference (RPD) Data

Within a lab sample matrix and concentration range, there must be three or more Duplicate results for a given analyte in order to generate a report.

10.3. Spike Summary

Spike Summary of Percent Recovery (PR) Data

Within a lab sample matrix, there must be three or more Spike results for a given analyte in order to generate a report.

10.4. SRM Summary

Standard Reference Material Summary of Percent Recovery (PR) Data

Within an SRM ID, there must be three or more Recoveries for a given analyte in order to generate a report.

11. QA/QC Anomalies

1. Blank Frequency Anomalies

The required number of blank analyses were performed.

11.2. Duplicate Frequency Anomalies

The required number of duplicate analyses were performed.

11.3. Spike Frequency Anomalies

The required number of spike sample analyses were performed with the following exceptions.

Analyte	Lab Matrix	Number of Samples	Number of Spikes	Frequency (%)	See QA/QC Note No.
BDE# 1	Animal Tissue	32	0	0	1
BDE# 10	Animal Tissue	32	0	0	2
BDE# 11	Animal Tissue	32	0	0	3
BDE# 116	Animal Tissue	32	0	0	4
BDE# 118	Animal Tissue	32	0	0	5
BDE# 119	Animal Tissue	32	0	0	6
BDE# 12	Animal Tissue	32	0	0	7
BDE# 126	Animal Tissue	32	0	0	8
BDE# 13	Animal Tissue	32	0	0	9
BDE# 15	Animal Tissue	32	0	0	10
BDE# 155	Animal Tissue	32	0	0	11
BDE# 166	Animal Tissue	32	0	0	12
BDE# 181	Animal Tissue	32	0	0	13
BDE# 2	Animal Tissue	32	0	0	14
BDE# 25	Animal Tissue	32	0	0	15
BDE# 3	Animal Tissue	32	0	0	16
BDE# 30	Animal Tissue	32	0	0	17
BDE# 32	Animal Tissue	32	0	0	18

The required number of spike sample analyses were performed with the following exceptions.					
Analyte	**Lab Matrix**	**Number of Samples**	**Number of Spikes**	**Frequency (%)**	**See QA/QC Note No.**
BDE# 33	Animal Tissue	32	0	0	19
BDE# 35	Animal Tissue	32	0	0	20
BDE# 37	Animal Tissue	32	0	0	21
BDE# 7	Animal Tissue	32	0	0	22
BDE# 75	Animal Tissue	32	0	0	23
BDE# 77	Animal Tissue	32	0	0	24
BDE# 8	Animal Tissue	32	0	0	25
BHC (Total)	Animal Tissue	32	0	0	26
C1-chrysenes	Animal Tissue	32	0	0	27
C1-dibenzothiophenes	Animal Tissue	32	0	0	28
C1-Fluoranthenes & Pyrenes	Animal Tissue	32	0	0	29
C1-fluorenes	Animal Tissue	32	0	0	30
C1-naphthalenes	Animal Tissue	32	0	0	31
C1-Phenanthrenes & Anthracenes	Animal Tissue	32	0	0	32
C2-chrysenes	Animal Tissue	32	0	0	33
C2-dibenzothiophenes	Animal Tissue	32	0	0	34
C2-fluorenes	Animal Tissue	32	0	0	35
C2-naphthalenes	Animal Tissue	32	0	0	36
C2-Phenanthrenes & Anthracenes	Animal Tissue	32	0	0	37
C3-chrysenes	Animal Tissue	32	0	0	38
C3-dibenzothiophenes	Animal Tissue	32	0	0	39
C3-fluorenes	Animal Tissue	32	0	0	40
C3-naphthalenes	Animal Tissue	32	0	0	41
C3-Phenanthrenes & Anthracenes	Animal Tissue	32	0	0	42
C4-chrysenes	Animal Tissue	32	0	0	43
C4-naphthalenes	Animal Tissue	32	0	0	44

The required number of spike sample analyses were performed with the following exceptions.					
Analyte	**Lab Matrix**	**Number of Samples**	**Number of Spikes**	**Frequency (%)**	**See QA/QC Note No.**
C4-Phenanthrenes & Anthracenes	Animal Tissue	32	0	0	45
endosulfan I	Animal Tissue	32	0	0	46
PCB# 1	Animal Tissue	32	0	0	47
PCB# 107	Animal Tissue	32	0	0	48
PCB# 114/131/122	Animal Tissue	32	0	0	49
PCB# 126	Animal Tissue	32	0	0	50
PCB# 129	Animal Tissue	32	0	0	51
PCB# 136	Animal Tissue	32	0	0	52
PCB# 141/179	Animal Tissue	32	0	0	53
PCB# 146	Animal Tissue	32	0	0	54
PCB# 149/123	Animal Tissue	32	0	0	55
PCB# 15	Animal Tissue	32	0	0	56
PCB# 151	Animal Tissue	32	0	0	57
PCB# 156/171/202	Animal Tissue	32	0	0	58
PCB# 158	Animal Tissue	32	0	0	59
PCB# 16/32	Animal Tissue	32	0	0	60
PCB# 166	Animal Tissue	32	0	0	61
PCB# 167	Animal Tissue	32	0	0	62
PCB# 169	Animal Tissue	32	0	0	63
PCB# 172	Animal Tissue	32	0	0	64
PCB# 174	Animal Tissue	32	0	0	65
PCB# 176/137	Animal Tissue	32	0	0	66
PCB# 177	Animal Tissue	32	0	0	67
PCB# 178	Animal Tissue	32	0	0	68
PCB# 183	Animal Tissue	32	0	0	69
PCB# 185	Animal Tissue	32	0	0	70
PCB# 189	Animal Tissue	32	0	0	71
PCB# 191	Animal Tissue	32	0	0	72
PCB# 194	Animal Tissue	32	0	0	73
PCB# 196/203	Animal Tissue	32	0	0	74
PCB# 200/157/173	Animal Tissue	32	0	0	75

The required number of spike sample analyses were performed with the following exceptions.					
Analyte	**Lab Matrix**	**Number of Samples**	**Number of Spikes**	**Frequency (%)**	**See QA/QC Note No.**
PCB# 201	Animal Tissue	32	0	0	76
PCB# 205	Animal Tissue	32	0	0	77
PCB# 22/51	Animal Tissue	32	0	0	78
PCB# 24/27	Animal Tissue	32	0	0	79
PCB# 25	Animal Tissue	32	0	0	80
PCB# 26	Animal Tissue	32	0	0	81
PCB# 31	Animal Tissue	32	0	0	82
PCB# 33/53/20	Animal Tissue	32	0	0	83
PCB# 40	Animal Tissue	32	0	0	84
PCB# 41/64	Animal Tissue	32	0	0	85
PCB# 42/59/37	Animal Tissue	32	0	0	86
PCB# 43	Animal Tissue	32	0	0	87
PCB# 45	Animal Tissue	32	0	0	88
PCB# 46	Animal Tissue	32	0	0	89
PCB# 47/48/75	Animal Tissue	32	0	0	90
PCB# 49	Animal Tissue	32	0	0	91
PCB# 56/60	Animal Tissue	32	0	0	92
PCB# 7/9	Animal Tissue	32	0	0	93
PCB# 70	Animal Tissue	32	0	0	94
PCB# 74/61	Animal Tissue	32	0	0	95
PCB# 77	Animal Tissue	32	0	0	96
PCB# 81	Animal Tissue	32	0	0	97
PCB# 82	Animal Tissue	32	0	0	98
PCB# 83	Animal Tissue	32	0	0	99
PCB# 84	Animal Tissue	32	0	0	100
PCB# 85	Animal Tissue	32	0	0	101
PCB# 86	Animal Tissue	32	0	0	102
PCB# 88	Animal Tissue	32	0	0	103
PCB# 92	Animal Tissue	32	0	0	104
PCB# 95	Animal Tissue	32	0	0	105
PCB# 97	Animal Tissue	32	0	0	106
PCB# 99	Animal Tissue	32	0	0	107

The required number of spike sample analyses were performed with the following exceptions.					
Analyte	**Lab Matrix**	**Number of Samples**	**Number of Spikes**	**Frequency (%)**	**See QA/QC Note No.**
PCB-1242	Animal Tissue	32	0	0	108
PCB-1248	Animal Tissue	32	0	0	109
PCB-1254	Animal Tissue	32	0	0	110
PCB-1260	Animal Tissue	32	0	0	111
PCB-TOTAL	Animal Tissue	32	0	0	112
Total DDT's	Animal Tissue	32	0	0	113
toxaphene	Animal Tissue	32	0	0	114

11.4. Reference Material Frequency Anomalies

No Standard Reference Material data exists in this set of results; therefore, the anomaly test was not performed.

11.5. Mass Spec Frequency Anomalies

The required number of mass spec confirmations were performed with the following exceptions.				
Lab Matrix	**Number of Analytes**	**Number of Confirmations**	**Frequency (%)**	**See QA/QC Note No.**
Animal Tissue	436	4	0.92	115

11.6. Limit of Detection Anomalies

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 1	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00637	116
BDE# 1	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00622	117
BDE# 1	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00640	118
BDE# 1	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00521	119
BDE# 1	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00607	120
BDE# 1	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00565	121

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 1	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00611	122
BDE# 1	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00565	123
BDE# 1	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00566	124
BDE# 1	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00567	125
BDE# 1	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00616	126
BDE# 1	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00625	127
BDE# 1	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00612	128
BDE# 1	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00604	129
BDE# 1	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00491	130
BDE# 1	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00606	131
BDE# 1	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00577	132
BDE# 10	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00640	133
BDE# 10	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00596	134
BDE# 10	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00625	135
BDE# 10	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00567	136
BDE# 10	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00607	137
BDE# 10	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00618	138
BDE# 10	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00570	139
BDE# 10	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00567	140
BDE# 10	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00491	141
BDE# 10	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00637	142
BDE# 10	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00641	143
BDE# 10	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00566	144
BDE# 10	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00616	145
BDE# 10	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00565	146
BDE# 10	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00612	147
BDE# 10	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00492	148
BDE# 10	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00622	149
BDE# 10	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00604	150
BDE# 10	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00613	151
BDE# 10	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00560	152
BDE# 10	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00565	153

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 10	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00606	154
BDE# 10	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00577	155
BDE# 10	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00521	156
BDE# 10	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00635	157
BDE# 10	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00587	158
BDE# 10	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00633	159
BDE# 10	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00532	160
BDE# 10	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00487	161
BDE# 10	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00611	162
BDE# 10	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00621	163
BDE# 10	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00586	164
BDE# 100	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00402	165
BDE# 100	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00348	166
BDE# 100	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00409	167
BDE# 100	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00378	168
BDE# 100	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00428	169
BDE# 100	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00438	170
BDE# 100	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00454	171
BDE# 100	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00433	172
BDE# 100	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00438	173
BDE# 100	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00430	174
BDE# 100	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00442	175
BDE# 100	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00452	176
BDE# 100	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00435	177
BDE# 100	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00443	178
BDE# 11	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00621	179
BDE# 11	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00641	180
BDE# 11	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00604	181
BDE# 11	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00521	182
BDE# 11	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00491	183
BDE# 11	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00560	184
BDE# 11	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00567	185

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 11	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00566	186
BDE# 11	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00586	187
BDE# 11	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00635	188
BDE# 11	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00587	189
BDE# 11	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00567	190
BDE# 11	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00487	191
BDE# 11	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00625	192
BDE# 11	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00616	193
BDE# 11	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00606	194
BDE# 11	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00618	195
BDE# 11	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00637	196
BDE# 11	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00612	197
BDE# 11	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00607	198
BDE# 11	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00633	199
BDE# 11	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00622	200
BDE# 11	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00613	201
BDE# 11	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00596	202
BDE# 11	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00611	203
BDE# 11	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00640	204
BDE# 11	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00577	205
BDE# 11	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00565	206
BDE# 11	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00570	207
BDE# 11	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00565	208
BDE# 11	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00492	209
BDE# 11	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00532	210
BDE# 116	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00370	211
BDE# 116	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00346	212
BDE# 116	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00349	213
BDE# 116	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00450	214
BDE# 116	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00442	215
BDE# 116	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00435	216
BDE# 116	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00423	217

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 116	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00433	218
BDE# 116	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00378	219
BDE# 116	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00416	220
BDE# 116	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00452	221
BDE# 116	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00401	222
BDE# 116	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00402	223
BDE# 116	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00438	224
BDE# 116	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00404	225
BDE# 116	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00443	226
BDE# 116	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00434	227
BDE# 116	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00431	228
BDE# 116	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00450	229
BDE# 116	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00402	230
BDE# 116	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00430	231
BDE# 116	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00417	232
BDE# 116	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00455	233
BDE# 116	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00441	234
BDE# 116	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00438	235
BDE# 116	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00409	236
BDE# 116	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00348	237
BDE# 116	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00397	238
BDE# 116	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00454	239
BDE# 116	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00401	240
BDE# 116	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00401	241
BDE# 116	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00428	242
BDE# 118	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00404	243
BDE# 118	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00441	244
BDE# 118	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00349	245
BDE# 118	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00348	246
BDE# 118	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00397	247
BDE# 118	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00438	248
BDE# 118	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00431	249

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 118	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00452	250
BDE# 118	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00442	251
BDE# 118	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00430	252
BDE# 118	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00454	253
BDE# 118	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00433	254
BDE# 118	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00401	255
BDE# 118	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00417	256
BDE# 118	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00435	257
BDE# 118	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00401	258
BDE# 118	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00402	259
BDE# 118	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00434	260
BDE# 118	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00443	261
BDE# 118	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00450	262
BDE# 118	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00370	263
BDE# 118	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00402	264
BDE# 118	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00409	265
BDE# 118	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00428	266
BDE# 118	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00423	267
BDE# 118	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00346	268
BDE# 118	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00450	269
BDE# 118	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00455	270
BDE# 118	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00416	271
BDE# 118	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00438	272
BDE# 118	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00378	273
BDE# 118	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00401	274
BDE# 119	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00348	275
BDE# 119	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00450	276
BDE# 119	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00435	277
BDE# 119	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00402	278
BDE# 119	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00431	279
BDE# 119	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00452	280
BDE# 119	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00442	281

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 119	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00378	282
BDE# 119	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00349	283
BDE# 119	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00438	284
BDE# 119	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00397	285
BDE# 119	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00423	286
BDE# 119	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00438	287
BDE# 119	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00401	288
BDE# 119	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00401	289
BDE# 119	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00454	290
BDE# 119	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00346	291
BDE# 119	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00370	292
BDE# 119	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00428	293
BDE# 119	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00443	294
BDE# 119	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00417	295
BDE# 119	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00430	296
BDE# 119	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00433	297
BDE# 119	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00434	298
BDE# 119	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00455	299
BDE# 119	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00441	300
BDE# 119	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00402	301
BDE# 119	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00401	302
BDE# 119	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00416	303
BDE# 119	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00404	304
BDE# 119	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00450	305
BDE# 119	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00409	306
BDE# 12	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00606	307
BDE# 12	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00633	308
BDE# 12	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00532	309
BDE# 12	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00577	310
BDE# 12	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00612	311
BDE# 12	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00635	312
BDE# 12	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00616	313

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 12	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00492	314
BDE# 12	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00621	315
BDE# 12	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00487	316
BDE# 12	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00521	317
BDE# 12	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00566	318
BDE# 12	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00567	319
BDE# 12	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00570	320
BDE# 12	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00491	321
BDE# 12	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00613	322
BDE# 12	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00560	323
BDE# 12	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00565	324
BDE# 12	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00625	325
BDE# 12	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00637	326
BDE# 12	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00641	327
BDE# 12	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00640	328
BDE# 12	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00565	329
BDE# 12	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00587	330
BDE# 12	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00611	331
BDE# 12	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00607	332
BDE# 12	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00622	333
BDE# 12	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00618	334
BDE# 12	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00596	335
BDE# 12	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00567	336
BDE# 12	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00604	337
BDE# 12	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00586	338
BDE# 126	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00378	339
BDE# 126	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00450	340
BDE# 126	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00401	341
BDE# 126	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00423	342
BDE# 126	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00452	343
BDE# 126	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00349	344
BDE# 126	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00441	345

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 126	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00438	346
BDE# 126	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00402	347
BDE# 126	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00416	348
BDE# 126	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00346	349
BDE# 126	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00370	350
BDE# 126	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00428	351
BDE# 126	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00409	352
BDE# 126	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00438	353
BDE# 126	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00417	354
BDE# 126	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00402	355
BDE# 126	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00454	356
BDE# 126	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00348	357
BDE# 126	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00397	358
BDE# 126	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00443	359
BDE# 126	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00450	360
BDE# 126	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00430	361
BDE# 126	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00401	362
BDE# 126	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00404	363
BDE# 126	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00433	364
BDE# 126	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00435	365
BDE# 126	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00431	366
BDE# 126	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00434	367
BDE# 126	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00442	368
BDE# 126	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00455	369
BDE# 126	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00401	370
BDE# 13	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00566	371
BDE# 13	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00618	372
BDE# 13	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00613	373
BDE# 13	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00577	374
BDE# 13	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00621	375
BDE# 13	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00635	376
BDE# 13	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00492	377

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 13	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00606	378
BDE# 13	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00567	379
BDE# 13	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00604	380
BDE# 13	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00641	381
BDE# 13	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00487	382
BDE# 13	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00622	383
BDE# 13	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00637	384
BDE# 13	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00565	385
BDE# 13	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00612	386
BDE# 13	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00586	387
BDE# 13	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00640	388
BDE# 13	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00596	389
BDE# 13	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00616	390
BDE# 13	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00607	391
BDE# 13	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00625	392
BDE# 13	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00565	393
BDE# 13	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00521	394
BDE# 13	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00633	395
BDE# 13	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00532	396
BDE# 13	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00567	397
BDE# 13	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00570	398
BDE# 13	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00611	399
BDE# 13	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00560	400
BDE# 13	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00491	401
BDE# 13	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00587	402
BDE# 138	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00710	403
BDE# 138	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00663	404
BDE# 138	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00612	405
BDE# 138	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00755	406
BDE# 138	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00697	407
BDE# 138	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00768	408
BDE# 138	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00778	409

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 138	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00776	410
BDE# 138	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00799	411
BDE# 138	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00706	412
BDE# 138	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00752	413
BDE# 138	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00704	414
BDE# 138	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00719	415
BDE# 138	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00762	416
BDE# 138	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00732	417
BDE# 138	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00704	418
BDE# 138	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00761	419
BDE# 138	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00742	420
BDE# 138	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00611	421
BDE# 138	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00649	422
BDE# 138	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00797	423
BDE# 138	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00791	424
BDE# 138	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00764	425
BDE# 138	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00770	426
BDE# 138	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00730	427
BDE# 138	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00705	428
BDE# 138	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00774	429
BDE# 138	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00607	430
BDE# 138	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00706	431
BDE# 138	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00756	432
BDE# 138	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00789	433
BDE# 138	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00794	434
BDE# 15	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00567	435
BDE# 15	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00487	436
BDE# 15	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00570	437
BDE# 15	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00616	438
BDE# 15	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00604	439
BDE# 15	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00641	440
BDE# 15	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00640	441

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 15	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00611	442
BDE# 15	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00635	443
BDE# 15	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00607	444
BDE# 15	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00577	445
BDE# 15	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00492	446
BDE# 15	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00566	447
BDE# 15	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00625	448
BDE# 15	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00613	449
BDE# 15	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00618	450
BDE# 15	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00587	451
BDE# 15	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00596	452
BDE# 15	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00491	453
BDE# 15	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00560	454
BDE# 15	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00565	455
BDE# 15	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00521	456
BDE# 15	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00622	457
BDE# 15	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00612	458
BDE# 15	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00586	459
BDE# 15	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00633	460
BDE# 15	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00606	461
BDE# 15	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00565	462
BDE# 15	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00532	463
BDE# 15	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00637	464
BDE# 15	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00567	465
BDE# 15	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00621	466
BDE# 153	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00413	467
BDE# 153	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00331	468
BDE# 153	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00408	469
BDE# 153	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00395	470
BDE# 153	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00328	471
BDE# 153	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00330	472
BDE# 153	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00418	473

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 153	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00382	474
BDE# 153	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00409	475
BDE# 153	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00380	476
BDE# 153	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00407	477
BDE# 153	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00411	478
BDE# 153	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00377	479
BDE# 153	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00382	480
BDE# 153	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00351	481
BDE# 153	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00419	482
BDE# 153	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00381	483
BDE# 153	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00380	484
BDE# 153	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00421	485
BDE# 153	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00388	486
BDE# 153	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00429	487
BDE# 153	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00416	488
BDE# 153	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00431	489
BDE# 153	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00412	490
BDE# 153	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00384	491
BDE# 153	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00395	492
BDE# 153	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00358	493
BDE# 153	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00401	494
BDE# 154	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00496	495
BDE# 154	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00482	496
BDE# 154	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00507	497
BDE# 154	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00452	498
BDE# 154	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00416	499
BDE# 154	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00511	500
BDE# 154	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00497	501
BDE# 154	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00488	502
BDE# 154	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00460	503
BDE# 154	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00451	504
BDE# 154	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00425	505

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 154	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00468	506
BDE# 154	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00512	507
BDE# 154	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00489	508
BDE# 154	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00447	509
BDE# 154	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00469	510
BDE# 154	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00484	511
BDE# 154	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00451	512
BDE# 154	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00452	513
BDE# 154	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00455	514
BDE# 154	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00452	515
BDE# 154	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00499	516
BDE# 154	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00392	517
BDE# 154	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00389	518
BDE# 154	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00488	519
BDE# 154	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00493	520
BDE# 154	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00509	521
BDE# 154	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00485	522
BDE# 154	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00476	523
BDE# 155	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00392	524
BDE# 155	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00392	525
BDE# 155	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00511	526
BDE# 155	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00451	527
BDE# 155	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00452	528
BDE# 155	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00493	529
BDE# 155	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00507	530
BDE# 155	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00506	531
BDE# 155	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00488	532
BDE# 155	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00416	533
BDE# 155	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00476	534
BDE# 155	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00389	535
BDE# 155	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00499	536
BDE# 155	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00460	537

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 155	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00509	538
BDE# 155	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00482	539
BDE# 155	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00485	540
BDE# 155	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00455	541
BDE# 155	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00452	542
BDE# 155	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00496	543
BDE# 155	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00469	544
BDE# 155	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00451	545
BDE# 155	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00492	546
BDE# 155	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00484	547
BDE# 155	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00447	548
BDE# 155	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00425	549
BDE# 155	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00512	550
BDE# 155	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00488	551
BDE# 155	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00468	552
BDE# 155	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00497	553
BDE# 155	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00452	554
BDE# 155	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00489	555
BDE# 166	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00455	556
BDE# 166	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00460	557
BDE# 166	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00485	558
BDE# 166	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00452	559
BDE# 166	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00392	560
BDE# 166	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00511	561
BDE# 166	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00416	562
BDE# 166	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00447	563
BDE# 166	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00512	564
BDE# 166	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00451	565
BDE# 166	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00507	566
BDE# 166	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00469	567
BDE# 166	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00497	568
BDE# 166	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00482	569

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 166	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00489	570
BDE# 166	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00389	571
BDE# 166	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00484	572
BDE# 166	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00506	573
BDE# 166	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00392	574
BDE# 166	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00488	575
BDE# 166	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00492	576
BDE# 166	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00452	577
BDE# 166	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00452	578
BDE# 166	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00493	579
BDE# 166	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00476	580
BDE# 166	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00496	581
BDE# 166	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00451	582
BDE# 166	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00509	583
BDE# 166	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00499	584
BDE# 166	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00488	585
BDE# 166	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00468	586
BDE# 166	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00425	587
BDE# 17	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00633	588
BDE# 17	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00616	589
BDE# 17	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00622	590
BDE# 17	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00521	591
BDE# 17	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00560	592
BDE# 17	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00570	593
BDE# 17	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00621	594
BDE# 17	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00637	595
BDE# 17	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00612	596
BDE# 17	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00625	597
BDE# 17	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00596	598
BDE# 17	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00587	599
BDE# 17	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00565	600
BDE# 17	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00618	601

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 17	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00492	602
BDE# 17	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00577	603
BDE# 17	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00567	604
BDE# 17	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00487	605
BDE# 17	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00640	606
BDE# 17	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00491	607
BDE# 17	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00566	608
BDE# 17	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00606	609
BDE# 17	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00532	610
BDE# 17	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00586	611
BDE# 17	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00565	612
BDE# 17	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00635	613
BDE# 17	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00611	614
BDE# 17	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00604	615
BDE# 17	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00607	616
BDE# 17	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00613	617
BDE# 17	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00567	618
BDE# 17	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00641	619
BDE# 181	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00548	620
BDE# 181	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00503	621
BDE# 181	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00547	622
BDE# 181	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00462	623
BDE# 181	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00501	624
BDE# 181	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00472	625
BDE# 181	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00568	626
BDE# 181	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00501	627
BDE# 181	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00432	628
BDE# 181	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00496	629
BDE# 181	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00539	630
BDE# 181	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00536	631
BDE# 181	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00563	632
BDE# 181	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00512	633

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 181	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00543	634
BDE# 181	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00435	635
BDE# 181	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00554	636
BDE# 181	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00436	637
BDE# 181	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00538	638
BDE# 181	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00521	639
BDE# 181	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00503	640
BDE# 181	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00520	641
BDE# 181	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00542	642
BDE# 181	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00544	643
BDE# 181	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00552	644
BDE# 181	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00502	645
BDE# 181	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00529	646
BDE# 181	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00565	647
BDE# 181	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00569	648
BDE# 181	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00562	649
BDE# 181	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00551	650
BDE# 181	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00505	651
BDE# 183	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00543	652
BDE# 183	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00562	653
BDE# 183	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00503	654
BDE# 183	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00472	655
BDE# 183	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00568	656
BDE# 183	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00432	657
BDE# 183	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00529	658
BDE# 183	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00503	659
BDE# 183	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00520	660
BDE# 183	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00496	661
BDE# 183	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00536	662
BDE# 183	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00435	663
BDE# 183	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00547	664
BDE# 183	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00512	665

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 183	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00565	666
BDE# 183	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00538	667
BDE# 183	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00501	668
BDE# 183	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00551	669
BDE# 183	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00554	670
BDE# 183	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00542	671
BDE# 183	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00563	672
BDE# 183	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00462	673
BDE# 183	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00521	674
BDE# 183	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00505	675
BDE# 183	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00544	676
BDE# 183	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00552	677
BDE# 183	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00539	678
BDE# 183	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00436	679
BDE# 183	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00548	680
BDE# 183	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00502	681
BDE# 183	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00569	682
BDE# 183	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00501	683
BDE# 190	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00539	684
BDE# 190	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00536	685
BDE# 190	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00499	686
BDE# 190	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00559	687
BDE# 190	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00434	688
BDE# 190	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00509	689
BDE# 190	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00460	690
BDE# 190	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00499	691
BDE# 190	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00433	692
BDE# 190	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00494	693
BDE# 190	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00560	694
BDE# 190	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00549	695
BDE# 190	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00566	696
BDE# 190	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00550	697

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 190	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00545	698
BDE# 190	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00563	699
BDE# 190	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00500	700
BDE# 190	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00526	701
BDE# 190	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00565	702
BDE# 190	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00500	703
BDE# 190	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00470	704
BDE# 190	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00535	705
BDE# 190	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00503	706
BDE# 190	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00552	707
BDE# 190	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00541	708
BDE# 190	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00519	709
BDE# 190	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00544	710
BDE# 190	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00430	711
BDE# 190	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00518	712
BDE# 190	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00540	713
BDE# 190	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00533	714
BDE# 190	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00500	715
BDE# 2	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00532	716
BDE# 2	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00487	717
BDE# 2	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00625	718
BDE# 2	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00521	719
BDE# 2	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00635	720
BDE# 2	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00596	721
BDE# 2	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00640	722
BDE# 2	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00587	723
BDE# 2	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00616	724
BDE# 2	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00491	725
BDE# 2	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00621	726
BDE# 2	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00618	727
BDE# 2	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00565	728
BDE# 2	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00607	729

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 2	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00567	730
BDE# 2	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00570	731
BDE# 2	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00492	732
BDE# 2	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00604	733
BDE# 2	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00567	734
BDE# 2	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00560	735
BDE# 2	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00606	736
BDE# 2	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00586	737
BDE# 2	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00577	738
BDE# 2	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00613	739
BDE# 2	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00565	740
BDE# 2	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00633	741
BDE# 2	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00622	742
BDE# 2	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00612	743
BDE# 2	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00611	744
BDE# 2	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00566	745
BDE# 2	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00637	746
BDE# 2	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00641	747
BDE# 25	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00492	748
BDE# 25	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00586	749
BDE# 25	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00625	750
BDE# 25	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00607	751
BDE# 25	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00565	752
BDE# 25	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00622	753
BDE# 25	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00596	754
BDE# 25	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00640	755
BDE# 25	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00570	756
BDE# 25	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00604	757
BDE# 25	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00521	758
BDE# 25	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00491	759
BDE# 25	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00560	760
BDE# 25	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00612	761

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 25	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00637	762
BDE# 25	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00567	763
BDE# 25	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00587	764
BDE# 25	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00621	765
BDE# 25	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00532	766
BDE# 25	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00633	767
BDE# 25	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00577	768
BDE# 25	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00616	769
BDE# 25	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00613	770
BDE# 25	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00611	771
BDE# 25	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00566	772
BDE# 25	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00565	773
BDE# 25	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00606	774
BDE# 25	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00641	775
BDE# 25	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00618	776
BDE# 25	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00487	777
BDE# 25	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00567	778
BDE# 25	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00635	779
BDE# 28	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00274	780
BDE# 28	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00297	781
BDE# 28	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00288	782
BDE# 28	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00264	783
BDE# 28	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00289	784
BDE# 28	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00265	785
BDE# 28	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00244	786
BDE# 28	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00284	787
BDE# 28	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00249	788
BDE# 28	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00286	789
BDE# 28	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00292	790
BDE# 28	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00264	791
BDE# 28	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00262	792
BDE# 28	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00266	793

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 28	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00291	794
BDE# 28	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00299	795
BDE# 28	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00300	796
BDE# 28	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00287	797
BDE# 28	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00286	798
BDE# 28	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00275	799
BDE# 28	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00291	800
BDE# 28	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00230	801
BDE# 28	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00296	802
BDE# 28	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00298	803
BDE# 28	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00284	804
BDE# 28	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00265	805
BDE# 3	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00492	806
BDE# 3	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00606	807
BDE# 3	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00633	808
BDE# 3	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00532	809
BDE# 3	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00567	810
BDE# 3	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00641	811
BDE# 3	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00570	812
BDE# 3	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00640	813
BDE# 3	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00596	814
BDE# 3	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00621	815
BDE# 3	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00587	816
BDE# 3	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00577	817
BDE# 3	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00607	818
BDE# 3	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00616	819
BDE# 3	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00613	820
BDE# 3	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00635	821
BDE# 3	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00566	822
BDE# 3	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00625	823
BDE# 3	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00491	824
BDE# 3	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00612	825

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 3	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00565	826
BDE# 3	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00560	827
BDE# 3	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00567	828
BDE# 3	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00586	829
BDE# 3	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00611	830
BDE# 3	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00565	831
BDE# 3	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00604	832
BDE# 3	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00521	833
BDE# 3	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00622	834
BDE# 3	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00637	835
BDE# 3	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00618	836
BDE# 30	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00492	837
BDE# 30	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00604	838
BDE# 30	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00606	839
BDE# 30	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00635	840
BDE# 30	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00613	841
BDE# 30	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00625	842
BDE# 30	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00622	843
BDE# 30	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00596	844
BDE# 30	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00491	845
BDE# 30	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00637	846
BDE# 30	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00621	847
BDE# 30	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00570	848
BDE# 30	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00586	849
BDE# 30	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00616	850
BDE# 30	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00641	851
BDE# 30	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00633	852
BDE# 30	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00640	853
BDE# 30	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00611	854
BDE# 30	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00566	855
BDE# 30	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00521	856
BDE# 30	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00532	857

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 30	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00587	858
BDE# 30	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00567	859
BDE# 30	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00560	860
BDE# 30	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00565	861
BDE# 30	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00567	862
BDE# 30	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00577	863
BDE# 30	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00487	864
BDE# 30	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00612	865
BDE# 30	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00607	866
BDE# 30	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00618	867
BDE# 30	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00565	868
BDE# 32	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00577	869
BDE# 32	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00622	870
BDE# 32	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00637	871
BDE# 32	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00586	872
BDE# 32	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00606	873
BDE# 32	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00566	874
BDE# 32	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00570	875
BDE# 32	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00613	876
BDE# 32	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00596	877
BDE# 32	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00604	878
BDE# 32	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00612	879
BDE# 32	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00621	880
BDE# 32	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00567	881
BDE# 32	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00567	882
BDE# 32	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00607	883
BDE# 32	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00625	884
BDE# 32	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00618	885
BDE# 32	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00633	886
BDE# 32	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00521	887
BDE# 32	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00587	888
BDE# 32	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00640	889

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 32	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00611	890
BDE# 32	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00635	891
BDE# 32	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00616	892
BDE# 32	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00641	893
BDE# 32	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00487	894
BDE# 32	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00492	895
BDE# 32	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00560	896
BDE# 32	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00491	897
BDE# 32	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00565	898
BDE# 32	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00565	899
BDE# 32	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00532	900
BDE# 33	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00640	901
BDE# 33	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00567	902
BDE# 33	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00633	903
BDE# 33	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00618	904
BDE# 33	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00586	905
BDE# 33	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00567	906
BDE# 33	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00604	907
BDE# 33	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00587	908
BDE# 33	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00565	909
BDE# 33	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00641	910
BDE# 33	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00607	911
BDE# 33	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00491	912
BDE# 33	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00560	913
BDE# 33	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00570	914
BDE# 33	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00625	915
BDE# 33	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00521	916
BDE# 33	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00596	917
BDE# 33	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00611	918
BDE# 33	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00613	919
BDE# 33	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00532	920
BDE# 33	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00637	921

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 33	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00612	922
BDE# 33	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00616	923
BDE# 33	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00487	924
BDE# 33	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00492	925
BDE# 33	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00622	926
BDE# 33	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00577	927
BDE# 33	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00566	928
BDE# 33	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00621	929
BDE# 33	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00606	930
BDE# 33	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00565	931
BDE# 33	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00635	932
BDE# 35	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00565	933
BDE# 35	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00625	934
BDE# 35	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00616	935
BDE# 35	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00607	936
BDE# 35	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00622	937
BDE# 35	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00633	938
BDE# 35	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00618	939
BDE# 35	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00492	940
BDE# 35	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00566	941
BDE# 35	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00611	942
BDE# 35	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00491	943
BDE# 35	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00604	944
BDE# 35	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00532	945
BDE# 35	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00621	946
BDE# 35	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00640	947
BDE# 35	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00570	948
BDE# 35	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00487	949
BDE# 35	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00565	950
BDE# 35	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00613	951
BDE# 35	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00560	952
BDE# 35	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00586	953

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 35	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00641	954
BDE# 35	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00587	955
BDE# 35	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00637	956
BDE# 35	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00567	957
BDE# 35	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00567	958
BDE# 35	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00577	959
BDE# 35	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00612	960
BDE# 35	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00596	961
BDE# 35	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00635	962
BDE# 35	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00606	963
BDE# 35	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00521	964
BDE# 37	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00625	965
BDE# 37	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00532	966
BDE# 37	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00566	967
BDE# 37	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00613	968
BDE# 37	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00491	969
BDE# 37	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00612	970
BDE# 37	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00604	971
BDE# 37	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00587	972
BDE# 37	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00596	973
BDE# 37	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00567	974
BDE# 37	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00492	975
BDE# 37	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00570	976
BDE# 37	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00560	977
BDE# 37	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00641	978
BDE# 37	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00565	979
BDE# 37	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00621	980
BDE# 37	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00567	981
BDE# 37	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00565	982
BDE# 37	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00618	983
BDE# 37	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00487	984
BDE# 37	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00635	985

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 37	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00637	986
BDE# 37	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00606	987
BDE# 37	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00611	988
BDE# 37	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00640	989
BDE# 37	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00521	990
BDE# 37	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00607	991
BDE# 37	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00577	992
BDE# 37	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00586	993
BDE# 37	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00633	994
BDE# 37	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00616	995
BDE# 37	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00622	996
BDE# 47	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00319	997
BDE# 47	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00326	998
BDE# 47	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00313	999
BDE# 47	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00310	1000
BDE# 47	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00289	1001
BDE# 47	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00328	1002
BDE# 47	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00320	1003
BDE# 49/71	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00294	1004
BDE# 49/71	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00313	1005
BDE# 49/71	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00353	1006
BDE# 49/71	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00343	1007
BDE# 49/71	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00341	1008
BDE# 49/71	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00271	1009
BDE# 49/71	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00351	1010
BDE# 49/71	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00335	1011
BDE# 49/71	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00338	1012
BDE# 49/71	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00337	1013
BDE# 49/71	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00344	1014
BDE# 49/71	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00312	1015
BDE# 49/71	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00313	1016
BDE# 49/71	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00339	1017

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 49/71	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00354	1018
BDE# 49/71	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00352	1019
BDE# 49/71	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00350	1020
BDE# 49/71	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00324	1021
BDE# 49/71	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00345	1022
BDE# 66	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00378	1023
BDE# 66	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00395	1024
BDE# 66	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00348	1025
BDE# 66	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00381	1026
BDE# 66	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00377	1027
BDE# 66	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00350	1028
BDE# 66	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00351	1029
BDE# 66	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00372	1030
BDE# 66	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00393	1031
BDE# 66	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00383	1032
BDE# 66	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00391	1033
BDE# 66	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00386	1034
BDE# 66	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00350	1035
BDE# 66	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00392	1036
BDE# 66	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00303	1037
BDE# 66	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00349	1038
BDE# 66	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00362	1039
BDE# 66	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00303	1040
BDE# 66	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00374	1041
BDE# 66	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00328	1042
BDE# 66	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00384	1043
BDE# 66	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00377	1044
BDE# 66	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00356	1045
BDE# 66	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00321	1046
BDE# 66	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00348	1047
BDE# 66	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00362	1048
BDE# 66	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00395	1049

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 66	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00375	1050
BDE# 66	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00380	1051
BDE# 66	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00368	1052
BDE# 66	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00345	1053
BDE# 66	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00300	1054
BDE# 7	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00565	1055
BDE# 7	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00532	1056
BDE# 7	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00492	1057
BDE# 7	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00641	1058
BDE# 7	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00560	1059
BDE# 7	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00640	1060
BDE# 7	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00586	1061
BDE# 7	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00570	1062
BDE# 7	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00606	1063
BDE# 7	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00577	1064
BDE# 7	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00521	1065
BDE# 7	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00487	1066
BDE# 7	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00618	1067
BDE# 7	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00613	1068
BDE# 7	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00635	1069
BDE# 7	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00567	1070
BDE# 7	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00612	1071
BDE# 7	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00566	1072
BDE# 7	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00567	1073
BDE# 7	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00616	1074
BDE# 7	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00611	1075
BDE# 7	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00621	1076
BDE# 7	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00625	1077
BDE# 7	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00604	1078
BDE# 7	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00565	1079
BDE# 7	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00607	1080
BDE# 7	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00587	1081

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 7	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00633	1082
BDE# 7	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00622	1083
BDE# 7	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00637	1084
BDE# 7	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00596	1085
BDE# 7	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00491	1086
BDE# 75	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00312	1087
BDE# 75	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00271	1088
BDE# 75	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00340	1089
BDE# 75	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00324	1090
BDE# 75	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00294	1091
BDE# 75	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00335	1092
BDE# 75	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00343	1093
BDE# 75	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00288	1094
BDE# 75	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00354	1095
BDE# 75	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00351	1096
BDE# 75	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00338	1097
BDE# 75	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00352	1098
BDE# 75	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00272	1099
BDE# 75	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00341	1100
BDE# 75	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00313	1101
BDE# 75	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00353	1102
BDE# 75	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00309	1103
BDE# 75	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00329	1104
BDE# 75	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00319	1105
BDE# 75	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00334	1106
BDE# 75	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00345	1107
BDE# 75	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00312	1108
BDE# 75	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00350	1109
BDE# 75	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00335	1110
BDE# 75	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00312	1111
BDE# 75	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00313	1112
BDE# 75	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00315	1113

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 75	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00269	1114
BDE# 75	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00344	1115
BDE# 75	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00324	1116
BDE# 75	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00337	1117
BDE# 75	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00339	1118
BDE# 77	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00294	1119
BDE# 77	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00269	1120
BDE# 77	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00339	1121
BDE# 77	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00338	1122
BDE# 77	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00345	1123
BDE# 77	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00312	1124
BDE# 77	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00335	1125
BDE# 77	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00353	1126
BDE# 77	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00351	1127
BDE# 77	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00319	1128
BDE# 77	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00334	1129
BDE# 77	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00344	1130
BDE# 77	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00315	1131
BDE# 77	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00309	1132
BDE# 77	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00340	1133
BDE# 77	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00341	1134
BDE# 77	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00352	1135
BDE# 77	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00354	1136
BDE# 77	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00272	1137
BDE# 77	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00324	1138
BDE# 77	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00350	1139
BDE# 77	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00312	1140
BDE# 77	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00337	1141
BDE# 77	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00329	1142
BDE# 77	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00335	1143
BDE# 77	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00324	1144
BDE# 77	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00343	1145

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 77	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00288	1146
BDE# 77	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00313	1147
BDE# 77	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00271	1148
BDE# 77	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00313	1149
BDE# 77	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00312	1150
BDE# 8	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00567	1151
BDE# 8	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00521	1152
BDE# 8	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00577	1153
BDE# 8	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00604	1154
BDE# 8	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00637	1155
BDE# 8	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00565	1156
BDE# 8	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00625	1157
BDE# 8	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00492	1158
BDE# 8	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00633	1159
BDE# 8	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00532	1160
BDE# 8	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00565	1161
BDE# 8	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00491	1162
BDE# 8	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00618	1163
BDE# 8	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00606	1164
BDE# 8	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00587	1165
BDE# 8	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00641	1166
BDE# 8	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00487	1167
BDE# 8	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00616	1168
BDE# 8	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00612	1169
BDE# 8	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00622	1170
BDE# 8	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00596	1171
BDE# 8	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00607	1172
BDE# 8	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00621	1173
BDE# 8	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00567	1174
BDE# 8	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00566	1175
BDE# 8	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00613	1176
BDE# 8	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00586	1177

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 8	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00640	1178
BDE# 8	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00570	1179
BDE# 8	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00635	1180
BDE# 8	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00560	1181
BDE# 8	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00611	1182
BDE# 85	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00340	1183
BDE# 85	UACC01	Animal Tissue	0.0001	Wet	0.000300	0.00381	1184
BDE# 85	UPCC101	Animal Tissue	0.0001	Wet	0.000300	0.00373	1185
BDE# 85	LPBC02	Animal Tissue	0.0001	Wet	0.000300	0.00313	1186
BDE# 85	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00363	1187
BDE# 85	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00375	1188
BDE# 85	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00364	1189
BDE# 85	LAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00336	1190
BDE# 85	LPBC04	Animal Tissue	0.0001	Wet	0.000300	0.00346	1191
BDE# 85	UAAE01	Animal Tissue	0.0001	Wet	0.000300	0.00385	1192
BDE# 85	UALB01	Animal Tissue	0.0001	Wet	0.000300	0.00371	1193
BDE# 85	LASF01	Animal Tissue	0.0001	Wet	0.000300	0.00368	1194
BDE# 85	LPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00368	1195
BDE# 85	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00340	1196
BDE# 85	LABC01	Animal Tissue	0.0001	Wet	0.000300	0.00293	1197
BDE# 85	UASF01	Animal Tissue	0.0001	Wet	0.000300	0.00320	1198
BDE# 85	UPCC02	Animal Tissue	0.0001	Wet	0.000300	0.00353	1199
BDE# 85	UPCC103	Animal Tissue	0.0001	Wet	0.000300	0.00342	1200
BDE# 85	UPCC01	Animal Tissue	0.0001	Wet	0.000300	0.00339	1201
BDE# 85	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00339	1202
BDE# 85	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00295	1203
BDE# 85	LALB01	Animal Tissue	0.0001	Wet	0.000300	0.00295	1204
BDE# 85	LACC01	Animal Tissue	0.0001	Wet	0.000300	0.00381	1205
BDE# 85	LPBC03	Animal Tissue	0.0001	Wet	0.000300	0.00365	1206
BDE# 85	LPSB01	Animal Tissue	0.0001	Wet	0.000300	0.00383	1207
BDE# 85	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00367	1208
BDE# 85	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00358	1209

Limits of Detection were within the contract requirements with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	*** CRDL (ppm/%)**	**Basis**	**Acceptable To (ppm/%)**	**LOD (ppm/%)**	**See QA/QC Note No.**
BDE# 85	LPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00370	1210
BDE# 85	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00374	1211
BDE# 85	UABC01	Animal Tissue	0.0001	Wet	0.000300	0.00352	1212
BDE# 85	UPCC102	Animal Tissue	0.0001	Wet	0.000300	0.00340	1213
BDE# 85	UPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00384	1214
BDE# 99	LPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00294	1215
BDE# 99	UPAE01	Animal Tissue	0.0001	Wet	0.000300	0.00286	1216
BDE# 99	LPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00285	1217
BDE# 99	UACA01	Animal Tissue	0.0001	Wet	0.000300	0.00232	1218
BDE# 99	LACA01	Animal Tissue	0.0001	Wet	0.000300	0.00281	1219
BDE# 99	LPBC01	Animal Tissue	0.0001	Wet	0.000300	0.00267	1220
BDE# 99	UPSF01	Animal Tissue	0.0001	Wet	0.000300	0.00288	1221
BDE# 99	UPCA01	Animal Tissue	0.0001	Wet	0.000300	0.00267	1222
BDE# 99	LPLB01	Animal Tissue	0.0001	Wet	0.000300	0.00295	1223
BDE# 99	LPAE02	Animal Tissue	0.0001	Wet	0.000300	0.00266	1224

* CRDL = Contract Required Detection Limit.

11.7. Blank Anomalies

Procedural Blank analyses were acceptable with the following exceptions.					
Analyte	**Lab Matrix**	*** BEC (ppm/%)**	**LOD (ppm/%)**	**Basis**	**See QA/QC Note No.**
Pentachlorobenzene	Animal Tissue	0.000498	0.000089	Wet	1225

* BEC = Blank Equivalent Concentration.

11.8. Duplicate Anomalies

All duplicate results were within normal limits with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	**LOD Mean**	**Initial Result ppm/%**	**Duplicate Result ppm/%**	**Relative Percent Diff.**	**See QA/QC Note No.**
PCB-1248	UPLB01	Animal Tissue	0.00994	0.136	< 0.00487	186	1226

All duplicate results were within normal limits with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	**LOD Mean**	**Initial Result ppm/%**	**Duplicate Result ppm/%**	**Relative Percent Diff.**	**See QA/QC Note No.**
PCB-1260	UPLB01	Animal Tissue	0.00994	0.0101	0.126	185	1228
PCB-1254	UALB01	Animal Tissue	0.0101	0.0487	0.110	77.0	1227

11.9. Spike Anomalies

All spike results were within normal limits with the following exceptions.									
Analyte	**Sample Number**	**Lab Matrix**	**Sample Result ppm/%**	**LOD ppm/%**	**Spike Result ppm/%**	**Spike Level ppm/%**	**% Recovery**	**Spike / Background**	**See QA/QC Note No.**
1-methylphenanthrene	LPSF01	Animal Tissue	< 0.000463	0.000495	0.0141	0.0194	72.7	41.9	1229
anthracene	LPSF01	Animal Tissue	< 0.000226	0.000242	0.0136	0.0194	70.1	85.8	1230
BDE# 47	LPSF01	Animal Tissue	< 0.00319	0.00326	0.0260	0.0198	131	6.21	1231
BDE# 49/71	LALB01	Animal Tissue	< 0.00271	0.00293	0.0199	0.0164	121	6.05	1232
BDE# 49/71	LPSF01	Animal Tissue	< 0.00344	0.00352	0.0245	0.0198	124	5.76	1233
BDE# 99	LPSF01	Animal Tissue	< 0.00294	0.00301	0.0253	0.0198	128	6.74	1234
chlorpyrifos	LALB01	Animal Tissue	0.000454	0.000223	0.00420	0.00750	49.9	16.5	1235
chlorpyrifos	LPSF01	Animal Tissue	< 0.000214	0.000229	0.00417	0.00770	54.2	36.0	1236
dibenzothiophene	LPSF01	Animal Tissue	< 0.000309	0.000331	0.0138	0.0194	71.1	62.8	1237

All spike results were within normal limits with the following exceptions.									
Analyte	**Sample Number**	**Lab Matrix**	**Sample Result ppm/%**	**LOD ppm/%**	**Spike Result ppm/%**	**Spike Level ppm/%**	**% Recovery**	**Spike / Background**	**See QA/QC Note No.**
endosulfan II	LPSF01	Animal Tissue	< 0.000348	0.000372	0.000623	0.00770	8.09	22.1	1238
pyrene	LPSF01	Animal Tissue	0.000500	0.000389	0.0146	0.0194	72.7	38.8	1239

11.10. S.R.M. Anomalies

All SRM results were within normal limits with the following exceptions.							
Analyte	**S.R.M. ID**	**Certified Value**	**95% Confidence Interval**	**LOD (ppm/%)**	**Result (ppm/%)**	**% Recovery**	**See QA/QC Note No.**
alpha chlordane	NIST 1974b	0.00136	0.000100	0.0000990	0.000844	62.1	1240
benzo(b)fluoranthene	NIST 1974b	0.00646	0.000590	0.000334	0.00810	125	1241
chrysene	NIST 1974b	0.00630	0.00100	0.000472	0.00820	130.	1242
chrysene	NIST 1974b	0.00630	0.00100	0.000460	0.00960	152	1243
p,p'-DDE	NIST 1974b	0.00415	0.000380	0.0000950	0.00268	64.7	1244
PCB# 107	NIST 1974b	0.00103	0.000120	0.000108	0.000621	60.3	1245
PCB# 180	NIST 1974b	0.00117	0.000100	0.000133	0.00149	127	1246
PCB# 180	NIST 1974b	0.00117	0.000100	0.000137	0.00150	129	1247
trans-nonachlor	NIST 1974b	0.00130	0.000140	0.000106	0.000773	59.5	1248

S.R.M Names

SRM ID	SRM Name
NIST 1974b	Organics in Mussel Tissue

11.11. QA/QC Notes

QA/QC Note Number and Comments
Additional Lab Comments: Resubmission with corrections and result modifier notes. ---------- 1-114 A sufficient number spikes were analyzed with these samples. This acceptable. 115 Some samples were analyzed by GC/MS. Other analytes were confirm by GC/MS. This is acceptable. 116-1224 These LODs were higher than the ECDMS default. They are acceptable. 1225 This analyte was present in the blank. Results that are less than 10 times the amount found in the blank are considered non-detects. 1226-1228 The variability of these duplicate analyses were high. Results are considered estimates. 1229-1239. The BDE recoveries were higher than normal. The other analytes had lower than normal recoveries. BDE's results for these analytes may be biased high. Results for the other analytes may be biased low. The recovery for endosulfan II was extremely low. Positive results are considered non-detects. 1240-1248 SRM recoveries for benzo(b)fluoranthene, chrysene, and PCB# 180 were high. Results may be biased high. Analytes alpha chlordane, p,p'-DDE, PCB# 107 and Trans-nonachlor had low recoveries. Results may be biased low. QA/QC approved 11/13/2008 Walter Riley Organic Chemist Reapproved 12/15/2008 Walter Riley Organic Chemist Reapproved 1/26/2009 Walter Riley Organic Chemist

12. Analytical Methods

Below are the analytical methods used by TDI to produce the results included in this report.

Method Codes:	001

Lab Matrix	Analyte
Animal Tissue	% Lipid
	% Moisture

Method Code: 001

LABORATORY: TDI Brooks International, Inc.

Tissue Extraction Method (PAH and OCs)

Tissue samples are either immediately processed or stored frozen (-20°C) until processing. Tissues are processed as appropriate for the tissue type (e.g. dissection, shucking). Processed tissues are homogenized using a variety of mechanical methods (Waring blender, Hobart meat grinder or Tissumisser), depending upon the tissue amount and type. After homogenization, an approximate 1 g aliquot is removed and dried in an oven at 105°C to a constant weight to determine % moisture. The remaining samples are stored in certified pre-cleaned jars frozen (- 20°C) until analysis. Prior to extraction, tissue samples may be lypholized or a wet aliquot is chemically dried using a dessicant such as Hydromatrix or sodium sulfate. Samples are then extracted using a Dionex ASE200 Accelerated Solvent Extractor (ASE). The dried sample or the sample and dessicant material is loaded into 22 or 33 mL stainless steel ASE extraction tubes. The extraction are performed using 100% dicholormethane at 100°C and 2000 psi. The extracted organics dissolved in the solvent are collected in 60 mL glass vials. The extract is concentrated to approximately 10 mL in the collection vials and then transferred to 25 mL Kurdena-Danish (KD) concentrator tubes. The sample extract is concentrated to 3 mL in a water bath at 55-60°C. If lipid weight is required, a 100 mL aliquot is removed and weighed using a microbalance. Interfering non-contaminant organic material (primarily lipids) must be removed prior to instrument analyses.

The extract is processed through silica gel/alumina chromatography columns and High Performance Liquid Chromatography (HPLC). The remaining 2.9 mL of sample extracted are loaded on top of 300 mm x 19 mm glass liquid chromatography columns packed with 10 g of deactivated alumina and 20 g of deactivated silica gel. The columns are loaded in 100 % dichloromethane. The dichloromethane is replaced by adding 40 mL of pentane. The extract is carefully added to the top of the chromatography columns. The column is flushed at a rate of 1-2 mL per minute using 200 mL of 50:50 pentane/dichloromethane and collected into 250 mL flasks. The eluent collected in the 250 mL flask is evaporated to 2 mL using a waterbath at 55-50°C. The samples is transferred into 4 mL amber vials. Extracts subsequently processed by HPLC to further remove lipid interferences. Lipid removal is accomplished by flushing samples with dichlormethane through size exclusion Phenogel 10 m GPC 100 A columns. Approximately 40 mL is collected using a fraction collector, which is concentrated to 0.5 mL using a water bath at 55-60C. The concentrated extract is then analyzed by GC/MS for polynuclear aromatic hydrocarbons (PAHs) or GC/ECD for selected organochlorines (OCs).

Additional column chromatography is required to separate PCBs from toxaphene/pesticides when toxphene analysis is required and to separate planar PCBs. If toxaphene analyses is required, an aliquot of the extract prior to HPLC clean up is processed through a 3% deactivated silica gel column. The column is packed in dicloromethane which is then flushed with 50 mL of pentane. The sample extract is transferred to the top of the column and flushed with 100 mL of pentane. The fraction contains PCBs and DDTs. The column is then flushed with 120 mL of 50:50 pentane/dichloromethane. This fraction contains toxaphene and chlorinated pesticides. Both fractions are reduced to 1 mL using a water bath at 55-60°C. The extracts are then ready for instrument analysis.

If planar PCB analyses are required, the PCB/DDT fraction prepared by 3% silica gel column is further processed by column chromatography packed with 2 g of 1:19 (5% by weight) mixture of activated carbon/Celite. The column and flushed with 25 mL of 1:4 dichloromethane/cyclohexane mixture. The sample is added to the top of the column and flushed with 50 mL of 1:4 dichloromethane/cyclohexane mixture, followed by 30 mL of 9:1 dichloromethane/toluene. This is followed by the addition of 40 mL of toluene. The toluene fraction contains the planar PCBs and is concentrated to 1 mL in a Zymark TurboVap II concentrator at 42°C and 20 psi. The sample is ready for instrument analysis.

REFERENCES:

Lauenstein, G.G. and A.Y. Cantillo, ed. (1993). Sampling Analytical Methods of the National Status and Trends Program National Benthic Surveillance and Mussel Watch Projects 1984-1992; Volume IV: Comprehensive Descriptions of Trace Organic Analytical Methods. NOAA Technical memorandum NOS ORCA 71, Silver Spring, MD.

U.S. Environmental Protection Agency. 2001. National Coastal Assessment Quality Assurance Project Plan 2001-2004. United States Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL. EPA/620/R-01/002.

Environmental Protection Agency, "Method 3545: Pressurized Fluid Extraction (PFE)," in Test Methods for Evaluating Solid Waste, Physical/Chemical Methods EPA SW-846 [Version 2 (December 1997), Integrated Manual through Update III] Washington DC, U.S. Environmental Protection Agency (1997)

Zuloaga, O.; Etxebarria, N.; Fernandez L. A.;Madariaga, J.M.; Optimization and comparison of MAE, ASE and Soxhlet extraction for the determination of HCH isomers in soil samples. Fresenius J Anal Chem, 2000, 367, 733-737.

Schantz, M.; Nichols, J. J.; Wise, S. A.; Evaluation of Pressurized Fluid Extraction for the Extraction of Environmental Matrix Reference Material, Anal. Chem., 1997, 69, 4210-4219.

Method Codes:	001 002

Lab Matrix	Analyte
Animal Tissue	1,6,7-Trimethyl-naphthalene
	1-methylnaphthalene

1-methylphenanthrene
2,6-dimethylnaphthalene
2-methylnaphthalene
Benzo(a)anthracene
C1-Fluoranthenes & Pyrenes
C1-Phenanthrenes & Anthracenes
C1-chrysenes
C1-dibenzothiophenes
C1-fluorenes
C1-naphthalenes
C2-Phenanthrenes & Anthracenes
C2-chrysenes
C2-dibenzothiophenes
C2-fluorenes
C2-naphthalenes
C3-Phenanthrenes & Anthracenes
C3-chrysenes
C3-dibenzothiophenes
C3-fluorenes
C3-naphthalenes
C4-Phenanthrenes & Anthracenes
C4-chrysenes
C4-naphthalenes
Dibenz(a,h)anthracene
acenaphthalene
acenaphthene
anthracene
benzo(a)pyrene
benzo(b)fluoranthene
benzo(e)pyrene
benzo(g,h,i)perylene
benzo(k)fluoranthene
biphenyl
chrysene

dibenzothiophene
fluoranthene
fluorene
indeno(1,2,3-cd)pyrene
naphthalene
perylene
phenanthrene
pyrene

Method Code: 001

LABORATORY: TDI Brooks International, Inc.

Tissue Extraction Method (PAH and OCs)

Tissue samples are either immediately processed or stored frozen (-20°C) until processing. Tissues are processed as appropriate for the tissue type (e.g. dissection, shucking). Processed tissues are homogenized using a variety of mechanical methods (Waring blender, Hobart meat grinder or Tissumisser), depending upon the tissue amount and type. After homogenization, an approximate 1 g aliquot is removed and dried in an oven at 105°C to a constant weight to determine % moisture. The remaining samples are stored in certified pre-cleaned jars frozen (- 20°C) until analysis. Prior to extraction, tissue samples may be lypholized or a wet aliquot is chemically dried using a dessicant such as Hydromatrix or sodium sulfate. Samples are then extracted using a Dionex ASE200 Accelerated Solvent Extractor (ASE). The dried sample or the sample and dessicant material is loaded into 22 or 33 mL stainless steel ASE extraction tubes. The extraction are performed using 100% dicholormethane at 100°C and 2000 psi. The extracted organics dissolved in the solvent are collected in 60 mL glass vials. The extract is concentrated to approximately 10 mL in the collection vials and then transferred to 25 mL Kurdena-Danish (KD) concentrator tubes. The sample extract is concentrated to 3 mL in a water bath at 55-60°C. If lipid weight is required, a 100 mL aliquot is removed and weighed using a microbalance. Interfering non-contaminant organic material (primarily lipids) must be removed prior to instrument analyses.

The extract is processed through silica gel/alumina chromatography columns and High Performance Liquid Chromatography (HPLC). The remaining 2.9 mL of sample extracted are loaded on top of 300 mm x 19 mm glass liquid chromatography columns packed with 10 g of deactivated alumina and 20 g of deactivated silica gel. The columns are loaded in 100 % dichloromethane. The dichloromethane is replaced by adding 40 mL of pentane. The extract is carefully added to the top of the chromatography columns. The column is flushed at a rate of 1-2 mL per minute using 200 mL of 50:50 pentane/dichloromethane and collected into 250 mL flasks. The eluent collected in the 250 mL flask is evaporated to 2 mL using a waterbath at 55-50°C. The samples is transferred into 4 mL amber vials. Extracts subsequently processed by HPLC to further remove lipid interferences. Lipid removal is accomplished by flushing samples with dichlormethane through size exclusion Phenogel 10 m GPC 100 A columns. Approximately 40 mL is collected using a fraction collector, which is concentrated to 0.5 mL using a water bath at 55-60C. The concentrated extract is then analyzed by GC/MS for polynuclear aromatic hydrocarbons (PAHs) or GC/ECD for selected organochlorines (OCs).

Additional column chromatography is required to separate PCBs from toxaphene/pesticides when toxphene analysis is required

and to separate planar PCBs. If toxaphene analyses is required, an aliquot of the extract prior to HPLC clean up is processed through a 3% deactivated silica gel column. The column is packed in dicloromethane which is then flushed with 50 mL of pentane. The sample extract is transferred to the top of the column and flushed with 100 mL of pentane. The fraction contains PCBs and DDTs. The column is then flushed with 120 mL of 50:50 pentane/dichloromethane. This fraction contains toxaphene and chlorinated pesticides. Both fractions are reduced to 1 mL using a water bath at 55-60°C. The extracts are then ready for instrument analysis.

If planar PCB analyses are required, the PCB/DDT fraction prepared by 3% silica gel column is further processed by column chromatography packed with 2 g of 1:19 (5% by weight) mixture of activated carbon/Celite. The column and flushed with 25 mL of 1:4 dichloromethane/cyclohexane mixture. The sample is added to the top of the column and flushed with 50 mL of 1:4 dichloromethane/cyclohexane mixture, followed by 30 mL of 9:1 dichloromethane/toluene. This is followed by the addition of 40 mL of toluene. The toluene fraction contains the planar PCBs and is concentrated to 1 mL in a Zymark TurboVap II concentrator at 42°C and 20 psi. The sample is ready for instrument analysis.

REFERENCES:

Lauenstein, G.G. and A.Y. Cantillo, ed. (1993). Sampling Analytical Methods of the National Status and Trends Program National Benthic Surveillance and Mussel Watch Projects 1984-1992; Volume IV: Comprehensive Descriptions of Trace Organic Analytical Methods. NOAA Technical memorandum NOS ORCA 71, Silver Spring, MD.

U.S. Environmental Protection Agency. 2001. National Coastal Assessment Quality Assurance Project Plan 2001-2004. United States Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL. EPA/620/R-01/002.

Environmental Protection Agency, "Method 3545: Pressurized Fluid Extraction (PFE)," in Test Methods for Evaluating Solid Waste, Physical/Chemical Methods EPA SW-846 [Version 2 (December 1997), Integrated Manual through Update III] Washington DC, U.S. Environmental Protection Agency (1997)

Zuloaga, O.; Etxebarria, N.; Fernandez L. A.;Madariaga, J.M.; Optimization and comparison of MAE, ASE and Soxhlet extraction for the determination of HCH isomers in soil samples. Fresenius J Anal Chem, 2000, 367, 733-737.

Schantz, M.; Nichols, J. J.; Wise, S. A.; Evaluation of Pressurized Fluid Extraction for the Extraction of Environmental Matrix Reference Material, Anal. Chem., 1997, 69, 4210-4219.

Method Code: 002

LABORATORY: TDI Brooks International, Inc.

Aromatic Hydrocarbon Determination by Selected
Ion Monitoring (SIM) Gas Chromatography/
Mass Spectrometry (GC/MS)

Polycyclic aromatic hydrocarbons (PAH) and their alkylated homologues are analyzed in sample extracts by a HewlettPackard, model 5890 GS and model 5972 MS operated in SIM using a capillary column. The GC is operated in splitless mode and the capillary column is an Agilent Technologies HP-5MS (60 m x 0.25 mm ID and 0.25 mm film thickness). The carrier gas is helium at

a flow rate of 1 mL/minute. The temperature of the injection port is 300°C and transfer line is 290°C. The initial oven temperature is 60°C, the ramp rate is 7°C/minutes to a final oven temperature of 310°C and held for 20 minutes. For analyte identification, the extracted ion current profiles of the primary m/z and the confirmatory ion for each analyte must be at a maximum in the same scan or within one scan of each other and the retention time must fall with 5 seconds of the retention time of the authentic standard or alkyl homologue grouping. The pattern of alkylated PAH homologue groupings is established by analysis of reference oil standards. The relative peak heights of the primary mass ion compared to the confirmation or secondary mass ion must fall within 30 % of the relative intensities of these masses in a reference mass spectrum.

REFERENCES:

Lauenstein, G.G. and A.Y. Cantillo, ed. (1993). Sampling Analytical Methods of the National Status and Trends Program National Benthic Surveillance and Mussel Watch Projects 1984-1992; Volume IV: Comprehensive Descriptions of Trace Organic Analytical Methods. NOAA Technical memorandum NOS ORCA 71, Silver Spring, MD.

U.S. Environmental Protection Agency. 2001. National Coastal Assessment Quality Assurance Project Plan 2001-2004. United States Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL. EPA/620/R-01/002.

Method Codes:	001 003

Lab Matrix	Analyte
Animal Tissue	1,2,3,4-Tetrachlorobenzene
	1,2,4,5-Tetrachlorobenzene
	Aldrin
	BHC (Total)
	DDMU
	HCB
	Heptachlor
	PCB# 1
	PCB# 101/90
	PCB# 105
	PCB# 107
	PCB# 110/77
	PCB# 114/131/122
	PCB# 118
	PCB# 126

PCB# 128
PCB# 129
PCB# 136
PCB# 138/160
PCB# 141/179
PCB# 146
PCB# 149/123
PCB# 15
PCB# 151
PCB# 153/132
PCB# 156/171/202
PCB# 158
PCB# 16/32
PCB# 166
PCB# 167
PCB# 169
PCB# 170/190
PCB# 172
PCB# 174
PCB# 176/137
PCB# 177
PCB# 178
PCB# 18
PCB# 180
PCB# 183
PCB# 185
PCB# 187
PCB# 189
PCB# 191
PCB# 194
PCB# 195/208
PCB# 196/203
PCB# 199
PCB# 200/157/173

PCB# 201
PCB# 205
PCB# 206
PCB# 209
PCB# 22/51
PCB# 24/27
PCB# 25
PCB# 26
PCB# 28
PCB# 29
PCB# 31
PCB# 33/53/20
PCB# 40
PCB# 41/64
PCB# 42/59/37
PCB# 43
PCB# 44
PCB# 45
PCB# 46
PCB# 47/48/75
PCB# 49
PCB# 52
PCB# 56/60
PCB# 66
PCB# 7/9
PCB# 70
PCB# 74/61
PCB# 77
PCB# 8/5
PCB# 81
PCB# 82
PCB# 83
PCB# 84
PCB# 85

PCB# 86
PCB# 87/115
PCB# 88
PCB# 92
PCB# 95
PCB# 97
PCB# 99
PCB-1242
PCB-1248
PCB-1254
PCB-1260
PCB-TOTAL
Pentachlorobenzene
Total DDT's
alpha BHC
alpha chlordane
beta BHC
chlorpyrifos
cis-nonachlor
delta BHC
dieldrin
endosulfan I
endosulfan II
endosulfan sulfate
endrin
gamma BHC
gamma chlordane
heptachlor epoxide
mirex
o,p'-DDD
o,p'-DDE
o,p'-DDT
oxychlordane
p,p'-DDD

p,p'-DDE
p,p'-DDT
pentachloro-anisole
toxaphene
trans-nonachlor

Method Code: 001
LABORATORY: TDI Brooks International, Inc. Tissue Extraction Method (PAH and OCs) Tissue samples are either immediately processed or stored frozen (-20°C) until processing. Tissues are processed as appropriate for the tissue type (e.g. dissection, shucking). Processed tissues are homogenized using a variety of mechanical methods (Waring blender, Hobart meat grinder or Tissumisser), depending upon the tissue amount and type. After homogenization, an approximate 1 g aliquot is removed and dried in an oven at 105°C to a constant weight to determine % moisture. The remaining samples are stored in certified pre-cleaned jars frozen (- 20°C) until analysis. Prior to extraction, tissue samples may be lypholized or a wet aliquot is chemically dried using a dessicant such as Hydromatrix or sodium sulfate. Samples are then extracted using a Dionex ASE200 Accelerated Solvent Extractor (ASE). The dried sample or the sample and dessicant material is loaded into 22 or 33 mL stainless steel ASE extraction tubes. The extraction are performed using 100% dicholormethane at 100°C and 2000 psi. The extracted organics dissolved in the solvent are collected in 60 mL glass vials. The extract is concentrated to approximately 10 mL in the collection vials and then transferred to 25 mL Kurdena-Danish (KD) concentrator tubes. The sample extract is concentrated to 3 mL in a water bath at 55-60°C. If lipid weight is required, a 100 mL aliquot is removed and weighed using a microbalance. Interfering non-contaminant organic material (primarily lipids) must be removed prior to instrument analyses. The extract is processed through silica gel/alumina chromatography columns and High Performance Liquid Chromatography (HPLC). The remaining 2.9 mL of sample extracted are loaded on top of 300 mm x 19 mm glass liquid chromatography columns packed with 10 g of deactivated alumina and 20 g of deactivated silica gel. The columns are loaded in 100 % dichloromethane. The dichloromethane is replaced by adding 40 mL of pentane. The extract is carefully added to the top of the chromatography columns. The column is flushed at a rate of 1-2 mL per minute using 200 mL of 50:50 pentane/dichloromethane and collected into 250 mL flasks. The eluent collected in the 250 mL flask is evaporated to 2 mL using a waterbath at 55-50°C. The samples is transferred into 4 mL amber vials. Extracts subsequently processed by HPLC to further remove lipid interferences. Lipid removal is accomplished by flushing samples with dichlormethane through size exclusion Phenogel 10 m GPC 100 A columns. Approximately 40 mL is collected using a fraction collector, which is concentrated to 0.5 mL using a water bath at 55-60C. The concentrated extract is then analyzed by GC/MS for polynuclear aromatic hydrocarbons (PAHs) or GC/ECD for selected organochlorines (OCs). Additional column chromatography is required to separate PCBs from toxaphene/pesticides when toxphene analysis is required and to separate planar PCBs. If toxaphene analyses is required, an aliquot of the extract prior to HPLC clean up is processed through a 3% deactivated silica gel column. The column is packed in dicloromethane which is then flushed with 50 mL of pentane. The sample extract is transferred to the top of the column and flushed with 100 mL of pentane. The fraction contains PCBs and DDTs. The column is then flushed with 120 mL of 50:50 pentane/dichloromethane. This fraction contains toxaphene and

chlorinated pesticides. Both fractions are reduced to 1 mL using a water bath at 55-60°C. The extracts are then ready for instrument analysis.

If planar PCB analyses are required, the PCB/DDT fraction prepared by 3% silica gel column is further processed by column chromatography packed with 2 g of 1:19 (5% by weight) mixture of activated carbon/Celite. The column and flushed with 25 mL of 1:4 dichloromethane/cyclohexane mixture. The sample is added to the top of the column and flushed with 50 mL of 1:4 dichloromethane/cyclohexane mixture, followed by 30 mL of 9:1 dichloromethane/toluene. This is followed by the addition of 40 mL of toluene. The toluene fraction contains the planar PCBs and is concentrated to 1 mL in a Zymark TurboVap II concentrator at 42°C and 20 psi. The sample is ready for instrument analysis.

REFERENCES:

Lauenstein, G.G. and A.Y. Cantillo, ed. (1993). Sampling Analytical Methods of the National Status and Trends Program National Benthic Surveillance and Mussel Watch Projects 1984-1992; Volume IV: Comprehensive Descriptions of Trace Organic Analytical Methods. NOAA Technical memorandum NOS ORCA 71, Silver Spring, MD.

U.S. Environmental Protection Agency. 2001. National Coastal Assessment Quality Assurance Project Plan 2001-2004. United States Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL. EPA/620/R-01/002.

Environmental Protection Agency, "Method 3545: Pressurized Fluid Extraction (PFE)," in Test Methods for Evaluating Solid Waste, Physical/Chemical Methods EPA SW-846 [Version 2 (December 1997), Integrated Manual through Update III] Washington DC, U.S. Environmental Protection Agency (1997)

Zuloaga, O.; Etxebarria, N.; Fernandez L. A.;Madariaga, J.M.; Optimization and comparison of MAE, ASE and Soxhlet extraction for the determination of HCH isomers in soil samples. Fresenius J Anal Chem, 2000, 367, 733-737.

Schantz, M.; Nichols, J. J.; Wise, S. A.; Evaluation of Pressurized Fluid Extraction for the Extraction of Environmental Matrix Reference Material, Anal. Chem., 1997, 69, 4210-4219.

Method Code: 003

LABORATORY: TDI Brooks International, Inc.

Chlorinated Hydrocarbon Determination by Gas Chromatography/Electron Capture Detection (GC/ECD)

Chlorinated hydrocarbons are determined in samples by GC/ECD. Samples are extracted as previously described and analyzed on a HewletPackard (HP), model 5890 GC equipped with an ECD. Between 1 to 5 mL of sample is injected using an HP, model 7673A autosampler. The instrument is set up with dual columns. The primary capillary column is a J&W DB-5 (30 m x 24 mm ID and 0.25 mm film thickness). The second column, a confirmation column, is a J&W DB-17HT (30 m x 0.25 mm ID and 0.15 mm film thickness). The inlet system is splitless and the carrier gas is helium at a flow rate of 1 mL/min. For the analysis of standard halogenated hydrocarbons, the temperature of the injection port is 275°C and the detector is 325°C. The initial oven temperature is 100°C with a hold time of 1 minute. The ramp rate is 5°C/minute to 140°C with a hold time of 1 minute, followed by a ramp rate of 1.5°C /minute to 250C with a hold time of 1 minute and finally a ramp rate of 10°C/minutes to 300°C with a final hold time of 5

minutes. For planar PCBs the instrument is operated in the splitless mode with helium as the carrier gas with a flow rate of 1 mL/minute. The temperature of the injection port is 275°C and the detector is 325°C. The initial oven temperature is 100°C, which is held for 1 minute. The ramp rate is 10°C/minute to 150°C, followed by a ramp rate of 6.0°C/minute to 270°C with a hold time of 3 minutes. The retention time of sample analytes must fall within 15 seconds of the retention time of analytes in a calibration standard or a retention index solutions. The levels of aroclors and toxophene are determined using retention index solutions of both complex mixtures. Arochlors are determined in a similar method to that described in EPA SW-846 Test Methods for Evaluating Solid Waste Physical/Chemical Methods, Method 8082 (1997).

REFERENCES:

Lauenstein, G.G. and A.Y. Cantillo, ed. (1993). Sampling Analytical Methods of the National Status and Trends Program National Benthic Surveillance and Mussel Watch Projects 1984-1992; Volume IV: Comprehensive Descriptions of Trace Organic Analytical Methods. NOAA Technical memorandum NOS ORCA 71, Silver Spring, MD.

U.S. Environmental Protection Agency. 2001. National Coastal Assessment Quality Assurance Project Plan 2001-2004. United States Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL. EPA/620/R-01/002.

Environmental Protection Agency, "Method 8082: Polychlorinated Biphenls (PCBs) by Gas Chromatography," in Test Methods for Evaluating Solid Waste, Physical/Chemical Methods EPA SW-846 [Version 2 (December 1997), Integrated Manual through Update III] Washington DC, U.S. Environmental Protection Agency (1997)

Method Codes:	001 003 004

Lab Matrix	Analyte
Animal Tissue	PCB# 101/90
	PCB# 110/77
	PCB# 118
	PCB# 138/160
	PCB# 153/132
	PCB# 180
	PCB# 187
	PCB# 44
	PCB# 52
	alpha chlordane
	p,p'-DDE
	trans-nonachlor

Method Code: 001

LABORATORY: TDI Brooks International, Inc.

Tissue Extraction Method (PAH and OCs)

Tissue samples are either immediately processed or stored frozen (-20°C) until processing. Tissues are processed as appropriate for the tissue type (e.g. dissection, shucking). Processed tissues are homogenized using a variety of mechanical methods (Waring blender, Hobart meat grinder or Tissumisser), depending upon the tissue amount and type. After homogenization, an approximate 1 g aliquot is removed and dried in an oven at 105°C to a constant weight to determine % moisture. The remaining samples are stored in certified pre-cleaned jars frozen (- 20°C) until analysis. Prior to extraction, tissue samples may be lypholized or a wet aliquot is chemically dried using a dessicant such as Hydromatrix or sodium sulfate. Samples are then extracted using a Dionex ASE200 Accelerated Solvent Extractor (ASE). The dried sample or the sample and dessicant material is loaded into 22 or 33 mL stainless steel ASE extraction tubes. The extraction are performed using 100% dicholormethane at 100°C and 2000 psi. The extracted organics dissolved in the solvent are collected in 60 mL glass vials. The extract is concentrated to approximately 10 mL in the collection vials and then transferred to 25 mL Kurdena-Danish (KD) concentrator tubes. The sample extract is concentrated to 3 mL in a water bath at 55-60°C. If lipid weight is required, a 100 mL aliquot is removed and weighed using a microbalance. Interfering non-contaminant organic material (primarily lipids) must be removed prior to instrument analyses.

The extract is processed through silica gel/alumina chromatography columns and High Performance Liquid Chromatography (HPLC). The remaining 2.9 mL of sample extracted are loaded on top of 300 mm x 19 mm glass liquid chromatography columns packed with 10 g of deactivated alumina and 20 g of deactivated silica gel. The columns are loaded in 100 % dichloromethane. The dichloromethane is replaced by adding 40 mL of pentane. The extract is carefully added to the top of the chromatography columns. The column is flushed at a rate of 1-2 mL per minute using 200 mL of 50:50 pentane/dichloromethane and collected into 250 mL flasks. The eluent collected in the 250 mL flask is evaporated to 2 mL using a waterbath at 55-50°C. The samples is transferred into 4 mL amber vials. Extracts subsequently processed by HPLC to further remove lipid interferences. Lipid removal is accomplished by flushing samples with dichlormethane through size exclusion Phenogel 10 m GPC 100 A columns. Approximately 40 mL is collected using a fraction collector, which is concentrated to 0.5 mL using a water bath at 55-60C. The concentrated extract is then analyzed by GC/MS for polynuclear aromatic hydrocarbons (PAHs) or GC/ECD for selected organochlorines (OCs).

Additional column chromatography is required to separate PCBs from toxaphene/pesticides when toxphene analysis is required and to separate planar PCBs. If toxaphene analyses is required, an aliquot of the extract prior to HPLC clean up is processed through a 3% deactivated silica gel column. The column is packed in dicloromethane which is then flushed with 50 mL of pentane. The sample extract is transferred to the top of the column and flushed with 100 mL of pentane. The fraction contains PCBs and DDTs. The column is then flushed with 120 mL of 50:50 pentane/dichloromethane. This fraction contains toxaphene and chlorinated pesticides. Both fractions are reduced to 1 mL using a water bath at 55-60°C. The extracts are then ready for instrument analysis.

If planar PCB analyses are required, the PCB/DDT fraction prepared by 3% silica gel column is further processed by column chromatography packed with 2 g of 1:19 (5% by weight) mixture of activated carbon/Celite. The column and flushed with 25 mL of 1:4 dichloromethane/cyclohexane mixture. The sample is added to the top of the column and flushed with 50 mL of 1:4 dichloromethane/cyclohexane mixture, followed by 30 mL of 9:1 dichloromethane/toluene. This is followed by the addition of 40 mL

of toluene. The toluene fraction contains the planar PCBs and is concentrated to 1 mL in a Zymark TurboVap II concentrator at 42°C and 20 psi. The sample is ready for instrument analysis.

REFERENCES:

Lauenstein, G.G. and A.Y. Cantillo, ed. (1993). Sampling Analytical Methods of the National Status and Trends Program National Benthic Surveillance and Mussel Watch Projects 1984-1992; Volume IV: Comprehensive Descriptions of Trace Organic Analytical Methods. NOAA Technical memorandum NOS ORCA 71, Silver Spring, MD.

U.S. Environmental Protection Agency. 2001. National Coastal Assessment Quality Assurance Project Plan 2001-2004. United States Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL. EPA/620/R-01/002.

Environmental Protection Agency, "Method 3545: Pressurized Fluid Extraction (PFE)," in Test Methods for Evaluating Solid Waste, Physical/Chemical Methods EPA SW-846 [Version 2 (December 1997), Integrated Manual through Update III] Washington DC, U.S. Environmental Protection Agency (1997)

Zuloaga, O.; Etxebarria, N.; Fernandez L. A.;Madariaga, J.M.; Optimization and comparison of MAE, ASE and Soxhlet extraction for the determination of HCH isomers in soil samples. Fresenius J Anal Chem, 2000, 367, 733-737.

Schantz, M.; Nichols, J. J.; Wise, S. A.; Evaluation of Pressurized Fluid Extraction for the Extraction of Environmental Matrix Reference Material, Anal. Chem., 1997, 69, 4210-4219.

Method Code: 003

LABORATORY: TDI Brooks International, Inc.

Chlorinated Hydrocarbon Determination by Gas Chromatography/Electron Capture Detection (GC/ECD)

Chlorinated hydrocarbons are determined in samples by GC/ECD. Samples are extracted as previously described and analyzed on a HewletPackard (HP), model 5890 GC equipped with an ECD. Between 1 to 5 mL of sample is injected using an HP, model 7673A autosampler. The instrument is set up with dual columns. The primary capillary column is a J&W DB-5 (30 m x 24 mm ID and 0.25 mm film thickness). The second column, a confirmation column, is a J&W DB-17HT (30 m x 0.25 mm ID and 0.15 mm film thickness). The inlet system is splitless and the carrier gas is helium at a flow rate of 1 mL/min. For the analysis of standard halogenated hydrocarbons, the temperature of the injection port is 275°C and the detector is 325°C. The initial oven temperature is 100°C with a hold time of 1 minute. The ramp rate is 5°C/minute to 140°C with a hold time of 1 minute, followed by a ramp rate of 1.5°C /minute to 250C with a hold time of 1 minute and finally a ramp rate of 10°C/minutes to 300°C with a final hold time of 5 minutes. For planar PCBs the instrument is operated in the splitless mode with helium as the carrier gas with a flow rate of 1 mL/minute. The temperature of the injection port is 275°C and the detector is 325°C. The initial oven temperature is 100°C, which is held for 1 minute. The ramp rate is 10°C/minute to 150°C, followed by a ramp rate of 6.0°C/minute to 270°C with a hold time of 3 minutes. The retention time of sample analytes must fall within 15 seconds of the retention time of analytes in a calibration standard or a retention index solutions. The levels of aroclors and toxophene are determined using retention index solutions of both complex mixtures. Arochlors are determined in a similar method to that described in EPA SW-846 Test Methods for Evaluating Solid Waste Physical/Chemical Methods, Method 8082 (1997).

REFERENCES:

Lauenstein, G.G. and A.Y. Cantillo, ed. (1993). Sampling Analytical Methods of the National Status and Trends Program National Benthic Surveillance and Mussel Watch Projects 1984-1992; Volume IV: Comprehensive Descriptions of Trace Organic Analytical Methods. NOAA Technical memorandum NOS ORCA 71, Silver Spring, MD.

U.S. Environmental Protection Agency. 2001. National Coastal Assessment Quality Assurance Project Plan 2001-2004. United States Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL. EPA/620/R-01/002.

Environmental Protection Agency, "Method 8082: Polychlorinated Biphenls (PCBs) by Gas Chromatography," in Test Methods for Evaluating Solid Waste, Physical/Chemical Methods EPA SW-846 [Version 2 (December 1997), Integrated Manual through Update III] Washington DC, U.S. Environmental Protection Agency (1997)

Method Code: 004

LABORATORY: TDI Brooks International, Inc.

Confirmation of Analytes

The presence of pesticides and PCBs is confirmed by gas chromatography/mass spectrometry (GC/MS) in either full scan or selection ion monitoring mode (SIM). Samples are extracted as previously described. Samples are initially screened by GC/ECD and GC/MS to confirm the presence of specific analytes in a sample. When analytes are detected at 10 x the SIM limit of detection they may be confirmed by SIM GC/MS. The samples are analyzed on a HewlettPackard 5890GC/ 5972MS. The GC is temperature- programmed and operated in splitless mode. The analytical column is an Aglient Technologies HP5MS (60 m x 0.25 mm ID and with a 0.25 mm film thickness). The carrier gas is helium with a flow rate of 1mL/min. The temperature of the injection port is 300°C and the transfer line is 290°C. The oven is at an initial temperature of 60°C with a ramp time of 7°C/minute. Analytes are "confirmed" when the spectrum contains at least 3 of the major ions. The chromatographic peaks must be at least 3 x the background noise and must be within once scan of each other and match the retention time of the standard run under the same conditions to be "confirmed"

REFERENCES:

Environmental Protection Agency, "Method 8270C: Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)" in Test Methods for Evaluating Solid Waste, Physical/Chemical Methods EPA SW-846 [Version 2 (December 1997), Integrated Manual through Update III] Washington DC, U.S. Environmental Protection Agency (1997)

Method Codes:	001 012

Lab Matrix	Analyte
Animal Tissue	BDE# 1

BDE# 10
BDE# 100
BDE# 11
BDE# 116
BDE# 118
BDE# 119
BDE# 12
BDE# 126
BDE# 13
BDE# 138
BDE# 15
BDE# 153
BDE# 154
BDE# 155
BDE# 166
BDE# 17
BDE# 181
BDE# 183
BDE# 190
BDE# 2
BDE# 25
BDE# 28
BDE# 3
BDE# 30
BDE# 32
BDE# 33
BDE# 35
BDE# 37
BDE# 47
BDE# 49/71
BDE# 66
BDE# 7
BDE# 75
BDE# 77

BDE# 8
BDE# 85
BDE# 99

Method Code: 001

LABORATORY: TDI Brooks International, Inc.

Tissue Extraction Method (PAH and OCs)

Tissue samples are either immediately processed or stored frozen (-20°C) until processing. Tissues are processed as appropriate for the tissue type (e.g. dissection, shucking). Processed tissues are homogenized using a variety of mechanical methods (Waring blender, Hobart meat grinder or Tissumisser), depending upon the tissue amount and type. After homogenization, an approximate 1 g aliquot is removed and dried in an oven at 105°C to a constant weight to determine % moisture. The remaining samples are stored in certified pre-cleaned jars frozen (- 20°C) until analysis. Prior to extraction, tissue samples may be lypholized or a wet aliquot is chemically dried using a dessicant such as Hydromatrix or sodium sulfate. Samples are then extracted using a Dionex ASE200 Accelerated Solvent Extractor (ASE). The dried sample or the sample and dessicant material is loaded into 22 or 33 mL stainless steel ASE extraction tubes. The extraction are performed using 100% dicholormethane at 100°C and 2000 psi. The extracted organics dissolved in the solvent are collected in 60 mL glass vials. The extract is concentrated to approximately 10 mL in the collection vials and then transferred to 25 mL Kurdena-Danish (KD) concentrator tubes. The sample extract is concentrated to 3 mL in a water bath at 55-60°C. If lipid weight is required, a 100 mL aliquot is removed and weighed using a microbalance. Interfering non-contaminant organic material (primarily lipids) must be removed prior to instrument analyses.

The extract is processed through silica gel/alumina chromatography columns and High Performance Liquid Chromatography (HPLC). The remaining 2.9 mL of sample extracted are loaded on top of 300 mm x 19 mm glass liquid chromatography columns packed with 10 g of deactivated alumina and 20 g of deactivated silica gel. The columns are loaded in 100 % dichloromethane. The dichloromethane is replaced by adding 40 mL of pentane. The extract is carefully added to the top of the chromatography columns. The column is flushed at a rate of 1-2 mL per minute using 200 mL of 50:50 pentane/dichloromethane and collected into 250 mL flasks. The eluent collected in the 250 mL flask is evaporated to 2 mL using a waterbath at 55-50°C. The samples is transferred into 4 mL amber vials. Extracts subsequently processed by HPLC to further remove lipid interferences. Lipid removal is accomplished by flushing samples with dichlormethane through size exclusion Phenogel 10 m GPC 100 A columns. Approximately 40 mL is collected using a fraction collector, which is concentrated to 0.5 mL using a water bath at 55-60C. The concentrated extract is then analyzed by GC/MS for polynuclear aromatic hydrocarbons (PAHs) or GC/ECD for selected organochlorines (OCs).

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If planar PCB analyses are required, the PCB/DDT fraction prepared by 3% silica gel column is further processed by column chromatography packed with 2 g of 1:19 (5% by weight) mixture of activated carbon/Celite. The column and flushed with 25 mL of 1:4 dichloromethane/cyclohexane mixture. The sample is added to the top of the column and flushed with 50 mL of 1:4 dichloromethane/cyclohexane mixture, followed by 30 mL of 9:1 dichloromethane/toluene. This is followed by the addition of 40 mL of toluene. The toluene fraction contains the planar PCBs and is concentrated to 1 mL in a Zymark TurboVap II concentrator at 42°C and 20 psi. The sample is ready for instrument analysis.

REFERENCES:

Lauenstein, G.G. and A.Y. Cantillo, ed. (1993). Sampling Analytical Methods of the National Status and Trends Program National Benthic Surveillance and Mussel Watch Projects 1984-1992; Volume IV: Comprehensive Descriptions of Trace Organic Analytical Methods. NOAA Technical memorandum NOS ORCA 71, Silver Spring, MD.

U.S. Environmental Protection Agency. 2001. National Coastal Assessment Quality Assurance Project Plan 2001-2004. United States Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL. EPA/620/R-01/002.

Environmental Protection Agency, "Method 3545: Pressurized Fluid Extraction (PFE)," in Test Methods for Evaluating Solid Waste, Physical/Chemical Methods EPA SW-846 [Version 2 (December 1997), Integrated Manual through Update III] Washington DC, U.S. Environmental Protection Agency (1997)

Zuloaga, O.; Etxebarria, N.; Fernandez L. A.;Madariaga, J.M.; Optimization and comparison of MAE, ASE and Soxhlet extraction for the determination of HCH isomers in soil samples. Fresenius J Anal Chem, 2000, 367, 733-737.

Schantz, M.; Nichols, J. J.; Wise, S. A.; Evaluation of Pressurized Fluid Extraction for the Extraction of Environmental Matrix Reference Material, Anal. Chem., 1997, 69, 4210-4219.

Method Code: 012

Laboratory: TDI Brooks International, Inc.

Polybrominated Diphenyl Ether (PBDE) Determination by Negative Chemical Ionization (NCI)-Selected Ion Monitoring (SIM) Gas Chromatography/Mass Spectrometry (GC/MS)

Polybrominated diphenyl ethers are analyzed in sample extracts by a Thermo Trace GC and DSQ-II MS operated in SIM using a capillary column. The GC is operated in splitless mode using a PTV injection port and the capillary column is an Agilent Technologies DB-XLB (15 m x 0.25 mm ID and 0.10 mm film thickness). The carrier gas is helium at a flow rate of 1 mL/minute and methane is used as the reactant gas with a flow rate of 2.0 mL/min. The temperature of the injection port is 40 degrees C (ramp to 300 degrees C) and transfer line is 290 degrees C. The initial oven temperature is 110 degrees C, the ramp rate is 7 degrees C/minutes to a final oven temperature of 280 degrees C and held for 20 minutes. For analyte identification, the extracted ion current profiles of the primary m/z and the confirmatory ion for each analyte must be at a maximum in the same scan or within one scan of each other and the retention time must fall with 5 seconds of the retention time of the authentic standard.

Analytical Results Report TOC

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1. ECDMS Analytical Results Report 10/31/2008

Catalog Number	Purchase Order Number	Lab ID	Catalog Submitter	ECDMS User ID
5020129	94420-08-Y868	LET	Pinkney, Fred - Annapolis, MD	r5afo

Catalog Title	Fish Tissue Analysis: DC Dept of the Environment
Lab Name:	Laboratory and Environmental Testing
Regional Study ID:	5F01
Regional Study Title:	Emergency Analytical Funds

Notes, Symbols and Abbreviations Used
Based on the report options selected the report should be **printed in landscape mode**
Notes, Symbols and Abbreviations Used The following may appear before a reported result (e.g. < 1234). < - Less than symbol indicates that the actual result is less than the reported detection limit. > - Greater than symbol indicates that the actual result is greater than the reported result.
All results are reported as 3 significant digits.
All results are reported as parts per million (ppm), or percent, unless otherwise noted.

1. Integrity Report

Lab Receipt Date	08/05/2008	**Lab Approval Date**	08/05/2008

Catalog Problems
No problems reported
Problem Resolution

2. Bulk Data

Sample Number	Sample Matrix	Percent Moisture
LACA01	Fillets with Skin	70.6
LALB01	Fillets with Skin	79.1
LASF01	Fillets with Skin	79.9
LPCA01	Fillets with Skin	74.3
LPLB01	Fillets with Skin	78.4
LPSB01	Fillets with Skin	79.3
LPSF01	Fillets with Skin	80.4
UACA01	Fillets with Skin	70.8
UALB01	Fillets with Skin	77.7
UASF01	Fillets with Skin	78.4
UPCA01	Fillets with Skin	69.0
UPLB01	Fillets with Skin	78.4
UPSF01	Fillets with Skin	80.2
LAAE01	Fillets without Skin	62.5
LABC01	Fillets without Skin	77.1
LACC01	Fillets without Skin	80.2
LPAE01	Fillets without Skin	66.0
LPAE02	Fillets without Skin	71.0
LPBC01	Fillets without Skin	78.0
LPBC02	Fillets without Skin	82.3
LPBC03	Fillets without Skin	78.8
LPBC04	Fillets without Skin	77.0
LPCC01	Fillets without Skin	79.5
UAAE01	Fillets without Skin	62.6
UABC01	Fillets without Skin	78.7
UACC01	Fillets without Skin	79.3
UPAE01	Fillets without Skin	63.8
UPCC01	Fillets without Skin	77.3
UPCC02	Fillets without Skin	79.8
UPCC101	Fillets without Skin	77.1
UPCC102	Fillets without Skin	77.9

Sample Number	Sample Matrix	Percent Moisture
UPCC103	Fillets without Skin	75.1

4. Contaminant Concentrations

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
Aluminum						
	LACA01	Fillets with Skin	< 2.00	2.00	< 0.600	0.600
	LALB01	Fillets with Skin	4.00	2.00	0.900	0.400
	LASF01	Fillets with Skin	6.00	2.00	1.00	0.400
	LPCA01	Fillets with Skin	4.00	2.00	0.900	0.500
	LPLB01	Fillets with Skin	4.00	2.00	1.00	0.400
	LPSB01	Fillets with Skin	3.00	2.00	0.600	0.400
	LPSF01	Fillets with Skin	9.00	2.00	1.80	0.400
	UACA01	Fillets with Skin	< 2.00	2.00	< 0.600	0.600
	UALB01	Fillets with Skin	3.00	2.00	0.600	0.400
	UASF01	Fillets with Skin	4.00	2.00	0.900	0.400
	UPCA01	Fillets with Skin	< 2.00	2.00	< 0.600	0.600
	UPLB01	Fillets with Skin	2.00	2.00	0.500	0.400
	UPSF01	Fillets with Skin	19.0	2.00	3.80	0.400
	LAAE01	Fillets without Skin	4.00	2.00	2.00	0.700
	LABC01	Fillets without Skin	3.00	2.00	0.800	0.500
	LACC01	Fillets without Skin	4.00	2.00	0.800	0.400
	LPAE01	Fillets without Skin	4.00	2.00	1.00	0.700
	LPAE02	Fillets without Skin	26.0	2.00	7.60	0.600
	LPBC01	Fillets without Skin	21.0	2.00	4.50	0.400
	LPBC02	Fillets without Skin	3.00	2.00	0.600	0.400
	LPBC03	Fillets without	4.00	2.00	0.800	0.400

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	LPBC04	Fillets without Skin	3.00	2.00	0.700	0.500
	LPCC01	Fillets without Skin	4.00	2.00	0.900	0.400
	UAAE01	Fillets without Skin	20.0	2.00	7.60	0.700
	UABC01	Fillets without Skin	9.30	2.00	2.00	0.400
	UACC01	Fillets without Skin	4.00	2.00	0.800	0.400
	UPAE01	Fillets without Skin	14.0	2.00	5.10	0.700
	UPCC01	Fillets without Skin	6.60	2.00	1.00	0.500
	UPCC02	Fillets without Skin	14.0	2.00	2.80	0.400
	UPCC101	Fillets without Skin	3.00	2.00	0.800	0.500
	UPCC102	Fillets without Skin	3.00	2.00	0.700	0.400
	UPCC103	Fillets without Skin	3.00	2.00	0.700	0.500
Arsenic						
	LACA01	Fillets with Skin	0.400	0.200	0.100	0.0600
	LALB01	Fillets with Skin	0.600	0.200	0.120	0.0400
	LASF01	Fillets with Skin	0.780	0.200	0.160	0.0400
	LPCA01	Fillets with Skin	0.600	0.200	0.100	0.0500
	LPLB01	Fillets with Skin	0.400	0.200	0.0800	0.0400
	LPSB01	Fillets with Skin	0.500	0.200	0.100	0.0400
	LPSF01	Fillets with Skin	0.780	0.200	0.150	0.0400
	UACA01	Fillets with Skin	0.300	0.200	0.0900	0.0600

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.500	0.200	0.100	0.0400
	UASF01	Fillets with Skin	0.500	0.200	0.100	0.0400
	UPCA01	Fillets with Skin	< 0.200	0.200	< 0.0600	0.0600
	UPLB01	Fillets with Skin	0.500	0.200	0.100	0.0400
	UPSF01	Fillets with Skin	0.620	0.200	0.120	0.0400
	LAAE01	Fillets without Skin	0.300	0.200	0.100	0.0700
	LABC01	Fillets without Skin	0.400	0.200	0.0800	0.0500
	LACC01	Fillets without Skin	< 0.200	0.200	< 0.0400	0.0400
	LPAE01	Fillets without Skin	0.400	0.200	0.100	0.0700
	LPAE02	Fillets without Skin	0.300	0.200	0.0800	0.0600
	LPBC01	Fillets without Skin	0.200	0.200	0.0500	0.0400
	LPBC02	Fillets without Skin	< 0.200	0.200	< 0.0400	0.0400
	LPBC03	Fillets without Skin	< 0.200	0.200	< 0.0400	0.0400
	LPBC04	Fillets without Skin	0.200	0.200	0.0500	0.0500
	LPCC01	Fillets without Skin	0.400	0.200	0.0800	0.0400
	UAAE01	Fillets without Skin	< 0.200	0.200	< 0.0700	0.0700
	UABC01	Fillets without Skin	0.200	0.200	0.0500	0.0400
	UACC01	Fillets without Skin	0.300	0.200	0.0500	0.0400
	UPAE01	Fillets without Skin	0.680	0.200	0.250	0.0700

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	0.200	0.200	0.0500	0.0500
	UPCC02	Fillets without Skin	< 0.200	0.200	< 0.0400	0.0400
	UPCC101	Fillets without Skin	0.640	0.200	0.100	0.0500
	UPCC102	Fillets without Skin	< 0.200	0.200	< 0.0400	0.0400
	UPCC103	Fillets without Skin	0.300	0.200	0.0800	0.0500
Boron						
	LACA01	Fillets with Skin	< 2.00	2.00	< 0.600	0.600
	LALB01	Fillets with Skin	< 2.00	2.00	< 0.400	0.400
	LASF01	Fillets with Skin	< 2.00	2.00	< 0.400	0.400
	LPCA01	Fillets with Skin	< 2.00	2.00	< 0.500	0.500
	LPLB01	Fillets with Skin	3.00	2.00	0.700	0.400
	LPSB01	Fillets with Skin	< 2.00	2.00	< 0.400	0.400
	LPSF01	Fillets with Skin	< 2.00	2.00	< 0.400	0.400
	UACA01	Fillets with Skin	< 2.00	2.00	< 0.600	0.600
	UALB01	Fillets with Skin	< 2.00	2.00	< 0.400	0.400
	UASF01	Fillets with Skin	< 2.00	2.00	< 0.400	0.400
	UPCA01	Fillets with Skin	< 2.00	2.00	< 0.600	0.600
	UPLB01	Fillets with Skin	< 2.00	2.00	< 0.400	0.400
	UPSF01	Fillets with Skin	< 2.00	2.00	< 0.400	0.400
	LAAE01	Fillets without Skin	< 2.00	2.00	< 0.700	0.700
	LABC01	Fillets without Skin	< 2.00	2.00	< 0.500	0.500
	LACC01	Fillets without Skin	< 2.00	2.00	< 0.400	0.400
	LPAE01	Fillets without Skin	< 2.00	2.00	< 0.700	0.700

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 2.00	2.00	< 0.600	0.600
	LPBC01	Fillets without Skin	< 2.00	2.00	< 0.400	0.400
	LPBC02	Fillets without Skin	< 2.00	2.00	< 0.400	0.400
	LPBC03	Fillets without Skin	< 2.00	2.00	< 0.400	0.400
	LPBC04	Fillets without Skin	< 2.00	2.00	< 0.500	0.500
	LPCC01	Fillets without Skin	< 2.00	2.00	< 0.400	0.400
	UAAE01	Fillets without Skin	< 2.00	2.00	< 0.700	0.700
	UABC01	Fillets without Skin	< 2.00	2.00	< 0.400	0.400
	UACC01	Fillets without Skin	< 2.00	2.00	< 0.400	0.400
	UPAE01	Fillets without Skin	< 2.00	2.00	< 0.700	0.700
	UPCC01	Fillets without Skin	< 2.00	2.00	< 0.500	0.500
	UPCC02	Fillets without Skin	2.00	2.00	0.500	0.400
	UPCC101	Fillets without Skin	< 2.00	2.00	< 0.500	0.500
	UPCC102	Fillets without Skin	< 2.00	2.00	< 0.400	0.400
	UPCC103	Fillets without Skin	< 2.00	2.00	< 0.500	0.500
Barium						
	LACA01	Fillets with Skin	1.10	0.200	0.330	0.0600
	LALB01	Fillets with Skin	0.200	0.200	0.0500	0.0400

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LASF01	Fillets with Skin	0.840	0.200	0.170	0.0400
	LPCA01	Fillets with Skin	0.840	0.200	0.220	0.0500
	LPLB01	Fillets with Skin	0.400	0.200	0.0800	0.0400
	LPSB01	Fillets with Skin	0.500	0.200	0.100	0.0400
	LPSF01	Fillets with Skin	0.990	0.200	0.190	0.0400
	UACA01	Fillets with Skin	0.400	0.200	0.100	0.0600
	UALB01	Fillets with Skin	0.200	0.200	0.0500	0.0400
	UASF01	Fillets with Skin	1.10	0.200	0.250	0.0400
	UPCA01	Fillets with Skin	< 0.200	0.200	< 0.0600	0.0600
	UPLB01	Fillets with Skin	0.300	0.200	0.0600	0.0400
	UPSF01	Fillets with Skin	1.50	0.200	0.300	0.0400
	LAAE01	Fillets without Skin	1.50	0.200	0.550	0.0700
	LABC01	Fillets without Skin	< 0.200	0.200	< 0.0500	0.0500
	LACC01	Fillets without Skin	0.300	0.200	0.0500	0.0400
	LPAE01	Fillets without Skin	1.10	0.200	0.370	0.0700
	LPAE02	Fillets without Skin	1.90	0.200	0.550	0.0600
	LPBC01	Fillets without Skin	< 0.200	0.200	< 0.0400	0.0400
	LPBC02	Fillets without Skin	0.200	0.200	0.0400	0.0400
	LPBC03	Fillets without Skin	0.200	0.200	0.0400	0.0400
	LPBC04	Fillets without Skin	< 0.200	0.200	< 0.0500	0.0500
	LPCC01	Fillets without Skin	0.300	0.200	0.0600	0.0400
	UAAE01	Fillets without	0.730	0.200	0.270	0.0700

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	< 0.200	0.200	< 0.0400	0.0400
	UACC01	Fillets without Skin	0.300	0.200	0.0600	0.0400
	UPAE01	Fillets without Skin	1.50	0.200	0.550	0.0700
	UPCC01	Fillets without Skin	0.300	0.200	0.0600	0.0500
	UPCC02	Fillets without Skin	< 0.200	0.200	< 0.0400	0.0400
	UPCC101	Fillets without Skin	< 0.200	0.200	< 0.0500	0.0500
	UPCC102	Fillets without Skin	< 0.200	0.200	< 0.0400	0.0400
	UPCC103	Fillets without Skin	< 0.200	0.200	< 0.0500	0.0500
Beryllium						
	LACA01	Fillets with Skin	< 0.100	0.100	< 0.0300	0.0300
	LALB01	Fillets with Skin	< 0.100	0.100	< 0.0200	0.0200
	LASF01	Fillets with Skin	< 0.100	0.100	< 0.0200	0.0200
	LPCA01	Fillets with Skin	< 0.100	0.100	< 0.0300	0.0300
	LPLB01	Fillets with Skin	< 0.100	0.100	< 0.0200	0.0200
	LPSB01	Fillets with Skin	< 0.100	0.100	< 0.0200	0.0200
	LPSF01	Fillets with Skin	< 0.100	0.100	< 0.0200	0.0200
	UACA01	Fillets with Skin	< 0.100	0.100	< 0.0300	0.0300
	UALB01	Fillets with Skin	< 0.100	0.100	< 0.0200	0.0200
	UASF01	Fillets with Skin	< 0.100	0.100	< 0.0200	0.0200
	UPCA01	Fillets with Skin	< 0.100	0.100	< 0.0300	0.0300
	UPLB01	Fillets with Skin	< 0.100	0.100	< 0.0200	0.0200
	UPSF01	Fillets with Skin	< 0.100	0.100	< 0.0200	0.0200

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	< 0.100	0.100	< 0.0400	0.0400
	LABC01	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	LACC01	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	LPAE01	Fillets without Skin	< 0.100	0.100	< 0.0300	0.0300
	LPAE02	Fillets without Skin	< 0.100	0.100	< 0.0300	0.0300
	LPBC01	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	LPBC02	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	LPBC03	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	LPBC04	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	LPCC01	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	UAAE01	Fillets without Skin	< 0.100	0.100	< 0.0400	0.0400
	UABC01	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	UACC01	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	UPAE01	Fillets without Skin	< 0.100	0.100	< 0.0400	0.0400
	UPCC01	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	UPCC02	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	UPCC101	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	UPCC103	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
Cadmium						
	LACA01	Fillets with Skin	< 0.100	0.100	< 0.0300	0.0300
	LALB01	Fillets with Skin	< 0.100	0.100	< 0.0200	0.0200
	LASF01	Fillets with Skin	< 0.100	0.100	< 0.0200	0.0200
	LPCA01	Fillets with Skin	< 0.100	0.100	< 0.0300	0.0300
	LPLB01	Fillets with Skin	< 0.100	0.100	< 0.0200	0.0200
	LPSB01	Fillets with Skin	< 0.100	0.100	< 0.0200	0.0200
	LPSF01	Fillets with Skin	< 0.100	0.100	< 0.0200	0.0200
	UACA01	Fillets with Skin	< 0.100	0.100	< 0.0300	0.0300
	UALB01	Fillets with Skin	< 0.100	0.100	< 0.0200	0.0200
	UASF01	Fillets with Skin	< 0.100	0.100	< 0.0200	0.0200
	UPCA01	Fillets with Skin	< 0.100	0.100	< 0.0300	0.0300
	UPLB01	Fillets with Skin	< 0.100	0.100	< 0.0200	0.0200
	UPSF01	Fillets with Skin	< 0.100	0.100	< 0.0200	0.0200
	LAAE01	Fillets without Skin	< 0.100	0.100	< 0.0400	0.0400
	LABC01	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	LACC01	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	LPAE01	Fillets without Skin	< 0.100	0.100	< 0.0300	0.0300
	LPAE02	Fillets without Skin	0.100	0.100	0.0400	0.0300
	LPBC01	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	LPBC02	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	LPBC04	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	LPCC01	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	UAAE01	Fillets without Skin	< 0.100	0.100	< 0.0400	0.0400
	UABC01	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	UACC01	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	UPAE01	Fillets without Skin	< 0.100	0.100	< 0.0400	0.0400
	UPCC01	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	UPCC02	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	UPCC101	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	UPCC102	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
	UPCC103	Fillets without Skin	< 0.100	0.100	< 0.0200	0.0200
Chromium						
	LACA01	Fillets with Skin	< 0.500	0.500	< 0.100	0.100
	LALB01	Fillets with Skin	2.30	0.500	0.470	0.100
	LASF01	Fillets with Skin	5.80	0.500	1.20	0.100
	LPCA01	Fillets with Skin	< 0.500	0.500	< 0.100	0.100
	LPLB01	Fillets with Skin	2.20	0.500	0.470	0.100
	LPSB01	Fillets with Skin	3.00	0.500	0.620	0.100
	LPSF01	Fillets with Skin	0.900	0.500	0.200	0.100
	UACA01	Fillets with Skin	1.00	0.500	0.320	0.100

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.900	0.500	0.200	0.100
	UASF01	Fillets with Skin	0.700	0.500	0.200	0.100
	UPCA01	Fillets with Skin	1.70	0.500	0.500	0.200
	UPLB01	Fillets with Skin	0.600	0.500	0.100	0.100
	UPSF01	Fillets with Skin	0.900	0.500	0.200	0.100
	LAAE01	Fillets without Skin	0.600	0.500	0.200	0.200
	LABC01	Fillets without Skin	0.500	0.500	0.100	0.100
	LACC01	Fillets without Skin	0.700	0.500	0.100	0.100
	LPAE01	Fillets without Skin	4.60	0.500	1.60	0.200
	LPAE02	Fillets without Skin	1.60	0.500	0.460	0.100
	LPBC01	Fillets without Skin	1.00	0.500	0.320	0.100
	LPBC02	Fillets without Skin	1.80	0.500	0.320	0.0900
	LPBC03	Fillets without Skin	0.800	0.500	0.200	0.100
	LPBC04	Fillets without Skin	0.500	0.500	0.100	0.100
	LPCC01	Fillets without Skin	1.00	0.500	0.200	0.100
	UAAE01	Fillets without Skin	1.70	0.500	0.650	0.200
	UABC01	Fillets without Skin	1.00	0.500	0.300	0.100
	UACC01	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
	UPAE01	Fillets without Skin	0.600	0.500	0.200	0.200

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
	UPCC02	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
	UPCC101	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
	UPCC102	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
	UPCC103	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
Copper						
	LACA01	Fillets with Skin	1.50	0.300	0.440	0.0900
	LALB01	Fillets with Skin	9.00	0.300	1.80	0.0600
	LASF01	Fillets with Skin	9.50	0.300	1.90	0.0600
	LPCA01	Fillets with Skin	2.80	0.300	0.730	0.0800
	LPLB01	Fillets with Skin	38.2	0.300	8.25	0.0600
	LPSB01	Fillets with Skin	18.0	0.300	3.70	0.0600
	LPSF01	Fillets with Skin	4.00	0.300	0.780	0.0600
	UACA01	Fillets with Skin	3.20	0.300	0.940	0.0900
	UALB01	Fillets with Skin	2.20	0.300	0.480	0.0700
	UASF01	Fillets with Skin	16.0	0.300	3.40	0.0600
	UPCA01	Fillets with Skin	4.20	0.300	1.30	0.0900
	UPLB01	Fillets with Skin	1.80	0.300	0.390	0.0600
	UPSF01	Fillets with Skin	5.30	0.300	1.00	0.0600
	LAAE01	Fillets without Skin	2.60	0.300	0.990	0.100
	LABC01	Fillets without Skin	5.00	0.300	1.10	0.0700
	LACC01	Fillets without Skin	6.80	0.300	1.40	0.0600
	LPAE01	Fillets without Skin	20.0	0.300	6.80	0.100

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	11.0	0.300	3.20	0.0900
	LPBC01	Fillets without Skin	4.50	0.300	0.980	0.0700
	LPBC02	Fillets without Skin	4.40	0.300	0.780	0.0500
	LPBC03	Fillets without Skin	2.90	0.300	0.610	0.0600
	LPBC04	Fillets without Skin	2.80	0.300	0.660	0.0700
	LPCC01	Fillets without Skin	16.0	0.300	3.20	0.0600
	UAAE01	Fillets without Skin	52.1	0.300	19.5	0.100
	UABC01	Fillets without Skin	7.00	0.300	1.50	0.0600
	UACC01	Fillets without Skin	2.10	0.300	0.440	0.0600
	UPAE01	Fillets without Skin	2.10	0.300	0.740	0.100
	UPCC01	Fillets without Skin	2.90	0.300	0.650	0.0700
	UPCC02	Fillets without Skin	2.10	0.300	0.420	0.0600
	UPCC101	Fillets without Skin	1.40	0.300	0.310	0.0700
	UPCC102	Fillets without Skin	5.40	0.300	1.20	0.0700
	UPCC103	Fillets without Skin	2.80	0.300	0.700	0.0700
Iron						
	LACA01	Fillets with Skin	36.0	2.00	11.0	0.600
	LALB01	Fillets with Skin	28.0	2.00	5.60	0.400

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LASF01	Fillets with Skin	56.0	2.00	11.0	0.400
	LPCA01	Fillets with Skin	37.0	2.00	9.50	0.500
	LPLB01	Fillets with Skin	27.0	2.00	5.80	0.400
	LPSB01	Fillets with Skin	27.0	2.00	5.70	0.400
	LPSF01	Fillets with Skin	18.0	2.00	3.60	0.400
	UACA01	Fillets with Skin	47.0	2.00	14.0	0.600
	UALB01	Fillets with Skin	14.0	2.00	3.20	0.400
	UASF01	Fillets with Skin	14.0	2.00	3.10	0.400
	UPCA01	Fillets with Skin	45.0	2.00	14.0	0.600
	UPLB01	Fillets with Skin	16.0	2.00	3.40	0.400
	UPSF01	Fillets with Skin	17.0	2.00	3.30	0.400
	LAAE01	Fillets without Skin	14.0	2.00	5.20	0.700
	LABC01	Fillets without Skin	18.0	2.00	4.00	0.500
	LACC01	Fillets without Skin	24.0	2.00	4.70	0.400
	LPAE01	Fillets without Skin	43.0	2.00	15.0	0.700
	LPAE02	Fillets without Skin	38.0	2.00	11.0	0.600
	LPBC01	Fillets without Skin	24.0	2.00	5.20	0.400
	LPBC02	Fillets without Skin	35.0	2.00	6.20	0.400
	LPBC03	Fillets without Skin	37.0	2.00	7.80	0.400
	LPBC04	Fillets without Skin	23.0	2.00	5.20	0.500
	LPCC01	Fillets without Skin	17.0	2.00	3.50	0.400
	UAAE01	Fillets without	29.0	2.00	11.0	0.700

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	24.0	2.00	5.20	0.400
	UACC01	Fillets without Skin	25.0	2.00	5.20	0.400
	UPAE01	Fillets without Skin	19.0	2.00	7.00	0.700
	UPCC01	Fillets without Skin	19.0	2.00	4.20	0.500
	UPCC02	Fillets without Skin	15.0	2.00	3.00	0.400
	UPCC101	Fillets without Skin	11.0	2.00	2.50	0.500
	UPCC102	Fillets without Skin	16.0	2.00	3.50	0.400
	UPCC103	Fillets without Skin	24.0	2.00	5.90	0.500
Mercury						
	LACA01	Fillets with Skin	0.100	0.100	0.0400	0.0300
	LALB01	Fillets with Skin	0.770	0.100	0.160	0.0200
	LASF01	Fillets with Skin	0.310	0.100	0.0620	0.0200
	LPCA01	Fillets with Skin	0.350	0.100	0.0900	0.0300
	LPLB01	Fillets with Skin	0.620	0.100	0.130	0.0200
	LPSB01	Fillets with Skin	0.720	0.100	0.150	0.0200
	LPSF01	Fillets with Skin	0.760	0.100	0.150	0.0200
	UACA01	Fillets with Skin	0.300	0.100	0.0800	0.0300
	UALB01	Fillets with Skin	0.890	0.100	0.200	0.0200
	UASF01	Fillets with Skin	0.200	0.100	0.0300	0.0200
	UPCA01	Fillets with Skin	0.200	0.100	0.0600	0.0300
	UPLB01	Fillets with Skin	1.30	0.100	0.290	0.0200
	UPSF01	Fillets with Skin	0.490	0.100	0.0960	0.0200

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	0.200	0.100	0.0800	0.0400
	LABC01	Fillets without Skin	0.340	0.100	0.0770	0.0200
	LACC01	Fillets without Skin	0.530	0.100	0.110	0.0200
	LPAE01	Fillets without Skin	0.590	0.100	0.200	0.0300
	LPAE02	Fillets without Skin	0.450	0.100	0.130	0.0300
	LPBC01	Fillets without Skin	0.430	0.100	0.0940	0.0200
	LPBC02	Fillets without Skin	1.80	0.100	0.310	0.0200
	LPBC03	Fillets without Skin	1.00	0.100	0.220	0.0200
	LPBC04	Fillets without Skin	1.50	0.100	0.350	0.0200
	LPCC01	Fillets without Skin	0.350	0.100	0.0720	0.0200
	UAAE01	Fillets without Skin	0.200	0.100	0.0800	0.0400
	UABC01	Fillets without Skin	0.450	0.100	0.0950	0.0200
	UACC01	Fillets without Skin	0.640	0.100	0.130	0.0200
	UPAE01	Fillets without Skin	0.580	0.100	0.210	0.0400
	UPCC01	Fillets without Skin	0.380	0.100	0.0860	0.0200
	UPCC02	Fillets without Skin	0.360	0.100	0.0720	0.0200
	UPCC101	Fillets without Skin	0.360	0.100	0.0830	0.0200

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	0.450	0.100	0.0990	0.0200
	UPCC103	Fillets without Skin	0.300	0.100	0.0700	0.0200
Magnesium						
	LACA01	Fillets with Skin	953	2.00	280.	0.600
	LALB01	Fillets with Skin	1330	2.00	269	0.400
	LASF01	Fillets with Skin	1450	2.00	291	0.400
	LPCA01	Fillets with Skin	1100	2.00	283	0.500
	LPLB01	Fillets with Skin	1270	2.00	274	0.400
	LPSB01	Fillets with Skin	1490	2.00	310.	0.400
	LPSF01	Fillets with Skin	1550	2.00	304	0.400
	UACA01	Fillets with Skin	872	2.00	255	0.600
	UALB01	Fillets with Skin	1320	2.00	294	0.400
	UASF01	Fillets with Skin	1440	2.00	307	0.400
	UPCA01	Fillets with Skin	718	2.00	223	0.600
	UPLB01	Fillets with Skin	1320	2.00	285	0.400
	UPSF01	Fillets with Skin	1520	2.00	300.	0.400
	LAAE01	Fillets without Skin	719	2.00	270.	0.700
	LABC01	Fillets without Skin	957	2.00	219	0.500
	LACC01	Fillets without Skin	1050	2.00	208	0.400
	LPAE01	Fillets without Skin	845	2.00	287	0.700
	LPAE02	Fillets without Skin	992	2.00	287	0.600
	LPBC01	Fillets without Skin	1060	2.00	232	0.400
	LPBC02	Fillets without Skin	1100	2.00	195	0.400

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	963	2.00	205	0.400
	LPBC04	Fillets without Skin	971	2.00	223	0.500
	LPCC01	Fillets without Skin	1240	2.00	255	0.400
	UAAE01	Fillets without Skin	591	2.00	221	0.700
	UABC01	Fillets without Skin	1090	2.00	233	0.400
	UACC01	Fillets without Skin	1020	2.00	212	0.400
	UPAE01	Fillets without Skin	727	2.00	263	0.700
	UPCC01	Fillets without Skin	1140	2.00	259	0.500
	UPCC02	Fillets without Skin	1120	2.00	225	0.400
	UPCC101	Fillets without Skin	1050	2.00	240.	0.500
	UPCC102	Fillets without Skin	1090	2.00	241	0.400
	UPCC103	Fillets without Skin	934	2.00	232	0.500
Manganese						
	LACA01	Fillets with Skin	1.00	0.500	0.430	0.100
	LALB01	Fillets with Skin	0.900	0.500	0.200	0.100
	LASF01	Fillets with Skin	3.20	0.500	0.630	0.100
	LPCA01	Fillets with Skin	1.60	0.500	0.410	0.100
	LPLB01	Fillets with Skin	0.900	0.500	0.200	0.100
	LPSB01	Fillets with Skin	1.00	0.500	0.300	0.100
	LPSF01	Fillets with Skin	4.70	0.500	0.920	0.100
	UACA01	Fillets with Skin	0.800	0.500	0.200	0.100

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	0.700	0.500	0.200	0.100
	UASF01	Fillets with Skin	17.0	0.500	3.60	0.100
	UPCA01	Fillets with Skin	0.600	0.500	0.200	0.200
	UPLB01	Fillets with Skin	1.00	0.500	0.200	0.100
	UPSF01	Fillets with Skin	6.00	0.500	1.20	0.100
	LAAE01	Fillets without Skin	7.70	0.500	2.90	0.200
	LABC01	Fillets without Skin	0.900	0.500	0.200	0.100
	LACC01	Fillets without Skin	0.800	0.500	0.200	0.100
	LPAE01	Fillets without Skin	13.0	0.500	4.40	0.200
	LPAE02	Fillets without Skin	11.0	0.500	3.20	0.100
	LPBC01	Fillets without Skin	0.800	0.500	0.200	0.100
	LPBC02	Fillets without Skin	0.700	0.500	0.100	0.0900
	LPBC03	Fillets without Skin	0.900	0.500	0.200	0.100
	LPBC04	Fillets without Skin	0.500	0.500	0.100	0.100
	LPCC01	Fillets without Skin	1.00	0.500	0.300	0.100
	UAAE01	Fillets without Skin	4.40	0.500	1.70	0.200
	UABC01	Fillets without Skin	0.800	0.500	0.200	0.100
	UACC01	Fillets without Skin	1.00	0.500	0.200	0.100
	UPAE01	Fillets without Skin	9.70	0.500	3.50	0.200

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	1.00	0.500	0.300	0.100
	UPCC02	Fillets without Skin	0.600	0.500	0.100	0.100
	UPCC101	Fillets without Skin	0.500	0.500	0.100	0.100
	UPCC102	Fillets without Skin	0.600	0.500	0.100	0.100
	UPCC103	Fillets without Skin	0.600	0.500	0.100	0.100
Molybdenum						
	LACA01	Fillets with Skin	< 2.00	2.00	< 0.600	0.600
	LALB01	Fillets with Skin	< 2.00	2.00	< 0.400	0.400
	LASF01	Fillets with Skin	< 2.00	2.00	< 0.400	0.400
	LPCA01	Fillets with Skin	< 2.00	2.00	< 0.500	0.500
	LPLB01	Fillets with Skin	< 2.00	2.00	< 0.400	0.400
	LPSB01	Fillets with Skin	< 2.00	2.00	< 0.400	0.400
	LPSF01	Fillets with Skin	< 2.00	2.00	< 0.400	0.400
	UACA01	Fillets with Skin	< 2.00	2.00	< 0.600	0.600
	UALB01	Fillets with Skin	< 2.00	2.00	< 0.400	0.400
	UASF01	Fillets with Skin	< 2.00	2.00	< 0.400	0.400
	UPCA01	Fillets with Skin	< 2.00	2.00	< 0.600	0.600
	UPLB01	Fillets with Skin	< 2.00	2.00	< 0.400	0.400
	UPSF01	Fillets with Skin	< 2.00	2.00	< 0.400	0.400
	LAAE01	Fillets without Skin	< 2.00	2.00	< 0.700	0.700
	LABC01	Fillets without Skin	< 2.00	2.00	< 0.500	0.500
	LACC01	Fillets without Skin	< 2.00	2.00	< 0.400	0.400
	LPAE01	Fillets without Skin	< 2.00	2.00	< 0.700	0.700

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 2.00	2.00	< 0.600	0.600
	LPBC01	Fillets without Skin	< 2.00	2.00	< 0.400	0.400
	LPBC02	Fillets without Skin	< 2.00	2.00	< 0.400	0.400
	LPBC03	Fillets without Skin	< 2.00	2.00	< 0.400	0.400
	LPBC04	Fillets without Skin	< 2.00	2.00	< 0.500	0.500
	LPCC01	Fillets without Skin	< 2.00	2.00	< 0.400	0.400
	UAAE01	Fillets without Skin	< 2.00	2.00	< 0.700	0.700
	UABC01	Fillets without Skin	< 2.00	2.00	< 0.400	0.400
	UACC01	Fillets without Skin	< 2.00	2.00	< 0.400	0.400
	UPAE01	Fillets without Skin	< 2.00	2.00	< 0.700	0.700
	UPCC01	Fillets without Skin	< 2.00	2.00	< 0.500	0.500
	UPCC02	Fillets without Skin	< 2.00	2.00	< 0.400	0.400
	UPCC101	Fillets without Skin	< 2.00	2.00	< 0.500	0.500
	UPCC102	Fillets without Skin	< 2.00	2.00	< 0.400	0.400
	UPCC103	Fillets without Skin	< 2.00	2.00	< 0.500	0.500
Nickel						
	LACA01	Fillets with Skin	1.00	0.500	0.350	0.100
	LALB01	Fillets with Skin	3.10	0.500	0.620	0.100

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LASF01	Fillets with Skin	2.90	0.500	0.580	0.100
	LPCA01	Fillets with Skin	0.800	0.500	0.200	0.100
	LPLB01	Fillets with Skin	12.0	0.500	2.60	0.100
	LPSB01	Fillets with Skin	4.50	0.500	0.930	0.100
	LPSF01	Fillets with Skin	5.80	0.500	1.10	0.100
	UACA01	Fillets with Skin	0.900	0.500	0.300	0.100
	UALB01	Fillets with Skin	< 0.500	0.500	< 0.100	0.100
	UASF01	Fillets with Skin	3.10	0.500	0.670	0.100
	UPCA01	Fillets with Skin	< 0.500	0.500	< 0.200	0.200
	UPLB01	Fillets with Skin	1.80	0.500	0.390	0.100
	UPSF01	Fillets with Skin	2.50	0.500	0.490	0.100
	LAAE01	Fillets without Skin	1.00	0.500	0.500	0.200
	LABC01	Fillets without Skin	1.00	0.500	0.200	0.100
	LACC01	Fillets without Skin	2.00	0.500	0.390	0.100
	LPAE01	Fillets without Skin	5.00	0.500	1.70	0.200
	LPAE02	Fillets without Skin	3.20	0.500	0.930	0.100
	LPBC01	Fillets without Skin	1.00	0.500	0.310	0.100
	LPBC02	Fillets without Skin	1.00	0.500	0.200	0.0900
	LPBC03	Fillets without Skin	0.800	0.500	0.200	0.100
	LPBC04	Fillets without Skin	1.00	0.500	0.200	0.100
	LPCC01	Fillets without Skin	3.60	0.500	0.740	0.100
	UAAE01	Fillets without	9.30	0.500	3.50	0.200

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	1.00	0.500	0.200	0.100
	UACC01	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
	UPAE01	Fillets without Skin	< 0.500	0.500	< 0.200	0.200
	UPCC01	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
	UPCC02	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
	UPCC101	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
	UPCC102	Fillets without Skin	0.900	0.500	0.200	0.100
	UPCC103	Fillets without Skin	0.700	0.500	0.200	0.100
Lead						
	LACA01	Fillets with Skin	< 0.200	0.200	< 0.0600	0.0600
	LALB01	Fillets with Skin	< 0.200	0.200	< 0.0400	0.0400
	LASF01	Fillets with Skin	0.300	0.200	0.0500	0.0400
	LPCA01	Fillets with Skin	< 0.200	0.200	< 0.0500	0.0500
	LPLB01	Fillets with Skin	1.20	0.200	0.260	0.0400
	LPSB01	Fillets with Skin	0.500	0.200	0.100	0.0400
	LPSF01	Fillets with Skin	0.200	0.200	0.0500	0.0400
	UACA01	Fillets with Skin	< 0.200	0.200	< 0.0600	0.0600
	UALB01	Fillets with Skin	< 0.200	0.200	< 0.0400	0.0400
	UASF01	Fillets with Skin	0.400	0.200	0.0900	0.0400
	UPCA01	Fillets with Skin	0.300	0.200	0.100	0.0600
	UPLB01	Fillets with Skin	0.500	0.200	0.100	0.0400
	UPSF01	Fillets with Skin	0.200	0.200	0.0400	0.0400

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LAAE01	Fillets without Skin	1.10	0.200	0.400	0.0700
	LABC01	Fillets without Skin	< 0.200	0.200	< 0.0500	0.0500
	LACC01	Fillets without Skin	< 0.200	0.200	< 0.0400	0.0400
	LPAE01	Fillets without Skin	0.820	0.200	0.280	0.0700
	LPAE02	Fillets without Skin	1.00	0.200	0.290	0.0600
	LPBC01	Fillets without Skin	0.200	0.200	0.0500	0.0400
	LPBC02	Fillets without Skin	< 0.200	0.200	< 0.0400	0.0400
	LPBC03	Fillets without Skin	< 0.200	0.200	< 0.0400	0.0400
	LPBC04	Fillets without Skin	< 0.200	0.200	< 0.0500	0.0500
	LPCC01	Fillets without Skin	0.500	0.200	0.0900	0.0400
	UAAE01	Fillets without Skin	1.20	0.200	0.440	0.0700
	UABC01	Fillets without Skin	< 0.200	0.200	< 0.0400	0.0400
	UACC01	Fillets without Skin	< 0.200	0.200	< 0.0400	0.0400
	UPAE01	Fillets without Skin	0.600	0.200	0.200	0.0700
	UPCC01	Fillets without Skin	< 0.200	0.200	< 0.0500	0.0500
	UPCC02	Fillets without Skin	< 0.200	0.200	< 0.0400	0.0400
	UPCC101	Fillets without Skin	< 0.200	0.200	< 0.0500	0.0500

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC102	Fillets without Skin	< 0.200	0.200	< 0.0400	0.0400
	UPCC103	Fillets without Skin	< 0.200	0.200	< 0.0500	0.0500
Selenium						
	LACA01	Fillets with Skin	2.30	0.200	0.680	0.0600
	LALB01	Fillets with Skin	1.90	0.200	0.390	0.0400
	LASF01	Fillets with Skin	1.80	0.200	0.360	0.0400
	LPCA01	Fillets with Skin	1.70	0.200	0.440	0.0500
	LPLB01	Fillets with Skin	2.10	0.200	0.460	0.0400
	LPSB01	Fillets with Skin	1.90	0.200	0.400	0.0400
	LPSF01	Fillets with Skin	1.50	0.200	0.300	0.0400
	UACA01	Fillets with Skin	1.70	0.200	0.490	0.0600
	UALB01	Fillets with Skin	1.80	0.200	0.390	0.0400
	UASF01	Fillets with Skin	1.70	0.200	0.360	0.0400
	UPCA01	Fillets with Skin	1.80	0.200	0.550	0.0600
	UPLB01	Fillets with Skin	1.90	0.200	0.420	0.0400
	UPSF01	Fillets with Skin	1.70	0.200	0.350	0.0400
	LAAE01	Fillets without Skin	0.900	0.200	0.340	0.0700
	LABC01	Fillets without Skin	0.700	0.200	0.160	0.0500
	LACC01	Fillets without Skin	0.680	0.200	0.130	0.0400
	LPAE01	Fillets without Skin	0.670	0.200	0.230	0.0700
	LPAE02	Fillets without Skin	1.20	0.200	0.340	0.0600
	LPBC01	Fillets without Skin	0.740	0.200	0.160	0.0400
	LPBC02	Fillets without Skin	0.500	0.200	0.0800	0.0400

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPBC03	Fillets without Skin	1.00	0.200	0.210	0.0400
	LPBC04	Fillets without Skin	0.770	0.200	0.180	0.0500
	LPCC01	Fillets without Skin	0.920	0.200	0.190	0.0400
	UAAE01	Fillets without Skin	1.30	0.200	0.490	0.0700
	UABC01	Fillets without Skin	0.740	0.200	0.160	0.0400
	UACC01	Fillets without Skin	0.720	0.200	0.150	0.0400
	UPAE01	Fillets without Skin	1.30	0.200	0.480	0.0700
	UPCC01	Fillets without Skin	0.740	0.200	0.170	0.0500
	UPCC02	Fillets without Skin	0.880	0.200	0.180	0.0400
	UPCC101	Fillets without Skin	0.600	0.200	0.100	0.0500
	UPCC102	Fillets without Skin	0.860	0.200	0.190	0.0400
	UPCC103	Fillets without Skin	0.800	0.200	0.200	0.0500
Strontium						
	LACA01	Fillets with Skin	7.90	0.200	2.30	0.0600
	LALB01	Fillets with Skin	3.20	0.200	0.650	0.0400
	LASF01	Fillets with Skin	9.70	0.200	2.00	0.0400
	LPCA01	Fillets with Skin	5.90	0.200	1.50	0.0500
	LPLB01	Fillets with Skin	3.90	0.200	0.830	0.0400
	LPSB01	Fillets with Skin	14.0	0.200	2.90	0.0400
	LPSF01	Fillets with Skin	18.0	0.200	3.50	0.0400
	UACA01	Fillets with Skin	3.10	0.200	0.900	0.0600

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UALB01	Fillets with Skin	6.70	0.200	1.50	0.0400
	UASF01	Fillets with Skin	12.0	0.200	2.60	0.0400
	UPCA01	Fillets with Skin	0.940	0.200	0.290	0.0600
	UPLB01	Fillets with Skin	9.30	0.200	2.00	0.0400
	UPSF01	Fillets with Skin	23.3	0.200	4.59	0.0400
	LAAE01	Fillets without Skin	12.0	0.200	4.70	0.0700
	LABC01	Fillets without Skin	0.950	0.200	0.220	0.0500
	LACC01	Fillets without Skin	1.10	0.200	0.220	0.0400
	LPAE01	Fillets without Skin	18.0	0.200	6.00	0.0700
	LPAE02	Fillets without Skin	22.5	0.200	6.51	0.0600
	LPBC01	Fillets without Skin	1.00	0.200	0.220	0.0400
	LPBC02	Fillets without Skin	1.00	0.200	0.180	0.0400
	LPBC03	Fillets without Skin	1.70	0.200	0.360	0.0400
	LPBC04	Fillets without Skin	0.720	0.200	0.170	0.0500
	LPCC01	Fillets without Skin	2.90	0.200	0.600	0.0400
	UAAE01	Fillets without Skin	7.20	0.200	2.70	0.0700
	UABC01	Fillets without Skin	1.50	0.200	0.320	0.0400
	UACC01	Fillets without Skin	2.80	0.200	0.590	0.0400
	UPAE01	Fillets without Skin	15.0	0.200	5.50	0.0700

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	UPCC01	Fillets without Skin	3.20	0.200	0.720	0.0500
	UPCC02	Fillets without Skin	2.20	0.200	0.440	0.0400
	UPCC101	Fillets without Skin	0.730	0.200	0.170	0.0500
	UPCC102	Fillets without Skin	0.500	0.200	0.100	0.0400
	UPCC103	Fillets without Skin	1.10	0.200	0.270	0.0500
Vanadium						
	LACA01	Fillets with Skin	< 0.500	0.500	< 0.100	0.100
	LALB01	Fillets with Skin	< 0.500	0.500	< 0.100	0.100
	LASF01	Fillets with Skin	< 0.500	0.500	< 0.100	0.100
	LPCA01	Fillets with Skin	< 0.500	0.500	< 0.100	0.100
	LPLB01	Fillets with Skin	< 0.500	0.500	< 0.100	0.100
	LPSB01	Fillets with Skin	< 0.500	0.500	< 0.100	0.100
	LPSF01	Fillets with Skin	< 0.500	0.500	< 0.100	0.100
	UACA01	Fillets with Skin	< 0.500	0.500	< 0.100	0.100
	UALB01	Fillets with Skin	< 0.500	0.500	< 0.100	0.100
	UASF01	Fillets with Skin	< 0.500	0.500	< 0.100	0.100
	UPCA01	Fillets with Skin	< 0.500	0.500	< 0.200	0.200
	UPLB01	Fillets with Skin	< 0.500	0.500	< 0.100	0.100
	UPSF01	Fillets with Skin	< 0.500	0.500	< 0.100	0.100
	LAAE01	Fillets without Skin	< 0.500	0.500	< 0.200	0.200
	LABC01	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
	LACC01	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
	LPAE01	Fillets without Skin	< 0.500	0.500	< 0.200	0.200

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LPAE02	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
	LPBC01	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
	LPBC02	Fillets without Skin	< 0.500	0.500	< 0.0900	0.0900
	LPBC03	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
	LPBC04	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
	LPCC01	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
	UAAE01	Fillets without Skin	< 0.500	0.500	< 0.200	0.200
	UABC01	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
	UACC01	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
	UPAE01	Fillets without Skin	< 0.500	0.500	< 0.200	0.200
	UPCC01	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
	UPCC02	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
	UPCC101	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
	UPCC102	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
	UPCC103	Fillets without Skin	< 0.500	0.500	< 0.100	0.100
Zinc						
	LACA01	Fillets with Skin	81.9	0.500	24.1	0.100
	LALB01	Fillets with Skin	50.0	0.500	10.0	0.100

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
	LASF01	Fillets with Skin	69.9	0.500	14.0	0.100
	LPCA01	Fillets with Skin	117	0.500	30.0	0.100
	LPLB01	Fillets with Skin	47.0	0.500	10.2	0.100
	LPSB01	Fillets with Skin	47.0	0.500	9.70	0.100
	LPSF01	Fillets with Skin	84.1	0.500	16.5	0.100
	UACA01	Fillets with Skin	95.9	0.500	28.1	0.100
	UALB01	Fillets with Skin	44.0	0.500	9.90	0.100
	UASF01	Fillets with Skin	59.0	0.500	12.6	0.100
	UPCA01	Fillets with Skin	111	0.500	34.5	0.200
	UPLB01	Fillets with Skin	65.1	0.500	14.1	0.100
	UPSF01	Fillets with Skin	77.7	0.500	15.4	0.100
	LAAE01	Fillets without Skin	53.2	0.500	20.0	0.200
	LABC01	Fillets without Skin	28.0	0.500	6.30	0.100
	LACC01	Fillets without Skin	40.0	0.500	7.80	0.100
	LPAE01	Fillets without Skin	87.6	0.500	29.8	0.200
	LPAE02	Fillets without Skin	82.4	0.500	23.9	0.100
	LPBC01	Fillets without Skin	31.0	0.500	6.80	0.100
	LPBC02	Fillets without Skin	66.7	0.500	11.8	0.0900
	LPBC03	Fillets without Skin	48.0	0.500	10.2	0.100
	LPBC04	Fillets without Skin	32.0	0.500	7.40	0.100
	LPCC01	Fillets without Skin	41.0	0.500	8.40	0.100
	UAAE01	Fillets without	83.1	0.500	31.1	0.200

Analyte	Sample Number	Sample Matrix	Dry Weight (ppm)	DL Dry Weight (ppm)	Wet Weight (ppm)	DL Wet Weight (ppm)
		Skin				
	UABC01	Fillets without Skin	28.0	0.500	6.10	0.100
	UACC01	Fillets without Skin	42.0	0.500	8.70	0.100
	UPAE01	Fillets without Skin	59.0	0.500	21.3	0.200
	UPCC01	Fillets without Skin	32.0	0.500	7.30	0.100
	UPCC02	Fillets without Skin	26.0	0.500	5.30	0.100
	UPCC101	Fillets without Skin	26.0	0.500	5.90	0.100
	UPCC102	Fillets without Skin	25.0	0.500	5.60	0.100
	UPCC103	Fillets without Skin	29.0	0.500	7.20	0.100

5. Procedural Blanks

Analyte	Lab Sample Number	Lab Sample Matrix	Result Total UG	** BEC (ppm/%)	Basis
Aluminum					
	Blank-1	Animal Tissue	4.00	< 2.00	Dry
	Blank-2	Animal Tissue	4.00	< 2.00	Dry
Arsenic					
	Blank-1	Animal Tissue	0.400	< 0.200	Dry
	Blank-2	Animal Tissue	0.400	< 0.200	Dry
Boron					
	Blank-1	Animal Tissue	4.00	< 2.00	Dry
	Blank-2	Animal Tissue	4.00	< 2.00	Dry
Barium					
	Blank-1	Animal Tissue	0.400	< 0.200	Dry
	Blank-2	Animal Tissue	0.400	< 0.200	Dry
Beryllium					
	Blank-1	Animal Tissue	0.200	< 0.100	Dry
	Blank-2	Animal Tissue	0.200	< 0.100	Dry
Cadmium					
	Blank-1	Animal Tissue	0.200	< 0.100	Dry
	Blank-2	Animal Tissue	0.200	< 0.100	Dry
Chromium					
	Blank-1	Animal Tissue	1.00	< 0.500	Dry
	Blank-2	Animal Tissue	1.00	< 0.500	Dry
Copper					
	Blank-1	Animal Tissue	0.600	< 0.300	Dry
	Blank-2	Animal Tissue	0.600	< 0.300	Dry
Iron					
	Blank-1	Animal Tissue	4.00	< 2.00	Dry
	Blank-2	Animal Tissue	4.00	< 2.00	Dry
Mercury					
	Blank-1	Animal Tissue	0.200	< 0.100	Dry
	Blank-2	Animal Tissue	0.200	< 0.100	Dry

Analyte	Lab Sample Number	Lab Sample Matrix	Result Total UG	** BEC (ppm/%)	Basis
Magnesium					
	Blank-1	Animal Tissue	4.00	< 2.00	Dry
	Blank-2	Animal Tissue	4.00	< 2.00	Dry
Manganese					
	Blank-1	Animal Tissue	1.00	< 0.500	Dry
	Blank-2	Animal Tissue	1.00	< 0.500	Dry
Molybdenum					
	Blank-1	Animal Tissue	4.00	< 2.00	Dry
	Blank-2	Animal Tissue	4.00	< 2.00	Dry
Nickel					
	Blank-1	Animal Tissue	1.00	< 0.500	Dry
	Blank-2	Animal Tissue	1.00	< 0.500	Dry
Lead					
	Blank-1	Animal Tissue	0.400	< 0.200	Dry
	Blank-2	Animal Tissue	0.400	< 0.200	Dry
Selenium					
	Blank-1	Animal Tissue	0.400	< 0.200	Dry
	Blank-2	Animal Tissue	0.400	< 0.200	Dry
Strontium					
	Blank-1	Animal Tissue	0.400	< 0.200	Dry
	Blank-2	Animal Tissue	0.400	< 0.200	Dry
Vanadium					
	Blank-1	Animal Tissue	1.00	< 0.500	Dry
	Blank-2	Animal Tissue	1.00	< 0.500	Dry
Zinc					
	Blank-1	Animal Tissue	1.00	< 0.500	Dry
	Blank-2	Animal Tissue	1.00	< 0.500	Dry

** Blank Equivalent Concentration

6. Duplicates

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
% Moisture							
	LALB01	Fillets with Skin	Percent	79.1	80.5	79.8	1.75
	LPLB01	Fillets with Skin	Percent	78.4		39.2	200.
	UASF01	Fillets with Skin	Percent	78.4	78.8	78.6	0.510
	UPCC102	Fillets without Skin	Percent	77.9		39.0	200.
Aluminum							
	LALB01	Fillets with Skin	Dry	4.00	6.30	5.15	44.7
	LPLB01	Fillets with Skin	Dry	4.00	4.00	4.00	0.000
	UASF01	Fillets with Skin	Dry	4.00	4.00	4.00	0.000
	UPCC102	Fillets without Skin	Dry	3.00	3.00	3.00	0.000
Arsenic							
	LALB01	Fillets with Skin	Dry	0.600	0.500	0.550	18.2
	LPLB01	Fillets with Skin	Dry	0.400	0.500	0.450	22.2
	UASF01	Fillets with Skin	Dry	0.500	0.600	0.550	18.2
	UPCC102	Fillets without Skin	Dry	< 0.200	< 0.200	0.100	0.000
Boron							
	LALB01	Fillets with Skin	Dry	< 2.00	3.00	2.00	100.
	LPLB01	Fillets with Skin	Dry	3.00	< 2.00	2.00	100.
	UASF01	Fillets with	Dry	< 2.00	< 2.00	1.00	0.000

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
		Skin					
	UPCC102	Fillets without Skin	Dry	< 2.00	< 2.00	1.00	0.000
Barium							
	LALB01	Fillets with Skin	Dry	0.200	0.200	0.200	0.000
	LPLB01	Fillets with Skin	Dry	0.400	0.400	0.400	0.000
	UASF01	Fillets with Skin	Dry	1.10	1.20	1.15	8.70
	UPCC102	Fillets without Skin	Dry	< 0.200	0.200	0.150	66.7
Beryllium							
	LALB01	Fillets with Skin	Dry	< 0.100	< 0.100	0.0500	0.000
	LPLB01	Fillets with Skin	Dry	< 0.100	< 0.100	0.0500	0.000
	UASF01	Fillets with Skin	Dry	< 0.100	< 0.100	0.0500	0.000
	UPCC102	Fillets without Skin	Dry	< 0.100	< 0.100	0.0500	0.000
Cadmium							
	LALB01	Fillets with Skin	Dry	< 0.100	< 0.100	0.0500	0.000
	LPLB01	Fillets with Skin	Dry	< 0.100	< 0.100	0.0500	0.000
	UASF01	Fillets with Skin	Dry	< 0.100	< 0.100	0.0500	0.000
	UPCC102	Fillets without Skin	Dry	< 0.100	< 0.100	0.0500	0.000
Chromium							
	LALB01	Fillets with Skin	Dry	2.30	2.60	2.45	12.2
	LPLB01	Fillets with Skin	Dry	2.20	2.30	2.25	4.44

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	UASF01	Fillets with Skin	Dry	0.700	1.00	0.850	35.3
	UPCC102	Fillets without Skin	Dry	< 0.500	< 0.500	0.250	0.000
Copper							
	LALB01	Fillets with Skin	Dry	9.00	8.90	8.95	1.12
	LPLB01	Fillets with Skin	Dry	38.2	38.1	38.2	0.260
	UASF01	Fillets with Skin	Dry	16.0	16.0	16.0	0.000
	UPCC102	Fillets without Skin	Dry	5.40	5.40	5.40	0.000
Iron							
	LALB01	Fillets with Skin	Dry	28.0	28.0	28.0	0.000
	LPLB01	Fillets with Skin	Dry	27.0	28.0	27.5	3.64
	UASF01	Fillets with Skin	Dry	14.0	15.0	14.5	6.90
	UPCC102	Fillets without Skin	Dry	16.0	15.0	15.5	6.45
Mercury							
	LALB01	Fillets with Skin	Dry	0.770	0.800	0.785	3.82
	LPLB01	Fillets with Skin	Dry	0.620	0.590	0.605	4.96
	UASF01	Fillets with Skin	Dry	0.200	0.200	0.200	0.000
	UPCC102	Fillets without Skin	Dry	0.450	0.430	0.440	4.55
Magnesium							
	LALB01	Fillets with Skin	Dry	1330	1270	1300	4.62
	LPLB01	Fillets with	Dry	1270	1330	1300	4.62

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
		Skin					
	UASF01	Fillets with Skin	Dry	1440	1430	1440	0.700
	UPCC102	Fillets without Skin	Dry	1090	1100	1100	0.910
Manganese							
	LALB01	Fillets with Skin	Dry	0.900	0.700	0.800	25.0
	LPLB01	Fillets with Skin	Dry	0.900	1.00	0.950	10.5
	UASF01	Fillets with Skin	Dry	17.0	17.0	17.0	0.000
	UPCC102	Fillets without Skin	Dry	0.600	0.600	0.600	0.000
Molybdenum							
	LALB01	Fillets with Skin	Dry	< 2.00	< 2.00	1.00	0.000
	LPLB01	Fillets with Skin	Dry	< 2.00	< 2.00	1.00	0.000
	UASF01	Fillets with Skin	Dry	< 2.00	< 2.00	1.00	0.000
	UPCC102	Fillets without Skin	Dry	< 2.00	< 2.00	1.00	0.000
Nickel							
	LALB01	Fillets with Skin	Dry	3.10	3.00	3.05	3.28
	LPLB01	Fillets with Skin	Dry	12.0	12.0	12.0	0.000
	UASF01	Fillets with Skin	Dry	3.10	3.20	3.15	3.17
	UPCC102	Fillets without Skin	Dry	0.900	0.800	0.850	11.8
Lead							
	LALB01	Fillets with Skin	Dry	< 0.200	< 0.200	0.100	0.000

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
	LPLB01	Fillets with Skin	Dry	1.20	1.10	1.15	8.70
	UASF01	Fillets with Skin	Dry	0.400	0.400	0.400	0.000
	UPCC102	Fillets without Skin	Dry	< 0.200	< 0.200	0.100	0.000
Selenium							
	LALB01	Fillets with Skin	Dry	1.90	2.10	2.00	10.0
	LPLB01	Fillets with Skin	Dry	2.10	2.10	2.10	0.000
	UASF01	Fillets with Skin	Dry	1.70	1.70	1.70	0.000
	UPCC102	Fillets without Skin	Dry	0.860	0.800	0.830	7.23
Strontium							
	LALB01	Fillets with Skin	Dry	3.20	1.80	2.50	56.0
	LPLB01	Fillets with Skin	Dry	3.90	5.20	4.55	28.6
	UASF01	Fillets with Skin	Dry	12.0	12.0	12.0	0.000
	UPCC102	Fillets without Skin	Dry	0.500	0.600	0.550	18.2
Vanadium							
	LALB01	Fillets with Skin	Dry	< 0.500	< 0.500	0.250	0.000
	LPLB01	Fillets with Skin	Dry	< 0.500	< 0.500	0.250	0.000
	UASF01	Fillets with Skin	Dry	< 0.500	< 0.500	0.250	0.000
	UPCC102	Fillets without Skin	Dry	< 0.500	< 0.500	0.250	0.000
Zinc							
	LALB01	Fillets with	Dry	50.0	47.0	48.5	6.19

Analyte	Sample Number	Sample Matrix	Basis	Initial Result (ppm/%)	Duplicate Result (ppm/%)	Average	Relative Percent Diff.
		Skin					
	LPLB01	Fillets with Skin	Dry	47.0	48.0	47.5	2.11
	UASF01	Fillets with Skin	Dry	59.0	58.7	58.8	0.510
	UPCC102	Fillets without Skin	Dry	25.0	25.0	25.0	0.000

* See "Laboratory Notes" section.

7. Spike Recoveries

Analyte	Sample Number	Sample Matrix	Basis	Spike Level (ppm/%)	Amount Recovered (ppm/%)	*** Spike Background	Percent Recovery
Aluminum							
	UACA01	Fillets with Skin	Dry	99.0	95.0	99.0	96.0
	UPSF01	Fillets with Skin	Dry	98.8	101	5.20	102
	LPBC02	Fillets without Skin	Dry	99.6	97.0	33.2	97.4
	UPCC01	Fillets without Skin	Dry	99.2	103	15.0	104
Arsenic							
	UACA01	Fillets with Skin	Dry	9.96	9.70	33.2	97.4
	UPSF01	Fillets with Skin	Dry	9.84	9.38	15.9	95.3
	LPBC02	Fillets without Skin	Dry	9.92	8.90	99.2	89.7
	UPCC01	Fillets without Skin	Dry	10.0	9.80	50.0	98.0
Boron							
	UACA01	Fillets with Skin	Dry	98.2	97.0	98.2	98.8
	UPSF01	Fillets with Skin	Dry	98.8	97.0	98.8	98.2
	LPBC02	Fillets without Skin	Dry	99.6	98.0	99.6	98.4
	UPCC01	Fillets without Skin	Dry	99.2	99.0	99.2	99.8
Barium							
	UACA01	Fillets with Skin	Dry	19.6	20.1	49.0	103
	UPSF01	Fillets with Skin	Dry	19.8	20.4	13.2	103
	LPBC02	Fillets without Skin	Dry	19.9	20.8	99.5	105
	UPCC01	Fillets without Skin	Dry	19.8	20.4	66.0	103
Beryllium							
	UACA01	Fillets with Skin	Dry	9.82	10.0	196	102
	UPSF01	Fillets with Skin	Dry	9.88	10.4	198	106

Analyte	Sample Number	Sample Matrix	Basis	Spike Level (ppm/%)	Amount Recovered (ppm/%)	*** Spike Background	Percent Recovery
	LPBC02	Fillets without Skin	Dry	9.96	10.2	199	103
	UPCC01	Fillets without Skin	Dry	9.92	10.4	198	105
Cadmium							
	UACA01	Fillets with Skin	Dry	9.82	9.55	196	97.2
	UPSF01	Fillets with Skin	Dry	9.88	9.55	198	96.7
	LPBC02	Fillets without Skin	Dry	9.96	9.25	199	92.9
	UPCC01	Fillets without Skin	Dry	9.92	9.45	198	95.3
Chromium							
	UACA01	Fillets with Skin	Dry	29.5	29.0	29.5	98.3
	UPSF01	Fillets with Skin	Dry	29.6	29.1	32.9	98.3
	LPBC02	Fillets without Skin	Dry	29.9	29.2	16.6	97.7
	UPCC01	Fillets without Skin	Dry	29.8	30.8	119	103
Copper							
	UACA01	Fillets with Skin	Dry	29.5	29.1	9.22	98.6
	UPSF01	Fillets with Skin	Dry	29.6	31.7	5.58	107
	LPBC02	Fillets without Skin	Dry	29.9	28.5	6.80	95.3
	UPCC01	Fillets without Skin	Dry	29.8	29.5	10.3	99.0
Iron							
	UACA01	Fillets with Skin	Dry	196	204	4.17	104
	UPSF01	Fillets with Skin	Dry	198	203	11.6	103
	LPBC02	Fillets without Skin	Dry	199	204	5.69	103
	UPCC01	Fillets without Skin	Dry	198	202	10.4	102
Mercury							
	UACA01	Fillets with Skin	Dry	3.93	4.60	13.1	117

Analyte	Sample Number	Sample Matrix	Basis	Spike Level (ppm/%)	Amount Recovered (ppm/%)	*** Spike Background	Percent Recovery
	UPSF01	Fillets with Skin	Dry	3.95	4.21	8.06	107
	LPBC02	Fillets without Skin	Dry	3.98	4.10	2.21	103
	UPCC01	Fillets without Skin	Dry	3.97	4.62	10.4	116
Magnesium							
	UACA01	Fillets with Skin	Dry	196	148	0.220	75.5
	UPSF01	Fillets with Skin	Dry	198	170.	0.130	85.9
	LPBC02	Fillets without Skin	Dry	199	200.	0.180	100.
	UPCC01	Fillets without Skin	Dry	198	190.	0.170	96.0
Manganese							
	UACA01	Fillets with Skin	Dry	39.3	41.2	49.1	105
	UPSF01	Fillets with Skin	Dry	39.5	41.0	6.58	104
	LPBC02	Fillets without Skin	Dry	39.8	41.3	56.9	104
	UPCC01	Fillets without Skin	Dry	39.7	41.0	39.7	103
Molybdenum							
	UACA01	Fillets with Skin	Dry	39.3	39.0	39.3	99.2
	UPSF01	Fillets with Skin	Dry	39.5	41.0	39.5	104
	LPBC02	Fillets without Skin	Dry	39.8	41.0	39.8	103
	UPCC01	Fillets without Skin	Dry	39.7	40.0	39.7	101
Nickel							
	UACA01	Fillets with Skin	Dry	29.5	29.1	32.8	98.6
	UPSF01	Fillets with Skin	Dry	29.6	28.5	11.8	96.3
	LPBC02	Fillets without Skin	Dry	29.9	30.0	29.9	100.
	UPCC01	Fillets without Skin	Dry	29.8	28.8	119	96.5
Lead							

Analyte	Sample Number	Sample Matrix	Basis	Spike Level (ppm/%)	Amount Recovered (ppm/%)	*** Spike Background	Percent Recovery
	UACA01	Fillets with Skin	Dry	9.82	9.60	98.2	97.8
	UPSF01	Fillets with Skin	Dry	9.88	9.80	49.4	99.2
	LPBC02	Fillets without Skin	Dry	9.96	9.90	99.6	99.4
	UPCC01	Fillets without Skin	Dry	9.92	10.9	99.2	110.
Selenium							
	UACA01	Fillets with Skin	Dry	9.96	10.3	5.86	103
	UPSF01	Fillets with Skin	Dry	9.90	10.3	5.82	104
	LPBC02	Fillets without Skin	Dry	9.92	10.5	19.8	106
	UPCC01	Fillets without Skin	Dry	9.92	10.3	13.4	103
Strontium							
	UACA01	Fillets with Skin	Dry	19.6	19.3	6.32	98.5
	UPSF01	Fillets with Skin	Dry	19.8	17.8	0.850	89.9
	LPBC02	Fillets without Skin	Dry	19.9	22.2	19.9	112
	UPCC01	Fillets without Skin	Dry	19.8	20.5	6.19	104
Vanadium							
	UACA01	Fillets with Skin	Dry	19.6	19.8	78.4	101
	UPSF01	Fillets with Skin	Dry	19.8	19.8	79.2	99.8
	LPBC02	Fillets without Skin	Dry	19.9	20.8	79.6	104
	UPCC01	Fillets without Skin	Dry	19.8	19.8	79.2	99.8
Zinc							
	UACA01	Fillets with Skin	Dry	98.2	93.1	1.02	94.8
	UPSF01	Fillets with Skin	Dry	98.8	101	1.27	103
	LPBC02	Fillets without Skin	Dry	99.6	100.	1.49	101
	UPCC01	Fillets without Skin	Dry	99.2	105	3.10	106

*** For a spike to be a valid measure of method accuracy, this ratio must be higher than 1.0.

8. Reference Materials

Analyte	Lab Sample Number	S.R.M. ID	Basis	Certified Reference Value	95% Confidence Interval	Result (ppm/%)	Percent Recovery
Aluminum							
	QC-1	NIST 1566b	Dry	197.2	6	92.0	46.6
	QC-2	NRCC TORT-2	Dry			15.0	
Arsenic							
	QC-1	NIST 1566b	Dry	7.65	0.65	7.00	91.5
	QC-2	NRCC TORT-2	Dry	21.6	1.8	21.0	97.2
Boron							
	QC-1	NIST 1566b	Dry	4.5	1.9	5.00	111
	QC-2	NRCC TORT-2	Dry			5.00	
Barium							
	QC-1	NIST 1566b	Dry	8.6	0.3	6.80	79.1
	QC-2	NRCC TORT-2	Dry			1.70	
Beryllium							
	QC-1	NIST 1566b	Dry			< 0.100	
	QC-2	NRCC TORT-2	Dry			< 0.100	
Cadmium							
	QC-1	NIST 1566b	Dry	2.48	0.08	2.40	96.8
	QC-2	NRCC TORT-2	Dry	26.7	0.6	24.4	91.4
Chromium							
	QC-1	NIST 1566b	Dry			< 0.500	
	QC-2	NRCC TORT-2	Dry	0.77	0.15	< 0.500	
Copper							
	QC-1	NIST 1566b	Dry	71.6	1.6	67.3	94.0
	QC-2	NRCC TORT-2	Dry	106	10	92.9	87.6
Iron							
	QC-1	NIST 1566b	Dry	205.8	6.8	190.	92.3
	QC-2	NRCC TORT-2	Dry	105	13	93.0	88.6
Mercury							
	QC-1	NIST 1566b	Dry	0.0371	0.0013	< 0.100	

Analyte	Lab Sample Number	S.R.M. ID	Basis	Certified Reference Value	95% Confidence Interval	Result (ppm/%)	Percent Recovery
	QC-2	NRCC TORT-2	Dry	0.27	0.06	0.340	126
Magnesium							
	QC-1	NIST 1566b	Dry	1085	23	1000	92.2
	QC-2	NRCC TORT-2	Dry			1050	
Manganese							
	QC-1	NIST 1566b	Dry	18.5	0.2	18.0	97.3
	QC-2	NRCC TORT-2	Dry	13.6	1.2	12.0	88.2
Molybdenum							
	QC-1	NIST 1566b	Dry			< 2.00	
	QC-2	NRCC TORT-2	Dry	0.95	0.1	< 2.00	
Nickel							
	QC-1	NIST 1566b	Dry	1.04	0.09	1.00	96.2
	QC-2	NRCC TORT-2	Dry	2.5	0.19	2.10	84.0
Lead							
	QC-1	NIST 1566b	Dry	0.308	0.009	0.300	97.4
	QC-2	NRCC TORT-2	Dry	0.35	0.13	0.400	114
Selenium							
	QC-1	NIST 1566b	Dry	2.06	0.15	2.00	97.1
	QC-2	NRCC TORT-2	Dry	5.63	0.67	5.20	92.4
Strontium							
	QC-1	NIST 1566b	Dry	6.8	0.2	6.20	91.2
	QC-2	NRCC TORT-2	Dry	45.2	1.9	41.7	92.3
Vanadium							
	QC-1	NIST 1566b	Dry	0.577	0.023	< 0.500	
	QC-2	NRCC TORT-2	Dry	1.64	0.19	1.70	104
Zinc							
	QC-1	NIST 1566b	Dry	1424	46	1390	97.6
	QC-2	NRCC TORT-2	Dry	180	6	174	96.7

S.R.M Names

SRM ID	SRM Name
NIST 1566b	Oyster Tissue
NRCC TORT-2	Lobster Hepatopancreas

9. Laboratory Notes

Analyte	Sample Number	Result Modifier
% Moisture		
	LPLB01	W
	UPCC102	W

Code List

If appropriate, labs are instructed to use the following codes when entering laboratory notes. The labs may use one or more of the codes in each note displayed above.

Code	Comment
A	Values reported based on Aldrin response factor.
C	Sample possibly compromised due to improper handling / packaging.
D	Sample was deleted from the catalog by the submitter.
H	Due to sample characteristics it was difficult to obtain adequate sample homogeneity - precision was impacted.
I	Interferences occurred during analysis.
L	Sample compromised or destroyed during shipment - sample not analyzed.
M	Compound identity was confirmed by GC/MS.
N	Sample was not analyzed.
P	Sample destroyed during preparation at lab - sample not analyzed.
Q	Insufficient sample quantity to perform requested analysis.
R	Sample is highly decomposed - results may be impacted.
S	Sample was substituted by the submitter.
T	Retention time relative to Aldrin.
U	GC/MS identifies the unknown compound to be _____ (fill in analyte).
W	Insufficient sample quantity to perform duplicate / spike analyses.
Y	Sample was analyzed but results may be impacted (see 'C')

10. QAQC Summary

1. Procedural Blank Summary

Procedural Blank Summary of Blank Equivalent Concentration (BEC) Data

Within a lab sample matrix, there must be three or more Blank results for a given analyte in order to generate a report.

10.2. Duplicate Summary

Duplicate Summary of Relative Percent Difference (RPD) Data

Within a lab sample matrix and concentration range, there must be three or more Duplicate results for a given analyte in order to generate a report.

Mean concentration 2 to 10 times the Limit of Detection						
Analyte	**Lab Sample Matrix**	**No. of Samples**	**Lowest RPD**	**Highest RPD**	**RPD Mean**	**RPD SDEV**
Aluminum	Animal Tissue	3	0.0	44.66	14.89	25.78
Arsenic	Animal Tissue	3	18.18	22.22	19.53	2.33
Mercury	Animal Tissue	4	0.0	4.96	3.33	2.27
Selenium	Animal Tissue	3	0.0	10.0	5.74	5.16
Mean concentration greater than 10 times the Limit of Detection						
Analyte	**Lab Sample Matrix**	**No. of Samples**	**Lowest RPD**	**Highest RPD**	**RPD Mean (ppm)**	**RPD STD**
Copper	Animal Tissue	4	0.0	1.12	0.34	0.53
Magnesium	Animal Tissue	4	0.7	4.62	2.71	2.2
Strontium	Animal Tissue	3	0.0	56.0	28.19	28.0
Zinc	Animal Tissue	4	0.0	6.19	2.2	2.8

RPD = Relative Percent Difference STD = Standard Deviation

10.3. Spike Summary

Spike Summary of Percent Recovery (PR) Data

Within a lab sample matrix, there must be three or more Spike results for a given analyte in order to generate a report.

Analyte	**Lab Sample Matrix**	**No. of Samples**	**Lowest PR**	**Highest PR**	**PR Mean**	**PR STD**
Aluminum	Animal Tissue	4	96.97	104.23	100.2	3.59
Arsenic	Animal Tissue	4	90.73	98.0	95.36	3.29
Boron	Animal Tissue	4	99.19	100.81	99.8	0.72
Barium	Animal Tissue	4	102.55	104.52	103.28	0.86

Analyte	Lab Sample Matrix	No. of Samples	Lowest PR	Highest PR	PR Mean	PR STD
Beryllium	Animal Tissue	4	102.85	106.28	104.6	1.72
Cadmium	Animal Tissue	4	93.37	97.76	96.02	1.95
Chromium	Animal Tissue	4	97.66	104.03	99.58	2.98
Copper	Animal Tissue	4	95.32	107.09	100.01	5.0
Iron	Animal Tissue	4	102.02	104.08	102.78	0.9
Mercury	Animal Tissue	4	103.02	117.05	110.75	7.04
Magnesium	Animal Tissue	4	75.51	100.5	89.46	11.13
Manganese	Animal Tissue	4	103.27	104.83	103.92	0.66
Molybdenum	Animal Tissue	4	101.78	106.33	104.23	2.08
Nickel	Animal Tissue	4	96.28	100.33	98.14	1.75
Lead	Animal Tissue	4	98.78	110.89	102.31	5.76
Selenium	Animal Tissue	4	103.41	105.85	104.18	1.15
Strontium	Animal Tissue	4	89.9	111.56	100.87	9.08
Vanadium	Animal Tissue	4	101.01	105.53	102.4	2.14
Zinc	Animal Tissue	4	94.81	105.85	100.97	4.63

PR = Percent Recovery STD = Standard Deviation

10.4. SRM Summary

Standard Reference Material Summary of Percent Recovery (PR) Data

Within an SRM ID, there must be three or more Recoveries for a given analyte in order to generate a report.

11. QA/QC Anomalies

1. Blank Frequency Anomalies

The required number of blank analyses were performed.

11.2. Duplicate Frequency Anomalies

The required number of duplicate analyses were performed.

11.3. Spike Frequency Anomalies

The required number of spike analyses were performed.

11.4. Reference Material Frequency Anomalies

The required number of Standard Reference Material analyses were performed.

11.5. Mass Spec Frequency Anomalies

No Carbamate, OC, or OP data exists in this set of results; therefore, the anomaly test was not performed.

11.6. Limit of Detection Anomalies

Limits of Detection were within the contract requirements.

11.7. Blank Anomalies

Procedural Blank analyses were acceptable.

11.8. Duplicate Anomalies

All duplicate results were within normal limits with the following exceptions.							
Analyte	**Sample Number**	**Lab Matrix**	**LOD Mean**	**Initial Result ppm/%**	**Duplicate Result ppm/%**	**Relative Percent Diff.**	**See QA/QC Note No.**
Strontium	LPLB01	Animal Tissue	0.200	3.90	5.20	28.6	2
Strontium	LALB01	Animal Tissue	0.200	3.20	1.80	56.0	1

11.9. Spike Anomalies

All spike results were within normal limits.

11.10. S.R.M. Anomalies

All SRM results were within normal limits with the following exceptions.							
Analyte	**S.R.M. ID**	**Certified Value**	**95% Confidence Interval**	**LOD (ppm/%)**	**Result (ppm/%)**	**% Recovery**	**See QA/QC Note No.**
Aluminum	NIST 1566b	197	6.00	2.00	92.0	46.6	3

S.R.M Names

SRM ID	SRM Name
NIST 1566b	Oyster Tissue

11.11. QA/QC Notes

QA/QC Note Number and Comments
New comments: Additional Lab Comments:

Sample IDs LPLBO1 and UPCC1O2 were too small for % Moisture duplicates and a "W" was placed in the field which is a notation for no moisture data.

Note: RPDs of 200% are listed in the catalog because there was insufficient sample for a duplicate. Therefore, the RPD calculation was performed using the initial result value and a duplicate value of 0%. These values should be ignored because there is no duplicate data.

The entire sample set was completely redigested and analyzed with digested duplicates and spikes utilizing the larger sufficient sample. This data should be a better representation of the sample set. Old QA/QC comments are included for reference information.

1-2 Values for elements that are primaily in the bone have larger variations due to the difficulty of getting two 0.5g aliquots with the same amount of bone in each. Sr is one the elements primarily affected. Based on other duplicate data, these values should have no effect on the interpretation of the data.

3 One SRM recovery value was low for Al in NIST 1566b. This value is within the acceptable range of recovery based on prior reported values for Al in SRM NIST 1566b by this lab.

BM, Inorganic Chemist 10/31/08

Old comments:

Additional Lab Comments:
There were no % Moisture Duplicates, digestion Duplicates or Digestion Spikes. A "W" was placed in the field with no data. The reason for this is samples sizes dry weight were mostly between 0.5 to 0.9 grams with only 5 over 1 gram (the highest 1.35 g.). To do a dup or spike we should have 2.0 or more grams dry weight.

1-18 Sample matrix duplicates were not analyzed because of small sample sizes. The sample sizes dry weights were mostly between 0.5 to 0.9 grams with only 5 samples with weights over 1 gram (the highest sample weight was 1.35 g). In order to perform a duplicate the lab requires 2.0 g or more dry weight. A "W" was placed in the field with no data (See Section 9 for an example).

Note: RPDs of 200% are listed in the catalog because there was insufficient sample for a duplicate. Therefore, the RPD calculation was performed using the initial result value and a duplicate value of 0%. These values should be ignored because there is no duplicate data.

19-36 Sample matrix spikes were not analyzed because of small sample sizes. The sample sizes dry weights were mostly between 0.5 to 0.9 grams with only 5 samples with weights over 1 gram (the highest sample weight was 1.35 g). In order to perform a spike the lab requires 2.0 g or more dry weight.

12. Analytical Methods

Below are the analytical methods used by LET to produce the results included in this report.

Method Codes:	001 002

Lab Matrix	Analyte
Animal Tissue	% Moisture

Method Code: 001

LABORATORY: Laboratory and Environmental Testing, Inc.

Homogenization

1. Sample homogenization will depend on the sample type and size.

2. Water samples will not need to be homogenized.

3. For samples weighing less than 100 grams the whole sample will be freeze-dried first, and then homogenized, unless aliquots are being sent for Organic determination, then the sample would be homogenized first and an aliquot taken for freeze-drying.

4. Larger animal samples will be homogenized with a meat grinder. Then an aliquot of approximately 100 grams will be freeze-dried and then further homogenized using a blender, or if necessary, a Spex mixer mill with a Tungsten Carbide vial and ball.

5. Soil and Sediment samples will be mixed and aliquots of 100-200 grams taken for freeze-drying. After freeze-drying, soils will be sieved with a 20 mesh sieve and sediments will be sieved with a 10 mesh sieve followed by grinding with a Spex mixer mill, using a Tungsten Carbide vial and ball.

6. Plant samples will be freeze-dried and then homogenized with a blender, followed if necessary by grinding in a Spex mixer mill with a Tungsten Carbide vial and ball. If aliquots are being sent for Organic determinations, then the samples will be homogenized first, followed by freeze-drying, and further homogenization.

Method Code: 002

LABORATORY: Laboratory and Environmental Testing, Inc.

L9 - Freeze drying and % Moisture

1. Choose an appropriately sized container for the sample. Usually a Whirl-Pak works best for tissue samples. If the sample weighs less than 50 grams and is not being split for

organics then use the whole sample.

2. Weigh and record the weight of the bag. If the sample weighs more than 2 grams then a three-place balance should be used. Small samples may require the use of a four or five-place balance.

3. Weight the bag, record the weight and transfer the sample to the bag. Weigh the bag and sample and record the weight. Seal the container or bag and place in a freezer at least overnight or until frozen solid.

4. After the samples are frozen, they are ready to place in the freeze-drier. Turn on the freeze-drier and start the refrigeration. When the temperature reaches -50 C open the container or Whirl-Pak and place in the chamber of the freeze-drier. Close the chamber and start the vacuum pump.

5. Depending on the number of samples and the amount of water present freeze-drying may take 1 - 5 days. When the pressure stops going lower, the samples may be done. If, upon removal, the samples are still cold, place back in the freeze-drier for a longer period of time.

6. After the samples are dry, remove them from the chamber. Then seal the container and weigh on the same balance. Record the weight of the bag and dry sample.

7. Calculate the weight of the dry sample and the weight of the wet sample. To calculate % Moisture divide the weight of the dry sample by the weight of the wet sample, subtract 1 and multiply by 100. Ignore the - sign.

Notes:

1. If the samples do not require % Moisture, then all of the weighing steps can be eliminated.

Method Codes:	001 002 007 012

Lab Matrix	**Analyte**

Animal Tissue	Arsenic
	Selenium

Method Code: 001

LABORATORY: Laboratory and Environmental Testing, Inc.

Homogenization

1. Sample homogenization will depend on the sample type and size.

2. Water samples will not need to be homogenized.

3. For samples weighing less than 100 grams the whole sample will be freeze-dried first, and then homogenized, unless aliquots are being sent for Organic determination, then the sample would be homogenized first and an aliquot taken for freeze-drying.

4. Larger animal samples will be homogenized with a meat grinder. Then an aliquot of approximately 100 grams will be freeze-dried and then further homogenized using a blender, or if necessary, a Spex mixer mill with a Tungsten Carbide vial and ball.

5. Soil and Sediment samples will be mixed and aliquots of 100-200 grams taken for freeze-drying. After freeze-drying, soils will be sieved with a 20 mesh sieve and sediments will be sieved with a 10 mesh sieve followed by grinding with a Spex mixer mill, using a Tungsten Carbide vial and ball.

6. Plant samples will be freeze-dried and then homogenized with a blender, followed if necessary by grinding in a Spex mixer mill with a Tungsten Carbide vial and ball. If aliquots are being sent for Organic determinations, then the samples will be homogenized first, followed by freeze-drying, and further homogenization.

Method Code: 002

LABORATORY: Laboratory and Environmental Testing, Inc.

L9 - Freeze drying and % Moisture

1. Choose an appropriately sized container for the sample. Usually a Whirl-Pak works best for tissue samples. If the sample weighs less than 50 grams and is not being split for organics then use the whole sample.

2. Weigh and record the weight of the bag. If the sample weighs more than 2 grams then a three-place balance should be used. Small samples may require the use of a four or five-place balance.

3. Weight the bag, record the weight and transfer the sample to

the bag. Weigh the bag and sample and record the weight. Seal the container or bag and place in a freezer at least overnight or until frozen solid.

4. After the samples are frozen, they are ready to place in the freeze-drier. Turn on the freeze-drier and start the refrigeration. When the temperature reaches -50 C open the container or Whirl-Pak and place in the chamber of the freeze-drier. Close the chamber and start the vacuum pump.

5. Depending on the number of samples and the amount of water present freeze-drying may take 1 - 5 days. When the pressure stops going lower, the samples may be done. If, upon removal, the samples are still cold, place back in the freeze-drier for a longer period of time.

6. After the samples are dry, remove them from the chamber. Then seal the container and weigh on the same balance. Record the weight of the bag and dry sample.

7. Calculate the weight of the dry sample and the weight of the wet sample. To calculate % Moisture divide the weight of the dry sample by the weight of the wet sample, subtract 1 and multiply by 100. Ignore the - sign.

Notes:

1. If the samples do not require % Moisture, then all of the weighing steps can be eliminated.

Method Code: 007

LABORATORY: Laboratory and Environmental Testing, Inc.

L5 - Magnesium Dry Ash

1. Weigh 0.5 g. of sample on a three-place balance and transfer to a cleaned 100 ml. glass beaker with etched numbers. Record the beaker number as well as the sample weight.

2. Wet with 3 ml. of methanol. Then add 5 drops of anti-foam agent, 10 ml. of 40% (W/V) Magnesium Nitrate Hexahydrate, 10 ml. of concentrated trace metal grade HNO3 and 2 ml. of concentrated trace metal grade HCl.

3. Cover with a watch glass and reflux on a hot plate overnight (8-12 hours) at low heat (70-80 C).

4. After reflux increase temperature to 200 C. Slide the watch glass to the side to allow for faster evaporation and cook to complete dryness. This may take 8-12 hours.

5. When no moisture is visible, cover fully with the watch glass and allow to cool.

6. Transfer samples to the cold muffle furnace and use the following program: Start at 250 C and ramp to 500 C at a rate of 1 degree per minute. When 500 C is reached hold for 3 hours then turn off and allow samples to cool to room temperature.

7. Place the cooled samples on a hot plate and add 20 ml. of 50% trace metal grade HCl. Allow the samples to gently boil for 1 hour. After 1 hour readjust volume to 20 ml. with 50 % HCl. Do not allow the samples to go dry. If necessary add more 50 % HCl during the heating.

8. Allow the samples to cool. Then dilute to 50.0 ml. with D.I. water and transfer to a clean 2 oz. labeled bottle.

Notes:

1. This digestion can be used for As or Se by Hydride Generation AA.

2. This digestion must be used on fish for As by Hydride Generation AA.

Method Code: 012

LABORATORY: Laboratory and Environmental Testing, Inc.

Hydride Generation AA

Turn on the computer, printer, 3100, FIAS 200.and Argon. Place the appropriate lamp in the instrument and if an EDL turn to its required power. Place the furnace in the burner compartment if it is not already present.

When the computer is ready double click on the WinLab Analyst icon. If the technique is not already FI-Hydride then click on technique and change to FI-Hydride. After the computer has confirmed the IEEE connections are OK, click on Workspace and double click fias.fms. When the screens come up double click on the method and double click on either the Se-Fias or As-Fias method. Click on FIAS and turn on the cell.

When the lamp has had time to warm up click on lamps and enter the element and click on EDL. Check lamp alignment and wavelength to give the maximum signal. Close lamps.

Prepare the 10% HCl, 0.2% NaBH4-0.05% NaOH, Calibration standards, and check standards. Change the FIAS tubing and mixing cell if it is not already the set for this element. Change the position of the tubing or new tubes, if both positions have been used.

Check the alignment of the furnace in the light path by clicking on Tools and Continuous graphics. Autozero, then check all three positional knobs to get the lowest reading. Autozero whenever necessary.

Start the pumps and place the tubes in the HCl and Borohydride. Run a 5 or 10 PPB standard until the sensitivity has stabilized and consecutive readings vary by less than 2%.

Enter the samples to be run into the Sample Information File. Enter a name for the Data file, and make sure that print log and store data are checked. When the instrument is ready click on Analyze All.

Calibration is done with 0, 1.0, 5.0, 15.0 PPB. QC checks are 10.0 and a known Reference sample (Usually ERA). The 5.00 PPB standard is checked every 10 tubes and if is more than 5% from 5.00 the instrument is recalibrated. If the value is more than 10% from 5.00, then the last 10 samples must be rerun.

After the analysis is finished, rinse system with D.I. water, turn off the pumps (release the pressure), turn off the EDL lamp, the Argon, FIAS and 3100. Click on File then Exit to close the WinLabs Analyst.

Click on WinLab Reformat Icon. Click on Open Design. Pick the design for As or Se FIAS. Then Browse and find the file name given the data. Place a 3.5" disk in the computer and click on Save Results.

Transfer disk to computer and using Excel calculate the results.

Method Codes:	001 002 009 013

Lab Matrix	Analyte
Animal Tissue	Mercury

Method Code: 001

LABORATORY: Laboratory and Environmental Testing, Inc.

Homogenization

1. Sample homogenization will depend on the sample type and size.

2. Water samples will not need to be homogenized.

3. For samples weighing less than 100 grams the whole sample will be freeze-dried first, and then homogenized, unless aliquots are being sent for Organic determination, then the sample would be homogenized first and an aliquot taken for freeze-drying.

4. Larger animal samples will be homogenized with a meat grinder. Then an aliquot of approximately 100 grams will be freeze-dried and then further homogenized using a blender, or if necessary, a Spex mixer mill with a Tungsten Carbide vial and ball.

5. Soil and Sediment samples will be mixed and aliquots of 100-200 grams taken for freeze-drying. After freeze-drying, soils will be sieved with a 20 mesh sieve and sediments will be sieved with a 10 mesh sieve followed by grinding with a Spex mixer mill, using a Tungsten Carbide vial and ball.

6. Plant samples will be freeze-dried and then homogenized with a blender, followed if necessary by grinding in a Spex mixer mill with a Tungsten Carbide vial and ball. If aliquots are being sent for Organic determinations, then the samples will be homogenized first, followed by freeze-drying, and further homogenization.

Method Code: 002

LABORATORY: Laboratory and Environmental Testing, Inc.

L9 - Freeze drying and % Moisture

1. Choose an appropriately sized container for the sample. Usually a Whirl-Pak works best for tissue samples. If the sample weighs less than 50 grams and is not being split for organics then use the whole sample.

2. Weigh and record the weight of the bag. If the sample weighs more than 2 grams then a three-place balance should be used. Small samples may require the use of a four or five-place balance.

3. Weight the bag, record the weight and transfer the sample to the bag. Weigh the bag and sample and record the weight. Seal the container or bag and place in a freezer at least overnight or until frozen solid.

4. After the samples are frozen, they are ready to place in the freeze-drier. Turn on the freeze-drier and start the refrigeration. When the temperature reaches -50 C open the container or Whirl-Pak and place in the chamber of the freeze-drier. Close the chamber and start the vacuum pump.

5. Depending on the number of samples and the amount of water

present freeze-drying may take 1 - 5 days. When the pressure stops going lower, the samples may be done. If, upon removal, the samples are still cold, place back in the freeze-drier for a longer period of time.

6. After the samples are dry, remove them from the chamber. Then seal the container and weigh on the same balance. Record the weight of the bag and dry sample.

7. Calculate the weight of the dry sample and the weight of the wet sample. To calculate % Moisture divide the weight of the dry sample by the weight of the wet sample, subtract 1 and multiply by 100. Ignore the - sign.

Notes:

1. If the samples do not require % Moisture, then all of the weighing steps can be eliminated.

Method Code: 009

LABORATORY: Laboratory and Environmental Testing, Inc.

L10 - Microwave Digestion

1. Weigh 0.5 g of dry sample into a clean Teflon digestion vessel. Record the weight to three decimal places.

2. Add 5.0 ml. of concentrated trace metal grade HNO3.

3. Loosely seal to allow release of pressure from the initial acid reaction with the sample.

4. After a few minutes open the vessel and add 1.0 ml of high purity H2O2.

5. Loosely seal the vessel to allow release of pressure.

6. Cap the vessel at the recommended pressure and place in the microwave. Run the program set up for this type of sample.

7. After the microwave heating is complete and the samples have cooled to room temperature, open the vessels and dilute the sample to 50.0 ml. with D.I. water and transfer to a clean 2 oz. plastic bottle. Any vessels that vented during the digestion will

need to have the sample redigested and either use less sample or a longer ramp at the lower temperatures.

Notes:

1. Different sample types will require different heating programs to prevent losses due to exceeding the maximum vessel pressure.

2. To keep the same sample dilution, as little as 0.25 g of sample can be weighed and diluted to a final volume of 25.0 ml. using 1/2 of the HNO3 and H2O2.

3. This digestion can be used for Flame AA, HGA, CV, and ICP.

4. If Mercury is to be run, remove a 10 ml aliquot immediately after dilution and place in a plastic tube and add 100 microliters of concentrated Trace Metal grade Hydrochloric Acid.

Method Code: 013

LABORATORY: Laboratory and Environmental Testing, Inc.

Cold Vapor AA

Turn on the computer, printer, 3100, FIAS 200,and Argon. Place the appropriate lamp in the instrument and if an EDL turn to its required power. Place the furnace in the burner compartment if it is not already present.

When the computer is ready double click on the WinLab Analyst icon. If the technique is not already FI-Hydride then click on technique and change to FI-Hydride. After the computer has confirmed the IEEE connections are OK, click on Workspace and double click fias.fms. When the screens come up double click on the method and double click on the Hg-CV method. Click on FIAS and turn on the cell.

When the lamp has had time to warm up click on lamps and enter the Hg and click on EDL. Check lamp alignment and wavelength to give the maximum signal. Close lamps.

Prepare the 10% HCl, 5% Stanous Chloride-10% HCl, Calibration standards, and check standards. Change the FIAS tubing and mixing cell if it is not already the set for Mercury. Change the position of the tubing or new tubes, if both positions have been used or determining a different element.

Check the alignment of the furnace in the light path by clicking on Tools and Continuous graphics. Autozero, then check all three positional knobs to get the lowest reading. Autozero whenever necessary.

Start the pumps and place the tubes in the HCl and Stanous Chloride. Run a 10 or 20 PPB standard until the sensitivity has stabilized and consecutive readings vary by less the 2%.

Enter the samples to be run into the Sample Information File. Enter a name for the Data file, and make sure that print log and store data are checked. When the instrument is ready click on Analyze All.

Calibration is done with 0, 1.0, 5.0, 30.0 PPB. QC checks are 10.0, 20.0 and a known Reference Sample(Usually ERA). The 5.00 PPB standard is checked every 10 tubes and if is more than 5% from 5.00 the instrument is recalibrated. If the value is more than 10% from 5.00, then the last 10 samples must be rerun.

After the analysis is finished, rinse system with D.I. water, turn off the pumps (release the pressure), turn off the EDL lamp, the Argon, FIAS and 3100. Click on File then Exit to close the WinLabs Analyst.

Click on WinLab Reformat Icon. Click on Open Design. Pick the design for Hg-CV. Then Browse and find the file name given the data. Place a 3.5" disk in the computer and click on Save Results.

Transfer disk to computer and using Excel calculate the results.

Method Codes:	001 002 009 016

Lab Matrix	Analyte
Animal Tissue	Cadmium
	Lead

Method Code: 001

LABORATORY: Laboratory and Environmental Testing, Inc.

Homogenization

1. Sample homogenization will depend on the sample type and size.

2. Water samples will not need to be homogenized.

3. For samples weighing less than 100 grams the whole sample will be freeze-dried first, and then homogenized, unless aliquots are being sent for Organic determination, then the sample would be homogenized first and an aliquot taken for freeze-drying.

4. Larger animal samples will be homogenized with a meat grinder. Then an aliquot of approximately 100 grams will be freeze-dried and then further homogenized using a blender, or if necessary, a Spex mixer mill with a Tungsten Carbide vial and ball.

5. Soil and Sediment samples will be mixed and aliquots of 100-200 grams taken for freeze-drying. After freeze-drying, soils will be

sieved with a 20 mesh sieve and sediments will be sieved with a 10 mesh sieve followed by grinding with a Spex mixer mill, using a Tungsten Carbide vial and ball.

6. Plant samples will be freeze-dried and then homogenized with a blender, followed if necessary by grinding in a Spex mixer mill with a Tungsten Carbide vial and ball. If aliquots are being sent for Organic determinations, then the samples will be homogenized first, followed by freeze-drying, and further homogenization.

Method Code: 002

LABORATORY: Laboratory and Environmental Testing, Inc.

L9 - Freeze drying and % Moisture

1. Choose an appropriately sized container for the sample. Usually a Whirl-Pak works best for tissue samples. If the sample weighs less than 50 grams and is not being split for organics then use the whole sample.

2. Weigh and record the weight of the bag. If the sample weighs more than 2 grams then a three-place balance should be used. Small samples may require the use of a four or five-place balance.

3. Weight the bag, record the weight and transfer the sample to the bag. Weigh the bag and sample and record the weight. Seal the container or bag and place in a freezer at least overnight or until frozen solid.

4. After the samples are frozen, they are ready to place in the freeze-drier. Turn on the freeze-drier and start the refrigeration. When the temperature reaches -50 C open the container or Whirl-Pak and place in the chamber of the freeze-drier. Close the chamber and start the vacuum pump.

5. Depending on the number of samples and the amount of water present freeze-drying may take 1 - 5 days. When the pressure stops going lower, the samples may be done. If, upon removal, the samples are still cold, place back in the freeze-drier for a longer period of time.

6. After the samples are dry, remove them from the chamber. Then seal the container and weigh on the same balance. Record the weight of the bag and dry sample.

7. Calculate the weight of the dry sample and the weight of the

wet sample. To calculate % Moisture divide the weight of the dry sample by the weight of the wet sample, subtract 1 and multiply by 100. Ignore the - sign.

Notes:

1. If the samples do not require % Moisture, then all of the weighing steps can be eliminated.

Method Code: 009

LABORATORY: Laboratory and Environmental Testing, Inc.

L10 - Microwave Digestion

1. Weigh 0.5 g of dry sample into a clean Teflon digestion vessel. Record the weight to three decimal places.

2. Add 5.0 ml. of concentrated trace metal grade HNO3.

3. Loosely seal to allow release of pressure from the initial acid reaction with the sample.

4. After a few minutes open the vessel and add 1.0 ml of high purity H2O2.

5. Loosely seal the vessel to allow release of pressure.

6. Cap the vessel at the recommended pressure and place in the microwave. Run the program set up for this type of sample.

7. After the microwave heating is complete and the samples have cooled to room temperature, open the vessels and dilute the sample to 50.0 ml. with D.I. water and transfer to a clean 2 oz. plastic bottle. Any vessels that vented during the digestion will need to have the sample redigested and either use less sample or a longer ramp at the lower temperatures.

Notes:

1. Different sample types will require different heating programs to prevent losses due to exceeding the maximum vessel pressure.

2. To keep the same sample dilution, as little as 0.25 g of sample

can be weighed and diluted to a final volume of 25.0 ml. using
1/2 of the HNO3 and H2O2.

3. This digestion can be used for Flame AA, HGA, CV, and ICP.

4. If Mercury is to be run, remove a 10 ml aliquot immediately
after dilution and place in a plastic tube and add 100 microliters
of concentrated Trace Metal grade Hydrochloric Acid.

Method Code: 016

LABORATORY: Laboratory and Environmental Testing, Inc.

Graphite Furnace using the 5100 Zeeman

Turn on the Furnace Coolant, Argon, Computer, Furnace, Zeeman Power Supply and 5100 in that order. Make sure the lamp is in the right position in the turret, and if using an EDL turn on the lamp to the proper power.

Double click on the AA WinLab Analyst icon. After the ZHGA-600 and 5100 icons have a green check by them, click on workspace. Double click on LET.fm, then double click on the method. Choose the method to be run and double click on the name. Click on Browse by the Sample Information File, and then pick one for standards. (Example: Pbstds.sif) Click on sample information icon to edit the file with sample names, dilutions, etc. Click Browse for the Results Data Set and enter the name of the file to store data. (Example: Pb010101) Click on Analyze. When samples have been prepared and ready for analysis, click on Analyze All if doing calibration or Analyze Samples if just running samples. The instrument is usually calibrated with a zero and one standard. Then a zero and 3-5 standards are run to check the calibration, followed by an instrument check standard and detection limit. If this is acceptable then the samples are run. Be sure to check that the correct modifier is being used for the element being run. Some samples may require the method of Standard Additions.

After the analysis is completed, close AA WinLab Analyst, turn off furnace coolant, Argon, 5100, Zeeman Power supply, Furnace and EDL power supply. Double click on the WinLab Reformat icon. Click on Open Design and choose the design for your element and double click on the name. Click on Browse and find the data file you want to reformat. Double click on the name. Make sure there is a floppy disk in the disk drive and click on Save Results. Transfer to another computer and calculate using Excel.

Method Codes:	001 002 009 018

Lab Matrix	Analyte
Animal Tissue	Aluminum
	Boron
	Barium
	Beryllium

Chromium
Copper
Iron
Magnesium
Manganese
Molybdenum
Nickel
Strontium
Vanadium
Zinc

Method Code: 001

LABORATORY: Laboratory and Environmental Testing, Inc.

Homogenization

1. Sample homogenization will depend on the sample type and size.

2. Water samples will not need to be homogenized.

3. For samples weighing less than 100 grams the whole sample will be freeze-dried first, and then homogenized, unless aliquots are being sent for Organic determination, then the sample would be homogenized first and an aliquot taken for freeze-drying.

4. Larger animal samples will be homogenized with a meat grinder. Then an aliquot of approximately 100 grams will be freeze-dried and then further homogenized using a blender, or if necessary, a Spex mixer mill with a Tungsten Carbide vial and ball.

5. Soil and Sediment samples will be mixed and aliquots of 100-200 grams taken for freeze-drying. After freeze-drying, soils will be sieved with a 20 mesh sieve and sediments will be sieved with a 10 mesh sieve followed by grinding with a Spex mixer mill, using a Tungsten Carbide vial and ball.

6. Plant samples will be freeze-dried and then homogenized with a blender, followed if necessary by grinding in a Spex mixer mill with a Tungsten Carbide vial and ball. If aliquots are being sent for Organic determinations, then the samples will be homogenized first, followed by freeze-drying, and further homogenization.

Method Code: 002

LABORATORY: Laboratory and Environmental Testing, Inc.

L9 - Freeze drying and % Moisture

1. Choose an appropriately sized container for the sample.

Usually a Whirl-Pak works best for tissue samples. If the sample weighs less than 50 grams and is not being split for organics then use the whole sample.

2. Weigh and record the weight of the bag. If the sample weighs more than 2 grams then a three-place balance should be used. Small samples may require the use of a four or five-place balance.

3. Weight the bag, record the weight and transfer the sample to the bag. Weigh the bag and sample and record the weight. Seal the container or bag and place in a freezer at least overnight or until frozen solid.

4. After the samples are frozen, they are ready to place in the freeze-drier. Turn on the freeze-drier and start the refrigeration. When the temperature reaches -50 C open the container or Whirl-Pak and place in the chamber of the freeze-drier. Close the chamber and start the vacuum pump.

5. Depending on the number of samples and the amount of water present freeze-drying may take 1 - 5 days. When the pressure stops going lower, the samples may be done. If, upon removal, the samples are still cold, place back in the freeze-drier for a longer period of time.

6. After the samples are dry, remove them from the chamber. Then seal the container and weigh on the same balance. Record the weight of the bag and dry sample.

7. Calculate the weight of the dry sample and the weight of the wet sample. To calculate % Moisture divide the weight of the dry sample by the weight of the wet sample, subtract 1 and multiply by 100. Ignore the - sign.

Notes:

1. If the samples do not require % Moisture, then all of the weighing steps can be eliminated.

Method Code: 009

LABORATORY: Laboratory and Environmental Testing, Inc.

L10 - Microwave Digestion

1. Weigh 0.5 g of dry sample into a clean Teflon digestion vessel. Record the weight to three decimal places.

2. Add 5.0 ml. of concentrated trace metal grade HNO3.

3. Loosely seal to allow release of pressure from the initial acid reaction with the sample.

4. After a few minutes open the vessel and add 1.0 ml of high purity H2O2.

5. Loosely seal the vessel to allow release of pressure.

6. Cap the vessel at the recommended pressure and place in the microwave. Run the program set up for this type of sample.

7. After the microwave heating is complete and the samples have cooled to room temperature, open the vessels and dilute the sample to 50.0 ml. with D.I. water and transfer to a clean 2 oz. plastic bottle. Any vessels that vented during the digestion will need to have the sample redigested and either use less sample or a longer ramp at the lower temperatures.

Notes:

1. Different sample types will require different heating programs to prevent losses due to exceeding the maximum vessel pressure.

2. To keep the same sample dilution, as little as 0.25 g of sample can be weighed and diluted to a final volume of 25.0 ml. using 1/2 of the HNO3 and H2O2.

3. This digestion can be used for Flame AA, HGA, CV, and ICP.

4. If Mercury is to be run, remove a 10 ml aliquot immediately after dilution and place in a plastic tube and add 100 microliters of concentrated Trace Metal grade Hydrochloric Acid.

Method Code: 018

LABORATORY: Laboratory and Environmental Testing, Inc.

ICP on Perkin-Elmer 4300 DV

Make sure the instrument, Chiller, Air compressor, and gases are on, and at the proper temperatures and pressures. Turn on the computer and double click on the WinLAb32 icon.

Prepare standards and check samples to match the acid matrix of the samples to be analyzed. Change the pump tubing.

Click on "file", then "Open", and then "Method". Click on the method to be used and then click "OK", TO start the ICP program and call up the Method with the elements to be determined.

Click on the Plasma icon, and click on pump to start the pump and make sure the tubes are in the pump properly. Start the plasma by clicking the "On" icon. Click on the X in the upper right corner to close the Plasma Control. Allow the instrument to warm-up while the samples and standards are loaded into the auto-sampler racks. If the Sample Info table was not filled out previously, then fill in the sample information and save the table using the Batch ID.

Before starting the run, check the Hg wavelength by clicking on "Tools", and then "Spectrometer Control". Click on Hg Realign. When that is complete, aspirate a 10.0 Mn Standard and click on "Align View". After Align View is completed, close the box.

When ready to start analysis, click on the "Auto" icon, make sure that the data is being stored in a file with the correct name for the Batch, and that the right method is being used. Click the "Analyze" icon and click on "Analyze All".

When the run is completed, click on "File", then "Utilities", then "Data Manager". Highlight the file, and then click on "Export" icon. Click "Use Existing Design". Click "Browse" and choose the appropriate template (usually LET-ICP). Click "Open", place a disk in the "A" drive, and click "Finish". Click on "Export Data" to transfer data to disk in Drive "A".

Transfer data to the main computer and calculate the final Concentrations.

Method Codes:	007 012

Lab Matrix	Analyte
Animal Tissue	Arsenic
	Selenium

Method Code: 007

LABORATORY: Laboratory and Environmental Testing, Inc.

L5 - Magnesium Dry Ash

1. Weigh 0.5 g. of sample on a three-place balance and transfer to

a cleaned 100 ml. glass beaker with etched numbers. Record the beaker number as well as the sample weight.

2. Wet with 3 ml. of methanol. Then add 5 drops of anti-foam agent, 10 ml. of 40% (W/V) Magnesium Nitrate Hexahydrate, 10 ml. of concentrated trace metal grade HNO3 and 2 ml. of concentrated trace metal grade HCl.

3. Cover with a watch glass and reflux on a hot plate overnight (8-12 hours) at low heat (70-80 C).

4. After reflux increase temperature to 200 C. Slide the watch glass to the side to allow for faster evaporation and cook to complete dryness. This may take 8-12 hours.

5. When no moisture is visible, cover fully with the watch glass and allow to cool.

6. Transfer samples to the cold muffle furnace and use the following program: Start at 250 C and ramp to 500 C at a rate of 1 degree per minute. When 500 C is reached hold for 3 hours then turn off and allow samples to cool to room temperature.

7. Place the cooled samples on a hot plate and add 20 ml. of 50% trace metal grade HCl. Allow the samples to gently boil for 1 hour. After 1 hour readjust volume to 20 ml. with 50 % HCl. Do not allow the samples to go dry. If necessary add more 50 % HCl during the heating.

8. Allow the samples to cool. Then dilute to 50.0 ml. with D.I. water and transfer to a clean 2 oz. labeled bottle.

Notes:

1. This digestion can be used for As or Se by Hydride Generation AA.

2. This digestion must be used on fish for As by Hydride Generation AA.

Method Code: 012

LABORATORY: Laboratory and Environmental Testing, Inc.

Hydride Generation AA

Turn on the computer, printer, 3100, FIAS 200.and Argon. Place the appropriate lamp in the instrument and if an EDL turn to its required power. Place the furnace in the burner compartment if it is not already present.

When the computer is ready double click on the WinLab Analyst icon. If the technique is not already FI-Hydride then click on technique and change to FI-Hydride. After the computer has confirmed the IEEE connections are OK, click on Workspace and double click fias.fms. When the screens come up double click on the method and double click on either the Se-Fias or As-Fias method. Click on FIAS and turn on the cell.

When the lamp has had time to warm up click on lamps and enter the element and click on EDL. Check lamp alignment and wavelength to give the maximum signal. Close lamps.

Prepare the 10% HCl, 0.2% NaBH4-0.05% NaOH, Calibration standards, and check standards. Change the FIAS tubing and mixing cell if it is not already the set for this element. Change the position of the tubing or new tubes, if both positions have been used.

Check the alignment of the furnace in the light path by clicking on Tools and Continuous graphics. Autozero, then check all three positional knobs to get the lowest reading. Autozero whenever necessary.

Start the pumps and place the tubes in the HCl and Borohydride. Run a 5 or 10 PPB standard until the sensitivity has stabilized and consecutive readings vary by less than 2%.

Enter the samples to be run into the Sample Information File. Enter a name for the Data file, and make sure that print log and store data are checked. When the instrument is ready click on Analyze All.

Calibration is done with 0, 1.0, 5.0, 15.0 PPB. QC checks are 10.0 and a known Reference sample (Usually ERA). The 5.00 PPB standard is checked every 10 tubes and if is more than 5% from 5.00 the instrument is recalibrated. If the value is more than 10% from 5.00, then the last 10 samples must be rerun.

After the analysis is finished, rinse system with D.I. water, turn off the pumps (release the pressure), turn off the EDL lamp, the Argon, FIAS and 3100. Click on File then Exit to close the WinLabs Analyst.

Click on WinLab Reformat Icon. Click on Open Design. Pick the design for As or Se FIAS. Then Browse and find the file name given the data. Place a 3.5" disk in the computer and click on Save Results.

Transfer disk to computer and using Excel calculate the results.

Method Codes:	009 013

Lab Matrix	Analyte
Animal Tissue	Mercury

Method Code: 009

LABORATORY: Laboratory and Environmental Testing, Inc.

L10 - Microwave Digestion

1. Weigh 0.5 g of dry sample into a clean Teflon digestion vessel. Record the weight to three decimal places.

2. Add 5.0 ml. of concentrated trace metal grade HNO3.

3. Loosely seal to allow release of pressure from the initial acid reaction with the sample.

4. After a few minutes open the vessel and add 1.0 ml of high purity H2O2.

5. Loosely seal the vessel to allow release of pressure.

6. Cap the vessel at the recommended pressure and place in the microwave. Run the program set up for this type of sample.

7. After the microwave heating is complete and the samples have cooled to room temperature, open the vessels and dilute the sample to 50.0 ml. with D.I. water and transfer to a clean 2 oz. plastic bottle. Any vessels that vented during the digestion will need to have the sample redigested and either use less sample or a longer ramp at the lower temperatures.

Notes:

1. Different sample types will require different heating programs to prevent losses due to exceeding the maximum vessel pressure.

2. To keep the same sample dilution, as little as 0.25 g of sample can be weighed and diluted to a final volume of 25.0 ml. using 1/2 of the HNO3 and H2O2.

3. This digestion can be used for Flame AA, HGA, CV, and ICP.

4. If Mercury is to be run, remove a 10 ml aliquot immediately after dilution and place in a plastic tube and add 100 microliters

of concentrated Trace Metal grade Hydrochloric Acid.

Method Code: 013

LABORATORY: Laboratory and Environmental Testing, Inc.

Cold Vapor AA

Turn on the computer, printer, 3100, FIAS 200,and Argon. Place the appropriate lamp in the instrument and if an EDL turn to its required power. Place the furnace in the burner compartment if it is not already present.

When the computer is ready double click on the WinLab Analyst icon. If the technique is not already FI-Hydride then click on technique and change to FI-Hydride. After the computer has confirmed the IEEE connections are OK, click on Workspace and double click fias.fms. When the screens come up double click on the method and double click on the Hg-CV method. Click on FIAS and turn on the cell.

When the lamp has had time to warm up click on lamps and enter the Hg and click on EDL. Check lamp alignment and wavelength to give the maximum signal. Close lamps.

Prepare the 10% HCl, 5% Stanous Chloride-10% HCl, Calibration standards, and check standards. Change the FIAS tubing and mixing cell if it is not already the set for Mercury. Change the position of the tubing or new tubes, if both positions have been used or determining a different element.

Check the alignment of the furnace in the light path by clicking on Tools and Continuous graphics. Autozero, then check all three positional knobs to get the lowest reading. Autozero whenever necessary.

Start the pumps and place the tubes in the HCl and Stanous Chloride. Run a 10 or 20 PPB standard until the sensitivity has stabilized and consecutive readings vary by less the 2%.

Enter the samples to be run into the Sample Information File. Enter a name for the Data file, and make sure that print log and store data are checked. When the instrument is ready click on Analyze All.

Calibration is done with 0, 1.0, 5.0, 30.0 PPB. QC checks are 10.0, 20.0 and a known Reference Sample(Usually ERA). The 5.00 PPB standard is checked every 10 tubes and if is more than 5% from 5.00 the instrument is recalibrated. If the value is more than 10% from 5.00, then the last 10 samples must be rerun.

After the analysis is finished, rinse system with D.I. water, turn off the pumps (release the pressure), turn off the EDL lamp, the Argon, FIAS and 3100. Click on File then Exit to close the WinLabs Analyst.

Click on WinLab Reformat Icon. Click on Open Design. Pick the design for Hg-CV. Then Browse and find the file name given the data. Place a 3.5" disk in the computer and click on Save Results.

Transfer disk to computer and using Excel calculate the results.

Method Codes:	009 016

Lab Matrix	Analyte
Animal Tissue	Cadmium
	Lead

Method Code: 009

LABORATORY: Laboratory and Environmental Testing, Inc.

L10 - Microwave Digestion

1. Weigh 0.5 g of dry sample into a clean Teflon digestion vessel. Record the weight to three decimal places.

2. Add 5.0 ml. of concentrated trace metal grade HNO3.

3. Loosely seal to allow release of pressure from the initial acid reaction with the sample.

4. After a few minutes open the vessel and add 1.0 ml of high purity H2O2.

5. Loosely seal the vessel to allow release of pressure.

6. Cap the vessel at the recommended pressure and place in the microwave. Run the program set up for this type of sample.

7. After the microwave heating is complete and the samples have cooled to room temperature, open the vessels and dilute the sample to 50.0 ml. with D.I. water and transfer to a clean 2 oz. plastic bottle. Any vessels that vented during the digestion will need to have the sample redigested and either use less sample or a longer ramp at the lower temperatures.

Notes:

1. Different sample types will require different heating programs to prevent losses due to exceeding the maximum vessel

pressure.

2. To keep the same sample dilution, as little as 0.25 g of sample can be weighed and diluted to a final volume of 25.0 ml. using 1/2 of the HNO3 and H2O2.

3. This digestion can be used for Flame AA, HGA, CV, and ICP.

4. If Mercury is to be run, remove a 10 ml aliquot immediately after dilution and place in a plastic tube and add 100 microliters of concentrated Trace Metal grade Hydrochloric Acid.

Method Code: 016

LABORATORY: Laboratory and Environmental Testing, Inc.

Graphite Furnace using the 5100 Zeeman

Turn on the Furnace Coolant, Argon, Computer, Furnace, Zeeman Power Supply and 5100 in that order. Make sure the lamp is in the right position in the turret, and if using an EDL turn on the lamp to the proper power.

Double click on the AA WinLab Analyst icon. After the ZHGA-600 and 5100 icons have a green check by them, click on workspace. Double click on LET.fm, then double click on the method. Choose the method to be run and double click on the name. Click on Browse by the Sample Information File, and then pick one for standards. (Example: Pbstds.sif) Click on sample information icon to edit the file with sample names, dilutions, etc. Click Browse for the Results Data Set and enter the name of the file to store data. (Example: Pb010101) Click on Analyze. When samples have been prepared and ready for analysis, click on Analyze All if doing calibration or Analyze Samples if just running samples. The instrument is usually calibrated with a zero and one standard. Then a zero and 3-5 standards are run to check the calibration, followed by an instrument check standard and detection limit. If this is acceptable then the samples are run. Be sure to check that the correct modifier is being used for the element being run. Some samples may require the method of Standard Additions.

After the analysis is completed, close AA WinLab Analyst, turn off furnace coolant, Argon, 5100, Zeeman Power supply, Furnace and EDL power supply. Double click on the WinLab Reformat icon. Click on Open Design and choose the design for your element and double click on the name. Click on Browse and find the data file you want to reformat. Double click on the name. Make sure there is a floppy disk in the disk drive and click on Save Results. Transfer to another computer and calculate using Excel.

Method Codes:	009 018

Lab Matrix	Analyte
Animal Tissue	Aluminum
	Boron

Barium
Beryllium
Chromium
Copper
Iron
Magnesium
Manganese
Molybdenum
Nickel
Strontium
Vanadium
Zinc

Method Code: 009

LABORATORY: Laboratory and Environmental Testing, Inc.

L10 - Microwave Digestion

1. Weigh 0.5 g of dry sample into a clean Teflon digestion vessel. Record the weight to three decimal places.

2. Add 5.0 ml. of concentrated trace metal grade HNO3.

3. Loosely seal to allow release of pressure from the initial acid reaction with the sample.

4. After a few minutes open the vessel and add 1.0 ml of high purity H2O2.

5. Loosely seal the vessel to allow release of pressure.

6. Cap the vessel at the recommended pressure and place in the microwave. Run the program set up for this type of sample.

7. After the microwave heating is complete and the samples have cooled to room temperature, open the vessels and dilute the sample to 50.0 ml. with D.I. water and transfer to a clean 2 oz. plastic bottle. Any vessels that vented during the digestion will need to have the sample redigested and either use less sample

or a longer ramp at the lower temperatures.

Notes:

1. Different sample types will require different heating programs to prevent losses due to exceeding the maximum vessel pressure.

2. To keep the same sample dilution, as little as 0.25 g of sample can be weighed and diluted to a final volume of 25.0 ml. using 1/2 of the HNO3 and H2O2.

3. This digestion can be used for Flame AA, HGA, CV, and ICP.

4. If Mercury is to be run, remove a 10 ml aliquot immediately after dilution and place in a plastic tube and add 100 microliters of concentrated Trace Metal grade Hydrochloric Acid.

Method Code: 018

LABORATORY: Laboratory and Environmental Testing, Inc.

ICP on Perkin-Elmer 4300 DV

Make sure the instrument, Chiller, Air compressor, and gases are on, and at the proper temperatures and pressures. Turn on the computer and double click on the WinLAb32 icon.

Prepare standards and check samples to match the acid matrix of the samples to be analyzed. Change the pump tubing.

Click on "file", then "Open", and then "Method". Click on the method to be used and then click "OK", TO start the ICP program and call up the Method with the elements to be determined.

Click on the Plasma icon, and click on pump to start the pump and make sure the tubes are in the pump properly. Start the plasma by clicking the "On" icon. Click on the X in the upper right corner to close the Plasma Control. Allow the instrument to warm-up while the samples and standards are loaded into the auto-sampler racks. If the Sample Info table was not filled out previously, then fill in the sample information and save the table using the Batch ID.

Before starting the run, check the Hg wavelength by clicking on "Tools", and then "Spectrometer Control". Click on Hg Realign. When that is complete, aspirate a 10.0 Mn Standard and click on "Align View". After Align View is completed, close the box.

When ready to start analysis, click on the "Auto" icon, make sure that the data is being stored in a file with the correct name for the Batch, and that the right method is being used. Click the "Analyze" icon and click on "Analyze All".

When the run is completed, click on "File", then "Utilities", then "Data Manager". Highlight the file, and then click on "Export" icon. Click "Use Existing Design". Click "Browse" and choose the appropriate template (usually LET-ICP). Click "Open", place a disk in

the "A" drive, and click "Finish". Click on "Export Data" to transfer data to disk in Drive "A".

Transfer data to the main computer and calculate the final Concentrations.

APPENDIX C

Spreadsheets with analytical data

FINAL

REMEDIAL INVESTIGATION WORK PLAN

Anacostia River Sediment Project, Washington, DC

Prepared for

District Department of the Environment
Government of the District of Columbia

June 16, 2014

Prepared by

TETRA TECH

District Department of the Environment

Document Approval

The following District Department of the Environment staff certify that they approve this Remedial Investigation Work Plan for the Anacostia River Sediment Project located in Washington, DC:

Dev Murali, P.G.
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Document Approval Page (Tetra Tech, Inc.)

The following Tetra Tech professionals certify that they approve this Remedial Investigation Work Plan for the Anacostia River Sediment Project located in Washington, DC:

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ABBREVIATIONS AND ACRONYMS

AECOM	AECOM Technology Corporation
AFB	Air Force Base
ALM	Adult Lead Model
ANS	Academy of Natural Sciences
AOC	Area of Concern
AOI	Areas of Influence
ARAR	Applicable or Relevant and Appropriate Requirements
ARD	Assessment and Restoration Division
ASTM	American Society for Testing and Materials
AT	Averaging Time
ATSDR	Agency for Toxic Substances and Disease Registry
AVS	Acid Volatile Sulfides
AWTA	Anacostia Watershed Toxics Alliance
BAF	Bioaccumulation Factors
BaP	Benzo(a)pyrene
BERA	Baseline Ecological Risk Assessment
B-IBI	Benthic Index of Biotic Integrity
BOD	Biological Oxygen Demand
BSAF	Biota-Sediment Accumulation Factor
BTAG	Biological Technical Assistance Group
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
BW	Adult Body Weight (kg)
CalEPA	California Environmental Protection Agency
CC	Chain of Custody
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIP	Community Involvement Plan
CLP	Contract Laboratory Program
COC	Constituents of Concern
COPEC	Chemical of Potential Ecological Concern
CPAH	Carcinogenic Polycyclic Aromatic Hydrocarbon
CPRD	Coastal Protection and Restoration Division
CR	Contact Rate
CSM	Conceptual Site Model
CSO	Combined Sewer Outfall
CSS	Combined Sewer System
CSX	CSX Transportation
CTE	Central Tendency Exposure
CWA	Clean Water Act
DC	District of Columbia
DC Water	District of Columbia Water and Sewer Authority
DDD	Dichloro-diphenyl-dichloroethane
DDE	Dichloro-diphenyl-dichloroethylene
DDOE	District Department of the Environment

DDT	Dichloro-diphenyl-trichloroethane
DMR	Discharge Monitoring Report
DNAPL	Dense Nonaqueous Phase Liquid
DO	Dissolved Oxygen
DOI	Department of Interior
DQO	Data Quality Objectives
DRO	Diesel Range Organics
ED	Exposure Duration
EF	Exposure Frequency
EPA	Environmental Protection Agency
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ESA	Environmental Site Assessment
ESV	Ecological Screening Values
ET	Exposure Time (hr/day)
FCM	Food Chain Model
FFA	Federal Facilities Agreement
FSP	Field Sampling Plan
Fort McNair	Joint Base Myer – Henderson Hall
FWS	United States Fish and Wildlife Service
GIS	Geographic Information System
GPS	Global Positioning System
GSA	General Services Administration
GULF	Gulf Oil Corporation
HASP	Health and Safety Plan
HEAST	Health Effects Assessment Summary Tables
HEM	Hydrodynamic Ecosystem Model
HESS	Hess Oil Corporation
HHRA	Human Health Risk Assessment
HI	Hazard Index
HPAH	High Molecular Weight Polycyclic Aromatic Hydrocarbon
HQ	Hazard Quotient
HSPF	Hydrological Simulation Program – Fortran
I	Intake (Risk Assessment)
IEUBK	Integrated Exposure Update Biokinetic Model
IRIS	Integrated Risk Information System
IUR	Inhalation Unit Risk
JBAB	Joint Base Anacostia-Bolling
KL	Kingman Lake
KPN	Kenilworth Park Landfill North
KPS	Kenilworth Park Landfill South
LNAPL	Light Nonaqueous Phase Liquid
LOAEL	Lowest Observed Adverse Effect Level
LPAH	Low Molecular Weight Polycyclic Aromatic Hydrocarbon
LTCP	Long-Term Control Plan
LUST	Leaking Underground Storage Tank

MCL	Maximum Contaminant Level
MDE	Maryland Department of the Environment
MGP	Manufactured Gas Plant
MRL	Minimal Risk Level
MS4	Municipal Separate Storm Sewer System
MTBE	Methyl Tertiary Butyl Ether
NAPL	Non-Aqueous Phase Liquid
NAVFAC	Navy Facilities Engineering Command
NAVY	Depart of the Navy
NCP	National Oil and Hazardous Substances Contingency Plan
NFRAP	No Further Response Action Planned
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No Observed Adverse Effect Level
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRD	Naval Resource Damages
NRDA	Natural Resources Damage Assessment
NSFA	Naval Support Facility Anacostia
OCP	Organochlorine Pesticide
OERR	Office of Emergency and Remedial Response
OPA	Oil Pollution Act
ORD	Office of Research and Development
ORP	Oxidation and Reduction Potential
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PA	Preliminary Assessment
PA/SI	Preliminary Assessment/Site Investigation
PAH	Polycyclic Aromatic Hydrocarbon
PARCC	Precision, Accuracy, Representativeness, Completeness, and Comparability
PBDE	Polybrominated Diphenyl Ethers
PCB	Polychlorinated Biphenyl
PCDD	Polychlorinated Dibenzo-p-dioxins
PCDF	Polychlorinated Dibenzofurans
PDMS	Polydimethylsiloxane
PEC	Probable Effect Concentration
PID	Photoionization Detector
PMP	Project Management Plan
PP	Priority Pollutant
PPRTV	Provisional Peer-Reviewed Toxicity Values
PRG	Preliminary Remedial Goals
QAPP	Quality Assurance Project Plan
RAGS	Risk Assessment Guidance
RAS	Routine Analytical Services
RBC	Risk-Based Concentrations
RD/RA	Remedial Design/Remedial Action
REC	Recognized Environmental Condition

Region 3	U.S. Environmental Protection Agency Region 3
RfC	Reference Concentration
RfD	Reference Dose
RFI	RCRA Facility Investigation
RHA	Rivers and Harbors Act
RI/FS	Remedial Investigation/Feasibility Study
RME	Reasonable Maximum Exposure
ROD	Record of Decision
RP	Responsible Party
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SEFC	Southeast Federal Center
SEM	Sequentially Extracted Medals
SF	Slope Factor
SGT	Silica Gel Treated
SLERA	Screening Level Ecological Risk Assessment
SOW	Scope of Work
SPAWAR	Space and Naval Warfare Systems Center, San Diego
SQuiRTs	NOAA Screening Quick Reference Tables
SSC	Site Screaming Levels
SUF	Site Use Factor (Unitless)
SPMD	Semi-Permeable Membrane Devices
SVOC	Semivolatile Organic Compounds
2,3,7,8-TCDD	2,3,7,8-Tetrachlorodibenzo-p-Dioxin
TAL	Target Analyte List
TAM	Tidal Anacostia Model
TBC	To Be Considered
TCL	Target Compound List
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TRV	Toxicity Reference Values
TSS	Total Suspended Solids
UCL	Upper Confidence Limit
URS	URS Corporation
USACE	United States Army Core of Engineers
USACHPPM	U.S. Army Center for Health Promotion and Preventative Medicine
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VDEQ	Virginia Department of Environmental Quality
VOC	Volatile Organic Compounds
WASP	Water Quality Analysis Simulation Program
WASP5 EUTRO	Water Quality Analysis Simulation Program Eutrophication Model
WC	Washington Channel
WGL	Washington Gas Light Company

WNY Washington Navy Yard
WP Work Plan
XRF X-Ray Fluorescence

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1.0 INTRODUCTION

The District Department of the Environment (DDOE) is conducting a Remedial Investigation (RI) of the contaminated sediments within the tidal portion of the Anacostia River in Washington, D.C. The study area for the investigation is shown in **Figure 1.1**. On behalf of DDOE, Tetra Tech, Inc. (Tetra Tech) prepared this work plan (WP) consistent with elements of the Anacostia River Sediment Project Statement of Work (DDOE SOW) posted to http://ddoe.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/Anacostia%20River%20RIFS%20SOW%2004082013.pdf on April 10, 2013. Specifically, this WP addresses the DDOE SOW elements shown below (see **Table 1.1**). DDOE intends to initiate work on the other elements not specifically addressed by this WP in effort(s) separate from the RI.

TABLE 1.1.
Statement of Work Elements Addressed by this Work Plan

Scope Element	Addressed in this WP	Addressed as Separate Effort
Review existing data of the Anacostia River sediments, including the Conceptual Site Model (CSM) and Tidal Anacostia Model-Water Quality Analysis Simulation Program (TAM-WASP) Model prepared by Anacostia Watershed Toxic Alliance (AWTA)	✓	
Identify data gaps (including the age and validity of previously collected data) to support the remedial investigation and development and evaluation of remedial alternatives	✓	
Develop RI/FS Work Plan and Sampling and Analysis Plan (SAP) to address the identified data gaps	✓	
Perform all necessary field work to fill data gaps and support the RI	✓	
Update the CSM and TAM-WASP model based on the new data obtained		✓
Based on the new data obtained, determine the nature and extent of contamination in sediments for the tidal portion of the Anacostia River to build on prior investigations	✓	
Develop and implement a monitoring plan for tributaries, stormwater outfalls and combined sewer outfalls of the lower Anacostia watershed		✓
Monitor and update the status of the Anacostia River advanced capping demonstration site		✓
Prepare a draft remedial investigation report upon completion of field activities	✓	
Conduct a focused feasibility study to identify remediation requirements and establish cleanup levels as necessary to eliminate or prevent unacceptable risks to human health and the environment and identify, screen and evaluate potential remedial alternatives		✓
Prepare a draft feasibility study report		✓

This WP serves as the primary planning document governing characterization of river surface water, biota, and sediments (including the potential effects of groundwater seepage) for the purpose of completing the RI. Other planning documents associated with this WP prepared under separate cover include a field sampling plan (FSP), quality assurance project plan (QAPP), community involvement plan (CIP), project management plan (PMP), and health and safety plan (HASP). As requested by DDOE, the WP also addresses the environmental media characterization requirements associated with preparing a Natural Resources Damage Assessment (NRDA) for the river.

1.1 Objective

Consistent with the RI and NRDA processes, the objectives of this WP include the following:

- Determine the nature and extent of contaminated environmental media (surface water, sediment, groundwater seepage, and biota) in a manner consistent with the National Oil and Hazardous Substances Contingency Plan (NCP) 40 C.F.R. Part 300 and all applicable guidance and assess the associated risk to human health and the environment.
- Reduce overall costs for NRDA and RI field characterization by coordinating the NRDA and RI characterization sampling efforts to the extent practicable at this stage of the investigation.
- Collect site data to characterize general site conditions to support the completion of the feasibility study (FS) if needed to address unacceptable risk to human health and the environment.

1.2 Regulatory Background

As required by the DDOE SOW, this WP was prepared consistent with the RI process established in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended and the implementing regulations in the NCP, and Section 401(a)(2) of the District of Columbia Brownfield Revitalization Act of 2000. The United States Environmental Protection Agency (EPA) guidance document, *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA 1988) served as the primary resource for this effort.

A NRDA process is used to determine whether natural resources have been injured and to calculate damages needed to restore or compensate the public for the injured resources. As defined in the CERCLA statute, NRDA is separate from the RI process in that it focuses on injury and restoration of public resources. However, careful planning prior to sampling can integrate data collection so that much of the data collected during an RI can be used to support the NRDA process.

In addition to the above noted regulatory citation, the other relevant regulatory citations for the CERCLA and NRDA processes include 42 U.S.C. §§ 9601-9675, Executive Order 12580 and NRDA Regulations at 43 C.F.R. 11, Code § 8-632.01(b)(4) (allowing the District to recover for injury to, destruction of, or loss of natural resources, including the reasonable cost of assessing the injury, destruction, or loss resulting from the release of the hazardous substance), and 43 C.F.R. §§ 300.600 to 300.615 (trustees for natural resources).

1.3 Natural Resources Damage Assessment Strategy

Tetra Tech will integrate initial data collection for the NRDA with sampling and analysis for the RI, especially the ecological and human health risk assessments. Specifically, DDOE will attempt to collect data that will be useable once the NRDA is performed at a later date. Concurrent planning and sampling for the RI and NRDA saves time and money by eliminating multiple mobilizations and duplicate sampling. For example, fish, turtle, and invertebrate tissue concentrations and sediment toxicity data are used in both risk assessment and NRDA. Although Tetra Tech will optimize data collection for the NRDA during the RI field activity, the formal NRDA will be conducted at a later date pursuant to a separate work plan. Additional discussion regarding the NRDA process is provided in **Section 9.0**.

1.4 Scope

The current focus of the RI and NRDA is the tidal Anacostia River from its confluence with the Potomac River to its upper tidal limit at the confluence of Northeast Branch and Northwest Branch (**Figure 1.1**). By definition, the upper tidal limit is the upstream limit of tidal influence in the river. As a result of initial colonial era settlement and subsequent urbanization, the shoreline and channel have been significantly altered from predevelopment conditions. For the purposes of this WP, the scope includes the tidal river from bank to bank and excludes adjacent wetlands and floodplain surface soil. In addition, the surface soils on Kingman and Heritage Islands, mid-channel manmade islands located approximately 3.5 miles from the mouth, are considered to be similar to the floodplain soil and are, therefore, also excluded from this WP. The final boundaries of the study area will be based on the findings of the RI, and will be documented by DDOE in a record of decision (ROD) when the final remedy is selected. It should be noted that, based on the results of the tidal river investigation, additional future investigations, not covered by this work plan, may be performed in the river wetlands and floodplain.

Environmental investigation and cleanup work is completed, underway, or contemplated at multiple environmental cleanup sites bordering the tidal Anacostia River (**Figure 1.1**). From upstream to downstream, these sites include the following:

- Kenilworth Park Landfill
- Pepco Benning Road Facility
- CSX Benning Yard
- Steuart Petroleum Company Terminal Adjacent to the Washington Gas Light Company (WGL) East Station Site
- WGL East Station
- Washington Navy Yard
- Active Capping Pilot Study Site at O Street Combined Sewer Outfall (CSO)
- General Services Administration (GSA) Southeast Federal Center (SEFC)
- Former Steuart Petroleum Company/Hess Oil Corporation(Hess)/Gulf Oil Corporation (Gulf) Former Petroleum Terminals
- Joint Base Myer – Henderson Hall (Fort McNair)
- Joint Base Anacostia – Bolling
- Firth – Sterling Steel Company

If a Responsible Party (RP) is engaged in site cleanup activity at one of these sites, it is anticipated that the RP will also address sediment contamination in the adjacent impacted segment of the river channel, as warranted. The sampling approach for this WP incorporates the work already completed or planned at the known environmental cleanup sites. As such, although the sampling locations presented in this WP are defined broadly throughout the study area, some locations are also identified adjacent to the environmental cleanup sites (see **Figure 1.1**).

Figure 1.1 shows the portions (or Areas of Influence [AOI])of the tidal Anacostia River that could potentially be impacted by any contamination present on these sites. The AOIs are based on the contamination Areas of Concern (AOCs) identified by the AWTA in the "Charting a Course for the Cleanup of the Anacostia River" document (AWTA 2002). The AOCs were adjusted using the hotspots defined in the 2009 "White Paper" document also prepared by AWTA (AWTA 2009). If more detailed information was unavailable from the AWTA documents regarding the areas of sediment contamination, as a default AOI for these sites, AOI boundaries were extended to include the near shore sediments adjacent to the riverside boundary of each site.

1.5 Community Relations

DDOE is committed to public participation at every phase of the Anacostia River cleanup through an open process that encourages affected communities and interested organizations to provide input on the critical issues related to the site cleanup. DDOE has prepared a CIP (Tetra Tech 2013a) for the Anacostia contaminated sediments project. As noted above, the CIP is a companion document to this WP. The CIP describes the process the District and Tetra Tech will use to engage in dialogue and collaborate with communities and other key stakeholders. Overall, the goals for the community involvement program are as follows:

- Provide the public with accurate, timely, and understandable information and/or access to the information needed to understand the project as it moves forward;
- Provide the public with the opportunity to give informed and meaningful input;
- Ensure adequate time and opportunity for the public to provide input to be considered;
- Respect and give full consideration to the community input;
- Assist the public in understanding the project decision-making process during the project design and cleanup and the community's role in that process; and
- Provide consistency with CERCLA and the National Contingency Plan (NCP).

1.6 Work Plan Organization

In addition to this introduction, the WP includes ten sections. Tables and figures cited in each section are provided at the end of the section. A brief description of each is provided below.

Section 1.0 – Introduction. This section discusses the study objectives, regulatory context, project scope, and community involvement strategy for the Anacostia River Sediments RI.

Section 2.0 – Site Background and Physical Setting. This section provides information regarding site location, history, geology, hydrogeology, and sediment transport regimes. In addition, **Section 2.0** summarizes the key previous investigations and assesses data usability.

Section 3.0 – Preliminary Conceptual Model. The preliminary CSM discussion in this section includes an assessment of the constituents of concern (COC) in the investigation and describes contaminant sources, migration pathways, and potential human health and ecological receptors.

Section 4.0 – Work Plan Rationale. This section presents the data quality objectives (DQO) for the sediment investigation. In addition, the results of evaluations of the existing sediment (shallow and deep), surface water, fish tissue, and benthic community condition data are presented along with the results of a review of contaminant sources to the tidal Anacostia River. This section identifies the key remaining data gaps that will be addressed during the field phase of the RI.

Section 5.0 – Remedial Investigation. This section discusses the proposed sampling for the field investigation to fill identified data gaps (those identified in Section 4.0) for the RI and NRDA. Maps showing the proposed sampling locations are provided and discussed.

Section 6.0 – Data Evaluation and Reporting. Section 6 discusses the approach for managing, validating, evaluating, and reporting the data collected.

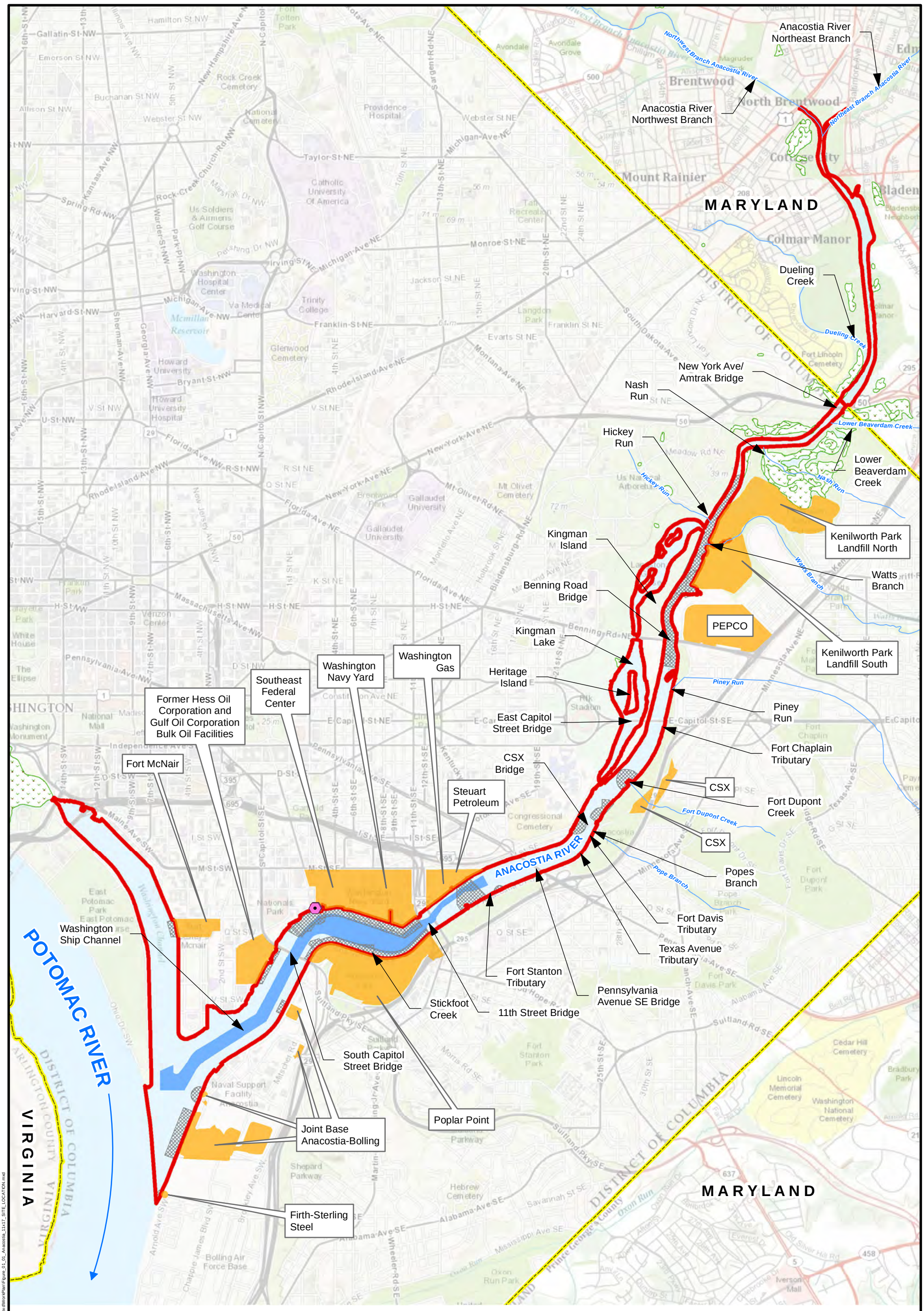
Section 7.0 – Ecological Risk Assessment. The process used to perform screening level and baseline ecological risk assessments (ERA) is discussed.

Section 8.0 – Human Health Risk Assessment. The process used to perform a human health risk assessment (HHRA) is discussed.

Section 9.0 – Natural Resources Damage Assessment Process. An overview of the NRDA process is provided in this section.

Section 10.0 – Schedule. Section 10 presents the schedule for the investigation and major deliverables associated with the RI.

Section 11.0 – References. A listing of the documents cited.



Legend

- O Street Outfall
- SEDIMENT STUDY AREA
- CLEANUP SITE BOUNDARY (LAND BASED PORTION)
- CLEANUP SITE AREA OF INFLUENCE
- WASHINGTON DC BOUNDARY
- WASHINGTON SHIP CHANNEL
- WETLANDS

SOURCE: MODIFIED FROM CH2MHILL, 2011, DCGIS, 2012, AND USFWS, 2012.

DRAFT

Note: The Cleanup Site Boundaries (Land Based Portion) for the Washington Navy Yard are reflective of its historic extent.

N W E S

0 1,500 3,000 Feet

ANACOSTIA RIVER SEDIMENTS PROJECT

FIGURE 1.1
SITE LOCATION MAP

TETRA TECH

Date Saved: 9/15/2014 9:34:45 AM User: joelpeters Path: S:\CADD\S\2592\mxd\WorkPlan\Figure_01_01_Anacostia_11x17_SITE_LOCATION.mxd

2.0 SITE BACKGROUND AND PHYSICAL SETTING

This section provides background information and discusses the physical setting of the tidal Anacostia River study area. Following a general description of the site and location in **Section 2.1**, **Sections 2.2 through 2.5** discuss site history, geologic setting, hydrogeology and hydrology, and sediment transport regimes. **Section 2.6** summarizes the key previous and ongoing investigations in the study area. The usability of the data generated in the previous site investigations is assessed in **Section 2.7**.

2.1 Site Location and Description

The Anacostia River drains an area of approximately 176 square miles (456 square kilometers) in Montgomery and Prince George's Counties in Maryland and Washington, DC. The study area for this investigation (**Figure 1.1**) includes the approximately nine mile tidal portion of the river which begins at the confluence of Northwest Branch and Northeast Branch near Bladensburg Marina in Prince George's County and extends downstream to the confluence of the Anacostia and Potomac rivers. The study area also includes the Washington Channel, an approximately 2.0 mile long channel extending northward from the mouth of the Anacostia at its confluence with the Potomac River. Haines Point separates the Washington Channel from the Potomac River. The upstream terminus of the Washington Channel is at the Tidal Basin, adjacent to the National Mall.

Section 303(d) of the federal Clean Water Act requires states to identify waters that fail to comply with water quality standards. A total maximum daily load (TMDL) is required for each exceeding substance. For the tidal Anacostia River, TMDLs have been established for polychlorinated biphenyls (PCBs), biochemical oxygen demand (BOD), bacteria, organics, metals, sediment, oil and grease, and trash (www.mde.state.md.us/programs/Water/TMDL/ApprovedFinalTMDLs/Pages/Programs/WaterPrograms/TMDL/approvedfinaltmdl/tmdl_final_anacostia_nutrients.aspx). The currently established 303(d) listing of TMDLs for several toxic constituents (PCBs, Polycyclic Aromatic Hydrocarbons [PAHs], and Organic Chlorine Pesticides [OCPs]) is based on limited data (Tetra Tech 2013c). As such, EPA and DDOE are currently conducting additional sampling of several Anacostia tributaries and will use the sampling results to support review and revision of the established TMDLs.

2.2 Site Dredging History

Elevated sedimentation rates have characterized the tidal Anacostia since colonial times. Beginning in the early 1600s, the dense hardwood forests originally present in the watershed were cleared for tobacco farming, leading to increasing erosion in the upland watershed and sedimentation in the estuary. In 1742 a port was established in Bladensburg to support the tobacco industry. By 1830, however, the port had become unusable because of channel siltation (United States Army Corps of Engineers (USACE) 1993). Several dredging events of the port were completed by the late 1800s.

Dredging of the Anacostia River has been ongoing with the destruction and reconstruction of wetlands during urbanization of the river over the past 100 years. USACE has been responsible for the dredging of the tidal Anacostia from the Potomac River in Washington DC to Bladensburg Maryland since the late 1890s (United States Geological Survey [USGS] 2009). Dredging is reported to be performed once every

two years (AWTA 2002). Expanded dredging operations occurred between 1910 and 1920 in response to concerns regarding mosquito-borne disease in communities near the mudflats that had formed upstream from the CSX railroad bridge. During this dredging campaign, the spoils generated were used to build Kingman Island and Heritage Island and form Kingman Lake.

Also during the 1916 timeframe, stone seawalls were constructed along the banks of the river with the area behind the seawall backfilled with dredge spoils. The construction of the seawalls eliminated almost all the tidal wetlands on the river with the exception of wetlands at the Kenilworth Park and Aquatic Gardens (USGS 2009). The area along the seawall bordering the eastern bank of the river was designated Anacostia Park (National Park Service (NPS) 2014). The seawall, particularly in upper reaches, has failed or is failing resulting in tidal influx through the resulting breaches and localized, limited reestablishment of wetlands.

Urbanization in the District and in neighboring Prince George's and Montgomery Counties accelerated in the 1940s and is ongoing. As discussed in more detail in Section 2.5, elevated sedimentation rates persist through the present time (USACE 1993).

In 1955 Congress approved reclamation and development work on the Anacostia including dredging Kingman Lake, dredging the river channel to Bladensburg, building seawalls, filling in low-lying areas with dredge material, and installing tidal gates (USACE 2011) on outfalls. In 1959 channel dredging and other improvements were completed.

Beginning in the early 1990s, some dredging was performed in association with wetlands restoration efforts focused on the reestablishment of the tidal freshwater marsh habitat that historically bordered the Anacostia River (USGS 2009). The USACE estimates that approximately 2,500 acres of tidal emergent wetlands have been destroyed in the Anacostia River between Bladensburg and the confluence with the Potomac River. This represents a 90 percent reduction from pre-urbanization conditions. Less than 100 acres of tidal emergent wetlands currently exist, including the restored Kenilworth Marsh. USACE completed several freshwater tidal wetland reconstructions on the Anacostia River between the early 1990s and the early 2000s. The restorations included the expansion of Kenilworth Marsh by 32 acres, the restoration of 42 acres of Kingman Marsh, and the restoration of six acres of Lower Kingman Island Fringe Wetlands. The wetlands were established through the placement of dredge sediment material from the Anacostia River, through hydraulic dredging, to increase elevations to support emergent vegetation (USGS 2009).

Dredged Anacostia River sediment that was used to restore Kenilworth Marsh was sampled shortly after placement at the marsh in 1993, and both sediment solids and sediment pore water exhibited evaluated concentrations of trace metals and various toxic contaminants. A 1998 document prepared by the U.S. Fish and Wildlife Service (Murphy et al. 1998) reports elevated levels of chromium, copper, lead, nickel, total PCBs, total dichloro-diphenyl-trichloroethane (DDT), and total chlordane in sediments, killifish tissue, and cattails in Kenilworth Marsh. Concentrations in these media were elevated relative to a regional reference location and to national averages. The report attributed the contamination to the use of dredged Anacostia River sediments that were used to restore the marsh and recommended that

in the future, dredge spoils from the Anacostia should be sampled and the results evaluated prior to their use for wetlands reclamation (Murphy et al. 1998).

Other dredging activity in the lower portion of the Anacostia (south of the CSX railroad bridge) included periodic dredging of the Washington Ship Channel. The following summary regarding Washington Ship Channel and Washington Navy Yard dredging is taken from the Washington Navy Yard RI report (CH2M Hill 2011a). The Washington Ship Channel was constructed to provide larger vessel access upstream to the foot of 15th Street Southeast, just downstream from the Pennsylvania Avenue Bridge. The channel width ranges from 800 to 400 feet and the depth ranges from 16 to 22 feet. The earliest dredging of the Washington Ship Channel occurred in the late 1800s. The most recent dredging of the channel occurred in 1985 and up to six feet of sedimentation has occurred in some portions of the dredged channel since that time. The area adjacent to the Washington Navy Yard piers was dredged in approximately 1965 to a depth of 24 to 26 feet below water surface (CH2M Hill 2011).

The maintenance of Washington Ship Channel and the lower reach of the Anacostia River, by USACE has been ongoing since 1935. The channel includes turning basins opposite the Washington Navy Yard (800 feet wide and 2400 feet long) and near the mouth of the Anacostia River (400 square feet).

2.3 Geologic Setting

The Washington, DC area straddles the Fall Line, a northeast-trending physiographic boundary separating the Piedmont province to the west from the Coastal Plain province to the east. The Piedmont is underlain by deeply weathered metamorphic and igneous rocks dipping to the southeast at about 125 feet per mile (Johnston 1964). In the study area, these units are overlain by an eastward thickening wedge of unconsolidated Coastal Plain deposits (Johnston 1964). The study area encompassing the tidal Anacostia River and Washington Channel is entirely underlain by Coastal Plain deposits.

Table 2.1 shows the geologic column for the study area. The Coastal Plain formations range in age from Cretaceous to Recent (Cooke 1952). From youngest to oldest, these units consist of fill material, Quaternary sediments, and Cretaceous age formations belonging to the Potomac Group. The Potomac Group is underlain by Paleozoic age metamorphic and igneous rocks collectively known as basement rock. In the study area, basement rock is encountered at a depth of approximately 400 feet below ground surface (Johnston 1964). The Quaternary deposits include natural river channel and over bank deposits consisting of sand, silt, and clay which generally coarsen toward the upstream limit of the tidal channel and where outfalls and tributaries enter the main stem. In addition to these deposits, dredge spoils (as noted above) and random fill have been used to extend upland areas into the river and adjacent wetlands. Random fill typically consists of building rubble, heterogeneous soils, and other miscellaneous materials.

Underlying the fill and recent deposits are the formations that collectively comprise the clay and silt facies of the Potomac Group. This facies includes the Arundel Clay and the Patapsco Formation which are undifferentiated in the District (D.C. Water Resources Research Center [DCWRRC] 1993). The clay and silt facies is underlain by the sand and gravel facies of the Potomac Group. The thickness of the both Potomac Group facies in tidal Anacostia River vicinity is approximately 350 feet (Koterba, Dieter, and

Miller 2010). The clay and silt facies is described as silty clay with interbedded irregular sand and gravel lenses (DCWRRC 1993). Where the Potomac Group attains greater thickness to the east and northeast of the District, this facies is differentiated into an upper, coarser grained unit (Patapsco Formation) and an underlying finer grained unit (Arundel Clay). The sand and gravel facies consists of gravel, sand, and arkosic sediments with occasional sandy clay lenses. This unit correlates with the Potomac Group Patuxent Formation (DCWRRC 1993).

2.4 Hydrogeology and Hydrology

This section provides a brief summary of the hydrogeology of the study area and the hydrology of the tidal Anacostia River.

Hydrogeology. The hydrostratigraphic units in the study area include, with increasing depth, perched groundwater units, the water table aquifer, the Potomac Group confining unit, and the Patuxent aquifer (**Table 2.1**). In the study area, perched groundwater may occur as isolated shallow saturated zones occurring within a depth of six feet below ground surface (DCWRRC 1993). The water table aquifer occurs in the saturated portions of the various permeable units present adjacent to and, in some cases, extending beneath the river channel. Depending on location, the geologic units that comprise the water table aquifer include the random fill units, Quaternary deposits, and Patapsco Formation sediments. The Potomac confining unit, corresponding to the Potomac Group clay and silt facies, is a confining unit separating the water table aquifer and the deeper Patuxent aquifer. As reported by Ecology and Environment, Inc. (2008), the Patuxent aquifer is confined in the study area vicinity. At a National Arboretum aquifer test well located approximately 0.5 miles northeast of the site, the static water level was 12 feet higher than the ambient water table elevation at the Kenilworth Park South Landfill site, an environmental cleanup site located nearby and adjacent to the river (Ecology and Environment 2008).

A review of the site characterization results from three cleanup sites located along the tidal Anacostia reveal general characteristics regarding the hydrogeology of the water table aquifer in the immediate vicinity of the Anacostia River. The three sites include the Kenilworth Park South Landfill (Ecology and Environment 2008), CSX Benning Yard (EnviroScience 2013), and the Washington Navy Yard (CH2M Hill 2011a). At each site, the lithology of the water table aquifer is quite diverse, ranging laterally and vertically from fill material unique to the each site to alluvium/dredge spoil to coarse grained Quaternary deposits. Interbedded lower conductivity units, primarily consisting of alluvium or alluvium-derived dredge spoil result in the presence of perched or confined groundwater of local extent. At each site, groundwater discharges to the Anacostia River. Tidal influence on water table aquifer groundwater level fluctuations is muted and restricted to wells in close proximity to the river.

Hydrology. Tidal influences in the Anacostia River extend throughout the study area and into the Northeast Branch and Northwest Branch for approximately one mile beyond the upstream limit of the study area. The average variation of the river's water surface over a tidal cycle is three feet (Behm et al. 2003). Tidal level changes occur as a standing wave (AWTA 2002), meaning that tidal changes occur nearly simultaneously throughout the estuary. The entire estuary, however, is freshwater (Behm et al. 2003). The following physical description of the river is excerpted from the document "TAM/WASP Toxics Screening Level Model for the Tidal Portion of the Anacostia River" (Behm et al. 2003):

From an analysis by the National Oceanographic and Atmospheric Administration (NOAA) of sounding data taken by the US Army Corps of Engineers prior to a 1999 dredging project combined with additional bathymetry data taken by the Navy in the summer of 2000, the volume of the tidal portion of the river at mean tide is approximately 10,000,000,000 liters (2,642,000,000 gallons), with a surface area of approximately 3,300,000 square meters (m2) (35,521,000 ft2). The width of the river varies from approximately 60 meters (m) (196 ft) in some upstream reaches to approximately 500 m (1,640 ft) near the confluence with the Potomac, and average depths across channel transects vary from approximately 1.2 m (3.9 ft) upstream of Bladensburg to about 5.6 m (18.3 ft) just downstream of the South Capitol Street Bridge. The average daily combined discharge of the Northeast and Northwest Branches into the tidal river is approximately 370,000,000 liter/day. During non-storm conditions, measured flow velocities during the tidal cycle have been in the range of 0 to 0.3 m/sec (0 – 1 ft/sec) (Katz et al. 2000; Schultz and Velinsky 2001).

The Northeast Branch and Northwest Branch account for approximately 77 percent (Warner et al. 1997) of the total discharge of the Anacostia River with the balance of the flow originating from tidal tributaries, storm sewer outfalls, combined sewer system (CSS) outfalls, overland flow, groundwater seepage, and precipitation. River current velocities and mixing are also discussed by Behm et al. (2003). An investigation by the Space and Naval Warfare Systems Center, San Diego (SPAWAR) (Katz et al. 2001) found that current velocities were primarily directed along the axis of the channel, were relatively homogeneous throughout the water column, and were relatively low. The maximum observed velocity over a tidal cycle (30 cm/sec [1.0 ft/sec]) was measured in the vicinity of the CSX railroad bridge located approximately 3.5 miles upstream from the mouth. The lowest velocity (10 cm/sec [0.33 ft/sec]) was measured downstream from the South Capitol Street Bridge, 1.5 miles from the mouth. Currents were directed primarily along the axis of the channel and homogeneous throughout the water column; cross-channel currents were negligible. AWTA (2002) estimates that the flushing time for the tidal channel averages 23 to 28 days.

2.5 Sediment Transport Regimes

The major physical processes that determine sediment contaminant fate and transport are bed load transport and deposition, sediment burial, and sediment resuspension in the water column. AWTA (2002) provides a general assessment of how these processes interrelate along the tidal Anacostia River and the following discussion summarizes this evaluation. The bulk of sediment transported to the estuary enters where Northeast Branch and Northwest Branch join to form the tidal Anacostia River. Scatena (1986) estimates the sediment contribution from these two tributaries to be 85 percent of the total load delivered to the estuary. Below the Northeast Branch – Northwest Branch confluence, the current is too slow to transport the coarser grain size fractions so these materials deposit in an accretion zone just downstream of the confluence. Finer silt and clay size material, however, remain suspended and continue downstream.

For the approximately 5.5 mile stretch of channel from Bladensburg south to the CSX Railroad Bridge, AWTA characterizes the sediment transport regime as akin to a "conveyor belt" in which fine sediments move downstream in suspension without net deposition or erosion. Localized deltas of coarser grained sediments occur where outfalls and tributary streams discharge to the main channel. Between the CSX Railroad Bridge and the 11th Street Bridge, the sediment transport regime is transitional from general equilibrium transport to total deposition. Here, transport or deposition may dominate depending on local variations in current speed. Below the 11th Street Bridge, the river channel widens and deepens and, as a result of decreased flow velocity, the sediment regime is dominated by total deposition.

Hydrodynamic and sediment contaminant transport modeling suggests that 90 percent of the sediment delivered to the tidal Anacostia River is trapped and deposited (AWTA 2002). A study of cores taken offshore from the Poplar Point environmental site estimates that the deposition rate in this portion of the river ranges between 3.0 and 7.0 centimeters per year (cm/yr) (Velinsky et al. 2011).

2.6 Previous Environmental Investigations and Ongoing Activities

The Anacostia River has been the subject of numerous previous investigations dating back to the 1980s. This section summarizes the previous specific investigations considered in the development of this WP. In general, each investigation focused on a particular medium, including surface sediment, subsurface sediment, surface water, fish tissue, or bioaccumulation by benthic invertebrates. Some previous sediment sampling investigations covered the entire study area while others focused on a limited area such the portion of the channel bordering one of the upland environmental sites noted in **Section 1.4**. Site-wide investigations of effects on fishes and benthic organisms have also been conducted (McGee et al. 2009; Pinkney et al. 2003; Pinkney 2009, 2013).

2.6.1 Site-wide Investigations

As a result of general concern regarding the poor quality of the Anacostia Watershed and to coordinate an overall strategy for cleanup, the EPA Office of Solid Waste and Emergency Response (OSWER) convened in 1999 the AWTA, a public and private consortium of government agencies, institutions, and private stakeholders. As stated on the AWTA website http://mapping.orr.noaa.gov/website/test/anacostia/guide/home/awta.html, AWTA's mission is "to work together in good faith as partners to evaluate the presence, sources, and impacts of chemical contaminants on the Anacostia River with all stakeholders, both public and private, plus other parties, and to evaluate and take actions to enhance the restoration of the river to its beneficial use to the community and ecosystem as a whole." AWTA is currently disbanded. As a member institution of the AWTA, the NOAA Assessment and Restoration Division (ARD) developed the Anacostia River Watershed Database and Mapping Project (NOAA database).

The NOAA database serves as a publicly accessible, geospatially-referenced data repository for the environmental data generated during key environmental investigations, past and present, conducted in the Anacostia Watershed. The NOAA database was used as the starting point for the development of a project database to support the development of this WP. The database was updated with the sampling results from two recently completed investigations including the work completed at the Washington

Navy Yard and CSX Benning Yard. Available fish tissue concentrations and benthic invertebrate condition data were also added to the project database.

Table 2.2 lists the previous investigations for which data are available in the project study area for the various environmental media. In addition, **Table 2.2** indicates the 11 previous investigation datasets that are included in the project database. **Figure 2.1** shows the spatial distribution of the surface sediment data for each of the previous investigations considered. Specific reference information for each investigation is shown in the table if this information was attainable. The table also shows the numbers of samples by environmental medium available from each study. The key investigations included in the review are summarized below. Data usability for the data retained for WP development is discussed in **Section 2.7**.

Academy of Natural Sciences (ANS), 2000 (Velinsky and Ashley 2001). A total of 134 surface sediment samples were collected providing reasonably good spatial coverage for the entire tidal Anacostia River and the Washington Channel. Samples were analyzed for PCB congeners, pesticides, semivolatile organic compounds (SVOCs) including priority pollutant (PP) PAHs, and selected metals.

Phelps, H. L., 2001 (and other studies). Asiatic clams were translocated from a presumably clean site in the Potomac River to Bladensburg Marina and the O Street CSS outfall near the Southeast Federal Center. The objective of the study was to use Asiatic clams as a surrogate to evaluate the bioavailability of sediment contaminants in benthic organisms. Details regarding this investigation are available in **Section 4.2.5.1**.

U.S. Fish and Wildlife Service (Pinkney et al., 2001 and Pinkney 2009). Fish tissue (fillets) sampling was conducted in two reaches of the Anacostia River designated as upper (north of the CSX Railroad Bridge) and lower (south of the CSX Railroad Bridge). This investigation focused on evaluating contaminant levels in the tissues of fish species typically caught and consumed by anglers. A description of this investigation is provided in **Section 4.2.5.2**.

DDOE, Ongoing. As a requirement of the District of Columbia Municipal Separate Storm Sewer System (MS4) National Pollutant Discharge Elimination System (NPDES) permit issued by EPA, DDOE historically conducted routine wet and dry weather sampling of nine stations in the Anacostia River watershed (Hawkins 2009). Under the latest MS4 Permit (issued October 2011), sampling is occurring at two stations in the Anacostia watershed on an interim basis. DDOE is in the process of developing a revised monitoring framework which is scheduled to be completed by May 2015. According to sampling protocol, storm water samples are to be collected during the first two hours of a storm event. The water is analyzed for BOD, total dissolved solids (TDS), total suspended solids (TSS), various inorganics, 13 metals, hardness, 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD), and bacteria (fecal coliform and fecal streptococcus).

DDOE Division of Fisheries and Wildlife conducts fish tissue surveys (with United States Fish and Wildlife Service [FWS]) about every five years to evaluate the need for fish consumption advisories, which have been in place on the Anacostia River since the late 1980s. Consumption advisories are in place because concentrations of PCBs and pesticides in fish tissue warrant institutional controls to protect human

health (Pinkney 2009). Fish tissue concentrations in samples collected in 2013 to update the consumption advisory will be incorporated into the HHRA. No additional fish samples will be collected under the RI to support the HHRA.

U.S. Environmental Protection Agency, Ongoing. In partnership with DDOE, EPA is conducting a review of TMDL determinations in the Anacostia River, Potomac River, Rock Creek, and selected tributaries to these streams (Tetra Tech 2013). The investigation involved a review of previously collected water, sediment, and fish tissue data from these waterbodies. This review has been completed as of the date of this work plan. Based on the results of this review, EPA is conducting, beginning in the third quarter of 2013, monitoring of 29 locations to assess the TMDL for the COCs. Fourteen of the locations are sited along the Anacostia River or one of its tributaries. Sampling will occur during one dry and two wet periods for the Anacostia River and tributaries and during one dry period for the Potomac River tributaries and Rock Creek tributaries. Sampling locations with any parameters above the applicable water quality criteria will be evaluated during TMDL development for the waterbody.

2.6.2 Site-Specific Investigations

As noted in **Section 1**, investigations are completed, ongoing, or contemplated at 13 environmental sites that border the river. The current regulatory status of each site, as presented in the DDOE SOW is summarized below. In addition, the available sediment characterization data are summarized. For sites with pending investigations, the planned sampling activities are discussed. Unless otherwise noted, with regard to PAH compound chemical analysis of environmental samples, the number of reported PAH compounds reported is assumed to be the 16 PP PAHs (see Section 3.1.1). Additional details regarding specific contamination issues at each site are provided in **Section 3**.

Kenilworth Park Landfill (The Johnson Company 2012). The Kenilworth Park landfill is a 130 acre site owned by the U.S. government and managed by the NPS, the lead agency carrying out CERCLA actions for the site. The site is located within Kenilworth Park and Aquatic Gardens, which is part of Anacostia Park. The site comprises two geographic areas divided by Watts Branch (a tributary of the Anacostia River), Kenilworth Park Landfill North (KPN) and Kenilworth Park Landfill South (KPS). Kenilworth Landfill was used as a dump from 1942 to 1968. During a portion of this period the landfill extended into the Anacostia River and no barriers were constructed to prevent migration of wastes mixed with soil into the water.

Between 1998 and 2009, a number of environmental investigations were undertaken to determine the nature and extent of contamination at the Kenilworth site, including Preliminary Assessment/Site Inspections (PA/SIs), Remedial Investigations (RIs), and supplemental data collection and associated reporting. The site has been divided into two operable units (OUs): OU1 comprises surface and subsurface soils, including the waste material disposed of within the landfill; OU2 is the shallow groundwater underlying OU1. In April 2012, NPS prepared a FS Report recommending a soil cap for OU1. On March 1, 2013, the Proposed Plan for Cleanup of the Kenilworth Park landfill site (OU1) was released for 60-day public comment period. However, as noted on the project website (www.nps.gov/nace/parkmgmt/kplspm.htm), NPS has decided to postpone selecting a final remedy for the landfill until more groundwater data are available. To ensure that contaminants are not being

transported from the landfill to the adjacent water bodies, NPS will collect additional groundwater data in 2014. The additional data will be used to supplement existing data in order to reevaluate whether the Anacostia River and adjacent surface water bodies may be at risk from contaminants originating from the wastes disposed in the landfill. The additional groundwater data also will be used to further inform the selection of the remedy for the landfill.

During the PA/SI conducted in 1998 by Ecology and Environment, Inc. (Ecology and Environment) (2008), 19 sediment samples were collected from the Anacostia River, 11 of which were located adjacent to the site. All samples were collected near the shoreline. The sampling occurred in two rounds. Samples from the first round were analyzed for PAHs, pesticides, PCB Aroclors, and metals while samples from the second round were analyzed for only PAHs, PCBs, and metals. EPA SW846 methods were used for all analyses with PAH, pesticide, PCB Aroclors, and metals analyzed via methods 8270C, 8081A, 8082, and 6010B, respectively.

The Kenilworth Landfill FS report (The Johnson Company 2012) summarizes the sediment sampling results from the Anacostia River in the vicinity of the site. The highest PAH concentrations observed in river sediments (13,780 and 12,900 ug/kg) were from samples collected across from the site along the eastern bank of Kingman Island. The FS reported a variable distribution of PCB Aroclor concentrations in the Anacostia River with the maximum concentration (1,334 ug/kg, total Aroclors) observed in a sample collected near the east bank of the river downstream from the site. Other total Aroclor concentrations measured in river sediments near the site ranged from 15.5 to 499 ug/kg. Lead concentrations in river sediments adjacent to the site ranged from less than 40,000 to 177,000 ug/kg . The data indicated a slight upward trend from upstream to downstream (The Johnson Company 2012).

Pepco Benning Road (AECOM Technology Corporation [AECOM] 2012). The Pepco Benning Road facility is located at 3400 Benning Road NE, Washington DC. Pepco currently uses the 77 acre site to manage operations and maintain equipment associated with their electrical distribution system. Several PCB, petroleum, and metals releases to the environment occurred between 1987 and 2003 resulting from spills of contaminated oil or leaking equipment. Pepco performed cleanup activities in response to each of these releases in accordance with applicable legal requirements. Pepco prepared an RI/FS work plan pursuant to a consent decree that was entered by the U.S. District Court for the District of Columbia on December 1, 2011. After an extensive review and comment period, the work plan was approved by DDOE on December 28, 2012. Field work associated with the RI/FS was initiated in January 2013. Analytical results from this investigation were unavailable as of the release date of the WP for public comment (January 2014).

The sediments portion of the investigation will characterize sediment quality horizontally and vertically in the vicinity of the Pepco site. The investigation will cover an area of approximately 10 to 15 acres which will extend approximately 1,500 feet south and 1,000 feet north of the site. A total of 45 surface sediment samples will be collected near the site with 10 additional surface sediment samples collected for background characterization purposes. Surface sediment samples will be analyzed for PCB Aroclors, metals, PAHs, and acid volatile sulfides (AVS)/simultaneously extracted metals (SEM). Selected surface sediment samples (up to 20) will be analyzed for volatile organic compounds (VOCs), SVOCs, pesticides,

and polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). In addition, up to eight samples will be analyzed for PCB homologs and/or congeners and PAH fingerprinting analyses.

Subsurface samples will be collected at three depths based on visual inspection at all 55 surface sediment sampling locations. Subsurface sediment will be accessed to a depth of eight to 10 feet via the vibracore drilling method. All subsurface samples will be analyzed for PCB Aroclors and PAHs. A subset of up to seven of the subsurface samples will also be analyzed for PCB homologs and/or congeners. Subsurface samples will also be analyzed for total organic carbon (TOC) and grain size.

Surface water samples will be collected at 20 locations from a depth of approximately one foot above the sediment surface. In addition to the measurement of field parameters (temperature, dissolved oxygen, pH, turbidity, and specific conductivity), samples will be laboratory-analyzed for PCBs, PAHs, hardness, and total and dissolved metals.

CSX Benning Yard (EnviroScience 2013). CSX Transportation (CSX) owns and operates Benning Yard located at 225 33rd Street, SE, Washington, DC. Benning Yard is an active railroad switching yard. Historically, a portion of Benning Yard was used to store and dispense diesel fuel to locomotives. In the 2004 timeframe, a new office building and parking facility were constructed in the area where fueling operations had previously been conducted. Subsurface hydrocarbon contamination was observed during this construction and, subsequently, it was determined that hydrocarbon-impacted groundwater was seeping into adjacent Fort Dupont Creek, a tributary to the tidal Anacostia River. Further investigations revealed the presence of a light nonaqueous phase liquid (LNAPL) plume in the water table aquifer and, on occasion, the presence of a petroleum sheen on Fort Dupont Creek. CSX submitted a corrective action plan to DDOE for cleaning up spill-contaminated soil and groundwater in April 2013.

A sediment investigation including Fort Dupont Creek and the Anacostia River was conducted in 2011. Surface sediment grab samples were collected at 18 locations on Fort Dupont Creek and 35 locations on the Anacostia River. Sediment core samples were collected at 18 of the surface sampling locations. All samples were analyzed for total petroleum hydrocarbons (TPH) diesel range organics (DRO) (Method 8015), VOCs (Method 8260), SVOCs (Method 8270), metals (Method 6020), pesticides (Method 8081), PCB Aroclors (Method 8082), TOC (Method 9060), oil and grease hexane extractable material, and TPH hexane extractable material silica gel treated (SGT). Anacostia River samples were also analyzed for 209 PCB congeners (EPA Method 1668) and PAH fingerprinting analyses. The total PAH analyses reported concentration results for 51 PAH compounds. Surface sediment and subsurface sediment samples were collected. Subsurface samples were collected from the depths of 0.5 to 1.0 foot, 1.0 to 2.0 feet, and 2.0 to 3.0 feet below the river bottom.

Sediment samples collected in the Anacostia River in close proximity to the Fort Dupont Creek Outfall were generally coarser in grain size and exhibited lower measured constituent concentrations. Within 150 feet of the outfall, total PAH concentrations in surface sediments range from less than 600 to more than 14,000 µg/kg. Concentrations away from the outfall generally exceed 12,000 µg/kg. Similarly, total PCB concentrations (sum of all congeners) were generally less than 100 µg/kg within 150 feet of the

outfall, while total PCB concentrations in the 300 to 800 µg/kg range were more typical out in the river channel and away from the outfall.

WGL Company Site (Hydro - Terra 1999). The WGL Company site covers an area of approximately 18 acres formerly containing the East Station manufactured gas plant. On September 26, 2012, WGL entered into a Consent Decree with the District of Columbia, Department of the Interior (DOI) NPS, and EPA to conduct additional landside and sediment studies. The 2012 Statement of Work (SOW) addresses the impacts to surface soil and subsurface soil (Operating Unit 1 [OU1]) as well as to groundwater, surface water, and river sediments (OU2). A draft Remedial Design/Remedial Action (RD/RA) Work plan for OU1 and a draft Remedial Investigation/Feasibility Study (RI/FS) Work plan for (Operating Unit 2 [OU2]) are under review by NPS and the DDOE.

Surface sediment samples were collected from the Anacostia River at seven locations adjacent to the WGL East Station site in 1996 (NOAA database). VOC concentrations ranged from 150 to 430 and averaged 260 µg/kg (EPA 1999). For total PAHs, concentrations ranged from 3,940 to 226,700 ug/kg. Total PAHs averaged 129,000 µg/kg (EPA 1999).

In accordance with the above noted 2012 scope of work that includes the OU2 RD/RA, WGL will conduct additional characterization of the nature and extent of site contamination in groundwater discharging to Anacostia River surface water and sediments (National Capital Parks – East 2011). Groundwater contamination and NAPL characterization will focus on the seawall portion of the site for the purpose of assessing preferential migration pathways to surface water and sediments.

WGL will also conduct a sediment investigation that will include a review of all existing data to identify data gaps, a bathymetric survey, a benthic organism study, the collection of pore water samples, and the delineation of the area and depth of contaminated sediment. Sediment sample analysis will include fingerprinting/forensic analysis of PAHs.

Poplar Point (Ridolfi Engineers 2003). The Poplar Point site is bordered to the north by the Anacostia River. Roadways, ramps and medians for the 11th Street Bridge form the northeast border of the site while roadways and medians for the South Capitol Street Bridge form the northwest edge of the site. The site is bordered to the south by Howard Road. The Poplar Point site encompasses an area of approximately 96 acres. The site includes former tree and plant nurseries that operated from 1927 to 1993. In addition, a separate portion of the site was used by the Navy as the Naval Receiving Station from 1942 through the 1960s (Ridolfi 2003a). In 1980, the Navy completed the decommissioning of this facility with the demolition or transferal of the remaining buildings to the NPS (Dolf 2001). Currently, the NPS is in the process of reviewing the draft RI/FS work plan. Following the approval of the WP, field activities will commence.

Anacostia River surface and subsurface sediments were sampled in the Poplar Point vicinity by Velinsky and others (2011). Sampling was conducted via vibracore to depths ranging from 13 to 16 feet below the sediment surface. Each coring location was from the undredged portion of the channel. Cores were subsampled at an interval of approximately one sample per each 1.3 – 1.5 feet and analyzed for metals,

PAHs, 100 PCB congeners, pesticides, grain size, and TOC. Cores were also sampled for lead and cesium isotopes for age dating purposes.

Results of the sampling showed that surface concentrations of total PAHs and total PCBs are lower than historical levels. The total PAH analyses reported concentration results for 41 PAH compounds. Surface sediment total PAH and total PCB concentrations were approximately 10,000 µg/kg and 200 µg/kg, respectively. Maximum total PAH concentrations ranged from 10,000 to 30,000 µg/kg with the peak occurring at depths ranging from 3.2 to 8.2 feet below the sediment surface. Maximum total PCB concentrations ranged from 1,700 to 3,000 µg/kg. Peak total PCB concentrations were observed at depths ranging from 3.2 to 13 feet below the sediment surface. Based on the age dating results, calculated sedimentation rates from the core data ranged from 3.0 to 7.0 cm/year.

Washington Navy Yard (CH2M Hill 2011a). This site is located on M street SE, near the 11th Street Bridge in southeast Washington, D.C. The southern side of Washington Navy Yard (WNY) is bounded by the Anacostia River. The WNY waterfront has historically consisted of piers, quay walls, slips, and dry dock facilities. A "Notification of Hazardous Waste Activity" was submitted to EPA by WNY in 1985. In 1998, the WNY was placed on the US EPA National Priorities List because of the contamination that was detected in the adjacent Anacostia River as well as on-site sediment and soil. In 1999, the Near-shore Sediment RCRA Facility Investigation (RFI) included the collection of surface sediment samples from 26 locations. The remedial investigation activities of the near-shore sediments (OU2) are documented in a Draft RI Report (CH2M Hill 2011a) and were conducted in the years 2006 and 2009 in accordance with the Federal Facilities Agreement (FFA). The Draft RI Report is under discussion between DDOE, EPA, and the Navy. The RI data have been uploaded to the NOAA Anacostia Watershed Database.

For the 2009 sampling phase documented in the 2011 RI Report, The Washington Navy Yard investigation included the collection of 20 samples to help characterize the surface sediments in and around OU2, to fill existing data gaps, to characterize the sediments near the Navy and D.C.-owned outfall locations, and to complement existing surface sediment results for the previous surface sediment investigation. OU2 includes the entire 2,400 foot site waterfront and extends the length of the facility's piers (approximately 200 feet) into the Anacostia River. In addition, subsurface sediment sampling was conducted at 34 locations within and near the pier area to depths ranging from 10 to 12 feet (middle depth) to approximately 20 feet (deep depth) below the river bottom. The historical dredge depth at the Washington Navy Yard is 22 feet below mean sea level. The middle depth and deep depth samples correspond to the interval above the typical dredging depth versus the deeper interval representing fluvial sediments. Sediment samples were analyzed for Target Analyte List metals (Method 6010B), cyanide (Method 9012B), PCB Aroclors (Method 8082), and PAHs (Method 8270_SIM), TOC, and grain size. Selected samples were also analyzed for VOCs (Method 8260), target compound list (TCL) pesticides (Method 8081A), 129 PCB Congeners (EPA Method 1668A), PCDD/PCDF (Method 8290), and AVS/SEM. The total PAH analyses reported concentration results for 31 PAH compounds.

For surface sediment, the highest constituent concentrations are consistently found at the western end of OU2, in the area of former Pier 5 and D.C. Combined Sewer Outfall 14, D.C. Storm Sewer 01, and Washington Navy Yard Outfall 9. Relatively higher constituent concentrations are also found near some

of the other Navy Yard outfalls. Total PAH concentrations in this area range up to 77,690 µg/kg. The average total PAH concentration for OU2 was 15,319 µg/kg. Gamma chlordane was the most frequently detected pesticide. Average and maximum gamma chlordane concentrations for OUs were 15.1 and 41 µg/kg, respectively. Total PCB Aroclor concentrations in OU2 surface sediments ranged from 96 to 830 µg/kg, with an average concentration of 219 µg/kg.

In addition, the RI included a comparison of sediment sampling results from the same locations sampled in 1999 and again in 2009. The results indicate that for most constituents, concentrations from the two years are comparable suggesting the absence of a pronounced trend upward or downward. Concentrations of PAHs and PCBs were more variable than concentrations of metals, but in general, there were no systematic increases or decreases in concentrations over time. The Navy is planning to conduct additional, near shore sediment sampling at the Washington Navy Yard to support the FS. The sampling is planned for the 2014 – 2015 timeframe.

Fish tissue samples were collected and analyzed to generate contaminant residue data for use in both the Baseline Ecological Risk Assessment (BERA) and HHRA at WNY. For the BERA, composite samples of whole-body mid-water (bluegill, pumpkinseed, and longear sunfish) and pelagic (blueback herring) forage species were analyzed for organochlorine pesticides, PCBs (Aroclors and congeners), and bioaccumulative metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc). For the HHRA, composite samples of fillets of largemouth bass and several species of catfish were analyzed for PCB congeners and bioaccumulative metals. PCBs and arsenic in HHRA indicated unacceptable carcinogenic and noncarcinogenic risks to humans consuming fish from locations adjacent to WNY (CH_2MHill 2011).

Active Capping Pilot Study (Horne Engineering 2003). A pilot project was initiated in 2004 to evaluate the performance of active capping technology as an approach to manage contaminated sediments. The project was undertaken at Area of Concern 1 (AOC1) defined by AWTA (2002). AOC1 is an area of elevated PAHs and PCBs located near the O Street Outfall, Southeast Federal Center, and the Washington Navy Yard. The demonstration project was implemented by a team led by Dr. Danny Reible and consisting of AWTA, the DC Department of Health, EPA organizations, and various universities (Reible et al. 2006). Three materials were tested including a bentonite material with a granular core, coke, and apatite. The granular core material physically entraps migrating sediments, coke sequesters organic constituents, and apatite removes metals through mineral deposition. Each material was installed in a pilot-scale, experimental cap specific for that material. After placement, early monitoring indicated that all cap materials were effectively isolating contaminants (Reible et al. 2006). For each of the experimental caps, Lampert et al. (2013) evaluated PAH monitoring data for concentrations in bulk solids, simultaneous bioaccumulation and pore water concentrations, and pore water concentration profiles. In general, data were collected six, 18, 30, 44, 54, and 66 months after placement of the caps. As determined through the profiling of cap pore water, concentrations in all of the caps approached near equilibrium within a few years as a result of surface recontamination and tidal pumping forces (Lampert et al. 2013). However, observed concentrations of seven PAHs in each of the caps were lower than those in the uncapped areas (Lampert et al. 2013).

Prior to placement of the caps, Horne Engineering (2003) characterized the river bottom near O Street Outfall where the caps were to be installed. The characterization included the performance of bathymetric, side-scan sonar, and benthic community surveys. In addition, the investigation included the collection of surface water, pore water, and surface and subsurface sediment samples. Surface sediment samples were collected via gravity corer at eight locations and via Ponar sampler at 60 locations. Subsurface samples were collected from the intervals 0.5 to 1.0 foot, and 1.0 to 3.0 feet from the eight gravity cores. Deep sediment samples were also collected from two locations. At each location, the sampled depths were 10.5 to 12.5 feet, 15.5 to 17.5, and 20 to 22 feet below the sediment surface.

Surface sediment PCB Aroclor concentrations ranged from 25 to 2,400 µg/kg with 1248 and 1254 two of the dominant Aroclors. Total PAH concentrations (16 PPs) ranged from 470 to 82,360 µg/kg with higher values occurring near the outfall. Some metals concentrations were highest at the outfall discharge point and decreased away from that maximum. This pattern was observed (maximum concentration shown) for antimony (5.0 mg/kg), chromium (94.8 mg/kg), lead (726 mg/kg), nickel (69.8 mg/kg), selenium (1.9 mg/kg), silver (22.5 mg/kg), thallium (2 mg/kg), and zinc (892 mg/kg).

Subsurface gravity core sediment PCB Aroclor concentrations ranged from 9,100 µg/kg (0.5 to 1.0 foot) to 400 µg/kg (1.0 to 3.0 foot). PCB congener concentrations in the subsurface gravity core samples are based on 22 congeners defined by EPA Region 2 (EPA 1992a) and ranged from 6,528 to 689 µg/kg. The maximum and minimum PCB congener sample results correspond to two samples in which the maximum and minimum Aroclor concentrations were observed. Total PAHs for the subsurface gravity cores range from 42,580 to 5,160 ug/kg and from 45,300 to 5,110 µg/kg measured at the depths of 0.5 to 1.0 and 1.0 to 2.0 feet, respectively.

With regard to the deep sediment samples, PCB Aroclors and total PAH were not detected at depths greater than seven feet below the sediment surface. For the interval from approximately five to seven feet, PCB Aroclor concentrations ranged from 29 to 2,390 µg/kg and total PAHs ranged from 929 to 10,600 µg/kg.

Southeast Federal Center (URS Group 2000). Southeast Federal Center (SEFC) is a 55.3-acre site located adjacent to and down-river from the Washington Navy Yard. The site was originally a portion of the Navy Yard and was used for manufacturing of naval ordnance, specifically medium and large caliber naval guns. The ordnance production and manufacturing ceased in 1962. The site was transferred to the General Services Administration in 1963. The site has housed a variety of government activities and clients, including administrative offices, warehouses and storage space, laboratories, and light industrial operations. As part of a 1998 consent decree, the Navy and GSA agreed to sample and analyze near shore river sediment along the SEFC waterfront.

On behalf of GSA, URS Corporation (URS) collected surface sediment samples at 11 locations and analyzed the samples for TAL metals, TCL VOCs, TCL SVOCs, TCL PCBs, and PAHs. The total PAH analyses reported concentration results for 17 PAH compounds. At three locations, PCDDs/PCDFs, Appendix IX VOCs, Appendix IX SVOCs, and PCB congeners (209 congeners) were also analyzed. The field work for the investigation was conducted in August 1999.

PCB Aroclors were detected in eight of the 11 samples. Aroclor 1254 and 1260 were the only species detected with concentrations ranging from 100 to 310 µg/kg for 1254 and from 98 to 510 µg/kg for 1260. For the three PCB congener analyses locations, total PCBs expressed as the sum of the detected congeners ranged from 1,018 to 2,894 µg/kg. One or more PAHs from each sample exceeded EPA Region 3 BTAG screening levels and the group of detected PAH compounds was consistent across all samples. Based on concentration data for SEFC site in the project database, high molecular weight polycyclic aromatic hydrocarbons (HPAH) concentrations ranged from approximately 2,800 to 52,300 µg/kg while low molecular weight polycyclic aromatic hydrocarbons (LPAH) concentrations ranged from 1,100 to 25,300 µg/kg.

Fort McNair. Fort McNair is a 108 acre Army facility situated adjacent to the mouth of the tidal Anacostia River. Fort McNair is part of Joint Base Myer-Henderson Hall command. The facility occupies the eastern portion of Buzzard Point, the peninsula separating the Anacostia River from the Washington Channel. Initially established in 1794 as an arsenal for defending the Capitol, the facility has since included a federal penitentiary, a general hospital (predecessor to Walter Reed Army Medical Center), and an Army education and training facility (www.jbmhh.army.mil/web/jbmhh/AboutJBMHH/FortMcNairHistory.html). Fort McNair is home to the National Defense University and various army ceremonial units including the Army's official escort to the President and the U.S. Army Band (DDOE 2012). A web search for potential environmental issues at Fort McNair suggests the absence of any significant current or historical environmental issues at the facility. However, the search revealed that several current and former leaking underground petroleum storage tank (LUST) sites exist at Fort McNair (**Table 2.3**). The records show that nine LUST cases involving petroleum products were identified between 1989 and 1996 (DDOE UST Branch 2012a). Specific information regarding the nature and extent of contamination and the various environmental media impacted by these subsurface spills is unavailable. The substances leaked included gasoline, waste/used oil, heating fuel oil, and kerosene. Contamination of soil and/or soil and groundwater resulted from these spills. Seven of the nine cases have been resolved and two remain open as of time of this report (June 2014) (DDOE UST Brach 2012b).

Joint Base Anacostia-Bolling (JBAB). This 905-acre site is located between the Potomac and Anacostia rivers and Interstate 295. JBAB comprises the former Naval Support Facility Anacostia (NSFA), the former Bolling Air Force Base (AFB), and the Bellevue Housing Area. Operations began on the southern portion of JBAB when the facility was formerly known as the Anacostia Naval Air Station, which originally operated as part of the U.S. Army's Bolling Air Field during World War I. When Bolling Air Field was relocated to its present-day location in 1935, the land it previously occupied was transferred to the U.S. Navy, which increased the size of the Anacostia Naval Air Station. Since 1961, the primary mission of the air station has evolved from testing airplanes and training naval reservists to conducting administrative activities. In October 1996, the Navy formally decommissioned the air station and renamed the facility NSFA. JBAB was established on October 1, 2010, in accordance with congressional legislation implementing the recommendations of the 2005 Base Realignment and Closure Commission.

Beginning in 1918, the NSFA served as a military airfield and was designated as the first headquarters of the United States Air Force in 1941. To ease airspace congestion in the vicinity of National Airport, all fixed wing aircraft operations at the facility ceased in 1962. The facility is currently primarily used by the

Navy for administrative purposes. In addition, it is home to organizations such as the Defense Intelligence Agency and the Naval Imaging Command (DDOE 2012). A web search for potential environmental issues at NSFA revealed several leaking underground storage tank (LUST) sites and several AOCs which are discussed further below. The search indicated that 17 former leaking LUST sites (**Table 2.3**) existed at NSFA between 1989 and 1997. Specific information regarding the nature and extent of contamination and the various environmental media impacted by these subsurface spills is unavailable. The substances leaked included gasoline, waste/used oil, heating fuel oil, and kerosene. Contamination of soil and/or soil and groundwater resulted from these spills. All 17 cases were resolved by 2003 (DDOE UST Branch 2012b).

In addition to the LUST sites, environmental investigations were conducted at four sites:

- AOC 1 (former incinerator and solid waste disposal area,
- Site 2 (two landfill areas),
- Site 3 Athletic Fields (petroleum discharge), and
- Site 1 (Building 168 crawlspace).

The environmental issues, sampling, and status of each of these sites are summarized below.

In 2011, CH2M Hill performed a site investigation of AOC 1 which was divided into two areas, each of which is a former location of an incinerator and solid waste disposal area. The investigation was performed for Naval Facilities Engineering Command (NAVFAC) Washington and Naval District Washington under the Comprehensive Long-Term Environmental Action, Navy III, Contract Number N62470-02-D-3052, Contract Task Order 70. The objective of the AOC 1 investigation was to determine whether past waste management and incinerator operating practices resulted in the release of hazardous constituents that may pose unacceptable risks to human health and ecological receptors. Six soil and six groundwater samples were collected during this investigation. CH2M Hill concluded barium, iron, manganese, and dioxins/furans in groundwater at AOC 1 may pose potentially unacceptable risks to aquatic organisms in the Anacostia River adjacent to AOC 1. The current status for AOC1 is No Further Response Action Planned (NFRAP). The NFRAP Decision Document was developed by the Department of the Navy (Navy), as lead agency, with input solicited from U.S. Environmental Protection Agency Region 3 (Region 3) (CH2M Hill 2011b).

In 2011, CH2M Hill performed a RI for the Navy at Site 2, comprised of two landfill areas. The objective of the RI was to determine the nature and extent of potential contamination at Site 2, its effects on groundwater quality, whether potential groundwater contamination is reaching the Anacostia River, and to collect sufficient data to prepare baseline human health and ecological risk assessments for the entire site. Eleven groundwater samples, 24 surface soil samples and 17 subsurface soil samples were collected during this investigation. The primary constituents detected in Site 2 media are SVOCs, metals, and to a lesser extent dioxins. Only barium, iron, and manganese were identified as posing a potential risk to water column receptors in the Anacostia River. CH2M Hill concluded that considering the conservativeness for this assessment and the low-level screening value exceedances, any associated

ecological risks were within an acceptable range. CH2M Hill has recommended NFRAP status for Site 2 to the Navy; no further details were available regarding site status (CH2M Hill 2011c).

During a Preliminary Assessment (PA) of Site 3 Athletic Fields in 1991, petroleum was observed in surface depressions with an associated petroleum-type odor. In 2012, CH2M Hill submitted a Draft No Action Decision Document for this site. In 1992 an investigation was conducted consisting of the collection of 12 surface soil samples, 15 soil gas samples, 7 subsurface soil samples, and 3 groundwater samples. VOCs, pesticides, and PCBs were not detected in groundwater at concentrations exceeding the tap water RSLs. Two SVOCs (bis(2-ethylhexyl)phthalate and naphthalene) were detected in groundwater samples at concentrations exceeding the corresponding RSL. However, they were detected in background at similar concentrations. Dissolved metals (copper, iron, and manganese) and total metals (barium, chromium, iron, and manganese) were detected at concentrations exceeding the human health RSLs. The concentrations were generally similar to background, with background concentrations also exceeding the screening values. The analytical results presented in the SI report for soil gas, surface soil, subsurface soil, and groundwater samples were considered to be below or at the site-specific background levels, and were not likely to pose any unacceptable risks to the human health and ecological receptors. Based on these results, CH2M Hill prepared a No Action Decision Closure Document for the Navy (NAVFAC 2012).

In 2012, CH2M Hill submitted a Draft NFRAP Decision Document regarding Site 1 Building 168 Crawlspace with Region 3 and DDOE providing input to this decision. Building 168 was constructed in the 1940s and utilized as a photographic laboratory. Several areas within Building 168 where hazardous substances were stored included darkrooms, copying rooms, color labs, and associated material storage rooms. Hazardous substances that were identified include developing chemicals, bleach, fixers, replenishers, alcohol, oils, acids, cements, buffer solutions, and cleaning compounds. Six existing shallow groundwater monitoring wells were sampled as part of the Site 1 investigation. The detected constituents that were present in groundwater were limited to VOCs, one SVOC, and metals. Only metals were present at concentrations exceeding screening criteria. The maximum concentrations of the detected metals in filtered groundwater samples were as follows: arsenic (11.9 µg/L), barium (373 µg/L), cadmium (0.83 µg/L), iron (64,300 µg/L), manganese (7,100 µg/L), thallium (6.2 µg/L), and vanadium (1.1 µg/L). CH2M Hill stated contamination specifically related to the crawlspace of Building 168 appears to be primarily inorganic and is distributed throughout the crawlspace without patterns or trends, confirming that the contamination is likely from localized leakage within the crawlspace and is not the result of a wide-spread or large-scale releases within Building 168 (CH2M Hill 2012).

Former Steuart Petroleum Company Adjacent to WGL East Station (CH2M Hill 2007 and NOAA 1992a). Steuart Petroleum operated a former bulk oil distribution facility at 1333 M Street SE, adjacent to WGL East Station. The facility consisted of ASTs and truck loading racks and was active from approximately 1966 through 1982. Support Terminal Services (site tenant) used underground and aboveground pipelines to transfer petroleum fuels from an offloading pier in Anacostia River to the storage and distribution facility. The three USTs (one 2,000-gallon diesel tank, one 5,000-gallon gasoline tank, and one 550-gallon used-oil tank) were installed and in operation on the property from 1966 through 1982 and were subsequently removed in 1987.

In January 1992, as a result of a valve failure, approximately 51,000 gallons of #4 fuel oil spilled from a 3.2 million gallon AST to the facility's containment area (NOAA 1992a). As a result of this spill, approximately 2,000 gallons of product drained into a storm drain that flowed into the Anacostia River. The oil entered the Anacostia River between the Phillip J. Sousa and 11th Street bridges. Emergency responders used boom in collection areas to collect oil that escaped into the river (NOAA 1992b).

A 1992 environmental investigation of the property included the installation of eight soil borings which were each converted to monitoring wells. Soil and groundwater samples collected from these borings and wells were analyzed for TPH, benzene, toluene, ethylbenzene, and xylenes (BTEX), methyl tertiary butyl ether (MTBE), and naphthalene. Results of this sampling indicated that the central portion of the property was contaminated by a release from a former UST, and the western portion of the property impacted by a release from an abandoned petroleum pipeline. Free-phase hydrocarbons were not detected in any of the groundwater monitoring wells. However, because of the leaking former UST, a LUST case was opened at the UST site in April 1993 (CH2M Hill, 2007).

Quarterly sampling of the groundwater was conducted at the UST site between February 1993 and October 1996. Concentrations of dissolved-phase hydrocarbons at the wells, on and adjacent to the UST site, exhibited a decreasing trend over time. In 1997, a technical review of the UST site was conducted, and it was determined that no further investigation or monitoring was warranted. The conclusion was based on the minimal concentrations of petroleum compounds detected in groundwater, the industrial use of the area and surrounding properties, and the use of municipally supplied potable water in the District and surrounding counties (CH2M Hill, 2007).

In 1998, the District of Columbia Pesticides, Hazardous Waste and UST Management Division issued a conditional case closure pursuant to the District's UST Management Act of 1990 and UST regulations. The case closure letter stated that the UST site did not pose a present threat to human health and the environment. The letter also stipulated that the District would require an approved work plan for any future excavation work at the site (CH2M Hill, 2007).

Steuart Petroleum Company/Hess/Gulf Former Petroleum Terminals (CH2M Hill 2007, NOAA 1992b and 1992c). Hess Petroleum Corporation (Hess) operated a former bulk oil facility located at 1620 South Capitol Street SW and adjacent to the South Capitol Street Bridge and Anacostia River. The facility was reportedly active from approximately 1920 through 1985 that included multiple large capacity ASTs with associated aboveground and sub-grade piping and several USTs. Several environmental investigations have occurred in relation to the property dating to at least 2004 that indicated soil and groundwater concentrations were above reportable conditions for metals, BTEX, TPH, and PAH. Remediation was recommended for soil and groundwater at the facility; however, no remediation has occurred at this site as of 2005 (MACTEC 2005).

Gulf Petroleum Corporation (Gulf) formerly operated a bulk gasoline and fuel oil terminal at the addresses of 1721 and 1724 South Capital Street SW on property located adjacent to above-noted Hess facility. The facility was active from approximately 1930 through 1969. Steuart Petroleum Company/Steuart Investment Company (Steuart) purchased the facility from Gulf in 1969 and operated

it until approximately 1989 after which Steuart ceased operations. When in service, Steuart used the property as a terminal for kerosene and fuel oils and reportedly operated a 1.2 million gallon AST, 20,000 gallon AST, and 14 4,000-gallon USTs. In addition, PEPCO operated a bulk gasoline and fuel oil storage facility to the west of the Steuart Investment Company for use in a former electric power generating station. During site investigations conducted during the 1990s and 2000s, non-aqueous phase liquid (NAPL) was observed on both sites and NAPL recovery efforts were implemented. Soil was also excavated from the properties based on BTEX, TPH, and PAH contamination observed from sampling efforts. LUST case documents indicate that the combined site's pump and treat groundwater remediation recovered 2,171 gallons of NAPL as of April 2005 (MACTEC, 2005).

Firth-Sterling Steel (www.washingtonpost.com/wp-dyn/content/article/2007/07/28/AR2007072801087.html). As reported in the Washington Post (July 29, 2007), on what is now a portion of JBAB, a former steel plant operated on 360 acres near Giesboro Point, on the eastern shore of the Anacostia River at its confluence with the Potomac River (**Figure 1.1**). Manufacturing operations occurred on 10 acres of the property and consisted of the manufacture of armor piercing projectiles for the U.S. Navy and coastal defenses. Also known as the Washington Steel and Ordnance Company, the plant was built in 1907 and operated until 1922 by the Firth-Sterling Steel Company of McKeesport, Pennsylvania. In 1922 the plant was closed and later demolished (Kelly 2007). No information could be located regarding potential environmental issues associated with this facility.

2.7 Data Usability

The data collected during previous investigations were screened to determine the usability of the data in the assessment of data gaps and for potential future use in FS and NRDA analyses. As discussed in **Section 6**, in addition to screening the data for the purpose of sample design, additional evaluation of the existing data will occur during the data evaluation phase of the RI. The usability assessment included the following elements.

Sampling Period. Environmental data from as early as 1990 were available for use in the development of this WP. To leverage the extensive spatial coverage of the ANS 2000 data set, data collected post-year 2000 were selected for use in the data gap assessment. Exceptions to the 2000 cutoff are inclusion of the sediment data from two investigations from 1998 and 1999, respectively. Both were included to enhance spatial coverage. The 1998 investigation included the collection of Anacostia River sediment samples in association with an ambient sediment toxicity investigation in the Chesapeake Bay watershed. The 1999 investigation consisted of surface sampling results for the SEFC sampling discussed above. As shown by **Table 2.2**, the data for 11 previous investigations were evaluated for this WP.

An assumption inherent in using data collected from up to 15 years ago is that sediment concentrations from these sampling events will reasonably approximate present day concentrations. In support of this assumption, the above-noted Washington Navy Yard RI data indicate that for most of the data set, systematic differences do not exist between the concentrations measured in 2009 and those measured in in the 2000 event at the same locations. A representative number of the 2000 locations will also be re-sampled for this investigation (approximately 20 percent of new sampling locations) to assess general usability of the earlier data.

Analytical Methods. Consistency of the analytical methods across the previous investigations included in the project database was assessed. **Table 2.4** shows the analytical methods for the five more significant investigations for which data are available. For the "Washington Navy Yard Sed/TSS," "GSA SE Federal Center," "CSX," and "Active Capping Site Char Rpt" data sources, analytical methods are generally consistent for SVOCs, PAHs, metals, pesticides, and PCB Aroclors. In most cases, the typical SW-846 method was used. PCB congener analysis methods, however, vary somewhat among the investigations as do the numbers of congeners analyzed. The "CSX" and "GSA SE Federal Center" investigations both analyzed for the full suite of 209 PCB congeners while 127, 81, and 57 congeners were measured in the "Washington Navy Yard Sed/TSS," "ANS 2000," and "Active Capping Site Char Rpt datasets," respectively. The various methods listed in **Table 2.4** for each group of analytes, including those used for the "ANS 2000" dataset, are generally comparable. Any discrepancies result from variation in method sensitivities as will be reflected in the associated method detection limits.

Ecological and Human Health Benchmarks Levels. Screening levels were identified for preliminary screening of sediment, soil, surface water, and groundwater sampling results in the preparation of this WP. In the discussions of existing sampling results for these media, concentrations are characterized as "elevated" if screening levels are exceeded. Sediment concentration data are compared to the EPA Region 3 Biological Technical Assistance Group Freshwater Screening Benchmarks (**Table 2.5**). These screening levels provide conservative reference levels for initial, preliminary evaluation of sediment quality data and will be re-evaluated as the RI/FS progresses. With regard to human health screening benchmarks, sediment, surface water, and fish tissue concentration results are compared to EPA Regional Screening Levels (RSLs) for industrial soil, residential tap water, and fish tissue respectively (**Table 2.6**).

Deep Sediments. In this investigation, deep sediments are defined as sediments that occur at a depth of 0.5 feet or more below the bottom of the river. The year 2000 cutoff for retaining investigations for the WP database applies to all environmental media with the exception of deep sediments. Because they are buried below the horizon where surface sediment transport processes are active, deep sediment data collected in non-dredged areas reflect current conditions at the time of deposition even if they are from investigations conducted many years ago. However, for some pre-2000 investigations, the NOAA Database provided insufficient documentation regarding sampling depths, either because specific depth information was absent or the units for depth measurement were unavailable. Only deep sediment data for which accurate depth information were available, which included only the post-2000 investigations were included in the WP database. During the performance of the RI, the WP database will be updated as deep sediment data from sediment investigations for the other sites in the study area becomes available.

Data Validation. Data from the Washington Navy Yard investigation were subjected to Region 3 data validation at an acceptance level sufficient for risk assessment. The CSX data underwent a Stage 2A data validation, a verification and validation process that assesses completeness and compliance checks of sample receipt conditions and only sample-related quality control results. Although data validation within the CERCLA framework was apparently not performed on the FWS fish tissue data, the Phelps

(2001) benthic invertebrate data, or other data sourced to the NOAA database, in most cases the sampling was or likely was performed with appropriate quality control.

Usability Determination. Review of the 11 selected investigations (**Table 2.2**) resulted in the determination that all are of sufficient quality for use in WP development without qualification with two exceptions. Two clam translocation studies (Phelps 2001 2002) showed that clams accumulated pesticides and PCBs when placed in the Anacostia River for several weeks. However, these studies did not attempt to distinguish between dissolved and particulate constituents as the source of contaminants. Nor were sediment concentrations at the reference and test locations measured. Concentrations of contaminants in overlying water were not measured or discussed. These and other features of the studies limit the usability of the results.

2.8 Regulatory Compliance

This section provides a preliminary screening of Applicable or Relevant and Appropriate Requirements (ARARs) as well as a summary of the regulatory permit requirements for conducting the field sample collection. At this stage of the investigation, ARARs will only be identified to the extent that they impact the collection of RI data during the planned field investigation or if they impact data quality objectives. Further consideration of ARARs will be given during the FS stage where ARARs are considered for the screening of potential remedial actions. Because the RI field work involves collection of data from both the State of Maryland and the District of Columbia, both jurisdictions are considered for the identification of ARARs and for permitting requirements.

2.8.1 ARARs

The identification of Federal and State ARARs is performed pursuant to CERCLA Section 121(d), which states that a remedial action selected for a CERCLA site shall attain a degree of cleanup which assures protection of human health and the environment, and attains “legally applicable or relevant and appropriate standard(s), requirement(s), criteria, or limitation(s).” United States Environmental Protection Agency (USEPA) regulations and guidance require that ARARs and criteria To Be Considered (TBC) be identified and defined during the FS and then met during the implementation of remedies. Therefore, more extensive consideration of ARARs and criteria TBC guidance will be given as part of the FS. Once identified, the ARARs and TBCs will be evaluated to identify those that may be technically impracticable to achieve and for which waivers may be required.

The NCP and relevant CERCLA guidance specify that ARARs may be grouped into three categories: chemical-specific, location-specific, or action-specific [40 CFR § 300.400(g)(1)]. Chemical-specific ARARs are considered primarily to establish data quality objectives such as detection limits and sample analytical methods so that analytical results that will be usable for further chemical-specific ARAR comparisons during the remedy selection process. Location- and action-specific ARARs more directly impact RI activities and frequently result in the need to obtain permits and permissions to conduct work in waters of the U.S. or within the boundaries of National Parks. Included in this section is a discussion of the regulatory authority to collect data for the purpose of documenting Natural Resource Damages (NRD).

The list of ARARs below describes the regulatory authority and the applicability or relevance to the remedial investigation.

Federal

- Clean Water Act (CWA), Ambient Water Quality Criteria (33 USC §§ 1251 et seq.; 40 CFR Part 131). *Applicable:* Surface water criteria established for the protection of human health and/or aquatic organisms.
- Clean Water Act and Rivers and Harbors Act (RHA), Dredge and Fill Standards (33 USC §§ 320-330 and 1344(b)(1); 40 CFR Part 230; Executive Order No. 11990). *Applicable:* Regulates the discharge of dredged or fill material into waters of the U.S. Includes protection of wetlands.
- Safe Drinking Water Act, National Primary Drinking Water Regulations Maximum Contaminant Levels (MCLs) (42 U.S.C. §§ 300f et seq.; 40 C.F.R. Part 141). *Relevant and Appropriate:* Human health-based standards, MCLs for public water systems. Although the Anacostia River is not used as drinking water, the river and groundwater recharged by the river are potential future drinking water sources.
- Resource Conservation and Recovery Act, Subtitle C (40 CFR Part 261). *Applicable:* If any CERCLA action constitutes treatment, storage, transport, or disposal of a RCRA hazardous waste.
- Toxic Substances Control Act (15 U.S.C. 2601; 40 CFR 761.60-761.79 (PCBs); 40 CFR 775.180-775.197(TCDD)). *Applicable:* Storage or disposal of waste material containing PCBs or TCDD.
- OSHA HAZWOPR (29 CFR 1910.120). *Applicable:* Requirements for workers engaged in response or other hazardous waste operations.
- Endangered Species Act (16 USC §§ 1531–1544; 50 CFR Part 402). *Applicable:* Establishes requirements for the protection of federally listed threatened and endangered species and their habitat. RI sampling could affect threatened or endangered species or their habitat.
- Fish and Wildlife Coordination Act (16 USC §§ 661 et seq.). *Applicable:* Requires consideration of impacts to wildlife resources resulting from the modification of waterways. RI will involve minimal sediment disturbance.
- National Historic Preservation Act (16 U.S.C. 470; 43 CFR Part 7, 7.4). *Relevant and Appropriate:* Protection of Archaeological Resources.
- Archaeological and Historic Preservation Act (16 USC §§ 469 et seq.; 16 USC §§ 470aa–ii, et seq.; 43 CFR §§ 7-1 et seq.). *Applicable:* Provides for the protection and preservation of archeological and historical resources that may be destroyed through the alteration of terrain as a result of federal construction projects. RI activities will avoid historic features, but could result in the discovery of archeological or historical resources.
- National Park Service Organic Act (16 USC § 1 et seq.). *Applicable:* Parts of the tidal Anacostia River to be sampled (sediment disturbance and aquatic organism sampling) are within National Parks managed lands. The Organic Act requires that national parks be managed in order to conserve the scenery, natural and historic objects, and wildlife in such a manner as to leave them unimpaired for the enjoyment of future generations.
- Solid Waste Disposal in National Parks (16 USC § 460l-22(c), 36 CFR Part 6). *Applicable:* Disposal of investigation derived waste; temporary activity. Prohibits the creation of new solid waste

disposal units and the operation of existing solid waste disposal units within park boundaries, except as specifically provided for in the regulations.

- National Park Resource Protection, Public Use and Recreation (36 CFR Part 2). *Relevant and Appropriate:* This regulation prescribes and regulates various activities in National Parks, such as the prohibition of possessing, destroying, injuring, defacing, removing, digging, or disturbing from its natural state: (i) . . . wildlife or fish. . . . (ii) Plants or the parts or products thereof. . . . feeding, touching, teasing, frightening or intentional disturbing of wildlife nesting, breeding or other activities. It also prohibits disposing of refuse in other than refuse receptacles. . . . (6) polluting or contaminating park area waters or water courses. Permits will be issued by NPS to address these prohibitions during RI sampling activities.
- NPS Management Policies 2006 (Available at: www.nps.gov/policy/mp2006.pdf). *Criteria TBC:* Provides policies and guidance for the management of natural and cultural resources by the NPS, including revegetation of disturbed land.
- Executive Order 13423. Consolidates and strengthens sustainability practices for Federal, Energy, and Transportation Management by advancing energy security and environmental protection with defined program goals. Applicable to achieve environmental protection and DDOE's Sustainability Program requirements.

State

- Clean Water Act, Water Quality Certification (CWA §§ 301, 302, 303, 306, and 307). District of Columbia. *Applicable:* Any applicant for a Federal license or permit to conduct an operation that may result in any discharge to navigable waters (§ 404), shall provide to the licensing/permitting agency a certification from the State that the discharge will comply with applicable provisions.
- Water Quality Standards for Surface Water (D.C. Code §§8-103 et seq. DCMR1 Title 21 Chapter 11). District of Columbia. *Applicable:* Discharges or impacts to surface waters that may exceed water quality standards for the Anacostia River including draft TMDLs for oil and grease, organics and metals in the River.
- Hazardous Waste Regulations (DCMR Title 20, Chapters 40-47). District of Columbia. *Applicable:* Sets forth criteria for classification and disposal of hazardous waste such as investigation derived waste.
- District of Columbia Historic Preservation (DCMR Title 10, Chapter 25). District of Columbia. *Applicable:* Requires the consideration of the existence and location of historic and prehistoric sites, buildings, objects, and properties of historical and archaeological significance when evaluating remedial alternatives. RI sampling activities are not likely to impact historical or archeological features, but may uncover artifacts of significance.
- District of Columbia Harbor Regulations-Throwing or Depositing Matter in Potomac River (D.C. Official Code § 22-4402). District of Columbia. *Applicable:* Prohibits the deposit of any stone, gravel, sand, ballast, dirt, oyster shells, or ashes in the water in any part of the Potomac River or its tributaries in the District of Columbia, or on the shores of the river below the high water mark. Further prohibiting the deposit of "filth of any kind whatsoever" in the Potomac River or its tributaries in the District of Columbia. However, Section 22-4402(c) states: "Nothing in this

section shall be construed to interfere with the work of improvement in or along the said river and harbor under the supervision of the United States government."

- Storage, treatment or disposal, and transportation of hazardous waste regulations (COMAR 26.13.02&.04; Annotated Code of Maryland, Environmental Article, Title 7, Hazardous Materials, and Hazardous Substances). State of Maryland. *Applicable:* Regulations and procedures for the identifications, listing, transportation, treatment, storage and disposal of hazardous wastes must be met. Any hazardous waste generated during sampling activities will be disposed of according to regulations. Any residues or by-products from sampling which are hazardous will be disposed of properly.
- Dredging and upland disposal of dredged material regulations (COMAR 26.24.03). State of Maryland. *Applicable:* Regulations require the preparation and implementation of a plan to perform dredging in State or private tidal wetlands and upland disposal of dredged material.
- Fish and fisheries management regulations (Annotated Code of Maryland, Natural Resource Article, Title 4 - Fish and Fisheries). State of Maryland. *Applicable:* Requirements to conserve species of fish for human enjoyment, for scientific purposes and to ensure their perpetuation as viable components of their ecosystems. The RI will impact some fish species in the Anacostia River within Maryland.
- Wildlife management regulations (Annotated Code of Maryland, Natural Resource Article, Title 10 – Wildlife). State of Maryland. *Applicable:* Requirements to conserve species of wildlife for human enjoyment, for scientific purposes and to ensure their perpetuation as viable components of their ecosystems. The RI will impact some wildlife species in the Anacostia River within Maryland.
- Chesapeake Bay Area Critical Protection Program (Annotated Code of Maryland, Natural Resource Article, Title 8 - Waters, Subtitle 18 - Chesapeake Bay Area Critical Protection Program). State of Maryland. *Relevant and Appropriate:* The Anacostia River is within the Chesapeake Bay Critical Area and, as such, sediment disturbing activities are guided by specific provisions in the adopted critical area criteria and local critical area program.
- State Tidal Wetland Regulations (COMAR 26.24; Annotated Code of Maryland, Environmental Article Title 5 - Water Resources; Annotated Code of Maryland, Environmental Article Title 16 - Wetlands and Riparian Rights). State of Maryland. *Applicable:* Provides that activities such as dredging, filling, removing, constructing, reconstruction, or activities otherwise altering tidal wetlands must be permitted by the State.
- State Water Quality Criteria (COMAR 26.08, Chapters 01-07). State of Maryland. *Applicable:* Sets criteria and standards for discharges limitations and policy for antidegradation of the State's surface water.

Natural Resource Damages

In addition to the ARARs described above, this RI addresses data gaps related to the District of Columbia's ongoing NRD considerations as a trustee for natural resources in and along the Anacostia River under CERCLA. CERCLA states that a "natural resource" is a resource "belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by" the United States, any State, an Indian

Tribe, a local government, or a foreign government [CERCLA §101(16)]. NRD are for injury to, destruction of, or loss of natural resources, including the reasonable costs of a damage assessment [CERCLA §§101(6); 107(a)(4)(C)]. The measure of damages is the cost of restoring injured resources to their baseline condition, compensation for the interim loss of injured resources pending recovery, and the reasonable cost of a damage assessment (43 CFR Part 11; 15 CFR Part 990). Section 990.24(b) of the CFR states that trustees must ensure compliance with any applicable consultation, permitting, or review requirements, including but not limited to: the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.); the Coastal Zone Management Act of 1972 (16 U.S.C. 1451 et seq.); the Migratory Bird Treaty Act (16 U.S.C. 703 et seq.); the National Marine Sanctuaries Act (16 U.S.C. 1431 et seq.); the National Historic Preservation Act (12 U.S.C. 470 et seq.); the Marine Mammal Protection Act (16 U.S.C. 1361 et seq.); and the Archaeological Resources Protection Act (16 U.S.C. 470 et seq.).

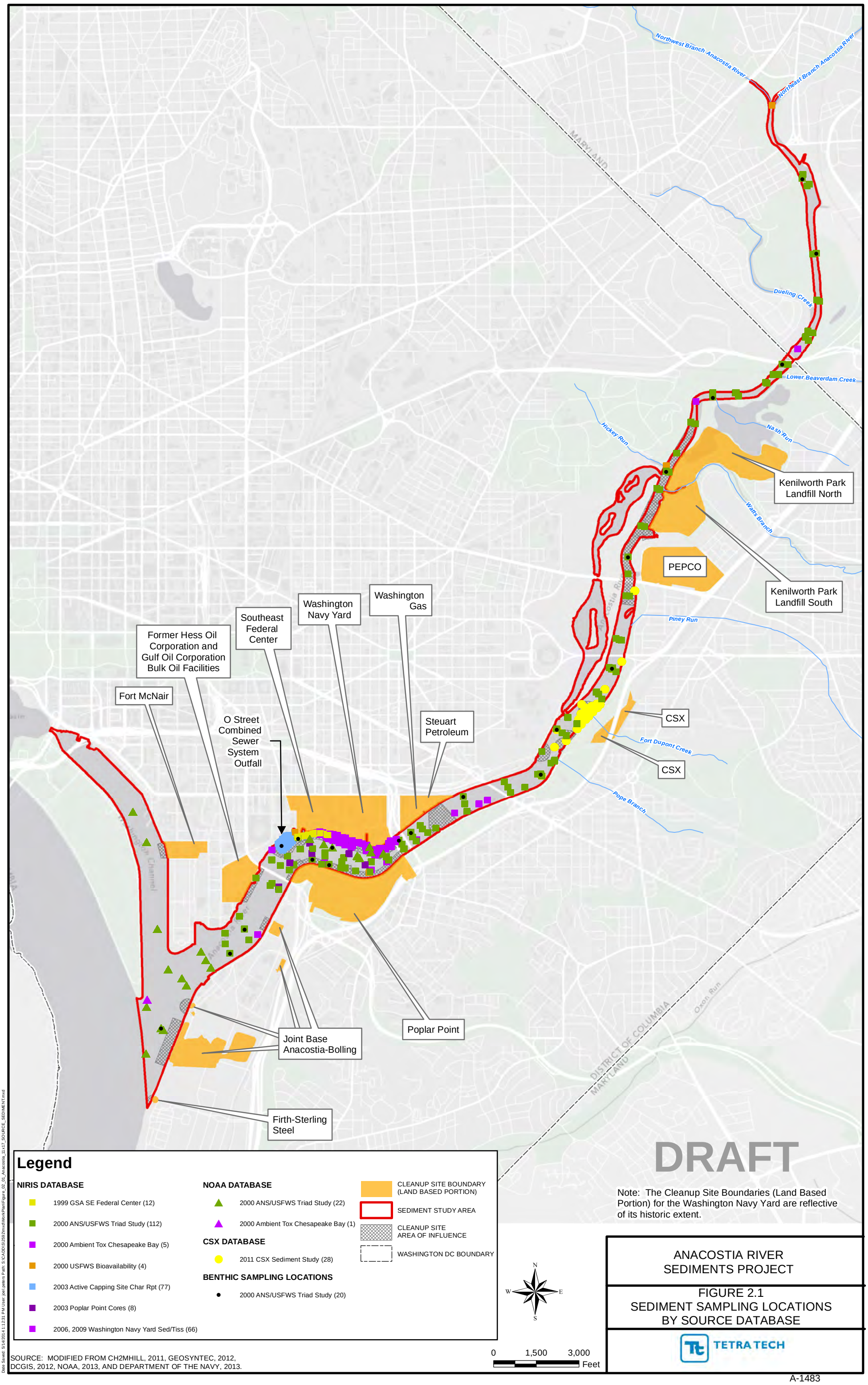
2.8.2 Permits and Other Access Agreements

The field work associated with sample collection will require limited disturbance of Anacostia River sediments, surface water and benthic and pelagic aquatic organisms. To comply with many of the ARARs noted in the section above, certain permits, permissions and access agreements are required. Below is a list of the permits, permissions and other access agreements that will be obtained prior to Anacostia River RI sampling activities to comply with the ARARs:

- CWA Section 402/404 and RHA Section 10 Permit. Nationwide Permit #6 for Survey Activities and General Permit issued by the Baltimore District of the U.S. Army Corps of Engineers. *Purpose:* to address sediment disturbance in a water of the U.S.
- CWA Section 401 Water Quality Certifications. District of Columbia Department of the Environment, Water Division and the Maryland Department of the Environment (MDE). *Purpose:* to provide State-specific CWA water quality considerations that go further than federal requirements are addressed.
- Maryland Wetland License. Maryland Department of the Environment. *Purpose:* obtain a General License from the Maryland Board of Public Works to conduct sampling in the Anacostia River within Maryland (authority delegated to MDE).
- Maryland Scientific Collection Permit. Maryland Department of Natural Resources. *Purpose:* to collect fish, turtles, and benthic organism tissue samples for scientific study.
- NPS Research and Collection Permit. Issued by the National Park Service since the Anacostia River is partially on National Park Service managed lands. *Purpose:* address NPS considerations regarding sample collection and river access on NPS lands.

Notification letters announcing and describing the sampling activities will be sent to the following governmental agencies to ensure that others with responsibilities involving the Anacostia River will be aware of the mobilization of equipment on the river:

- U. S. Coast Guard
- U.S. Navy
- Capital Police
- DC Police
- PG County Police
- PG County Parks and Recreation



SOURCE: MODIFIED FROM CH2MHILL, 2011, GEOSYNTEC, 2012, DCGIS, 2012, NOAA, 2013, AND DEPARTMENT OF THE NAVY, 2013.

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Group	Geologic Unit	Lithology	Hydrostratigraphic Unit	Formation Thickness (feet)
Not Applicable	Quaternary Deposits and Fill	Miscellaneous Fill; Orange-tan medium to coarse sand and gravel; silts and clays.	Isolated perched groundwater units	< 6
			Surficial aquifer	< 25
Potomac	Undifferentiated Patapsco, Ann Arundel, and Patuxent Formations	Clay and silt facies: Variegated red, gray, and brown hard and tight clays. Some silty and fine sandy lenses.	Potomac confining unit	< 350[2]
		Sand and gravel facies: Gray and tan gravel, sand, arkose with occasional sandy clay lenses.	Pautuxent Aquifer	
Bedrock	Wissahickon Schist	Schist bedrock	Lower confining	Unknown

Notes:

1. Geologic and hydrostratographic units summarized from D.C. Water Resources Research Center (1993)
2. Thickness taken from Koterba, Dieter, and Miller (2010)

Study Name In WP Database	Reference[1]	Database Source (# of Samples in Study Area)	Year of Sample Collection	Data Used for WP Development	Number of Samples*			
					Surface Sediment	Subsurface Sediment	Fish Tissue	Benthic Tissue
ICPRB/Limno-Tech Sediment Survey	NOAA database	N/A (Sample totals shown at right are from NOAA database only)	1989	No	12	0	0	0
WA Gas Light East Station Property	NOAA database		1988		0	12	0	0
EMAP-Chesapeake Bay	NOAA database		1990		1	0	0	0
FWS Organochlorine Resid/Histopath	NOAA database		1987		0	0	3	0
Bolling AFB - SW Corner Landfill	NOAA database		1992		6	0	0	0
DC Fish Tissue HHR	NOAA database		1989-1992		0	0	2	0
Potomac & Anacostia Sediment Study	NOAA database		1991		22	0	0	0
Wild Fish Tissue	NOAA database		1993-1995		0	0	2	0
PEPCO	NOAA database		1995, 1997		3	1	0	0
Washington Navy Yard	Clark and Crutchley (1995)		1995		7	0	0	0
FWS PAH/PCB - Mason Neck	NOAA database		1995		3	0	2	0
WA Gas - East Station Project	NOAA database		1996		7	0	0	0
DC Sediment Core Analysis	NOAA database		1995		7	7	0	0
USACE Federal Nav Channel	NOAA database		1998		4	4	0	0
WA Navy Yard RI	CH2M Hill (2011)		1999		34	0	0	0
GSA SE Federal Center	URS Group (2000)	NIRIS[2] (12)	1999	Yes	12	0	0	0
Ambient Tox Chesapeake Bay	NOAA database	NOAA[3] (1) NIRIS (5)	1998		6	0	0	0
ANS 2000 (ANS/USFWS Triad Study)[4]	NOAA database Velinsky and Ashley (2001)	NOAA (22) NIRIS (112)	2000		134	0	0	0
DDOE Fish Tissue Study	Pinkney (2001)	Not in database						
Larval Fish Toxicity	Pinkney et al. (2002)	Not in database						
USFWS Bioavailability	Pinkney et al. (2003)	NIRIS (4)	2000		4	0	0	0
Risk-based Monitoring, Kingman	Pinkney et al. (2006)	Not in database						
Invertebrate	Phelps (2001)	N/A (7)	2000, 2001		0	0	0	7
WA Navy Yard Pier No. 5	CH2M Hill (2011)	NIRIS (16)	2002		0	16	0	0
Poplar Point Cores	NIRIS database	NIRIS (8)	2003		8	0	0	0
Active Capping Site Char Rpt	Horne Engineering Servs., Inc. (2003)	NOAA (8) NIRIS (77)	2003		77	8	0	0
Washington Navy Yard Sed/Tiss	CH2M Hill (2011)	NIRIS (66, 70, 46)	2006, 2009		66	70	46	0
USFWS Fish Tissue	Pinkney (2009)	N/A (2)	2007		0	0	2	0
CSX	EnviroScience (2013)	CSX (28, 38)	2011		28	38	0	0

1. If the original reference for a given study was not available, the Anacostia River database maintained by NOAA is referenced.
2. NIRIS-Navy Installation Restoration Information Solution Database

3. NOAA-National Oceanic and Atmospheric Association Query Manager Database.
4. Referred to in the text as ANS 2000; NOAA database reference is "ANS/USFWS Triad Study."
* Totals include duplicate sampling locations

Facility	Contaminant Types	Sites with only Soil Contamination	Sites wth both Soil and Groundwater	Status
Fort McNair	Petroleum - Motor fuels, waste/used oil, heating oil	4	3	Closed
		0	2	Open
Naval Support Facility Anacostia		3	14	Closed
		0	0	Open

1. Source: DDOE website http://ddoe.dc.gov/publication/public-records-related-underground-storage-tank-ust-systems

Database	TPH	SVOC	PAH		VOC	Metals	Pesticides	PCDD/PCDF	PCB Aroclors	PCB Congeners	
			Method	Number						Method	Number
Washington Navy Yard Sed/TSS	NA[6]	NA[6]	8270_SIM[4,8]	31	NA[6]	6010B[4]	8081A[4]	8290[4]	8082[4]	1668A[7]	129
GSA SE Federal Center	NA[6]	CLP[1] SVOCs	8310[4]	17	CLP[1] VOCs	CLP[2]	NA[6]	8290[4]	CLP PCBs	8082[3]	209
CSX	8015[4]	8270[4]	8270[4]	51	8260[4]	6020[4]	8081[4]	NA[6]	8082[4]	1668[7]	209
Active Capping Site Char Rpt	8015B[4]	NA[6]	8270C[4]	16	NA[6]	6010[4]	8081[4]	NA[6]	8082[4]	3540C[5] 8082[4]	57
Poplar Point Cores	NA[6]	NA[6]	Soxhlet Extraction/ GC-MS[9]	41	NA[6]	Cold Vapor ICP MS[13] (Hg) Acid digestion (all metals but Hg) Graphite Furnace AAS[14] (Ag, Cd) FAA[15] (Cu, Fe, Mn, Ni, Pb, Zn) ICP-MS[13] (Al, Cr) Hydride AAS[14] (As)	Soxhlet Extraction/ Ni ECD[15]	NA[6]	NA[6]	Soxhlet Extraction/ Ni ECD	100
ANS 2000	NA[6]	NA[6]	Solvent Extraction/ GC-MS[9]	16	NA[6]	HF-HNO3[12] Total Digest/ICP OES[10]	Solvent Extraction/ GC-ECD[11]	NA[6]	NA[6]	Solvent Extraction/ GC-ECD[16]	81

Notes:

1. EPA CLP SOW OLM03.2
2. EPA CLP SOW ILM04.0 - (CLP)
3. SW-846 8082/NEA Comprehensive Quantitative Congener Specific Method
4. SW-846 Method
5. SW-846 Method 3540C Soxhlet Extraction
6. NA: not analyzed
7. EPA Method
8. SIM: Selective ion monitoring
9. GC-MS: Gas chromatography - mass spectrometry
10. ICP OES: Inductively coupled plasma optical emission spectroscopy
11. GC - ECD: Gas chromatography - electron capture detector
12. HF - HNO3: Hydrofluoric - nitric acid
13. ICP MS: Inductively coupled plasma mass specrtometry
14. AAS: Atomic adsorption spectrometry
15. FAA: Flame atomic adsorption
16. Ni ECD: Ni Electron capture detector
17. GC-ECD: Gas chromatograph - electron capture detector

Analyte	CAS	Group	Sediment BTAG Screening Level (mg/kg)	Sediment FW TEL[1] (mg/kg)	Sediment FW PEL [1] (mg/kg)	Sediment FW SEL[1] (mg/kg)	Surface Water Acute[3] FW (µg/L)	Surface Water Chronic[3] FW (µg/L)
Cyanide	57125	Cyano	0.1	NSL	NSL	NSL	22	5.2
2,3,7,8-TCDD	1746016	Dioxin	0.00000085	0.00000085	0.000022	NSL	0.010	0.000010
Antimony	7440360	Metal	2	NSL	NS	NSL	88	30
Arsenic	7440382	Metal	9.8	5.9	17	33	340	150
Beryllium	7440417	Metal	NSL	NSL	NSL	NSL	35	0.66
Cadmium	7440439	Metal	0.99	0.60	3.5	10	2.0	0.25
Chromium (III)	16065831	Metal	NSL	37.30	90	110	570	74
Chromium (VI)	18540299	Metal	NSL	NSL	NSL	NSL	16	11
Copper	7440508	Metal	31.6	36	197	110	13	6.0
Lead	7439921	Metal	35.8	35	91	250	65	2.5
Mercury	7439976	Metal	0.18	0.17	0.49	2.0	1.4	0.77
Nickel	7440020	Metal	22.7	18	36	75	470	52
Selenium	7782492	Metal	2	NSL	NSL	NSL	13	5.0
Silver	7440224	Metal	1	NSL	NSL	NSL	1.6	0.36
Thallium	7440280	Metal	NSL	NSL	NSL	NSL	110	0.030
Zinc	7440666	Metal	121	123	315	820	120	120
Acenaphthene	83329	PAH	0.0067	0.0067	0.089	NSL	1,700	5.8
Acenaphthylene	208968	PAH	0.0059	0.0059	0.13	NSL	NS	4,840
Anthracene	120127	PAH	0.0572	0.047	0.25	3.7	13	0.73
Benzo(a)Anthracene	56553	PAH	0.108	0.032	0.39	15	0.49	0.027
Benzo(a)Pyrene	50328	PAH	0.15	0.032	0.78	14	0.24	0.014
Benzo(b)Fluoranthene	205992	PAH	NSL	NSL	NSL	NSL	NS	9.1
Benzo(ghi)Perylene	191242	PAH	0.17	NSL	NSL	3.2	NS	7.6
Benzo(k)Fluoranthene	207089	PAH	0.24	NSL	NSL	13	NS	NS
Chrysene	218019	PAH	0.166	0.057	0.86	4.6	NS	NS
Dibenzo(a,h)Anthracene	53703	PAH	0.033	0.0062	0.14	1.3	NS	NS
Fluoranthene	206440	PAH	0.423	0.11	2.4	10	3,980	0.040
Fluorene	86737	PAH	0.0774	0.021	0.14	1.6	70	3.9
Indeno(1,2,3-cd)Pyrene	193395	PAH	0.017	NSL	NSL	3.2	NS	4.3
Naphthalene	91203	PAH	0.176	0.035	0.39	NSL	190	1.1
Phenanthrene	85018	PAH	0.204	0.042	0.52	10	30	6. 3
Pyrene	129000	PAH	0.195	0.053	0.88	8.5	NS	0.025
Total HMW PAHs	--	PAH	NSL	NSL	NSL	NSL	NSL	NSL
Total LMW PAHs	--	PAH	NSL	NSL	NSL	NSL	NSL	NSL
PCB-1016	12674112	PCB	NSL	NSL	NSL	NSL	NSL	NSL

Analyte	CAS	Group	Sediment BTAG Screening Level (mg/kg)	Sediment FW TEL[1] (mg/kg)	Sediment FW PEL [1] (mg/kg)	Sediment FW SEL[1] (mg/kg)	Surface Water Acute[3] FW (µg/L)	Surface Water Chronic[3] FW (µg/L)
PCB-1221	11104282	PCB	NSL	NSL	NSL	NSL	NSL	NSL
PCB-1232	11141165	PCB	NSL	NSL	NSL	NSL	NSL	NSL
PCB-1242	53469219	PCB	NSL	NSL	NSL	NSL	NSL	NSL
PCB-1248	12672296	PCB	NSL	NSL	NSL	NSL	NSL	NSL
PCB-1254	11097691	PCB	NSL	0.060	0.34	0.34	NSL	NSL
PCB-1260	11096825	PCB	NSL	NSL	NSL	NSL	NSL	NSL
Total PCBs	--	PCB	0.0598	0.0341	0.277	5.3	0.6	0.014
4,4'-DDD	72548	Pesticide	0.00488	0.0035	0.0085	0.060	0.19	0.011
4,4'-DDE	72559	Pesticide	0.00316	0.0014	0.0068	0.19	1,050	105
4,4'-DDT	50293	Pesticide	NSL	0.0012	0.0048	0.71	0.55	0.00050
Aldrin	309002	Pesticide	0.002	NSL	NSL	0.080	1.5	0.017
alpha-BHC	319846	Pesticide	0.006	NSL	NSL	0.10	39	2.2
alpha-Endosulfan	959988	Pesticide	0.0029	NSL	NSL	NSL	NSL	NSL
beta-BHC	319857	Pesticide	0.005	NSL	NSL	0.21	39	NS
beta-Endosulfan	33213659	Pesticide	0.014	NSL	NSL	NS	NSL	NSL
Chlordane	57749	Pesticide	0.00324	0.0045	0.01	0.060	1.2	0.0022
delta-BHC	319868	Pesticide	6.4	NSL	NSL	NSL	39	2.2
Dieldrin	60571	Pesticide	0.0019	0.0029	0.01	0.91	0.24	0.056
Endosulfan Sulfate	1031078	Pesticide	0.0054	NSL	NSL	NSL	NS	2.2
Endrin	72208	Pesticide	0.00222	0.0027	0.06	1.30	0.086	0.036
Endrin Aldehyde	7421934	Pesticide	NSL	NSL	NSL	NSL	NS	0.15
gamma-BHC	58899	Pesticide	0.00237	0.00094	0.0014	0.010	1.0	0.080
Heptachlor	76448	Pesticide	0.068	NSL	NSL	NSL	0.26	0.0019
Heptachlor Epoxide	1024573	Pesticide	0.00247	0.00060	0.0027	0.050	0.26	0.0019
Toxaphene	8001352	Pesticide	0.0001	0.00010	NSL	NSL	0.73	0.00020
1,2,4-Trichlorobenzene	120821	SVOC	2.1	NSL	NSL	NSL	700	24
1,2-Dichlorobenzene	95501	SVOC	0.0165	NSL	NSL	NSL	260	0.70
1,2-Diphenylhydrazine	122667	SVOC	NSL	NSL	NSL	NSL	270	27
1,3-Dichlorobenzene	541731	SVOC	4.43	NSL	NSL	NSL	630	713
1,4-Dichlorobenzene	106467	SVOC	0.599	NSL	NSL	NSL	180	60
2,4,6-Trichlorophenol	88062	SVOC	0.213	NSL	NSL	NS	NS	20
2,4-Dichlorophenol	120832	SVOC	0.117	NSL	NSL	NS	2,020	160
2,4-Dimethylphenol	105679	SVOC	0.029	NSL	NSL	NS	2,120	100
2,4-Dinitrophenol	51285	SVOC	NSL	NSL	NSL	NSL	230	45
2,4-Dinitrotoluene	121142	SVOC	0.0416	NSL	NSL	NSL	330	645
2,6-Dinitrotoluene	606202	SVOC	NSL	NSL	NSL	NSL	NS	NS

Analyte	CAS	Group	Sediment BTAG Screening Level (mg/kg)	Sediment FW TEL[1] (mg/kg)	Sediment FW PEL [1] (mg/kg)	Sediment FW SEL[1] (mg/kg)	Surface Water Acute[3] FW (µg/L)	Surface Water Chronic[3] FW (µg/L)
2-Chloronaphthalene	91587	SVOC	NSL	NSL	NSL	NSL	1,600	0.40
2-Chlorophenol	95578	SVOC	0.0312	NSL	NSL	NSL	4,380	490
2-Methyl-4,6-Dinitrophenol	534521	SVOC	NSL	NSL	NSL	NSL	NSL	NSL
2-Nitrophenol	88755	SVOC	NSL	NSL	NSL	NSL	NSL	NSL
3,3'-Dichlorobenzidine	91941	SVOC	0.127	NSL	NSL	NSL	NSL	5
3-Methyl-4-Chlorophenol	59507	SVOC	NSL	NSL	NSL	NSL	NSL	NSL
4-Bromophenyl Phenyl Ether	101553	SVOC	1.23	NSL	NSL	NSL	NSL	NSL
4-Chlorophenyl Phenyl Ether	7005723	SVOC	NSL	NSL	NSL	NSL	NSL	NSL
4-Nitrophenol	100027	SVOC	NSL	NSL	NSL	NSL	1,200	30
Benzidine	92875	SVOC	NSL	NSL	NSL	NSL	70	3.9
Bis(2-Chloroethoxy)Methane	111911	SVOC	NSL	NSL	NSL	NSL	11,000	NS
Bis(2-Chloroethyl)Ether	111444	SVOC	NSL	NSL	NSL	NSL	NS	1,900
Bis(2-Chloroisopropyl)Ether	108601	SVOC	NSL	NSL	NSL	NSL	NSL	NSL
Bis(2-Ethylhexyl)Phthalate	117817	SVOC	0.18	NSL	NSL	NSL	400	16
Butylbenzyl Phthalate	85687	SVOC	10.9	NSL	NSL	NSL	940	19
Diethyl Phthalate	84662	SVOC	0.603	NSL	NSL	NSL	1,800	210
Dimethyl Phthalate	131113	SVOC	NSL	NSL	NSL	NSL	940	3.0
Di-n-Butyl Phthalate	84742	SVOC	6.47	NSL	NSL	NSL	190	19
Di-n-Octyl Phthalate	117840	SVOC	NSL	NSL	NSL	NSL	940	3.0
Hexachlorobenzene	118741	SVOC	0.02	NSL	NSL	0.24	6.0	3. 68
Hexachlorobutadiene	87683	SVOC	NSL	NSL	NSL	NSL	90	1.3
Hexachlorocyclopentadiene	77474	SVOC	NSL	NSL	NSL	NSL	7.0	5.2
Hexachloroethane	67721	SVOC	1.027	NSL	NSL	NSL	210	12
Isophorone	78591	SVOC	NSL	NSL	NSL	NSL	117,000	1,170
Nitrobenzene	98953	SVOC	NSL	NSL	NSL	NSL	27,000	550
N-Nitrosodimethylamine	62759	SVOC	NSL	NSL	NSL	NSL	NSL	NSL
N-Nitrosodi-n-Propylamine	621647	SVOC	NSL	NSL	NSL	NSL	NSL	NSL
N-Nitrosodiphenylamine	86306	SVOC	2.68	NSL	NSL	NSL	3,800	210
Pentachlorophenol	87865	SVOC	0.504	NSL	NSL	NSL	19	15
Phenol	108952	SVOC	0.42	NSL	NSL	NSL	10,200	320
1,1,1-Trichloroethane	71556	VOC	0.0302	NSL	NSL	NSL	200	11
1,1,2,2-Tetrachloroethane	79345	VOC	1.36	NSL	NSL	NSL	2,100	111
1,1,2-Trichloroethane	79005	VOC	1.24	NSL	NSL	NSL	5,200	1,200
1,1-Dichloroethane	75343	VOC	NSL	NSL	NSL	NSL	830	47
1,1-Dichloroethylene	75354	VOC	0.031	NSL	NSL	NSL	450	25
1,2-Dichloroethane	107062	VOC	NSL	NSL	NSL	NSL	8,800	100

Analyte	CAS	Group	Sediment BTAG Screening Level (mg/kg)	Sediment FW TEL[1] (mg/kg)	Sediment FW PEL [1] (mg/kg)	Sediment FW SEL[1] (mg/kg)	Surface Water Acute[3] FW (µg/L)	Surface Water Chronic[3] FW (µg/L)
1,2-Dichloropropane	78875	VOC	NSL	NSL	NSL	NSL	NSL	NSL
1,2-TraNSL-Dichloroethylene	156605	VOC	1.05	NSL	NSL	NSL	11,600	1,160
1,3-Dichloropropylene	542756	VOC	0.0000509	NSL	NSL	NSL	NSL	NSL
2-Chloroethylvinyl Ether	110758	VOC	NSL	NSL	NSL	NSL	NSL	NSL
Acrolein	107028	VOC	NSL	NSL	NSL	NSL	68	0.01
Acrylonitrile	107131	VOC	NSL	NSL	NSL	NSL	7,550	2,600
Benzene	71432	VOC	NSL	NSL	NSL	NSL	2,300	46
Bromoform	75252	VOC	0.654	NSL	NSL	NSL	2,300	320
Carbon Tetrachloride	56235	VOC	0.0642	NSL	NSL	NSL	NS	10
Chlorobenzene	108907	VOC	0.00842	NSL	NSL	NSL	1,100	1.3
Chlorodibromomethane	124481	VOC	NSL	NSL	NSL	NSL	11,000	NSL
Chloroethane	75003	VOC	NSL	NSL	NSL	NSL	NSL	NSL
Chloroform	67663	VOC	NSL	NSL	NSL	NSL	490	2
Dichlorobromomethane	75274	VOC	NSL	NSL	NSL	NSL	11,000	NSL
Ethylbenzene	100414	VOC	1.1	NS	NS	NS	130	NSL

Analyte	CAS	Group	Sediment BTAG Screening Level (mg/kg)	Sediment FW TEL[1] (mg/kg)	Sediment FW PEL [1] (mg/kg)	Sediment FW SEL[1] (mg/kg)	Surface Water Acute[3] FW (µg/L)	Surface Water Chronic[3] FW (µg/L)
Methyl Bromide	74839	VOC	NSL	NSL	NSL	NSL	NSL	16
Methyl Chloride	74873	VOC	NSL	NSL	NSL	NSL	NSL	NSL
Methylene Chloride	75092	VOC	NSL	NSL	NSL	NSL	NSL	NSL
Tetrachloroethylene	127184	VOC	0.468	NSL	NSL	NSL	830	98
Toluene	108883	VOC	NSL	NSL	NSL	NSL	120	10
Trichloroethylene	79016	VOC	0.0969	NSL	NSL	NSL	440	21
Vinyl Chloride	75014	VOC	NSL	NSL	NSL	NSL	NS	930

Notes

1. Freshwater Sediment TELs and PELs are derived from Canadian Sediment Quality Guidelines for the protection of aquatic life; and SELs are derived from Guidelines for the protection and management of aquatic sediment quality in Ontario Aug 1993- referencing Screening Quick Reference Tables available at: http://archive.orr.noaa.gov/book_shelf/122_NEW-SQuiRTs.pdf
2. Aquatic Criteria - the primary source is US Ambient Water Quality Criteria, followed by the lowest of Tier II secondary acute values- referencing Screening Quick Reference Tables available at: http://archive.orr.noaa.gov/book_shelf/122_NEW-SQuiRTs.pdf

mg/kg	micrograms per kilogram	SEL	Severe effects level
NSL	No screening level available	SVOC	Semivolatile organic compound
PAH	Polycyclic aromatic hydrocarbon	TEL	Threshold effects level
PCB	Polychlorinated biphenyl	VOC	Volatile organic compound
PEL	Probable effects level	µg/L	micrograms per liter

Analyte	CAS	Group	EPA Regional Screening Levels[2]						Maximum Contaminant Level (ug/L)
			Industrial Soil 1E-06 Carcinogenic Screening Level (mg/kg)	Industrial Soil HI 0.1 Noncarcinogenic Screening Level (mg/kg)	Residential Tapwater 1E-06 Carcinogenic Screening Level (ug/L)	Residential Tapwater HI 0.1 Noncarcinogenic Screening Level (ug/L)	Fish Tissue Carcinogenic Screening Level (mg/kg)	Fish Tissue Noncarinogenic Screening Level (mg/kg)	
Cyanide	57125	Cyano	NSL	14	NSL	0.14	NSL	0.81	200
2,3,7,8-TCDD	1746016	Dioxin	0.000018	0.00006	0.00000052	0.0000011	0.000000024	0.00000095	0.00003
Antimony	7440360	Metal	NSL	41	NSL	0.6	NSL	0.54	6
Arsenic	7440382	Metal	2.4	38	0.045	0.47	0.0021	0.41	10
Beryllium	7440417	Metal	6900	200	NSL	1.6	NSL	2.7	4
Cadmium	7440439	Metal	9300	80	NSL	0.69	NSL	1.4	5
Chromium (III)	16065831	Metal	NSL	150000	NSL	1600	NSL	2000	NSL
Chromium (VI)	18540299	Metal	5.6	310	0.031	3.1	0.0063	4.1	NSL
Copper	7440508	Metal	NSL	4100	NSL	62	NSL	54	1300
Lead	7439921	Metal	NSL	800	NSL	NSL	NSL	NSL	15
Mercury	7439976	Metal	NSL	4.3	NSL	0.063	NSL	NSL	2
Nickel	7440020	Metal	64000	2000	NSL	30	NSL	NSL	NSL
Selenium	7782492	Metal	NSL	510	NSL	7.8	NSL	6.8	50
Silver	7440224	Metal	NSL	510	NSL	7.1	NSL	6.8	NSL
Thallium	7440280	Metal	NSL	1	NSL	0.016	NSL	0.014	2
Zinc	7440666	Metal	NSL	31000	NSL	470	NSL	410	NSL
Acenaphthene	83329	PAH	NSL	3300	NSL	40	NSL	81	NSL
Acenaphthylene	208968	PAH	NSL	NSL	NSL	NSL	NSL	NSL	NSL
Anthracene	120127	PAH	NSL	17000	NSL	130	NSL	410	NSL
Benzo(a)Anthracene	56553	PAH	2.1	NSL	0.029	NSL	0.0043	NSL	NSL
Benzo(a)Pyrene	50328	PAH	0.21	NSL	0.0029	NSL	0.00043	NSL	0.2
Benzo(b)Fluoranthene	205992	PAH	2.1	NSL	0.029	NSL	0.0043	NSL	NSL
Benzo(ghi)Perylene	191242	PAH	NSL	NSL	NSL	NSL	NSL	NSL	NSL
Benzo(k)Fluoranthene	207089	PAH	21	NSL	0.29	NSL	0.043	NSL	NSL
Chrysene	218019	PAH	210	NSL	2.9	NSL	0.43	NSL	NSL
Dibenzo(a,h)Anthracene	53703	PAH	0.21	NSL	0.0029	NSL	0.00043	NSL	NSL
Fluoranthene	206440	PAH	NSL	2200	NSL	63	NSL	54	NSL
Fluorene	86737	PAH	NSL	2200	NSL	22	NSL	54	NSL
Indeno(1,2,3-cd)Pyrene	193395	PAH	2.1	NSL	0.029	NSL	0.0043	NSL	NSL
Naphthalene	91203	PAH	18	62	0.14	0.61	NSL	27	NSL
Phenanthrene	85018	PAH	NSL	NSL	NSL	NSL	NSL	NSL	NSL
Pyrene	129000	PAH	NSL	1700	NSL	8.7	NSL	41	NSL
PCB-1016	12674112	PCB	21	3.7	0.96	0.11	0.045	0.095	NSL
PCB-1221	11104282	PCB	0.54	NSL	0.004	NSL	0.0016	NSL	NSL
PCB-1232	11141165	PCB	0.54	NSL	0.004	NSL	0.0016	NSL	NSL
PCB-1242	53469219	PCB	0.74	NSL	0.034	NSL	0.0016	NSL	NSL
PCB-1248	12672296	PCB	0.74	NSL	0.034	NSL	0.0016	NSL	NSL
PCB-1254	11097691	PCB	0.74	1.1	0.034	0.031	0.0016	0.027	NSL
PCB-1260	11096825	PCB	0.74	NSL	0.034	NSL	0.0016	NSL	NSL
4,4'-DDD	72548	Pesticide	7.2	NSL	0.027	NSL	0.013	NSL	NSL

Analyte	CAS	Group	EPA Regional Screening Levels[2]						Maximum Contaminant Level (ug/L)
			Industrial Soil 1E-06 Carcinogenic Screening Level (mg/kg)	Industrial Soil HI 0.1 Noncarcinogenic Screening Level (mg/kg)	Residential Tapwater 1E-06 Carcinogenic Screening Level (ug/L)	Residential Tapwater HI 0.1 Noncarcinogenic Screening Level (ug/L)	Fish Tissue Carcinogenic Screening Level (mg/kg)	Fish Tissue Noncarinogenic Screening Level (mg/kg)	
4,4'-DDE	72559	Pesticide	5.1	NSL	0.2	NSL	0.0093	NSL	NSL
4,4'-DDT	50293	Pesticide	7	43	0.2	0.78	0.0093	0.68	NSL
Aldrin	309002	Pesticide	0.1	1.8	0.004	0.047	0.00019	0.041	NSL
alpha-BHC	319846	Pesticide	0.27	490	0.0062	7.3	0.0005	11	NSL
alpha-Endosulfan	959988	Pesticide	NSL	NSL	NSL	NSL	NSL	NSL	NSL
beta-BHC	319857	Pesticide	0.96	NSL	0.022	NSL	0.0018	NSL	NSL
beta-Endosulfan	33213659	Pesticide	NSL	NSL	NSL	NSL	NSl	NSL	NSL
Chlordane	12789036	Pesticide	NSL	NSL	NSL	NSL	0.009	0.68	NSL
delta-BHC	319868	Pesticide	NSL	NSL	NSL	NSL	NSL	NSL	NSL
Dieldrin	60571	Pesticide	0.11	3.1	0.0015	0.028	0.0002	0.068	NSL
Endosulfan Sulfate	1031078	Pesticide	NSL	NSL	NSL	NSL	NSL	NSL	NSL
Endrin	72208	Pesticide	NSL	18	NSL	0.17	NSL	0.41	2
Endrin Aldehyde	7421934	Pesticide	NSL	NSL	NSL	NSL	NSL	NSL	NSL
gamma-BHC	58899	Pesticide	2.1	24	0.036	0.27	0.0029	0.41	0.2
Heptachlor	76448	Pesticide	0.38	31	0.0018	0.092	0.0007	0.68	0.4
Heptachlor Epoxide	1024573	Pesticide	0.19	0.8	0.0033	0.0092	0.00035	0.018	0.2
Toxaphene	8001352	Pesticide	1.6	NSL	0.013	NSL	0.0029	NSL	3
1,2,4-Trichlorobenzene	120821	SVOC	99	27	0.99	0.39	0.11	14	70
1,2-Dichlorobenzene	95501	SVOC	NSL	980	NSL	28	NSL	120	600
1,2-Diphenylhydrazine	122667	SVOC	2.2	NSL	0.067	NSL	0.0039	NSL	NSL
1,3-Dichlorobenzene	541731	SVOC	NSL	NSL	NSL	NSL	NSL	NSL	NSL
1,4-Dichlorobenzene	106467	SVOC	12	2500	0.42	47	0.58	95	75
2,4,6-Trichlorophenol	88062	SVOC	160	62	3.5	0.9	0.29	1.4	NSL
2,4-Dichlorophenol	120832	SVOC	NSL	180	NSL	3.5	NSL	4.1	NSL
2,4-Dimethylphenol	105679	SVOC	NSL	1200	NSL	27	NSL	27	NSL
2,4-Dinitrophenol	51285	SVOC	NSL	120	NSL	3	NSL	2.7	NSL
2,4-Dinitrotoluene	121142	SVOC	5.5	120	0.2	3	0.01	2.7	NSL
2,6-Dinitrotoluene	606202	SVOC	1.2	19	0.042	0.44	0.0021	0.41	NSL
2-Chloronaphthalene	91587	SVOC	NSL	8200	NSL	55	NSL	110	NSL
2-Chlorophenol	95578	SVOC	NSL	510	NSL	7.1	NSL	6.8	NSL
2-Methyl-4,6-Dinitrophenol	534521	SVOC	NSL	4.9	NSL	0.12	NSL	0.11	NSL
2-Nitrophenol	88755	SVOC	NSL	NSL	NSL	NSL	NSL	NSL	NSL
3,3'-Dichlorobenzidine	91941	SVOC	3.8	NSL	0.11	NSL	0.007	NSL	NSL
3-Methyl-4-Chlorophenol	59507	SVOC	NSL	6200	NSL	110	NSL	140	NSL
4-Bromophenyl Phenyl Ether	101553	SVOC	NSL	NSL	NSL	NSL	NSL	NSL	NSL
4-Chlorophenyl Phenyl Ether	7005723	SVOC	NSL	NSL	NSL	NSL	NSL	NSL	NSL
4-Nitrophenol	100027	SVOC	NSL	NSL	NSL	NSL	NSL	NSL	NSL
Benzidine	92875	SVOC	0.0075	180	0.000092	4.6	0.000014	4.1	NSL
Bis(2-Chloroethoxy)Methane	111911	SVOC	NSL	180	NSL	4.6	NSL	4.1	NSL

Analyte	CAS	Group	EPA Regional Screening Levels[2]						Maximum Contaminant Level (ug/L)
			Industrial Soil 1E-06 Carcinogenic Screening Level (mg/kg)	Industrial Soil HI 0.1 Noncarcinogenic Screening Level (mg/kg)	Residential Tapwater 1E-06 Carcinogenic Screening Level (ug/L)	Residential Tapwater HI 0.1 Noncarcinogenic Screening Level (ug/L)	Fish Tissue Carcinogenic Screening Level (mg/kg)	Fish Tissue Noncarinogenic Screening Level (mg/kg)	
Bis(2-Chloroethyl)Ether	111444	SVOC	1	NSL	0.012	NSL	0.0029		NSL
Bis(2-Chloroisopropyl)Ether	108601	SVOC	22	4100	0.31	55	0.045	54	NSL
Bis(2-Ethylhexyl)Phthalate	117817	SVOC	120	1200	4.8	31	0.23	27	6
Butylbenzyl Phthalate	85687	SVOC	910	12000	14	120	1.7	270	NSL
Diethyl Phthalate	84662	SVOC	NSL	49000	NSL	1100	NSL	1100	NSL
Dimethyl Phthalate	131113	SVOC	NSL	NSL	NSL	NSL	NSL	NSL	NSL
Di-n-Butyl Phthalate	84742	SVOC	NSL	6200	NSL	67	NSL	140	NSL
Di-n-Octyl Phthalate	117840	SVOC	NSL	620	NSL	16	NSL	14	NSL
Hexachlorobenzene	118741	SVOC	1.1	49	0.042	1.3	0.002	1.1	1
Hexachlorobutadiene	87863	SVOC	NSL	NSL	NSL	NSL	NSL	NSL	NSL
Hexachlorocyclopentadiene	77474	SVOC	NSL	370	NSL	2.2	NSL	8.1	50
Hexachloroethane	67721	SVOC	43	43	0.79	0.51	0.079	0.95	NSL
Isophorone	78591	SVOC	1800	12000	67	300	3.3	270	NSL
Nitrobenzene	98953	SVOC	24	120	0.12	1.1	NSL	2.7	NSL
N-Nitrosodimethylamine	62759	SVOC	0.034	0.49	0.00042	0.012	0.000062	0.011	NSL
N-Nitrosodi-n-Propylamine	621647	SVOC	0.25	NSL	0.0093	NSL	0.00045	NSL	NSL
N-Nitrosodiphenylamine	86306	SVOC	350	NSL	10	NSL	0.64	NSL	NSL
Pentachlorophenol	87865	SVOC	2.7	190	0.035	1.6	0.0079	6.8	1
Phenol	108952	SVOC	NSL	18000	NSL	450	NSL	410	NSL
1,1,1-Trichloroethane	71556	VOC	NSL[3]	3800	NSL	750	NSL	2700	200
1,1,2,2-Tetrachloroethane	79345	VOC	2.8	2000	0.066	28	0.016	27	NSL
1,12-Trichloroethane	79005	VOC	5.3	0.68	0.24	0.041	0.055	5.4	5
1,1-Dichloroethane	75343	VOC	17	20000	2.4	290	0.55	270	NSL
1,1-Dichloroethylene	75354	VOC	NSL	110	NSL	26	NSL	68	7
1,2-Dichloroethane	107062	VOC	2.2	15	0.15	1.3	0.035	8.1	5
1,2-Dichloropropane	78875	VOC	4.7	7.1	0.38	0.83	0.088	120	5
1,2-Trans-Dichloroethylene	156605	VOC	NSL	69	NSL	8.6	NSL	27	100
1,3-Dichloropropylene	542756	VOC	8.3	33	0.41	3.8	0.032	41	NSL
2-Chloroethylvinyl Ether	110758	VOC	NSL	NSL	NSL	NSL	NSL	NSL	NSL
Acrolein	107028	VOC	NSL	0.065	NSL	0.0041	NSL	0.68	NSL
Acrylonitrile	107131	VOC	1.2	7.2	0.045	0.41	0.0058	54	NSL
Benzene	71432	VOC	5.4	45	0.39	2.9	0.057	5.4	5
Bromoform	75252	VOC	220	1200	7.9	29	0.4	27	NSL
Carbon Tetrachloride	56235	VOC	3	60	0.39	4	0.045	5.4	5
Chlorobenzene	108907	VOC	NSL	140	NSL	7.2	NSL	27	100
Chlorodibromomethane	124481	VOC	3.3	1200	0.15	29	0.038	27	NSL
Chloroethane	75003	VOC	NSL	6100	NSL	2100	NSL	NSL	NSL
Chloroform	67663	VOC	1.5	110	0.19	8.4	0.1	14	NSL
Dichlorobromomethane	75274	VOC	1.4	2000	0.12	29	0.051	27	NSL

Analyte	CAS	Group	EPA Regional Screening Levels[2]						Maximum Contaminant Level (ug/L)
			Industrial Soil 1E-06 Carcinogenic Screening Level (mg/kg)	Industrial Soil HI 0.1 Noncarcinogenic Screening Level (mg/kg)	Residential Tapwater 1E-06 Carcinogenic Screening Level (ug/L)	Residential Tapwater HI 0.1 Noncarcinogenic Screening Level (ug/L)	Fish Tissue Carcinogenic Screening Level (mg/kg)	Fish Tissue Noncarinogenic Screening Level (mg/kg)	
Ethylbenzene	100414	VOC	27	2100	1.3	67	0.29	140	700
Methyl Bromide	74839	VOC	NSL	3.2	NSL	0.7	NSL	1.9	NSL
Methyl Chloride	74873	VOC	NSL	50	NSL	19	NSL	NSL	NSL
Methylene Chloride	75092	VOC	960	310	9.9	8.4	1.6	8.1	5
Tetrachloroethylene	127184	VOC	110	41	9.7	3.5	1.5	8.1	5
Toluene	108883	VOC	NSL	4500	NSL	86	NSL	110	1000
Trichloroethylene	79016	VOC	6.4	2	0.44	0.26	0.069	0.68	5
Vinyl Chloride	75014	VOC	1.7	39	0.015	3.6	0.0044	4.1	2

1. US EPA Region III Biological Technical Assistance Group Freshwater Sediment Screening Benchmarks (August 2006)
2. US EPA Regional Screening Level Table, May 2013 version
3. NSL: No screening level is defined for the analyte

3.0 PRELIMINARY CONCEPTUAL SITE MODEL

This section discusses the preliminary CSM for contaminated sediment in the tidal Anacostia River. A CSM is a functional description of what is known about an area of concern and the contamination known or suspected to be present. The CSM incorporates the available geologic, hydrogeologic, hydrologic, contaminant concentration, and environmental receptor data into an integrated understanding of site conditions. The CSM serves as the primary tool to identify data gaps and is updated as new data become available.

Figure 3.1 shows the general CSM for the sourcing and transport of hazardous constituents in the tidal Anacostia River and potential receptor exposure to these constituents. Contaminants enter the river via tributary inflow, sediment loading, groundwater seepage, and tidal mixing. Contaminants can also enter through direct spillage or wastewater discharges associated with former practices. Contaminants associated with suspended sediment may remain in suspended transport, desorb to surface water, or become deposited on the channel bottom. Deposited sediment may become re-suspended through biological process, erosion during storm flow conditions, and through dredging activities. Surface sediment contamination may contribute to low benthic species diversity and abundance. Benthic organisms that do survive may bioaccumulate hazardous chemicals. Consumption of contaminated benthic fauna by lower tier forage fish could result in further bioaccumulation in both lower tier forage fish and upper tier predatory species. Exposure to carcinogens in sediments and through the food chain results in an elevated prevalence of liver tumors in some bottom dwelling fish species. Human exposure can result from contact with contaminated sediment and surface water and from the consumption of contaminated fish, turtles, and invertebrates.

Section 3.1 discusses the physical elements of the CSM. **Sections 3.2** and **3.3** present the ecological and human health-specific CSM elements, respectively.

3.1 Physical Conceptual Site Model

The physical CSM describes the physical processes through which contaminants enter each of the environmental media of concern, the fate and transport processes affecting the distribution of these contaminants, and the potential pathways for exposure to human and ecologic receptors. **Section 3.1.1** discusses the constituents of concern in the investigation. **Sections 3.1.2, 3.1.3, 3.1.4,** and **3.1.5** discuss contaminant sources, release mechanisms, exposure media, and transport media, respectively. Watershed modeling that has been performed for the tidal Anacostia is discussed in **Section 3.1.6**.

3.1.1 Constituents of Concern

The COCs for this investigation consist of all VOC, SVOC, metals, pesticide, cyanide, and PCB Aroclor constituents included on the EPA PP List (**Table 3.1**). PCDDs/PCDFs will also be sampled but on a more limited basis. In addition to the analysis of PCB Aroclors, the full list of 209 PCB congeners will also be analyzed either for all samples or selectively, depending on the medium as discussed in detail in Section 5.0. The EPA PP List is comprised of 126 constituents including 28 VOCs, 57 SVOCs, 18 pesticides, 14 metals, seven PCB Aroclors, total cyanide, and 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD). The

57 SVOCs include 16 PAHs which are further classified as being of low or high molecular weight (LPAHs and HPAHs, respectively). HPAHs are the 10 PAHs with four or more aromatic rings and include the carcinogenic PAHs (CPAHs). As noted above for PCBs, alkylated PAHs will also be analyzed either in all samples or selectively, depending on the medium; Section 5.0 provides additional details.

A significant amount of sampling has already been conducted for many of the PP list constituents as reflected by the relatively extensive project database (**Section 2.6**). As will be discussed in the data gap identification portion of **Section 4**, however, additional sampling for PPs is necessary to address uncertainties in the existing characterization. Concentration data are available for surface sediment, deep sediment, and fish tissue. Previous sediment investigations in the Anacostia have shown that the primary contaminants that make the river unsafe for fishing or swimming are PCBs, PAHs, and selected metals and pesticides.

The PP list includes all the hazardous constituents whose presence in the river result in its Section 303(d) listing as an impaired water body. As discussed in **Section 2.1**, TMDLs have been established for PCBs, BOD, bacteria, organics, metals, sediment, oil and grease, and trash.

3.1.2 Sources

Sources of hazardous constituents to the tidal river include surface water inflow, seepage of groundwater from contaminated sites that border the river, groundwater discharge via seepage into the sewer system, and the loading of contaminated sediments. The predominant sources for contaminated groundwater are likely the environmental cleanup sites that border the river and have documented or potential groundwater contamination issues (**Section 3.1.2.1**). Primary surface water and sediment sources include tributary streams, CSS outfalls, and storm sewer outfalls (**Section 3.2.2.2**). Once contaminants enter the river, they may be redistributed by floods, storms, and other physical disturbances.

Groundwater seepage is a potential source for the observed contamination in Anacostia River sediments. A groundwater modeling investigation of the Anacostia River watershed by Logan (1999) puts into context the potential contaminant contributions from groundwater. The model indicates that average groundwater seepage through the river bottom and from adjacent wetlands is small compared to tributary inflow. Northeast Branch and Northwest Branch are the two largest tributary streams to the tidal Anacostia River. According to Logan (1999) the estimated groundwater discharge to the Anacostia River was approximately 3.8×10^5 ft^3/day or two percent of the combined average discharge of Northeast Branch and Northwest Branch of 1.9×10^7 ft^3/day (average for the period 1938 – 2000 [Miller et al. 2007]). The small groundwater seepage contribution to the river's discharge is a result of the low hydraulic conductivity of the clayey deposits that predominantly comprise the river bottom and adjacent floodplain. It should be noted, however, that groundwater preferential discharge pathways will exist where coarse grained materials intersect the river bottom. Based on existing site information, coarse grained material at or in close proximity to the river bottom likely is most commonly encountered near the confluence of Northeast Branch and Northwest Branch. Downstream from this area, however, deposition is dominated more by silt and clay size materials.

3.1.2.1 Environmental Cleanup Sites

Contaminants may enter the Anacostia River from the contaminated sites that border the river. Contaminant entry pathways include erosion and transport of contaminated soil, contaminated runoff, and seepage of contaminated groundwater. **Table 3.2** lists the environmental cleanup sites for which documentation exists regarding monitored constituents and the reported constituents at each site for surface soil, subsurface soil, groundwater, sediments, and surface water. Each of these media could serve as a primary or secondary source of contamination for site constituents. A brief summary for each site follows. Background information including a summary of the sediment sampling results from previous investigations is provided for each site in **Section 2.6.2**.

Kenilworth Park Landfill. In comparison to the screening levels discussed in **Section 2.7**, surface and subsurface soils at this 130 acre site contain elevated concentrations of PAHs, PCBs and various pesticides and metals. Portions of the fill area directly contact the river or are within 100 feet of the riverbank. In general, the water table occurs in the landfilled wastes. Groundwater migrating through the wastes is contaminated by dissolution of constituents from the wastes and by downward migrating leachate from the overlying unsaturated wastes. Groundwater constituents include metals and various VOCs. Groundwater from the site discharges directly to the river (Ecology and Environment 2007a). A supplemental groundwater investigation was started at this site in 2013.

Pepco Benning Road Facility. The 77-acre Pepco Benning Road facility contains several areas of known soil contamination. According to AECOM (2012), six petroleum USTs were either removed or closed in place. The potential exists that residual petroleum hydrocarbon contamination is present at these sites. In addition, excavation of PCB contaminated soil was conducted at several locations. Relative to the screening levels discussed in **Section 2.7**, residual elevated PCB levels may persist in soil at each location. In addition, elevated PAHs, PCBs, and metals have also been detected in a former sludge dewatering area. As a result of these issues, constituents of concern in soil, groundwater, sediment, and surface water at the Benning Road facility include VOCs, PAHs, PCBs, and metals.

CSX Benning Yard. The primary source of contamination at the CSX Benning Yard is groundwater contamination resulting from a subsurface diesel spill. Based on data provided in Geosyntec (2013a), a NAPL plume with an approximate area of 1.3 acres has resulted in discharge of contaminated groundwater to Fort Dupont Creek and, on occasion, the appearance of a petroleum hydrocarbon sheen in the creek. Downstream from Benning Yard, Fort Dupont Creek flows a distance of 806 feet through a 72-inch diameter reinforced concrete pipe (EnviroScience2013) to an outfall in the tidal Anacostia River. Site constituents of concern in soil include VOCs (BTEX) and TPH DRO. TPH DRO includes the range of LPAH and HPAH PP compounds. Sediment sampling was conducted in Fort Dupont Creek and in the river near the Fort Dupont Creek outfall. Sediment (downstream from the spill area) and groundwater constituents include metals and PAHs, TPH DRO; SVOCs are also a concern in groundwater.

WGL East Station. The WGL East Station site is a 18 acre site with contamination typical for manufactured gas plant (MGP) sites. An RI including near-shore sediments is ongoing. NAPL has been observed in the fill materials underlying the site. In addition, NAPL recovery is ongoing through the use of a pump and treat system. The extent to which groundwater discharge to the adjacent Anacostia River

is controlled hydraulically by a pump and treat system will be evaluated during the WGL OU2 RI. COCs include a range of metals, selected VOCs, PAHs, and complex cyanides.

Poplar Point. A Phase I environmental site assessment (ESA) completed by Ridolfi Engineers (Ridolfi) (2003b) identified a number of recognized environmental conditions (RECs) at the Poplar Point Site. Ridolfi also completed site characterization sampling at the site in 2002 (Ridolfi 2003a). Sampling included soil, sediments, groundwater, and surface water. Soil samples were screened using the lowest screening level obtained from reviewing EPA Region 3 BTAGs, DC Risk-Based Screening Levels (residential and industrial), EPA Region 3 Risk-Based Concentrations (RBCs) (residential and industrial), and EPA Region 3 Site Screening Levels (SSLs) for Soil to Groundwater Migration (dilution attenuation factors 1 and 20). Sediment sampling results were compared to Region 3 BTAGs and NOAA Screening Quick Reference Tables (SQuiRTs) sediments screening levels (threshold and probable effects levels). Groundwater samples were screened against EPA MCLs, DC Groundwater Criteria, DC Risk-Based Screening Levels for Groundwater (residential and industrial), and EPA Region 3 RBCs for tap water.

Benzo(a)pyrene (BaP), 4,4'-DDT, arsenic, and diesel constituents where significantly elevated in some site soil samples. The elevated BaP concentrations were observed in portions of the site formerly used as a tree nursery while the pesticides exceedances primarily occurred near wetland areas. Several soil samples exceeded the total PCB (Aroclors) screening level including one taken adjacent to a wetland and another collected adjacent to a former garage. In addition, groundwater samples from a former burn pit and various former petroleum storage areas exhibited elevated concentrations of benzene, toluene, ethylbenzene, xylene, and methyl tert-butyl ether. Other groundwater contaminants detected above screening levels included metals, pesticides, PCBs, VOCs, and SVOCs. In addition to environmental investigation activities, abandoned drums and inactive underground and above ground storage tanks have been removed during previous site actions.

Washington Navy Yard. The Washington Navy Yard encompasses 63 acres and is located adjacent to the WGL East Station. Residual sediment present in since-renovated sewer lines at the site contained, in comparison to **Section 2.7** screening levels, elevated PCBs, PAHs, and metals. PCB contamination exists in several areas including the former power plant. Soil containing elevated lead concentrations originating from lead-based paint has been removed during cleanup of site soils. In addition, mercury contaminated soil was remediated at one location. Elevated arsenic and lead concentrations are widespread in site groundwater. Low-level chlorinated VOC plumes have been identified at various locations. Trichloroethene, cis-dichloroethene, trans-dichloroethene, and vinyl chloride concentrations are typically below or slightly above the respective drinking water MCL for each compound (**Section 2.7**). COCs in soils include VOCs, PAHs, non-PAH SVOCs, PCBs, pesticides, and metals. Metals and chlorinated VOCs are of concern in groundwater. Sediment constituents include metals, PCBs, and PAHs. Polychlorinated dibenzo-p-dioxins/polychlorinated dibenzofurans (PCDD/PCDFs) were detected in site sediments but were not determined to be drivers of human health or ecological risk (CH2M Hill 2011a).

Joint Base Anacostia-Bolling. JBAB comprises 905-acres located between the Potomac and Anacostia rivers and Interstate 295. A web search revealed that 17 former leaking underground petroleum storage tank (LUST) sites existed at JBAB, identified between 1989 and 1997. The substances leaked included

gasoline, waste/used oil, heating fuel oil, and kerosene. Documented contamination of soil and/or soil and groundwater resulted from LUST sites and all 17 cases were resolved by 2003. Several localized investigations have been conducted at specific sites within JBAB associated with incinerator waste disposal areas (AOC 1), fill areas (Site 2), a petroleum-contaminated area (Site 3), and a hazardous materials storage and usage site (Building 168). Barium, iron, manganese, and dioxins/furans in groundwater at AOC 1 may pose potentially unacceptable risks to aquatic organisms in the Anacostia River adjacent to AOC 1. Barium, iron, and manganese were identified as posing a potential risk to water column receptors in the Anacostia River, adjacent to Site 2. Detected concentrations of SVOCs and metals at Site 3 were similar to background concentrations and were considered not likely to pose any unacceptable risks to the human health and ecological receptors. Six monitoring wells in the vicinity of Building 168 were sampled and only metals were present at concentrations exceeding screening criteria. Maximum concentrations of filtered groundwater samples collected from these six wells were as follows: arsenic (11.9 µg/L), barium (373 µg/L), cadmium (0.83 µg/L), iron (64,300 µg/L), manganese (7,100 µg/L), thallium (6.2 µg/L), and vanadium (1.1 µg/L).

Former Steaurt Petroleum Company Adjacent to the East of WGL East Station. The Former Steuart Petroleum Company property adjacent to the WGL East Station was formerly used as a bulk petroleum facility. Soil and groundwater were formerly contaminated with TPH, BTEX, MTBE, and naphthalene in the vicinity of former USTs and a release of #4 fuel oil (**Section 2.7**). The facility has achieved closure status in the District UST program.

Hess /Gulf Former Petroleum Terminals. Two former petroleum terminals conducted operations between the 1920s and 1980s adjacent to western terminus of the South Capital Street Bridge. Environmental investigations conducted in the 1990s and 2000s indicate that soil and groundwater at the site is contaminated with BTEX, TPH, PAHs, and NAPL (**Section 2.7**). Environmental remediation was ongoing at these facilities dating to at least 2005 including a groundwater pump and treat system.

3.1.2.2 Outfalls and Tributary Streams

With the exception of some isolated woodland areas which are mostly associated with parkland, the Anacostia watershed has been developed resulting in the covering of a high proportion of the land area with impervious surfaces (e.g., pavement in roads and parking lots, sidewalks, and residential/ commercial/industrial structures). As a result of reduced infiltration, surface water discharge from the outfalls and tributary streams to the Anacostia River is characterized by high sediment content and rapid velocities, particularly during storm events (AWTA 2002). Many tributaries receive large portions of their flow from storm sewers.

A large proportion of the contaminants contained in outfall and tributary discharge are associated with non-point source, low level “urban background” contamination levels present throughout the watershed. CSS outfalls, storm sewer outfalls, and tributary streams are all sources for this contamination.

PAHs, PCBs, pesticides, and metals are typical contaminants characteristic of urban background. PAHs are present in petroleum based fuels, lubricants, asphalt and combustion particles (soot) and are

characteristic of the runoff from roads and other urban surfaces. Although widespread use of PCBs in electrical equipment and various other products was banned in 1976, these compounds persist as surface water and sediment contaminants. Pesticide contaminants originate from current and previous citywide pest management campaigns and from general household use of these compounds. Metals are present in native soils and can originate from other diverse sources. For example, historical use of leaded gasoline has caused elevated lead levels in surface soil in urban areas. DDOE is in the preliminary planning stages of a study to characterize tributary loading to the tidal Anacostia River. This effort is being conducted external to the RI.

Combined Sewer System Outfalls. Significant sources of contaminated surface water and sediment to the tidal Anacostia River are the CSS outfalls operated by the District of Columbia Water and Sewer Authority (DC Water). Based on information obtained from the DC Water database, up to 16 CSS outfalls discharge or have discharged to the tidal river (**Figure 3.2**). Most of these outfalls are located in the lower Anacostia River, downstream from the CSX railroad bridge. DC Water indicates that 15 CSS outfalls currently discharge to the Anacostia River (DC Water 2012). **Table 3.3** summarizes the information available for each outfall included in the DC Water database. Each CSS outfall is permitted by EPA through the NPDES.

CSS outfalls discharge a mixture of sewage and storm water to surface water during high runoff periods such as a storm event. Under normal precipitation conditions, sewer capacity is sufficient to convey wastewater and runoff discharge volumes to a treatment facility (Blue Plains Advanced Wastewater Treatment Plant for the DC Water system). To avert flooding during a storm when the combined wastewater and storm water flows exceed the wastewater system capacity, CSS outfalls divert a mixture of raw sewage and storm water directly to the receiving surface water body, an event termed a CSS overflow. For the CSS outfalls that discharge to the tidal Anacostia River, sanitary flow capacity is exceeded even after moderate storm events. Combined discharge to the river occurs for precipitation events as low as 0.27 inches over a 24 hour period (AWTA 2002). For 2013, DC Water reported a total of 92 CSO releases and 1.8 billion gallons for the total CSO overflow volume (www.dcwater.com/wastewater_collection/css/css_reports.cfm).

As shown on **Table 3.3**, drainage area data are available for some of the Anacostia CSS outfalls. Over 93 percent of the CSS outfall flow volume was contributed by two CSS outfalls: the Main and O Streets (NPDES 12) CSS outfall near the Washington Navy Yard and the Northeast Boundary Facility "Swirl Concentrator" CSS outfall (NPDES 019) (AWTA 2002). The drainage areas for these two CSS outfalls are 1,153.83 and 4,242.39 acres, respectively. For the 10 other CSS outfalls for which data are available, drainage areas range from 13.56 to 259.91 acres and average 94.89 acres.

In addition to the contaminant loading common for all outfalls and tributaries in the Anacostia watershed, CSS outfall discharges also degrade water quality by causing elevated levels of pathogenic bacteria and increased BOD. Elevated BOD can result in oxygen-depleted zones unable to support aquatic life.

In accordance with a four-party 2005 consent decree signed by the Assistant U.S. Attorney General, the U.S. EPA Regional Administrator, the DC Water General Manager, and the DC City Administrator, DC Water has developed a comprehensive plan called the Long Term Control Plan (LTCP). As part of this plan, DC Water initiated construction in 2011 on a tunnel and pumping system that will substantially reduce CSS outfall discharges (DC Water originally predicted a 98 percent reduction) by collecting and storing excess storm water flows for treatment at the Blue Plains facility (DC Water 2012). The 2005 consent decree has been the subject of recent discussion between EPA, DC Water, and the District, as the feasibility of modifying the consent decree to incorporate aggressive implementation of green infrastructure is under evaluation. Pending court-approved modification of the consent decree, the reductions and implementation schedule originally specified in the LTCP may change.

Storm Sewer Outfalls. Storm sewer outfalls (referred to herein as MS4 outfalls) solely discharge storm water runoff without contributions from the sanitary sewer system. Together with the CSS outfalls, the MS4 outfalls, drain the surrounding urbanized area that, prior to development, was drained by native streams. **Figure 3.2** shows the 60 MS4 outfalls that the DC Water database lists as tributary to the tidal Anacostia River. Also shown are 13 Prince George's County MS4 outfalls (labeled for the purposes of this report as "PG-TMP-#") preliminarily identified from available data. MS4 outfalls are present mostly south of Benning Road and are most numerous in the Anacostia River from South Capitol Street to the river mouth and in the Washington Channel. **Table 3.4** lists the MS4 outfalls that discharge to the tidal Anacostia River. The drainage areas for the MS4 outfalls are undefined in the DC Water database and in the available data for the Prince George's County outfalls. As shown in this table, several outfalls originate as surface streams including Stickfoot Creek, Fort Davis Creek, Texas Avenue Tributary, Fort Dupont Creek, and Fort Chaplin Creek.

Tributaries. Table 3.5 lists the 14 streams that are tributary to the tidal Anacostia River within the study area. The three largest tributaries are Northwest Branch, Northeast Branch, and Lower Beaverdam Creek which account for 45, 32, and 17 percent, respectively of the total flow of the river (Warner et al. 1997).

A number of investigations have been conducted to assess the relative contributions of contaminants from the tributaries to the tidal river. The results from a 1997 study of Northwest Branch and Northeast Branch indicated that Northeast Branch total and dissolved concentrations of trace metals were consistently higher than those observed in Northwest Branch (AWTA 2002). Miller et al. (2007) evaluated total and dissolved trace metal concentrations for Northwest Branch and Northeast Branch for the period 2003 through 2005. Results of this study indicated that similar metals concentrations were measured in each stream and that concentrations in both streams were similar to the Susquehanna River and other rivers in the U.S. Total arsenic, cadmium, and lead concentrations from Miller et al. (2007) are compared to the SQuiRTs chronic freshwater screening levels of 150, 0.25, and 2.5 µg/L, respectively (http://archive.orr.noaa.gov/book_shelf/122_NEW-SQuiRTs.pdf). Arsenic and cadmium average total concentrations are less than the screening level for both Northeast Branch and Northwest Branch. Average total concentrations for lead from both streams exceed the screening level. Average concentrations for arsenic, cadmium, and lead (total) for Northwest Branch were 1.4, 0.16, and

20 µg/L, respectively. Average concentrations for arsenic, cadmium, and lead in the Northeast Branch were 1.4, 0.16, and 14 µg/L, respectively.

Foster et al. performed a study on surface water samples taken from the Northeast and Northwest Branches of the Anacostia River to determine the baseline concentrations of PAHs, PCBs and OCP. Samples were taken between September 1995 and September 1996 and included measurements during six base flow periods and four storm flow periods. A Fultz submersible pump using ultra-clean collection techniques was used to collect the samples which were taken above the head of tide near two USGS stream gauging stations.

Samples were analyzed for both the dissolved and particle phases of PCBs (85 congeners), PAHs (18 homologues) and OCPs. Particulates accounted for the majority of the contaminants in transport for all three organic contaminants groups, (88% and 91% of total-PAHS and t-PCBs respectively and the majority of the OCPs). Total fluxes in both the Northeast and Northwest branches of the Anacostia for PAHs and t-PCBs equaled 760 kg per year and 3.3 kg per year respectively. The greatest fluxes for OCPs were the chlordanes (including alpha- and gamma-chlordane, trans-nonachlor, heptachlor expoxide, and oxy-chlordane) which parallels the frequent pesticides detection in fish in the tidal Anacostia River. Data within Foster et al., 2000 suggests that organic contaminants are traveling from the watershed to the tidal river, predominantly in the particulate phase during high flow events.

Hwang and Foster (2008) monitored total and dissolved PCB concentrations in Lower Beaverdam Creek, Watts Branch, and Hickey Run for the period April 2002 through August 2002. Eighty-five PCB congeners were monitored in this study. Their results indicated that total PCBs (dissolved and particle-bound) were up to 80 times higher for storm flow in comparison to base flow concentrations and that more than 90 percent of the total PCB loading is associated with sediment particle transport. Dissolved phase concentrations were more enriched in the less chlorinated PCBs (e.g., PCB 28) relative to more chlorinated congeners (e.g., PCB 180). In addition, their results suggest that Lower Beaverdam Creek is a much more significant source of PCB contamination than are Northwest Branch and Northeast Branch. Compared to the SQuiRT surface water chronic screening level (0.014 µg/L), Lower Beaverdam Creek total PCB concentrations were lower for base flow (0.0118 µg/L) and elevated for storm flow (0.211 µg/L).

3.1.3 Release Mechanisms

Release mechanisms and the fate and transport of the various constituents of concern depend on the chemical properties of respective constituents.

The principal constituents of concern, PCBs, PAHs, pesticides, and metals, enter the Anacostia River primarily via the loading of contaminated sediments. These constituents, particularly metals, may also be present to some extent in the dissolved phase. As a result of the relatively low current velocity in the tidal Anacostia River, sediments delivered by outfalls and tributaries are size-differentiated with the coarser grained fractions forming bars and deltas at the entry point and the finer grained fractions remaining in suspension for continued transport. Fine suspended particles have a greater sorptive capacity than do coarse grained sediments because finer particles have greater surface area compared

with their weight and volume. The greater surface area coupled with the organic carbon fraction present in the sediment (as discussed further in **Section 3.1.5**) provides for more sorptive capacity, i.e., the ability to gather contaminants through absorption and/or adsorption. PCBs, PAHs, and pesticides are hydrophobic and tend to sorb to fine sediments. Metals also sorb to varying degrees depending on the metal and ambient geochemical conditions (pH, oxidation potential [Eh], solubilities of associated ions, etc.). Hydrophobic compounds and metals are thus transported downstream with the suspended sediment. These constituents are then removed from the water phase either by deposition in the lower portion of the Anacostia River or exit with discharging surface water to the Potomac River, although, as suggested by the modeling discussed in **Section 2.5**, most suspended sediment is trapped in the Anacostia and deposited. Deposited sediments may also become remobilized through biological processes such as borrowing and through physical processes such as erosion under storm flow conditions.

VOCs and LPAHs are also potential constituents of concern. These constituents have greater solubilities, are more volatile, and may be more vulnerable to degradation processes. VOCs and LPAHs may be released to the river via contaminated groundwater seepage from one of the environmental sites that border the river. Once exposed to the atmosphere or oxygenated surface water, the concentrations for VOCs and some LPAHs would be expected to decrease in the river system through volatilization or degrade through other processes.

Sediment chemistry changes can reflect the effects of sedimentation. McGee et al. (2009) compared surface sediment samples on the Anacostia River in 2000 to samples taken in 1992 (Schlekat et al. 1994) and concluded that contaminant concentrations had decreased since 1992. The statement was based on a comparison of seven stations between the East Capitol Street Bridge and the confluence of the Anacostia River to the Potomac River. Sediment organic carbon and grain size were compared between the two years. Sediment organic carbon content was similar, with an average increase of 15 percent, and, on average, there was 60 percent less fine grain sediment. Concentrations of total PCBs decreased by an average of 74 percent at all stations but one, the location at the confluence of the Anacostia River and the Potomac River which had an increase of 75 percent. Total DDT compounds in the upper river decreased by 43 percent and total-chlordane decreased by 40 percent with a similar trend to the total PCB concentrations in that the values increased at the two lower stations. Total PAHs concentrations at all stations increased by 84 percent. Similar trends were observed when organic contaminant concentrations were normalized to organic carbon (an increase in total PAHs and general decrease for total PCBs, total DDT and t-chlordane).

The comparison of metal concentrations exhibited a similar trend to the organic concentrations in that metal concentrations in the upper river were lower in 2000 when compared to 1992 and slightly higher concentrations were observed in the lower river. Average concentrations of cadmium, copper and mercury were eight, 14 and 31 percent higher (respectively) in 2000 when compared to 1992. Average concentrations of chromium, lead and zinc were 18, 21 and eight percent lower (respectively) in 2000. Because of the large difference of grain size between 1992 and 2000, the data were normalized to the amount of fine grained sediment. Four of the stations had higher concentrations of trace metals by a

factor of two for all metals and higher bulk and normalized metal concentrations were evident at lower river locations when compared to the upper locations.

3.1.4 Exposure Media

Contaminated media within the Anacostia River study area consist of surface water, surface sediment, deep sediment, and fish tissue. Contaminated suspended sediments are likely an important medium for exposures of ecologic and human health receptors to PCBs, PAHs, pesticides, and metals.

PCBs, PAHs, pesticides, and metals can also be present as dissolved constituents in the surface water (Gruessner et al. 1997). For example, Paul and Ghosh (2010) measured total PCB concentrations ranging up to 0.008 µg/L in Lower Beaverdam Creek. Total detected PCB congeners (57 measured) in Anacostia River water samples collected from mid water column near the O Street Outfall (adjacent to the Southeast Federal Center) averaged 0.005 µg/L (Horne Engineering 2003). Exposure, therefore, can occur through contact or ingestion of dissolved phase contaminants. An additional concern for surface water in the Anacostia River is human and ecologic exposure to pathogenic bacteria (which will not be evaluated in the RI).

3.1.5 Transport Media and Mechanisms

The dominant transport medium for the constituents of concern is the downstream migration of contaminants sorbed to suspended sediment. Coarse grained sediments are typically deposited in close proximity to release points. The transport of hydrophobic organic chemicals such as PCBs, PAHs, and pesticides is likely controlled by the amount of organic matter present in the sediment. Greater organic concentrations (or organic carbon fraction [f_{oc}]) result in a greater capacity to accumulate hydrophobic compounds through sorption. Champ (1979) measured dissolved and particulate average yearly organic carbon concentrations of 2.81 and 5.02 mg/L near the South Capitol Street Bridge. Velinsky et al. (1999) observed that particulate organic carbon concentrations in the water column increased in the vicinity of Kenilworth Aquatic Center and the CSX Railroad Bridge and declined downstream from these areas. In a 2011 sampling of Anacostia River surface sediments from near the Fort Dupont Creek outfall, the most recent event for which data are available, EnviroScience (2013) measured the organic carbon fraction (foc) in 28 samples. The f_{oc} in these samples ranged from 0.13 to 70 and averaged 7.8 percent. Foster et al. (2000) measured f_{oc} concentrations in storm water particulates from the upper Anacostia River that ranged from three to 10 percent. Behm et al. (2003) assumed an f_{oc} value of nine percent for the purposes of sediment fate and transport modeling.

A number of environmental conditions including pH, biochemical controls, and redox state affect the partitioning of trace metals between sorbed and dissolved phases. Prestegaard et al. (2010) investigated lead, zinc, cadmium, and copper mobilization and deposition in the Anacostia watershed. Results of this investigation indicated that the upper tributaries receive sediments from both surface and stream bank erosion and that metals are transported in both the sorbed and dissolved phases. Sediment contamination with trace metals is highest at the river's mouth where most metals are present as sorbed species. Dissolved concentrations are low in the lower Anacostia River likely as a result of the high pH (7-9) of urban runoff conveyed in cement-lined channels to the lower watershed (Prestegaard et al. 2010).

3.1.6 Watershed Modeling

The Anacostia watershed has been the subject of several modeling studies dating back to the 1980s (Mandel and Schultz 2000). The TAM was developed for the Metropolitan Washington Council of Governments in the late 1980s to evaluate CSS outfall abatement options and water quality management strategies for the watershed. The model included a hydrodynamic component for simulating flow velocities and tide heights and a water quality component for simulating dissolved oxygen dynamics and eutrophication. The TAM was based on the Hydrodynamic Ecosystem Model (HEM) developed by the Virginia Institute of Marine Science (Mandel and Schultz 2000). HEM is a one-dimensional hydrodynamic and water quality model developed to simulate small tidal embayments.

In 2000, EPA's Water Quality Analysis Simulation Program (WASP5) EUTRO model was incorporated into the TAM framework to simulate dissolved oxygen and eutrophication. The TAM/WASP Toxics Screening Level Model (TAM/WASP model) was completed in 2003 and included greater hydrodynamic resolution and the capability to simulate sediment quality and velocity-dependent deposition and resuspension of sediments. The model simulates daily changes in sediment concentrations in both the water column and the bed sediment by simulating the processes of advective transport, dispersive transport, deposition, and erosion. The TAM/WASP model was used to simulate loading, fate, and transport of zinc, lead, copper, arsenic, PCBs, PAHs, chlordane, heptachlor epoxide, dieldrin, and DDT in the tidal portion of the Anacostia River (Behm et al. 2003). In addition, the TAM WASP model was used to support District TMDL determinations for water quality parameters in the Anacostia River (DC Department of Health 2003).

Subsequent to the 2003 calibration, Kim et al. (2007) conducted an additional TAM/WASP assessment in support of Anacostia River watershed TMDL determinations for the Maryland Department of the Environment. They used the Hydrological Simulation Program – Fortran (HSPF) to simulate upland tributary sediment loading and updated the TAM/WASP model calibration using data from the three year period 1995 – 1997.

The TAM/WASP model results are summarized below for the modeling discussed in Schultz (2003) and Behm et al. (2003). The calibration period for the model was January 1, 1988 through December 31, 1990. In addition, this modeling considered the comprehensive sediment quality data set generated by the surface sediment sampling event conducted by the Academy of Natural Sciences in 2000.

Hydrodynamic Modeling and Simulation of Contaminant Loading. Consistent with the low flow velocities observed in the tidal Anacostia River, the model represents the estuary as a primarily depositional environment (Schultz 2003). For the calibration period, the modeled flow velocities are generally less than 0.1 m/sec in the portions of the channel near the head and mouth of the estuary. Flow velocities are moderately higher in the four mile channel reach beginning two miles downstream from the upper tidal limit (Schultz 2003). The model estimates that approximately 90 percent of the sediment entering the tidal river is deposited. Predicted accumulation rates are highest in the upper and lower portions of the river. The sedimentation rates are predicted to range from 0.6 to 3 cm/year for the upper portion of the estuary and 0.6 to 1.3 cm/year from 11th Street Bridge to the mouth of the river. As discussed in **Section 2.5**, sediment core analyses suggest that the estimated sedimentation rate in the

Poplar Point vicinity (just upstream from the 11th Street Bridge ranges from 3 to 7 cm/year. In comparison to this result, the model estimate appears biased low.

Sediment transport model loading for the constituents of concern is required for the TAM/WASP model. Daily sediment load was specified in the model using measured or estimated flows and estimated sediment concentrations. Depending on the source, sediment loads were obtained from direct monitoring results, from streams with available data, or from modeling results. For PCBs, PAHs, and pesticide loading, concentrations were estimated from data collected for Northwest Branch and Northeast Branch. Data that were more outfall or tributary-specific were available for metals (Schultz 2003).

Contaminant Fate and Transport. The TAM/WASP model simulated spatial trends for metals and organic contaminants. A general increase in concentration of most constituents is predicted with distance traveled downriver. Overlaying this pattern are locally elevated areas that typically appear to correspond to an outfall or tributary entry point.

The TAM/WASP model indicated that the upstream tributaries are the predominant sources for metals found in the tidal river bed sediments (Behm et al. 2003). In addition, the model indicates that Lower Beaverdam Creek contributes a disproportionately high metals load to the tidal river.

The model estimates that two-thirds of the metals and PCBs that enter the tidal Anacostia River are deposited in the bed sediments. With regard to PAHs, the model predicts that approximately half of the inbound mass is deposited; for chlordane and heptachlor epoxide, the deposited amounts are 56 and 27 percent of the mass loadings, respectively (Behm et al. 2003).

3.2 Ecological Conceptual Site Model

The ecological CSM describes the processes that link contamination sources to ecological receptors through complete exposure routes in the study area. The ecological CSM for the current investigation is summarized in the following sections.

3.2.1 Previous Screening Level Ecological Risk Assessment

A SLERA of the tidal Anacostia River conducted by Syracuse Research Corporation et al. (2000) serves as a starting point for the current analysis. The SLERA indicated that concentrations of chromium, lead, mercury, nickel, zinc, PAHs, PCBs, and several pesticides are sufficiently elevated in sediments in some reaches of the river to be harmful to benthic invertebrates. In addition, the 2000 SLERA indicated that elevated PAH concentrations posed a risk to fish. This SLERA and other published reports (McGee et al. 2009; Galli et al. 2010) provided a framework for the preliminary CSM for this RI.

3.2.2 Potential Ecological Receptors

Although the Anacostia River is a highly impacted urban river, a variety of ecological receptors exist within the project area. The tidal estuary is habitat for benthic and epibenthic invertebrates; pelagic, midwater, and benthic fish; amphibians; freshwater turtles, piscivorous and omnivorous birds; and carnivorous and omnivorous mammals. The distribution of these species within the project area is influenced by food supply, water depth and quality, current, shoreline habitat, and other factors.

The primary exposure pathways for aquatic receptors are (1) ingestion of contaminated surface water, sediments, and food items and (2) direct contact with surface water and sediments. Benthic and epibenthic invertebrates and fish likely experience the greatest exposure as they are in near constant direct contact with sediment and water and tend to ingest contaminated food from a limited area. Higher trophic level receptors such as omnivorous and carnivorous birds and mammals are exposed principally through ingestion of contaminated plants and prey, sediment, and water. Contaminants may bioaccumulate in higher trophic level animals that consume prey that have ingested contaminants.

Fishes in the Anacostia River include typical mid-Atlantic freshwater resident fish species (such as killifishes, sunfishes, catfishes, and American eel) , as well as anadromous runs of white perch, blueback herring, and alewife (Pinkney 2009; NOAA CPRD http://mapping.orr.noaa.gov/website/test/anacostia/guide/aboutar/fish.html). Omnivorous and carnivorous birds that forage in the river include herons, egrets, gulls, double-crested cormorant, osprey, bald eagles, and kingfisher (Rattner et al. 2004; NOAA CPRD http://mapping.orr.noaa.gov/website/test/anacostia/guide/aboutar/birds.html). Mammals known to forage in or near the river include beaver, river muskrat, otter, mink, fox, and raccoon (NOAA CPRD http://mapping.orr.noaa.gov/website/test/anacostia/guide/aboutar/mammals.html). Receptors vary in their sensitivity to various chemicals. The ERA will review available literature and develop toxicity profiles suitable for the receptors expected to occur in the Anacostia River. Sources such as the ATSDR toxicity profiles (ATSDR 2014) and the *Contaminant Hazard Review* series by Eisler (www.pwrc.usgs.gov/eisler/reviews.cfm).

Epibenthic invertebrates that likely contribute to contaminant transport from sediment to vertebrate predators include native and introduced crayfishes. Native and introduced freshwater clams as well as mussels likely occur in the river. The benthic community reflects the degraded water quality of the river from decades of industrial and urban activities, with low diversity, low abundance, and dominance by pollution-tolerant invertebrates (AWTA and AWRC 2002; McGee et al. 2009). Ecological receptors are discussed further in Section 7.0.

3.2.3 Potential Exposure Pathways

Benthic and epibenthic invertebrates and fish are potentially exposed to chemicals in the sediments through direct contact and ingestion. Important exposure routes for filter-feeding and particulate feeding bivalve invertebrates include ingestion of sediment and contaminated food particles, as well as direct contact with sediment, surface water, and pore water. Epibenthic invertebrates such as crayfish ingest sediment as well as prey that are closely associated with sediment. Like crayfish, benthic fish (such as carp and catfishes) are exposed to chemicals through direct contact with sediments, incidental ingestion of sediment during feeding, and consumption of contaminated prey. High incidence of liver tumors in brown bullhead (catfish) in the Anacostia River and neighboring waterbodies have been attributed to exposure to PAHs (Pinkney et al. 2013).

Pelagic fishes include both planktivorous species like the blueback herring (which is exposed predominately to water and the sediment and plankton suspended in it) and carnivorous species like the largemouth bass that consumes fish and crayfish. Carnivorous birds and mammals are exposed to

bioaccumulative chemicals in the tissues of contaminated prey, such as fish and crayfish. See Section 7.0 for discussion of complete exposure pathways.

3.3 Human Health Conceptual Site Model

The human health risk assessment CSM describes the inputs of hazardous constituents to the river, the physical and chemical fate and transport processes for these constituents, and the human receptors and relevant exposure pathways. The human health CSM for the current investigation is summarized in the following sections. **Sections 3.3.1, 3.3.2, and 3.3.3** discuss a previously completed human health screening assessment, potential human receptors, and exposure pathways, respectively.

3.3.1 Previous Human Health Risk Screening

In addition to the SLERA, Syracuse Research Corporation et al. (2000) performed a human health risk screening of sediment, surface water, and fish tissue from the tidal Anacostia River. The Syracuse screening served as a starting point for the current analysis. Based on conservative assumptions, the screening identified dioxins and furans, pesticides, PCBs, arsenic, cadmium, lead, and mercury as COC for human consumption of fish tissue. COCs for direct contact with sediment were arsenic, PCBs, and PAHs; COCs for surface water (direct contact and incidental ingestion) were arsenic, PCBs, and various pesticides. The HHRA at WNY also identified PCBs and arsenic as human health risk drivers (CH2MHill 2011a).

Since 1989, the District of Columbia has published and posted advisories regarding human consumption of fish caught in the Anacostia River. These advisories were issued because of the presence of toxic and bioaccumulative contaminants in the tissue of edible fish species in the river. A recent survey of anglers fishing in the Anacostia River was completed by OpinionWorks in 2012 (OpinionWorks, 2012). This study concluded that, based on the assumption that five percent of the lower Anacostia River watershed population consumes fish from the river; approximately 17,000 community residents may be exposed to the toxic chemicals through the consumption of contaminated fish

3.3.2 Potential Human Receptors

The Anacostia River flows through a heavily-populated section of the District and Maryland. Potential human health risks associated with the river include ingestion of fish, turtles, clams, and crayfish and direct contact with and incidental ingestion of sediment, surface water, and surface water-contaminated soil exposed along the river banks. Although warning signs are posted along the Anacostia River, subsistence fishing and human contact (related to various recreational activities) with media in and along the river is well documented.

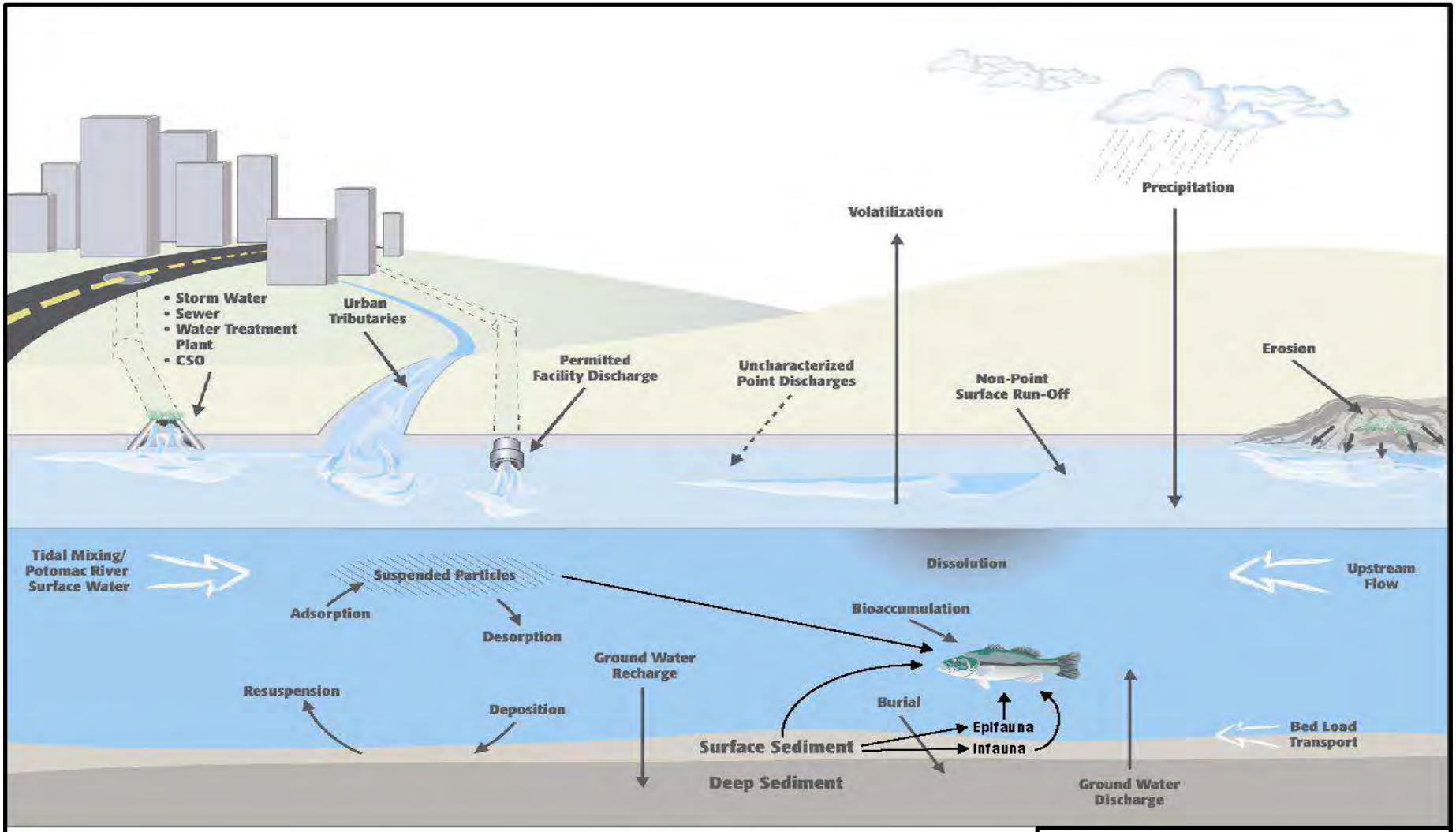
Since the late 1980s, a fish consumption advisory has been in effect for the Anacostia to protect people from ingesting fish contaminated with PCBs and pesticides. This is evidence that elevated levels of toxics are present in the river environment and are entering the food chain (AWTA 2002).

In addition to subsistence anglers and recreational receptors, construction and utility workers may also be exposed. Specifically, workers engaged in construction and utility-related activities may be exposed to contaminated sediment, surface water, and soil. Workers engaged in environmental restoration and research may also be exposed to contamination in these media.

3.3.3 Potential Exposure Pathways

The principal exposure pathway is recreational angling for mid-level and top-level predator fish such as largemouth bass and channel catfish. Some people may catch and eat freshwater turtles, especially the common snapping turtle (Shin 2000). Several species of native and introduced crayfish are likely to occur in the river (Kilian et al 2010) and may be harvested and consumed by people in the area. Although clams and other mollusks are known to inhabit the river, collection of these species for human consumption is not believed to be extensive.

Additional exposure pathways include direct contact with and incidental ingestion of contaminated sediment and surface water near the river's banks, as well as to soil that has been contaminated due to river flooding. Much of the existing shoreline on the Anacostia River is a public access park or other land used primarily for recreational purposes. This exposure could be in conjunction with fishing activity, or independent recreational activity. Construction and utility workers may be exposed while engaged in construction and utility installation and repair activities that require exposure to sediment, surface water, and soil within the banks of the Anacostia River.

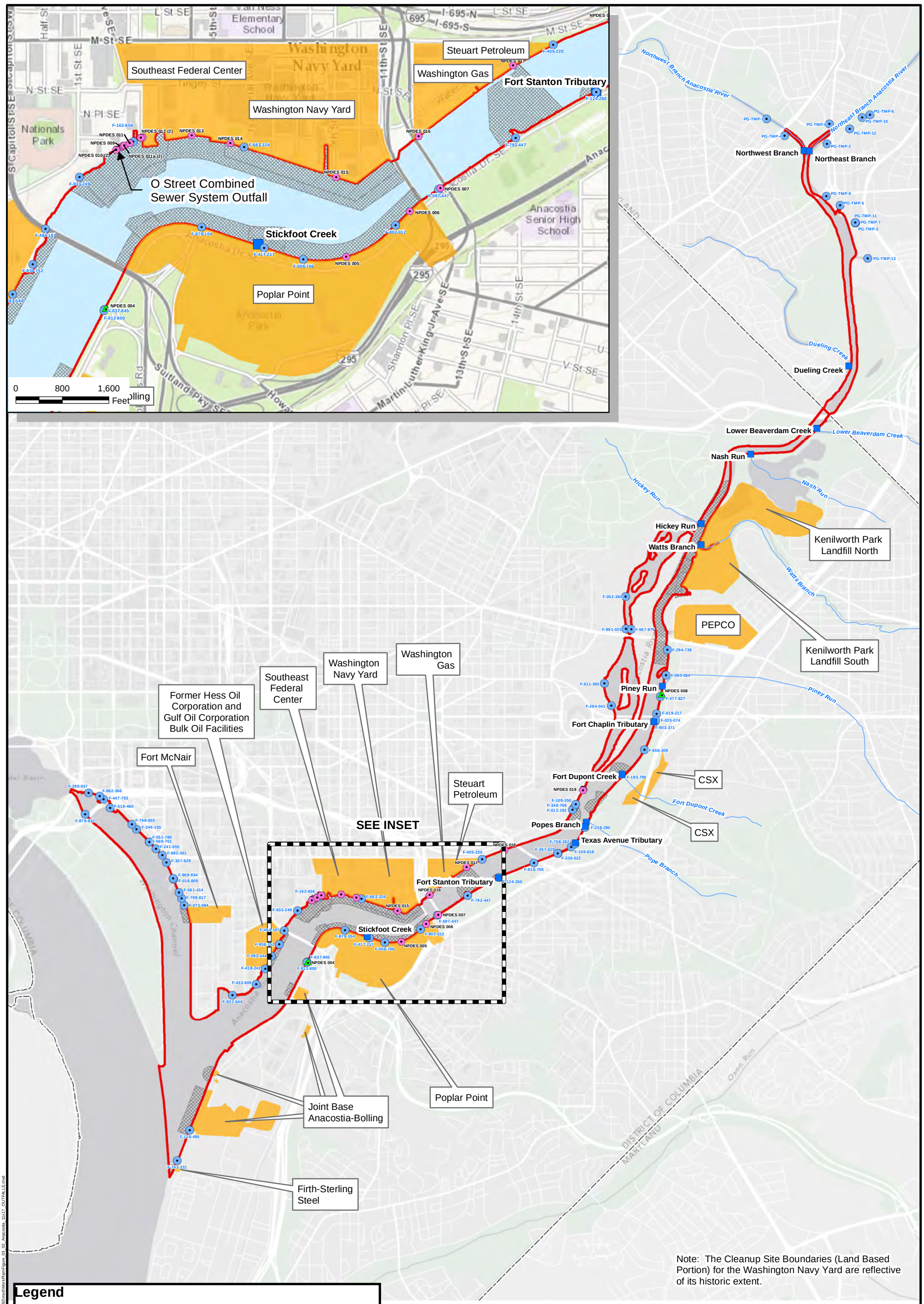


NOTE: FIGURE 3.1 WAS MODIFIED FROM FIGURE 2 OF THE UNDATED ANACOSTIA WATERSHED TOXICS ALLIANCE REPORT ENTITLED "CHARTING A COURSE TOWARD RESTORATION: A TOXIC CHEMICAL MANAGEMENT STRATEGY FOR THE ANACOSTIA RIVER."

ANACOSTIA RIVER SEDIMENTS PROJECT
REMEDIAL INVESTIGATION WORK PLAN

FIGURE 3.1. ANACOSTIA RIVER SEDIMENTS PROJECT CONCEPTUAL SITE MODEL

TETRA TECH


Southeast Federal Center
Washington Navy Yard
Steuart Petroleum
Washington Gas
Fort Stanton Tributary
O Street Combined Sewer System Outfall
Stickfoot Creek
Poplar Point
Anacostia Senior High School
Nationals Park
Northwest Branch
Northeast Branch
Dueling Creek
Lower Beaverdam Creek
Nash Run
Hickey Run
Watts Branch
Kenilworth Park Landfill North
Kenilworth Park Landfill South
PEPCO
Piney Run
Fort Chaplin Tributary
Fort Dupont Creek
CSX
Popes Branch
Texas Avenue Tributary
Former Hess Oil Corporation and Gulf Oil Corporation Bulk Oil Facilities
Fort McNair
SEE INSET
Joint Base Anacostia-Bolling
Firth-Sterling Steel
0 800 1,600 Feet
0 1,500 3,000 Feet
Legend
CSS OUTFALL
EMERGENCY RELIEF OUTFALL
MS4 OUTFALL
TIDAL TRIBUTARY CONFLUENCE
STREAM
SEDIMENT STUDY AREA
WASHINGTON DC BOUNDARY
CLEANUP SITE BOUNDARY (LAND BASED PORTION)
CLEANUP SITE AREA OF INFLUENCE
DRAFT
N
S
E
W
Note: The Cleanup Site Boundaries (Land Based Portion) for the Washington Navy Yard are reflective of its historic extent.
SOURCE: MODIFIED FROM CH2MHILL, 2011, AND DCGIS 2012, AND 2013.
ANACOSTIA RIVER SEDIMENTS PROJECT
FIGURE 3.2
LOCATION OF OUTFALLS IN THE ANACOSTIA RIVER STUDY AREA
TETRA TECH
A-1530

Constituent	Group	Constituent	Group	Constituent	Group	Constituent	Group	Constituent	Group
1,1,1-trichloreothane	VOC	1,2,4-trichlorobenzene	SVOC	Bis(2-chloroethoxy) methane	SVOC	4,4-DDD	Pesticide	Antimony	Metal
1,1,2,2-tetrachloroethane	VOC	1,2-dichlorobenzene	SVOC	Bis(2-chloroethyl) ether	SVOC	4,4-DDE	Pesticide	Arsenic	Metal
1,1,2-trichloroethane	VOC	1,2-diphenylhydrazine	SVOC	Bis(2-chloroisopropyl) ether	SVOC	4,4-DDT	Pesticide	Asbestos	Metal
1,1-dichloroethane	VOC	1,3-dichlorobenzene	SVOC	Bis(2-ethylhexyl) phthalate	SVOC	Aldrin	Pesticide	Beryllium	Metal
1,1-dichloroethylene	VOC	1,4-dichlorobenzene	SVOC	Butyl benzyl phthalate	SVOC	Alpha-BHC	Pesticide	Cadmium	Metal
1,2-dichloroethane	VOC	2,4,6-trichlorophenol	SVOC	Chrysene	SVOC	Alpha-endosulfan	Pesticide	Chromium	Metal
1,2-dichloropropane	VOC	2,4-dichlorophenol	SVOC	Dibenzo(,h) anthracene	SVOC	Beta-BHC	Pesticide	Copper	Metal
1,2-dichloropropylene	VOC	2,4-dimethylphenol	SVOC	Diethyl Phthalate	SVOC	Beta-endosulfan	Pesticide	Lead	Metal
1,2-trans-dichloroethylene	VOC	2,4-dinitrophenol	SVOC	Dimethyl phthalate	SVOC	Chlordane	Pesticide	Mercury	Metal
2-chloroethyl vinyl ethers	VOC	2,4-dinitrotoluene	SVOC	Di-N-Butyl Phthalate	SVOC	Delta-BHC	Pesticide	Nickel	Metal
Acrolein	VOC	2,6-dinitrotoluene	SVOC	Di-n-octyl phthalate	SVOC	Dieldrin	Pesticide	Selenium	Metal
Acrylonitrile	VOC	2-chloronaphthalene	SVOC	Fluoranthene	SVOC	Endosulfan sulfate	Pesticide	Silver	Metal
Benzene	VOC	2-chlorophenol	SVOC	Fluorene	SVOC	Endrin	Pesticide	Thallium	Metal
Bromoform	VOC	2-nitrophenol	SVOC	Hexachlorobenzene	SVOC	Endrin aldehyde	Pesticide	Zinc	Metal
Carbon tetrachloride	VOC	3,3-dichlorobenzidine	SVOC	Hexachlorobutadiene	SVOC	Gamma-BHC	Pesticide	2,3,7,8-TCDD [1]	Dioxin
Chlorobenzene	VOC	4,6-dinitro-o-cresol	SVOC	Hexachlorocyclopentadiene	SVOC	Heptachlor	Pesticide	Cyanide, Total	Cyano
Chlorodibromomethane	VOC	4-bromophenyl phenyl ether	SVOC	Hexachloroethane	SVOC	Heptachlor epoxide	Pesticide		
Chloroethane	VOC	4-chlorophenyl phenyl ether	SVOC	Indeno (1,2,3-cd) pyrene	SVOC	Toxaphene	Pesticide		
Chloroform	VOC	4-nitrophenol	SVOC	Isophorone	SVOC	PCB–1016 (Arochlor 1016)	PCB		
Dichlorobromomethane	VOC	Acenaphthene	SVOC	Naphthalene	SVOC	PCB–1221 (Arochlor 1221)	PCB		
Ethylbenzene	VOC	Acenaphthylene	SVOC	Nitrobenzene	SVOC	PCB–1232 (Arochlor 1232)	PCB		
Methyl bromide	VOC	Anthracene	SVOC	N-nitrosodimethylamine	SVOC	PCB–1242 (Arochlor 1242)	PCB		
Methyl chloride	VOC	Benzidine	SVOC	N-nitrosodi-n-propylamine	SVOC	PCB–1248 (Arochlor 1248)	PCB		
Methylene chloride	VOC	benzo(a) anthracene	SVOC	N-nitrosodiphenylamine	SVOC	PCB–1254 (Arochlor 1254)	PCB		
Tetrachloroethylene	VOC	Benzo(a)pyrene	SVOC	Parachlorometa cresol	SVOC	PCB–1260 (Arochlor 1260)	PCB		
Toluene	VOC	Benzo(b) fluoranthene	SVOC	Pentachlorophenol	SVOC				
Trichloroethylene	VOC	Benzo(ghi) perylene	SVOC	Phenanthrene	SVOC				
Vinyl chloride	VOC	Benzo(k) fluoranthene	SVOC	Phenol	SVOC				
				Pyrene	SVOC				

Notes:

1. 2,3,7,8-TCDD refers to 2,3,7,8-Tetrachlorodibenzo-p-dioxin

Site	Site Constituents Reported				
	Surface Soil	Subsurface Soil	Groundwater	Sediments	Surface Water
CSX Benning Yard [1] (Reference: Geosyntec 2013a, Geosyntec 2013b; EnviroScience 2013)	Priority pollutant metals, PAH[5], PCB Aroclors, pesticides, VOCs, Total petroleum hydrocarbons diesel-range organics (TPH-DRO), Total petroleum hydrocarbons gasoline-range organics (GRO-DRO)	Priority pollutant metals, PAH, PCB Aroclors, pesticides, VOCs, Total petroleum hydrocarbons diesel-range organics (TPH-DRO), Total petroleum hydrocarbons gasoline-range organics (GRO-DRO)	As, Ba, Cd, Cr, Fe, Pb, Hg, Se, Ag, Priority pollutant PAH, 4,4'-DDD, 4.4'-DDE, 4,4'-DDT, alpha chlordane, gamma-BHC, Benzene, Ethylbenzene, Toluene, Xylenes (total), and selected VOCs, selected SVOCs	Priority pollutant metals, PAH, PCB Aroclors, pesticides, VOCs, Total petroleum hydrocarbons diesel-range organics (TPH-DRO), Total petroleum hydrocarbons gasoline-range organics (GRO-DRO)	Priority pollutant metals, PAH, PCB Aroclors, pesticides, VOCs, Total petroleum hydrocarbons diesel-range organics (TPH-DRO), Total petroleum hydrocarbons gasoline-range organics (GRO-DRO)
Kenilworth Park North & South Landfills (Reference: Ecology and Environment, 2007a)	Al, Sb, As, Cd, Cu, Fe, Pb, Hg, Ag, Tl, V Aroclor 1254 Aroclor 1260 Dieldrin gamma- Chlordane PAH	Al, Sb, As, Cd, Cu, Fe, Pb, Mn, Hg, Ag, Tl, V Aroclor 1242 Aroclor 1248 Dieldrin PAH	Al, As, Ba, Cd, Cr, Fe, Pb, Sb Benzene Chloroform 1,4-dichlorobenzene Methylene chloride	Al, As, Fe, Tl, V Aroclor 1254 PAH	Surface water impacts to be further evaluated in conjunction with the shallow groundwater (OU2) remedial investigation
Pepco Benning Road Facility [2] (Reference: AECOM, 2012)	VOCs, TPH, PAH, Metals (Pb, Cu, Ni, V, Zn), PCBs, Pesticides, Dioxins/Furans	VOCs, TPH, PAH, Semi-volatile organic compounds (SVOCs), Metals, PCBs, Pesticides, Dioxins/Furans	VOCs, TPH, PAH, SVOCs, Metals, PCBs, Pesticides, Dioxins/Furans	VOCs, TPH, PAH, Metals, PCBs, Pesticides, Dioxins/Furans	VOCs, TPH, PAH, Metals, PCBs, Pesticides

Site	Site Constituents Reported				
	Surface Soil	Subsurface Soil	Groundwater	Sediments	Surface Water
Poplar Point Site (Reference: Ridolfi, 2003)	As Benzo(a)pyrene 4,4'-DDT TPH-DRO	As, Pb PAH 4,4'-DDE TPH-DRO Pyrene Total PCBs	As, Mn, Pb Benzene Methyl tertiary-butyl ether TPH-DRO, TPH-Gasoline range organics (GRO), TPH-Motor Range Organics (MRO) Vinyl chloride	As, Cd, Ni, Pb PAH 4,4'-DDD 4,4'-DDE 4,4'-DDT Dieldrin Total PCBs	Cu, Mn. Zn Benzene
Washington Gas East Station [3] (Reference: Ecology and Environment, 2006)	Total PAH, Al, Ar, Sb, Be, Cd, Cr, Cu, Co, Fe, Pb, Mn, Hg, Ni, Se, Ag, Th, V, Zn VOC, SVOC, PAH, Complex cyanides	Al, Ar, Sb, Be, Cd, Cr, Cu, Co, Fe, Pb, Mn, Hg, Ni, Se, Ag, Th, V, Zn, VOC, SVOC, PAH, Complex cyanides	Al, Ar, Sb, Be, Cd, Cr, Cu, Co, Fe, Pb, Mn, Hg, Ni, Se, Ag, Th, V, Zn, VOC, SVOC, PAH, Complex cyanides	Al, Ar, Sb, Be, Cd, Cr, Cu, Co, Fe, Pb, Mn, Hg, Ni, Se, Ag, Th, V, Zn, VOC, SVOC, PAH, Complex cyanides	Not sampled
Washington Navy Yard [4] (Reference: CH2MHILL, 2011)	VOCs, SVOCs, PAH, Metals, PCBs, Pesticides, Dioxins/Furans, Explosives	VOCs, SVOCs, PAH, Metals, PCBs, Pesticides, Dioxins/Furans, Explosives	As, Fe, Hg, Cis and trans-dichloroethene, Trichloroethene, Vinyl Chloride	As, Cr, Pb Aroclor-1260 PAH, Non-dioxin like PCBs	Ag, Ba, Fe, Mn
Southeast Federal Center	Not Sampled	Not Sampled	Not Sampled	VOCs, SVOCs, PAH, Metals, PCDDs, PCDFs, PCB Congeners	
Active Capping Pilot Study Site	Not sampled	Not sampled	Not sampled	TPH, PAH, Metals, Pesticides, PCB Congeners	Not sampled

Site	Site Constituents Reported				
	Surface Soil	Subsurface Soil	Groundwater	Sediments	Surface Water
Joint Base Anacostia Bolling (Reference: CH2M Hill 2011a, CH2M Hill 2011b, CH2M Hill 2012, NAVFAC 2012)	TPH, VOCs, SVOCs, 4,4-DDE, 4,4-DDT, and alpha-chlordane, Dioxins, Aroclor 1254, Dieldrin, Metals	TPH, VOCs, SVOCs, 4,4-DDE, 4,4-DDT, alpha-chlordane, gamma-chlordane, heptachlor, 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin, Octachlorodibenzo-p-dioxin, 1,2,3,4,6,7,8-heptachlorodibenzofuran, Aroclor 1254, dieldrin, Metals	VOCs, SVOCs, 4,4'-DDD, heptachlor epoxide, Octachlorodibenzo-p-dioxin, Heptachlorodibenzo-p-dioxin, Metals	Not sampled	Not sampled
Steuart Petroleum Company (Adjacent to WGL Site)	TPH, Benzene, Toluene, Ethylbenzene, Xylenes (total), MTBE, Naphthalene	TPH, Benzene, Toluene, Ethylbenzene, Xylenes (total), MTBE, Naphthalene	TPH, Benzene, Toluene, Ethylbenzene, Xylenes (total), MTBE, Naphthalene	Not sampled	Not sampled
Steuart Petroleum Company/ Hess Oil Corporation/ Gulf Oil Corporation (Adjacent to South Capital Street Bridge)	TPH, Benzene, Toluene, Ethylbenzene, Xylenes (total), MTBE, PAH	TPH, Benzene, Toluene, Ethylbenzene, Xylenes (total), MTBE, PAH	TPH, Benzene, Toluene, Ethylbenzene, Xylenes (total), MTBE, PAH	Not sampled	Not sampled

Notes:

1. Listed constituents are those tested for as indicated in the referenced documents.
2. Information obtained from the July 2012 Remedial Investigation and Feasibility Study (RI/FS) Work Plan.
3. COCs for each media are based upon chemicals identified in Tables 4 and 5 of the August 2006 Record of Decision.
4. COCs for surface soil, subsurface soil, and groundwater are based on summary of contamination discussion given in the referenced document.
5. PAH: Available documentation suggests that one or more PAHs were evaluated through sampling. PAH generically refers to the full range of Priority Pollutant PAHs

Name	Reach	X-Coordinate[1]	Y-Coordinate[1]	Type	Drainage Area (Acres)	Location Description
NPDES 004	S. Capital St. - Mouth	133205.054	399602.366	Sanitary	0	Howard Rd and Robbins Rd. S.E.
NPDES 005	11th St. - S. Capital St.	133413.428	400586.399	Combined	65.51	Across from Navy Yard, aligned with Parsons Ave, S.E.
NPDES 006	11th St. - S. Capital St.	133599.515	400846.748	Combined	13.56	Good Hope Rd and Welsh Memorial Bridge, S.E.
NPDES 015	11th St. - S. Capital St.	133737.646	400546.666	Combined	30.82	On Navy Yard property, aligned with 9th and M Sts, S.E.
NPDES 010	11th St. - S. Capital St.	133849.849	399646.535	Combined	0	Main St./O St. P.S., S.E.
NPDES 009	11th St. - S. Capital St.	133859.62	399665.495	Combined	41.27	Main St./O St. P.S., S.E.
NPDES 011	11th St. - S. Capital St.	133876.525	399702.348	Combined	0	Main St./O St. P.S., S.E.
NPDES 014	11th St. - S. Capital St.	133876.629	400113.344	Combined	128.06	On Navy Yard property, aligned with 6th and M Sts, S.E.
NPDES 012	11th St. - S. Capital St.	133897.86	399747.866	Combined	1153.83	Main St./O St. P.S., S.E.
NPDES 013	11th St. - S. Capital St.	133907.087	399955.436	Combined	20.1	In S.E. Federal Center, aligned with 4th Street S.E.
NPDES 007	Penn. Ave. - 11th St.	133694.349	400972.278	Combined	188.13	Between 11th St. and Anacostia Bridges, S.E.
NPDES 016	Penn. Ave. - 11th St.	133904.223	400882.603	Combined	152.58	12th and O Streets S.E.
NPDES 017	Penn. Ave. - 11th St.	134192.206	401269.196	Combined	259.91	M and Water Sts, S.E.
NPDES 018	Penn. Ave. - 11th St.	134376.57	401669.63	Combined	48.93	Barney Circle and PA Ave., S.E.
NPDES 019	E. Capitol St. - CSX	134997.934	402490.267	Combined	4242.39	Adjacent to Service Drive behind Swirl facility and D.C. General
NPDES 008	Benning Rd. - E. Capital St.	136008.902	403310.148	Sanitary	0	Anacostia and Blaine, N.E.

1. Coordinates in North American Datum of 1983, Maryland State Plane, feet

Name	Reach	X-Coordinate[1]	Y-Coordinate[1]	Tributary
F-073-094	Washington Channel	133796.18	398309.658	
F-799-817		133867.853	398280.685	
F-561-414		133926.963	398255.513	
F-018-809		134065.278	398198.211	
F-969-934		134077.656	398193.076	
F-307-629		134245.649	398123.103	
F-892-361		134317.906	398080.032	
F-241-055		134385.913	398013.434	
F-569-761		134454.928	397944.758	
F-551-780		134456.855	397942.835	
F-246-155		134591.425	397809.423	
F-768-655		134640.411	397760.547	
F-879-832		134747.344	397269.151	
F-518-460		134815.94	397531.58	
F-882-366		134905.039	397466.046	
F-447-703		134937.83	397421.78	
F-290-057		134970.651	397305.349	
F-743-331	S. Capital St. - Mouth	131117.653	398235.236	
F-128-495		131436.97	398366.81	
F-937-544		132852.043	398816.767	
F-433-609		132963.956	399064.03	
F-418-242		133129.35	399158.92	
F-812-800		133194.83	399597.02	
F-837-845		133199.349	399599.383	
F-093-544		133261.07	399223.55	
F-936-752		133383.68	399305.13	
F-494-187		133528.302	399357.799	
F-008-706	11th St. - S. Capital St.	133403.27	400412.22	
F-417-217		133450.869	400252.029	Stickfoot Creek
F-879-104		133533.987	399996.365	
F-802-012		133542.22	400788.63	
F-933-249		133737.66	399497.153	
F-683-324		133859.944	400169.665	
F-162-656		133883.144	399716.967	
F-597-447	11th ST. CSX Bridge	133689.571	400964.898	
F-792-447		133896.58	401279.96	
F-124-260		134085.078	401609.111	
F-818-706		134237.788	401975.282	
F-405-220		134277.25	401433	
F-336-622		134334.815	402224.97	
F-367-629		134335.66	402228.069	
F-758-282		134403.983	402365.714	
F-159-618		134438.39	402405.07	Texas Avenue Tributary
F-238-290		134607.906	402509.276	Fort Davis Creek

Name	Reach	X-Coordinate[1]	Y-Coordinate[1]	Tributary
F-012-192	E. Capital St. - CSX	134795.42	402382.51	
F-109-350		134811.38	402391.89	
F-348-769		134853.81	402414.87	
F-193-790		135166.51	402892.63	Fort Dupont Creek
F-656-309		135423.69	403133.29	
F-819-217		135717.01	403243.18	Fort Chaplin Tributary
F-903-371		135732.523	403251.299	Fort Chaplin Tributary
F-025-074	Benning Rd. - E. Capital St.	135803.068	403261.969	
F-477-827		135979.318	403303.321	
F-090-064		136204.359	403359.691	
F-294-739		136472.252	403374.215	
PG-TMP-1	Upper Tidal Limit - Benning Rd.	1326820.022	465993.0663	Prince George's County Storm Water Outfalls
PG-TMP-2		1328895.366	465129.5874	
PG-TMP-3		1329879.272	462401.0984	
PG-TMP-4		1327439.272	465411.5353	
PG-TMP-5		1329345.272	463017.7232	
PG-TMP-6		1330376.272	466138.9725	
PG-TMP-7		1329876.522	462414.6296	
PG-TMP-8		1328981.522	465816.3163	
PG-TMP-9		1328882.147	463321.2856	
PG-TMP-10		1330109.459	466036.41	
PG-TMP-11		1329873.772	462427.7857	
PG-TMP-12		1329680.522	465645.0663	
PG-TMP-13		1330302.313	461189.1609	
F-567-976	Kingman Lake	136687.73	402996.71	
F-991-021		136690.93	402938.98	
F-052-384		137027.24	402937.78	
F-284-041		135889.347	402785.807	
F-611-365		136120.31	402713.5	

1. Coordinates in North American Datum of 1983, Maryland State Plane, feet

Tributary Name	X-Coordinate	Y-Coordinate	Approximate Drainage Area (units as shown)	Watershed Land Use Characteristics
Northwest Branch[1, 4, 7]	1328109.413	464895.7153	53 sq. mi.	Northeast and Northwest Branches comprise approximately 72% of the total drainage area for the watershed
Northeast Branch[1, 4, 7]	1328288.792	464889.411	76 sq. mi.	
Lower Beaverdam Creek[1, 4, 8]	1328551.22	455359.9286	15.7 sq. mi.	Approximately 58% resdiential or commercial areas, 32% forested or park areas, 5% agricultural, and 4% industrial
Watts Branch[1, 4, 8]	1324569.767	451351.5522	3.8 sq. mi.	Approximately 80% urban residential and commercial areas, 15% forested, and 5% light industrial property. Approximately 47% of the watershed is in DC with the remainder in Maryland.
Hickey Run[1, 4, 8]	1324569.423	452079.9505	1.8 sq. mi.	Approximately 20% forest or U.S. Department of the Interior parkland; remainder of the watershed includes residential, commercial, and industrial areas, including railroad easements and a large bus parking and maintenance yard
Nash Run[1, 5, 8]	1326279.203	454467.4121	460 acres	Approximately 95% urban residential and commercial areas drained by storm drains; Approximately two-thirds of the watershed is located in DC, remainder is in Deanwood Park, Prince George's County
Fort Dupont Creek[1, 5, 8]	1321855.033	443454.5916	376 acres	Primary headwater receives urban runoff from residential areas; majority of the stream is buffered on both sides by forested parkland
Fort Chaplin Tributary[1, 5, 8]	1322937.691	445264.3464	270 acres	90% Residential / 10% Parkland; Generally buffered by 200 feet of forest on each side
Popes Branch[1, 5, 8]	1320615.031	441812.3636	249 acres	Approximately 85% residential and light commercial areas and 15% forested parkland; Fed by headwaters from many storm sewer lines

Tributary Name	X-Coordinate	Y-Coordinate	Approximate Drainage Area (units as shown)	Watershed Land Use Characteristics
Fort Stanton Tributary[3, 5, 8]	1317173.096	440058.9772	180 acres	Approximately 50% National Park Service parkland and 50% residential and commerical areas
Texas Avenue Tributary[1, 5, 8]	1320245.173	441103.8844	110 acres	Approximately 60% residential and light commercial areas and 40% forested parkland; Fed by a network of storm water pipes
Fort Davis Tributary[1, 5, 8]	1320564.407	441661.9341	70 acres	Approximately 50% forested National Parkland and 50% urban residential
Stickfoot Creek[2, 6, 8]	1329646.795	457491.6026	367 acres	30 to 70% impervious
Dueling Creek[2]	1313081.072	437874.3798	no data	no data

Notes:

1. Coordinates (Word Geographic System 1984 decimal degrees) obtained by utilizing the District of Columbia Online Maps Listing website (July 2013): http://octo.dc.gov/DC/OCTO/Maps+and+Apps/Online+Mapping/All+Online+Maps
2. Coordinates (World Geographic System 1984 decimal degrees) estimated from aerial photography
3. Coordinates (World Geographic System 1984 decimal degrees) obtained from US EPA website http://iaspub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=DCTFS01R_00&p_cycle=2010&p_report_type=
4. Drainage area obtained from http://www.anacostia.net/subwatershed.html#
5. Drainage area obtained from DDOE (2012)
6. Drainage area obtained from EA Engineering, Science, and Technology, Inc. (2006)
7. Watershed land use characteristics obtained from Kim et al. (2007)
8. Watershed land use characteristics obtained from D.C. Dept. of Health, Environmental Health Admin., Bureau of Environmental Water Quality Division (2003)

4.0 WORK PLAN RATIONALE

This section defines and provides justification for the DQO that will govern the collection and use of data in the RI and NRDA, describes the existing information on the nature and extent of contamination in each of the environmental media of concern, and identifies data gaps for each medium and pathway. The sampling approaches for sediments, benthic invertebrates, fish, and turtles are broadly described; some aspects of sampling will be determined based on conditions encountered at each sample location. Preliminarily defined sediment management areas are also discussed in this section.

4.1 Data Quality Objectives

DQOs are qualitative and quantitative statements that clarify investigation objectives, define the appropriate types of data to collect, determine the appropriate conditions from which to collect the data, and specify acceptable decision errors associated with each sampling approach. The DQOs for the RI and NRDA are defined in **Section 4.1.1**. The supporting DQO development process is discussed in **Section 4.1.2**.

The data collected will support the objectives of this WP which are to determine the nature and extent of contaminated environmental media and assess the associated risk to human health and the environment, conduct sampling that can used for an NRDA, and characterize general site conditions sufficient for the performance of the FS. Previous sampling completed in the Anacostia River included areas near environmental sites where known releases have occurred as well as broader studies encompassing the entire tidal river (Velinsky and Ashley 2001; McGee et al. 2000). Additional surface and subsurface sediment sampling is necessary to confirm current concentrations of constituents in sediment (which may or may not validate prior results); identify potential sources of COCs in sediment; and evaluate the potential for risk to human health and the environment. Additional data are also required to support the NRDA process and provide information needed to assess remedial options in a FS, including development of preliminary remedial goals (PRG).

4.1.1 Data Quality Objective Statement

The following DQOs were developed for this investigation:

- Characterize environmental conditions within the study area and refine the CSM;
- Update existing datasets from previous investigations in the study area so that current nature and extent of impacts can be defined;
- Identify potential site-wide or site-specific sources of COCs in sediment and surface water;
- Improve characterization of the sediments at the storm drain system and tributary network outfalls and the Anacostia River;
- Generate a dataset sufficient for updating and revising the existing watershed model;
- Assess the human health and ecological risks associated with elevated levels of contaminants in surface sediment, subsurface sediment, surface water, sediment pore water, benthic invertebrate tissue, fish tissue, and turtle tissue;
- Characterize site environmental media sufficient to support a NRDA; and

- Characterize site environmental media sufficient to support development and evaluation of remedial alternatives and PRGs.

Several analytical levels of data quality available to achieve the DQOs are designated as follows:

- **Level I** – Field screening or analysis using portable instruments, calibrated to non-compound-specific standards,
- **Level II** – Field analysis using portable instruments, calibrated to specific compounds,
- **Level III** – USEPA recommended performance based methodologies such as those outlined in EPA SW-846,
- **Level IV** – USEPA Contract Laboratory Program (CLP) Routine Analytical Services (RAS) methods, and
- **Level V** – Other internationally-recognized and/or non-standard analytical methods.

Field-screening data will be used to better understand the depth of the water column, better understand the configuration of the river bottom and identify the presence of potential utilities in the proposed investigation area.

Field screening data will be used as part of a weight-of-evidence approach in conjunction with laboratory data and geologic information to delineate impacts in the context of the CSM (see **Section 3.0**). Additionally, field screening and observations will be used by the field team to evaluate and adjust sampling depths and locations as needed. This approach to the field investigation is a key component of this dynamic work plan.

Field screening activities will be conducted under Level I data quality protocol. Field measurements [i.e., pH, temperature, turbidity, x-ray fluorescence (XRF)] will be completed under Level II data quality protocol. Samples submitted for fixed-base laboratory analysis and accredited on-site mobile laboratory will be analyzed, at a minimum, under Level III data quality protocol. Level IV or V could be applied for specialty methods such as high resolution PCB analysis or forensic analysis.

4.1.2 Data Quality Objective Development Process

The DQOs for the study area were developed using the EPA's DQO process, a multi-step, iterative process that ensures that the type, quantity, and quality of environmental data used in the decision making process are appropriate for its intended application. Each of the seven steps of the process is discussed in **Table 4.1** (below) with respect to the development of specific DQOs for the Anacostia River contaminated sediments project. Additional details regarding the DQOs, including metric thresholds and limits, are addressed in the QAPP.

As discussed in **Section 2.6**, previous sediment studies in the Anacostia River were reviewed for use in the current RI. During initial scoping meetings with DDOE and a review of historical databases, Tetra Tech determined that to ensure sufficient spatial coverage of the tidal Anacostia study area, the available sediment data collected since 2000 (with some minor exceptions as noted in **Section 2.7**) and thus including the comprehensive ANS 2000 sampling, will be used for identifying data gaps and defining new sampling locations. Other considerations regarding data usability are discussed **Section 2.7**.

TABLE 4.1
Data Quality Objectives

STEP 1: State the Problem
• The release of hazardous substances into the Anacostia River has the potential to adversely impact human health and the environment, including natural resources. A RI/FS and NRDA are required to evaluate risks to the environment and human health and to verify a potential injury, respectively.
• Based on prior sediment sampling completed in the Anacostia River, several COCs, including PCBs, PAHs, pesticides, and metals, were detected at concentrations above regulatory criteria or toxicological benchmarks. Previous sampling completed in the Anacostia River included areas near environmental sites where known releases have occurred as well as broader studies encompassing the entire tidal river (Velinsky and Ashley 2001; McGee et al. 2009). Additional sampling is necessary to validate past sampling, identify the potentially most significant sources of COCs in sediment, and evaluate the potential for risk to human health and the environment.
STEP 2: Identify the goals of the study
• The primary goal of the remedial investigation is to determine, for human health and the environment, the current risk and potential future risk posed by the Anacostia River. This will first involve verifying or updating past surface sediment analytical results, obtaining additional data to complete the spatial coverage of the site, and identifying potential source attribution of COCs in the sediment. Measures of direct and indirect toxicity of contaminants to target organisms is necessary to complete the risk assessment portion of the RI.
• A second goal is to gather information on historical, current, and ongoing injury to natural resources to support the NRDA process.
• A third goal is to gather information to support the FS.
• A fourth goal is to initiate the development of data that can be used to support efforts to update the TAM/WASP model or the development of alternative sediment modeling tools.
STEP 3: Identify information inputs
• The ERA and HHRA process will require measuring concentrations of contaminants in sediment (surface and sub-surface), sediment pore water, and surface water from the study area. Results of specialized analyses, such as PCB congeners, dioxins and furans, and AVS/SEMs, will be completed on a subset of the sediment samples. Field parameter data will also be collected (pH, oxidation/reduction potential, dissolved oxygen, and specific conductivity in surface water; organic vapor concentration in sediment). Some surface sediment samples will be tested using laboratory bioassays to assess direct risk to benthic invertebrates. Results of fish, turtle, and invertebrate tissue sample analyses will be used in the ERA (Section 7.0) and HHRA (Section 8.0)(as appropriate). Lipid concentration and percent moisture will be measured in all tissue samples. Existing data on fish tissue concentrations, benthic community condition, and sediment toxicity will be incorporated into the RI as warranted.
• The NRDA process will evaluate all of the data collected for the RI. Data interpretation is consistent between the RI and NRDA.
• The FS will incorporate the results from all RI field data collection activities including the results of the bathymetric and utility survey and sediment geotechnical sampling results as well as the data collected to support the ERA, HHRA, and NRDA in 2013-2014 to develop remedial alternatives to address risk and injury. Data available from the 13 environmental sites identified in the river will be evaluated as part of the overall characterization of the river.

STEP 4: Define the boundaries of the study
• The study area is the Anacostia River in Washington, D.C extending from the confluence with the Potomac River to the division into the northeast and northwest branches in Prince George's County, Maryland. The study area includes the Washington Channel (see **Figure 1.1**). The investigation will primarily address sediment conditions within an area of the Anacostia River approximately 700 acres in size and 9 miles in length. The project area is divided into nine sediment management units: Reaches 1-7, Reach KL (Kingman Lake) and Reach WC (Washington Channel) (**Figure 4.1**). Several environmental sites within the Anacostia River are being address by others (see **Section 2**). The results of environmental investigations conducted at these sites will be incorporated into the investigation as they become available. Deep sediments will be investigated to the depth of approximately 10 feet.
STEP 5: Develop the analytical approach
• Sediment sample results will be used to characterize the nature and vertical and lateral extent of contamination and assess risk to ecological and human health receptors. Subsurface sediment sampling horizons will be determined in the field and sediment samples from each horizon will be collected. Samples from up to three horizons within each core will be selected for immediate analyses; the remaining sample horizons will be archived for potential future analysis. Surface water chemistry data will be used to support risks posed to human health. Pore water data is needed to support the ecological risk assessment since pore water is an important pathway for contaminant uptake and can exhibit a strong relationship with tissue concentrations and toxicity. Pore water data will also be used to support FS remedy design needs and as a potential preliminary indicator of up-gradient groundwater contamination sources. Deep sediment data is needed to assess the depth of contamination and to assist in characterizing vertical variations in sediment lithology over the study area.
• Sediment, surface water, and sediment pore water data will be analyzed by EPA or equivalent methods. Samples will be analyzed for a broad range of constituents including PP VOCs, SVOCs, metals, PCB Aroclors, pesticides, and dioxins. Redox potential and TOC will be measured to support analysis of bioavailability. Selected samples will also be analyzed for PCB congeners and alkylated PAHs. The concentrations of chemicals in sediment samples will be compared to Region 3 benchmarks. Chemical concentrations in pore water samples will be compared with freshwater water quality criteria.
• Tissue concentrations in field-collected invertebrates, fish, and turtles serve dual purposes, as indicators of direct exposure and lifetime accumulation by organisms and as evidence of potential transfer of contaminants from the sediment (and water) to other organisms in the aquatic ecosystem. Fish will be collected along the river at various locations. Although fish and turtle tissue concentrations cannot be tied to a particular sediment location because these animals move throughout the area, tissue concentrations are useful in estimating ingested doses of chemicals to animals (and people) that eat fish and turtles. Fish tissue concentrations for the HHRA will be provided by a separate DDOE study conducted in 2013. Other measures of impact such as the index of benthic integrity, incidence of fish tumors, and sediment toxicity reported in the literature will be incorporated into the BERA as warranted.
• Specific locations and analytical requirements for each sample are shown in **Tables 5.1 and 5.2**. The ERA (Section 7.0) and HHRA (Section 8.0) will use the sediment, pore water, surface water, and tissue data to calculate risks. The data collected will also be used to develop remedial goals for the site. If new potential sources of contaminants or hotspots are identified, additional sampling may be warranted.

• Geotechnical analyses of surface and subsurface samples will contribute to the FS. Measures of grain size and other physical parameters will be used to assess the feasibility of dredging, dewatering, capping, and other potential remedies.
STEP 6: Specify performance or acceptance criteria
• The data quality indicators for screening and definitive data are defined in terms of the precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters. The assessment of the data quality indicators is necessary to determine data usability and involves the evaluation of the PARCC parameters. To ensure the quality and integrity of the project data, the precision and accuracy of the analysis, the representativeness of the results, the completeness of the data, the comparability of the data to existing data will be evaluated. Data that meet the DQOs and fulfill project goals will be deemed acceptable. Data that do not meet objectives and goals will be reviewed on a case-by-case basis to ascertain usefulness. To limit errors made based upon analytical data, the reporting limits (practical quantitation limits) for target analytes will be established at a level at least one half the applicable screening level whenever technically feasible. In general, statistical analysis will not be used to determine decision error tolerance limits.
• Sediment, pore water, surface water, and tissues will be analyzed by EPA or equivalent methods. Sediment toxicity tests will follow ASTM methods. All data will be validated by a subject-matter expert and the data's usability assessed.
• Survey information will be collected by a licensed surveyor with experience in bathymetric surveying. Survey information will be compared to previous surveys to verify that the elevations and other survey information are reasonable. Geotechnical data will be analyzed by ASTM or equivalent methods.
• The specific criteria for the PARCC parameters are specified in the QAPP. As part of the RI, historic data will be assessed against the criteria to determine usability for the various aspects of the RI (ERA, HHRA, nature and extent, updating the TAM/WASP model, and other analyses).
STEP 7: Develop the plan for obtaining data
• Sampling will be dynamic and tailored to the conditions observed in the field. A bathymetric survey was completed to provide a basis for understanding the depth of the water column and the configuration of the river bottom and was used to prepare a contour map of the top of the sediment surface in and around the investigation areas (Appendix A). Samples of environmental media will be collected from various locations within the study area. (See **Figures 5-1** and **5-2**). Sediment sampling locations are based on geomorphic evaluation of the bathymetric survey results. The geomorphic evaluation is summarized in an Appendix B. Sediment, surface water, and sediment pore water samples will be collected over a multi-week period.
• Various types of sampling equipment will be used to gather the required samples. Surface sediment samples will be collected for laboratory-based toxicity testing (i.e., bioassays) using the amphipod (*Hyalella azteca*) and midge (*Chironomus dilutus*). At up to half of the surface sediment sampling locations (opportunistically selected as described in **Section 5.1**), benthic invertebrates will be collected in the field for analysis of body burdens (bioaccumulation) if organisms are available. Fish sampling locations were selected to provide spatial coverage of all reaches of the river within the Study Area. Backwater areas were also targeted. Sample collection locations may be shifted in the field to accommodate logistical requirements of the selected sample collection methods. Data collected by others for development of fish consumption advisories and monitoring of fish health will be incorporated into the ERA and HHRA as warranted.

- Geotechnical data required for the assessment of potential remedial actions will be collected at sediment sampling locations. Grain size will be measured at every sediment sampling location. Bulk density, moisture content, and Atterberg Limits will be obtained from 20% of the sediment sampling locations. Geotechnical samples will be collected in conjunction with sediment samples collected for chemical analysis. Additional utility and debris survey information deemed relevant to the FS will be collected as needed.

Additional sampling is required to confirm current chemical concentrations in sediment, verify past surface sediment results, and update and expand tissue results to support the ERA, HHRA, and NRDA. The additional data will also provide representative spatial coverage of the site and support identification of potential sources of COCs in the sediment and biota. The additional data will also be used to support the FS and development of PRGs. An assessment of data gaps is provided in **Section 4.2.7**.

4.2 Nature and Extent of Contamination

This section summarizes the existing information regarding the nature and extent of contamination in each environmental medium considered in this investigation. To assist in the evaluation of the existing data, the study area was subdivided into nine channel reaches (**Figure 4.1**). The channel reach descriptions and associated two-character identifier are listed below.

- Washington Channel (WC)
- Mouth of River to South Capitol Street Bridge (R1)
- South Capitol Street Bridge to 11th Street Bridge (R2)
- 11th Street Bridge to CSX Bridge (R3)
- CSX Bridge to East Capitol Street Bridge (R4)
- East Capitol Street Bridge to Benning Road Bridge (R5)
- Benning Road Bridge to Amtrak Bridge (New York Avenue) Bridge (R6)
- Amtrak Bridge (New York Avenue) to Upper tidal limit (R7)
- Kingman Lake (KL)

The existing data assessment consisted of spatially reviewing the distribution of sampling points for each medium by sample year and data source. In addition, the data were evaluated regarding spatial coverage. For constituents with site-wide coverage, plots were constructed to review the numbers of constituents analyzed for each of the major constituent groups including PCB congeners, LPAHs, HPAHs, pesticides, and metals. The available data for some constituent groups such as PCB Aroclors, PCDDs, and PCDFs were highly localized primarily to the Washington Navy Yard and/or the CSX environmental cleanup sites. These constituent groups, therefore, were not included in the spatial data review.

For each of the channel reaches, the available data were reviewed with regard to spatial coverage, entry points for each CSS outfall, MS4 outfall, and tributary stream, and resampling of pre-existing locations. Visually-evident patterns or trends within each reach were assessed with a focus on LPAHS, HPAHs, total PCB congeners, and trace metals. Geographic information system (GIS) shapefiles were developed to facilitate concurrent review of multiple constituents. With a site aerial photo as background, the GIS

allowed the review of the existing concentration data and the identification of channel areas with observable geomorphologic features (e.g., sediment deltas and bars).

4.2.1 Surface Sediment

Although coverage is somewhat variable by constituent group, metals, PAHs, PCBs, and pesticides in surface sediment have been sampled at numerous locations throughout the tidal Anacostia River. Comparatively better coverage exists in the Anacostia River than in the Washington Channel. To provide an overview of the nature and extent of contamination in surface sediment, LPAH, total PAH, HPAH, total PCBs, and chlordane concentrations are shown on **Figures 4.2 to 4.6**, respectively. In addition, concentrations for aluminum, arsenic, cadmium, copper, chromium, lead, mercury, nickel, selenium, and zinc are shown on **Figures 4.7 to 4.16**, respectively.

As noted in Section 3.1.1, LPAH is defined as the sum of the measured concentrations for the six lower molecular weight PP PAHs (those with fewer than four rings) while HPAH consists of the sum of the remaining PP PAHs (those with four or more rings). If the full suite of PP PAHs were unavailable for any given sample, the calculation summed the concentrations for the subset for which data was available. Also, PCBs are defined as the sum of the PCB congeners analyzed for each sample.

In the following discussion, the general trend in the observed surface sediment distribution is discussed followed by an assessment of specific concentration ranges. Overall, the concentration distributions exhibited consistent trend characteristics from the upstream tidal limit to the lowermost reach from South Capitol Street Bridge downstream to the mouth. Most constituents in the lowermost reach of the Anacostia are at relatively lower concentrations, possibly related to the influence of the Potomac River (this area is referred to below as the Potomac mixing zone). Upstream from the lowermost tidal reach, constituent concentration trends in surface sediments can be grouped as follows:

- Increasing downstream: a generally increasing trend with distance down-river. Localized hotspots with much higher concentrations overlay this general trend, primarily near outfalls and adjacent upland environmental cleanup sites.
- Elevated without observable trend: concentrations are in general elevated everywhere and show no observable trends; localized hotspots exist near some outfalls and upland environmental cleanup sites.
- Data are insufficient to assess trends: the sampling distributions for several of the reviewed constituents were too sparse to assess general trends.

In addition, the term “elevated” is used where appropriate to characterize the observed concentrations. Concentrations are considered elevated if they exceed the EPA Region 3 BTAG freshwater sediment benchmarks screening levels shown in **Table 2.5**. However, the concentrations noted as elevated in this discussion may be below effects-based levels if other less conservative benchmarks were used. Although the BTAG levels are very conservative, they provide an appropriate initial reference for this evaluation of existing conditions prior to the performance of additional sampling for the RI. **Table 2.5** also lists threshold, probable, and severe effects level benchmarks. These and potentially other benchmarks will

be considered along with the BTAG levels during RI data evaluation at which time, the definition of the term “elevated” may be refined.

- **LPAHs.** LPAHs concentrations are non-trending in most of the tidal Anacostia River. A general reduction in concentration is observed from the South Capitol Street Bridge to the mouth and in Washington Channel (**Figure 4.2**). For the sampled locations, LPAH concentrations typically range from 300 to 4,400 µg/kg. Below South Capitol Street and in the Washington Channel, concentrations range from 300 to 1,700 µg/kg. LPAH concentrations appear elevated in the vicinity of the O Street Outfall and the Washington Navy Yard. Concentrations in these areas range up to 21,000 µg/kg. Concentrations in the 1,700 to 2,600 µg/kg range are observed in the reach from the AmTrak/New York Avenue bridges to the upstream tidal limit of the study area. For comparison, **Figure 4.3** shows the distribution of total PAHs within the study area.
- **HPAHs.** The HPAH concentration trend is similar to that described above for LPAHs –no observable trend in the river upstream from the South Capitol Street Bridge and a general reduction downstream from the South Capitol Street Bridge to the mouth and in Washington Channel (**Figure 4.4**). HPAH concentrations typically range from 4,400 to 13,000 µg/kg. Downstream from South Capitol Street Bridge, the concentrations range from approximately 4,400 to 8,500 µg/kg. Concentrations generally exceed 8,500 µg/kg from the Washington Navy Yard to the upper tidal limit of the study area with higher concentrations observed at the O Street Outfall (up to 52,300 µg/kg) and locally in the vicinity of some of the sewer outfalls and tributary confluences. Outfall F-819-217 and Hickey Run are examples. For comparison, **Figure 4.3** shows the distribution of total PAHs within the study area.
- **PCBs.** Total PCBs, calculated by summing all congener concentrations measured at a given location, are shown on **Figure 4.5**. Since the ANS 2000 sampling is the most spatially comprehensive, most PCB sampling results available are based on the ANS 2000 list of 81 congeners. PCB concentrations are non-trending and elevated throughout the study area. Concentrations typically range from 34 to 500 µg/kg. Two sampling points from Kingman Lake yielded concentrations of 300 and 500 µg/kg. Maximum total PCBs range from 2,600 to 6,500 µg/kg and are localized to the O Street outfall and the Washington Navy Yard.
- **Pesticides.** Beta-chlordane is an indicator pesticide constituent that is of concern in the tidal Anacostia River. The District and the Metropolitan Washington Council of Governments issued a fish consumption advisory in part because of elevated chlordane concentrations in fish tissue (Syracuse Research Corporation 2000). **Figure 4.6** shows the distribution of beta-chlordane in surface sediments. In general, beta-chlordane is elevated and non-trending (concentrations ranging from less than 0.17 to 30 µg/kg) from the upper tidal limit to the vicinity of the Washington Navy Yard and Poplar Point. In the channel reach opposite from these two sites, detected concentrations typically range from 15 to 70 µg/kg. Below the South Capitol Street Bridge beta-chlordane concentrations fall to the 10 to 15 µg/kg range. Beta-chlordane data is unavailable for the river mouth vicinity and for the Washington Channel.
- **Metals.** Ten metals that have been relatively widely sampled in shallow sediment from the river include aluminum, arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, and zinc.

- **Aluminum. Figure 4.7** shows the distribution of aluminum concentrations in surface sediment. From the upstream tidal limit to the Washington Navy Yard, aluminum concentrations are non-trending and range from 2,800 to 44,600 mg/kg. Maximum concentrations occur near the O Street outfall (in the range from 56,000 to 94,600 mg/kg), in the Washington Channel, in the lowermost reach of the Anacostia, and at the Washington Channel confluence.
- **Arsenic. Figure 4.8** shows the distribution of arsenic concentrations in surface sediment. Arsenic was not included in the group of metals analyzed in the 2000 ANS sampling effort and consequently the arsenic sampling distribution is of insufficient density for the assessment of general trends. The maximum concentrations (25 to 90 mg/kg range) observed occur opposite from the Fort Dupont Creek outfall and at the MS4 outfall F-294-739 located south of the Benning Road Bridge. Elevated concentrations in the range of 20 to 25 mg/kg are present in the O Street outfall/Washington Navy Yard vicinity.
- **Cadmium. Figure 4.9** shows the distribution of cadmium concentrations in surface sediment. Cadmium concentrations are non-trending throughout the study area, including the lowermost reach of the tidal Anacostia River and Washington Channel. Any reduction in the Potomac mixing zone is muted relative to most other metals. Concentrations generally range from 1.0 to 2.6 mg/kg. The maximum concentrations range from 2.0 to 8.0 mg/kg and occur at the O Street outfall, the eastern portion of the Navy Yard, opposite from the Fort Dupont Creek outfall, and at the MS4 outfall F-294-739 located south of the Benning Road Bridge.
- **Chromium. Figure 4.10** shows the distribution of chromium concentrations in surface sediment. Chromium exhibits a general increasing trend in concentration downstream to the Potomac mixing zone. Concentrations appear elevated (87 to 114 mg/kg range) in the reach extending between the confluence with Dueling Creek downstream to the New York Avenue bridge. From New York Avenue downstream to the WGL site, concentrations are generally below the BTAG screening level (43.4 mg/kg) with the exception of several isolated samples and an exceedance cluster at the mouth of Fort Dupont Creek. From WGL to the Potomac mixing zone, concentrations are elevated ranging up to 169 mg/kg. The maximum chromium concentrations encountered are at the O Street outfall and range between 141 and 169 mg/kg.
- **Copper. Figure 4.11** shows the distribution of copper concentrations in surface sediment. Copper exhibits an increasing trend in concentration downstream to the Potomac mixing zone where there is a reduction. From the upper tidal limit downstream to Benning Road, concentrations typically range from 5.0 to 30 mg/kg and increase to the range of 30 to 90 mg/kg in the reach from Benning Road to the vicinity of the WGL site. From this point south to the Potomac mixing area, concentrations range from 60 to 120 mg/kg. Localized hotspots exist at the O Street outfall (350 – 900 mg/kg) and in the small embayment/wetland area bordering Kenilworth Park South Landfill.
- **Lead. Figure 4.12** shows the distribution of lead concentrations in surface sediment. Lead concentrations are elevated (ranging from 35 to 100 mg/kg) but appear non-trending from the upper tidal limit to the vicinity of the Fort Dupont Creek outfall south of the East Capitol

Street Bridge. Below Fort Dupont Creek, samples with concentrations ranging from 100 to 200 mg/kg increase in frequency. From the Washington Navy Yard south to the Potomac mixing zone, a further increase in the number of samples in the 100 to 200 mg/kg range suggest the continuation of a general increasing trend in this portion of the river. The maximum lead concentrations, in the range from 500 to 1,000 mg/kg occur adjacent to the O Street Outfall and the Washington Navy Yard.

- **Mercury. Figure 4.13** shows the distribution of mercury concentrations in surface sediment. Mercury concentrations appear to increase with distance downstream from the upper tidal limit. Upstream from the Benning Road Bridge, concentrations ranged from 0.009 to 0.4 mg/kg; downstream from this point, concentrations are typically elevated and range from 0.18 to 0.4 mg/kg. Any reduction in the Potomac mixing zone is muted relative to most other metals. Maximum concentrations occur at the O Street outfall and Washington Navy Yard (3.0 to 10 mg/kg). Elevated concentrations also exist in the vicinity of the Fort Dupont Creek outfall (0.4 to 0.9 mg/kg).
- **Nickel. Figure 4.14** shows the distribution of nickel concentrations in surface sediment. Nickel exhibits a general increasing trend in concentration downstream to the Potomac mixing zone. Upstream from the Kenilworth Park Landfills, concentrations range from 0.2 to 64 mg/kg. Below this point to the vicinity of the WGL site, levels increase to the 23 to 64 mg/kg range. From WGL to the Potomac mixing zone, concentrations range between 47 and 100 mg/kg. The maximum nickel concentrations encountered are at the O Street outfall and range between 100 and 149 mg/kg.
- **Selenium. Figure 4.15** shows the distribution of selenium concentrations in surface sediment. Selenium was not included in the group of metals analyzed in the 2000 ANS sampling effort and consequently the sampling distribution is of insufficient density for the assessment of general trends. The maximum concentrations (5 to 12 mg/kg range) occur in the in the O Street outfall vicinity. Selenium was detected in the range of 0.3 to 1.6 mg/kg range near the Fort Dupont Creek outfall.
- **Zinc. Figure 4.16** shows the distribution of zinc concentrations in surface sediment. Zinc concentrations are generally elevated and show an increasing trend from the upper tidal limit downstream to the Potomac mixing zone. Concentrations typically range from 17 to 280 mg/kg to the vicinity of the Pepco site, below which, the general range increases to between 120 and 400 mg/kg. Downstream from the Poplar Point and the Washington Navy Yard, the range increases to 280 to 400 mg/kg. The maximum zinc concentrations are in the range of 900 to 1,800 mg/kg and occur in the vicinity of the O Street outfall.

4.2.2 Subsurface Sediment

Within the study area, subsurface sediment sampling is limited to three general locations (**Figure 4.17**), the Washington Navy Yard and in the vicinity of the Fort Dupont Creek outfall, downstream from CSX Benning Yard, and Poplar Point. Subsurface samples in these investigations were collected via vibracoring drilling methods.

Washington Navy Yard. CH2M Hill (2011a) describes the characterization of subsurface sediments at the Washington Navy Yard. Sampling was conducted at 34 locations within and near the pier area to depths ranging from 10 to 12 feet (middle depth) to approximately 20 feet (deep depth) below the river bottom. The historical dredge depth at the Washington Navy Yard is -22 feet below mean sea level. The middle depth and deep depth samples correspond to the interval above the typical dredging depth versus the interval representing older fluvial sediments.

- **VOCs.** VOCs were analyzed in deep sediments and were infrequently detected. Four compounds, including benzene, carbon disulfide, and cis-1,2-dichloroethene were detected at concentrations ranging from 1 and 15 µg/kg in a sample collected near DC CSS outfall 15. A concentration of 1,200 µg/kg for vinyl chloride was measured in this sample while VOCs were non-detect in a sample taken from the same depth at a lateral distance of approximately 50 feet away. The available data thus indicate that given the 34 locations sampled, elevated occurrences of VOCs, though observed, are relatively isolated.
- **PAHs.** Total PAHs calculated as the sum of the 16 PP PAHs in middle depth samples ranged from 1,362 to 92,280 µg/kg with a mean concentration of 20,349 µg/kg. Middle depth samples were elevated with respect to surface and deep zone samples. The most elevated concentrations were measured near the DC CSS outfall 15, near Washington Navy Yard outfalls, and immediately downstream of the neighboring WGL East Station site. Total PAH concentrations were generally lower and more often below detection levels in the deep sediments. Deep sediment total PAHs ranged from 320 to 27,719 and averaged 6,212 µg/kg. The most elevated concentrations were observed near facility outfalls.
- **Pesticides.** The most frequently detected pesticides included 4,4'-Dichloro-diphenyl-dichloroethane (DDD), 4,4'-Dichloro-diphenyl-dichloroethylene (DDE), alpha-chlordane, dieldrin, gamma-chlordane, and heptachlor expoxide. Gamma-chlordane, which CH2M Hill (2011a) determined to be a potentially significant contributor to risk in surface sediments, ranged from 5.2 to 58 and averaged 18.5 µg/kg in middle depth samples. Middle depth samples were generally elevated in comparison to surface and deep zone samples. In general, elevated gamma-chlordane concentrations occurred near facility outfalls and DC CSS outfall 15. More elevated gamma-chlordane concentrations (27 and 30 µg/kg) were observed at two deep sediment locations, both in close proximity to facility outfalls.
- **PCBs.** PCB congeners were analyzed in a subset of the deep sediment sampling locations, 10 middle-depth and eight deep-depth samples. Middle depth total PCBs were elevated with respect to surface and deep-zone samples. The average concentrations total PCB congeners (sum of the 102 congeners analyzed) was 3508 µg/kg for the middle depth and 316 µg/kg for the deep horizon. Maximums were 26,129 and 2,277, respectively. The most elevated concentrations occurred near DC CSS outfall 15 and outfalls for the facility.
- **Metals.** The list of 24 EPA target analyte list (TAL) metals was analyzed in all subsurface sediment samples. Most of the TAL metals were detected in all middle and deep-depth samples. Antimony, cadmium, thallium, selenium, and silver were exceptions and were detected in a subset of samples. Barium, chromium, copper, lead, and zinc were detected in all samples and indicate the general distribution of metals in the subsurface sediment samples. In comparison to

surface sediments and deep zone sediments, the most elevated occurrences of these five metals were observed in the middle-depth sediments. Barium concentrations averaged 200 mg/kg in the middle sediments and 162 mg/kg in the deep sediments. Chromium averaged 125 mg/kg in the middle zone and 34 mg/kg in the deep zone. Similarly, the average concentrations for copper, lead, and zinc were 95, 268, and 399 mg/kg, respectively for middle depth samples compared to 54, 102, and 168 mg/kg in the deep sediments.

CSX Benning Yard. Shallow subsurface samples were collected in the Anacostia River at 35 locations for the Benning Yard investigation. Twenty-two samples were collected at and in the general vicinity of the Fort Dupont Creek outfall (**Figure 4.17**). The remaining samples were collected to evaluate conditions in the river channel away from the Fort Dupont Creek outfall and at selected MS4 outfalls in the general vicinity upstream and downstream from Fort Dupont Creek. Samples were collected from the depths of 0.5 to 1.0 foot (upper interval), 1.0 to 2.0 feet (middle interval), and 2.0 to 3.0 feet (deep interval) below the river bottom. Sediments in the immediate vicinity of the outfall tend to contain more sand while those at distance from the outfall have larger silt and clay fractions.

- **LPAH.** Concentrations tend to increase with depth and are variable away from the Fort Dupont Creek outfall. Average concentrations in the upper interval were 1,384 µg/kg. For the middle and deep sample intervals, the average concentrations were 1,556 and 1,613 µg/kg. Concentrations also tended to increase with decreasing grain size. The maximum LPAH concentration (2,800 µg/kg) was observed in the shallow subsurface interval sample collected near the shoreline in close proximity to the Fort Dupont Creek outfall. The sample contained a large silt fraction. Coarser grained samples in the outfall vicinity generally exhibited lower concentrations. A mid-channel sample collected approximately 1,000 feet upstream is indicative of concentrations away from the outfall area. At this location, an LPAH concentration of approximately 1,200 µg/kg were observed in the shallow depth interval sample.
- **HPAH.** Concentrations exhibit a decreasing trend with depth. The averages for the sampled zones decrease from 9,547 µg/kg for the upper zone to 6,956 and 5,592 µg/kg for the middle and deep zones, respectively. As was true for LPAH, concentrations appear to be inversely correlated with grain size. The maximum HPAH concentration (21,600 µg/kg) was observed in a middle interval sample collected near the shoreline approximately 600 feet downstream from the Fort Dupont Creek outfall. Coarser grained samples in the outfall vicinity generally exhibited lower concentrations. As noted above for LPAH concentrations, the mid-channel sample collected approximately 1,000 feet upstream is indicative of concentrations away from the outfall area. At this location, an HPAH concentration of approximately 10,000 µg/kg was observed in the shallow depth-interval sample.
- **PCBs.** PCBs for the Benning Yard Anacostia River dataset exhibit an increasing trend with depth. Total PCBs for the Benning Yard dataset were calculated by summing the result reported for all 209 PCB congeners and, thus, are not directly comparable to the results discussed above for total PCBs for the ANS 2000 data set (summed results for 81 congeners). From an average concentration of 848 µg/kg in the upper interval, concentrations increase to 1,205 µg/kg in the middle interval and to 2,039 µg/kg in the deep interval. The maximum total PCB concentration

was observed in a deep zone sample collected near the shoreline approximately 750 feet upstream from the Dupont Creek outfall. In general, total PCB concentrations are lower in close proximity to the outfall.

- **Pesticides.** Chlordane is used as an indicator compound to summarize the pesticide concentrations. Chlordane was detected in 29 of 39 samples. Chlordane concentrations exhibit an increasing trend with depth. The averages for the sampled zones increase from 71 µg/kg for the upper zone to 123 and 146 for the middle and deep intervals, respectively. The maximum chlordane concentration was observed in a middle depth interval sample located near the shoreline and approximately 300 feet downstream from the Fort Dupont Creek outfall. Elevated chlordane concentrations also are present near the outfall and in some samples with a large sand size fraction.
- **Metals.** Arsenic, cadmium, lead, mercury, and selenium concentration distributions generated from the Benning Yard investigation were reviewed. With the exception of selenium, each of these metals were detected in essentially all of the 38 samples (one sample was non-detect for mercury) included in the dataset. Results for approximately half of the selenium analyses were below the detection level. Among the three sampling intervals, average concentrations for each metal were typically most elevated for the deep interval. Deep interval averages for arsenic and cadmium were 12.38 and 2.33 mg/kg. Lead, mercury, and selenium deep interval average concentrations were 194, 0.54, and 3.89, respectively. The maximum concentrations for arsenic, cadmium, and selenium (12, 2.7, and 1.3 (estimated) mg/kg) were in a mid-channel, deep interval sample collected 1,000 feet upstream from the Fort Dupont Creek outfall. A lead concentration of 120 mg/kg) was measured in the upper interval sampling at this location. The maximum mercury concentration (1.6 mg/kg) occurred in a sample located in mid-channel, 200 feet from the outfall. In general, mercury concentrations in the immediate vicinity (within 100 feet) of the outfall were very low (average 0.04 mg/kg) in comparison to the concentrations (average of 0.3 mg/kg) measured at more distant sampling locations (greater than 100 feet).

Poplar Point. Five sediment cores from the undredged portion of the channel in the Poplar Point vicinity were sampled by Vibracore; depths ranged from 13 to 16 feet below the sediment surface (Velinsky et al. 2011). Surface concentrations of PAHs and total PCBs were lower than deeper horizons. Maximum PAH concentrations ranged from 10,000 to 30,000 µg/kg, and were greatest at 3.2 to 8.2 feet below the sediment surface. Total PCB concentrations were greatest at 3.2 to 13 feet below the sediment surface; maximum total PCB concentrations ranged from 1,700 to 3,000 µg/kg. (See Section 2.6.2 for more details).

4.2.3 Pore Water and Surface Water

Pore water data and surface water data are not available in the project database. With respect to surface water, analytical data are available from discharge monitoring reports compiled for selected tributary streams and outfalls to the tidal Anacostia River. Pinkney et al. (2002) reported on four surface water samples collected in 2000. In addition, CH2M Hill (2011a) report field parameter measurements for surface water samples collected for the Washington Navy Yard RI.

Discharge Monitoring Report (DMR) Sampling. As a requirement of the District of Columbia Municipal Separate Storm Sewer System National Pollutant Discharge Elimination System (NPDES) permit issued by EPA, DDOE conducts routine wet and dry weather sampling of nine stations located in the Anacostia River watershed (Hawkins 2009). According to sampling protocol, storm water samples are to be collected during the first two hours of a storm event. Regarding dry weather monitoring, sampling is conducted sufficient to estimate the frequency and volume of dry weather discharges. The water is analyzed for BOD, TDS, TSS, various inorganics, 13 metals and hardness, 2,3,7,8-TCDD, and bacteria (fecal coliform and fecal streptococcus). Monitoring of the Anacostia stations occurs once each three years with 2011 the last year in which monitoring was performed. Based on monitoring results from 2008, TSS ranged from 5 mg/L (Hickey Run) to 853 mg/L at the O Street NPDES Outfall located adjacent to the Washington Navy Yard. In addition, 2,3,7,8-TCDD, pesticides, and all metals with the exception of cadmium, copper, lead, and zinc were below the detection level.

Main Channel Sampling in 2001. To support a study of the toxicity of Anacostia River water on larval-stage fish, Pinkney et al. (2002) collected six surface water samples during an approximately one month period spanning May and June, 2001. Two dry and four wet period samples were collected at four locations encompassing the length of the tidal Anacostia River. Water for toxicity testing was collected concurrently with the surface water samples. The water samples were analyzed for trace metals, organochlorine pesticides, PCBs (Aroclors), and PAHs. The majority of the constituents were non-detect or the results were qualified as a result of matrix interference. PCBs were uniformly below detection levels while detections of PAHs and metals were all less then water quality criteria. Pesticides were generally also non-detect with the exception of four instances of one detection of a single pesticide for the dry period samples. The toxicity test results suggested non-toxic river water conditions during dry weather. Wet period samples, however, suggested conditions may exist for reduced survival and growth.

Washington Navy Yard. As a part of a sediment triad investigation in the tidal Anacostia River near the Washington Navy Yard, CH2M Hill (CH2M Hill 2011a) measured surface water parameters at a height of one foot above the sediment surface. This sampling was conducted in August, 2009. The samples were collected at locations adjacent to the Navy Yard piers and outfalls and in reference areas located away from the immediate area of the Navy Yard but still in the general vicinity of the facility. The maximum, minimum, and average pH, dissolved oxygen (DO), oxidation and reduction potential (ORP) and specific conductivity for the 18 locations sampled are summarized in **Table 4.2**, below. Additional investigation is necessary to confirm these sampling results.

TABLE 4.2
Field-Measured Surface Water Quality Parameters, Washington Navy Yard

	pH	Dissolved Oxygen (mg/L)	Oxidation/ Reduction Potential (mV)	Specific Conductivity (mS/cm^3)
Average	7.33	6.22	-29.34	0.286
Maximum	7.78	8.06	4.8	0.327
Minimum	7.13	2.44	-59.2	0.250

4.2.4 Groundwater

The tidal Anacostia River is a regional discharge zone for groundwater. As such, the river receives groundwater inflow from throughout the watershed.

Elevated concentrations of groundwater contaminants are present or have the potential to be present at the currently identified environmental cleanup sites that border the river. A summary of the specific constituents for each site was provided in **Section 3.1.2.1** and **Table 3.2**. Although these sites do not represent every source of contaminated groundwater entering the river, they collectively include the known sources of significant groundwater contamination to the river. If additional investigation reveals the presence of other environmental sites bordering the river, they will be considered in the RI and the NRDA.

4.2.5 Invertebrate and Fish Studies

Field studies addressing potential exposure of benthic invertebrates and fish to contaminants in the Anacostia River are summarized below. Two types of studies are available: (1) bioavailability studies using transplanted Asiatic clams, and (2) tissue concentrations and physical evaluation of recreationally important fish. Both of these study programs provide data on potential impacts to humans ingesting contaminated organisms from the Anacostia River. However, neither of the studies was designed to support an ecological risk assessment.

4.2.5.1 Clam Bioaccumulation Studies

Studies conducted by the University of the District of Columbia used translocated Asiatic clams (non-native *Corbicula fluminea*) to evaluate bioavailability of contaminants at 45 locations in the Anacostia watershed in Washington, DC and Maryland (Phelps 2000, 2001, 2008, 2011, 2013). In several studies, clams were collected from reference or control sites in the Potomac River and moved to selected sites in the tidal and nontidal Anacostia River (Phelps 2001, 2008). Asiatic clams are exposed to dissolved contaminants in surface water and to contaminants associated with the suspended particulate matter that they ingest. Suspended particulates may carry adsorbed organic contaminants such as PAHs, PCBs, and pesticides. In a study focused on active biomonitoring of contaminant sources in the upper Anacostia watershed, tissue concentrations in translocated clams were compared with 40 clams from the Fort Foote reference area in the Potomac River (Phelps 2008).

In general, the clam translocation studies did not show strong correlation between sediment and tissue concentrations of most contaminants. However, it should be noted that sediment concentrations in the vicinity of the sampled clams and the level of bioaccumulated contaminants found in the clams may not necessarily correlate. The level of correlation found between sediment samples and clam tissue samples is related to several factors including the depositional environment in the vicinity of the clams, the bioavailability of the contaminants being studied, and the turbidity of the water being filtered by the clam.

The highest PCB concentrations in sediment were reported at the Bladensburg Marina site; however, concentrations of PCBs in clam tissues were highest near the Washington Navy Yard and the supposedly "clean" Potomac River locations (Phelps 2000). A clam translocation study associated with dredging and wetland creation at Kingman Island indicated that clams accumulated pesticides and PCBs following dredging. Clams at the dredging sites did not bioaccumulate metals to any substantial extent, compared with control samples in the Potomac River (Phelps 2001). This result may indicate that the metals found in sediment in the dredging sites had a low bioavailability or that low levels of metals were present in the sediment being transported.

Additional bioaccumulation studies using translocated clams at tributaries and other river locations provide similar corroborating evidence that hotspots of PAHs and chlordane may occur in the upper Anacostia River (above Bladensburg Marina) (Phelps 2011, 2013). However, these studies do not incorporate the controlled exposure scenarios necessary to support development of bioaccumulation factors usable in ERAs. (Phelps 2011, 2013).

Pinkney et al. (2003) analyzed contaminant uptake by semi-permeable membrane devices (SPMD) and Asiatic clams (*Corbicula fluminea*) at nine locations in the Anacostia River in 2000. The SMPDs take up dissolved but not particulate contaminants, while the clams accumulate both dissolved and particulate contaminants. PCB congeners, organochlorine pesticides, and PAHs were analyzed. Overall results suggest that constituent concentrations differed between the Northwest Branch and Northeast Branch, but that both locations tended to be elevated with respect to the Fort Foote reference stations. The magnitude and direction of the differences between the two branches varied between test type, with clams and SPMDs yielding conflicting results. Downstream sample locations were more uniform, likely due to mixing in the lower river. Median PCB, PAH, chlordane, and DDT concentrations in SPMDs in the lower river were elevated with respect to the Fort Foote reference locations.

4.2.5.2 Fish Tissue Concentrations and Physical Effects

Contaminants in fish tissue from the Anacostia River were analyzed in 2007 to support development of fish consumption advisories (Pinkney 2009). Collection efforts focused on species caught and consumed by anglers in the Anacostia and Potomac Rivers: American eel (*Anguilla rostrata*), bluegill (*Lepomis macrochirus*), pumpkinseed (*Lepomis gibbosus*), carp (*Cyprinus carpio*), channel catfish (*Ictalurus punctatus*), blue catfish (*Ictalurus furcatus*), and largemouth bass (*Micropterus salmoides*). Fish were collected using an electroshocking boat from two reaches in the Anacostia River (above and below the CSX Railroad bridge, respectively). Fish samples were also collected from two locations in the Potomac River (above and below the 14th street Bridge). All samples were fillets prepared for human

consumption (with or without skin, as the species was normally consumed); most samples were composites of several fish. Six samples were collected at each Anacostia River location, for a total of 12 samples.

Fish samples were analyzed for lipid and moisture content, metals, PAHs, organochlorine pesticides, total PCBs (including Aroclor analysis), 119 PCB congeners, and polybrominated diphenyl ethers (PBDE). The two measures of total PCBS yielded similar results; total PCBs measured as the sum of Aroclors were within 15 percent of totals calculated as the sum of the congeners (see Table 5 in Pinkney 2009).

Every fish sample analyzed exceeded the 0.02 ppm screening level for total PCBs. At least one sample exceeded human health screening levels for PCBs, DDTs, chlordane, dieldrin, heptachlor epoxide, hexachlorobenzene, PAHs, and mercury. Of these, total PCBs, total chlordane, total DDT, dieldrin, heptachlor epoxide, and total PAHs are considered to pose the greatest risk.

Temporal trends in fish tissue were evaluated qualitatively for PCBs and chlordane between 2000 and 2007; small sample size precluded formal statistical analysis. Median concentrations of both PCBs and chlordane increased in American eel, carp, and largemouth bass, but decreased in channel catfish. Concentrations in sunfish decreased slightly. Concentrations of PCBs and chlordane were generally higher in the Anacostia River than the Potomac River. In general, older fish tissue data are not reliably representative of current conditions (Pinkney 2009). DDOE conducts fish tissue studies about every five years to update the consumption advisories. Data collected in 2013 is currently under review and will be incorporated into the HHRA (see Section 8.0).

In a separate study focused on sediment adjacent to the Washington Navy Yard, fish tissue samples were reported to contain PCBs and arsenic concentrations above human health action levels (CH_2MHill 2011a).

4.2.5.3 Human Consumption of Contaminated Fish

The Anacostia Watershed Society and other local and federal partners conducted a year-long study (2011-2012) to determine to what extent people are catching, sharing and eating fish from the Anacostia River. Both the District of Columbia and Maryland advise the public to avoid eating certain fish species (for example, carp and channel catfish) and to limit consumption of other fish species to prevent long-term health effects. The interviews revealed that anglers and other community members have limited knowledge of the consumption advisories and poor understanding of the health risks associated with eating Anacostia River fish. People generally believe that they can tell whether a fish is harmful by looking at external signs. Anglers routinely share their catch with people who would otherwise not have sufficient protein to eat. People who receive fish from anglers are often unaware of the location of the catch. The study concluded that anglers and others either are not receiving or not heeding the available consumption advisory information (OpinionWorks 2012). Additionally, the *Washington City Paper* reported that freshwater turtles were being collected in the Anacostia River for human consumption (Shin 2000). (Shin 2000). No data on contaminants in turtle tissues from the study Area are available. However, turtles are known to accumulate contaminants and consumption advisories include turtles in other U.S. watersheds (EPA 2000).

4.2.5.4 Tumors in Fish

The FWS surveyed the prevalence of skin and liver tumors in brown bullhead (*Ameiurus nebulosus*) in the Anacostia River in 2009, 2010, and 2011 (Pinkney et al. 2013). Liver tumors typically are associated with exposure to PAHs, although the causal agent of lip tumors is less certain. The occurrence of tumors on brown bullhead in the Anacostia River was first documented by FWS in 1996; subsequent research provided extensive supporting evidence that the tumors were strongly correlated with exposure to PAHs in sediment. The incidence of lip and liver tumors in Anacostia River brown bullheads has decreased since 1996, but is still significantly higher than in largely rural "reference" areas of the Chesapeake Bay. Surveys from 2009 to 2011 indicated that 42 percent of brown bullhead females and 14 percent of brown bullhead males had liver tumors. Brown bullheads remain in a relatively small area (linear home range of 0.6-2.1 km [Sakaris et al. 2005]) and are closely associated with sediment; these traits suggest that contaminants in Anacostia River sediments may contribute to development of liver tumors (Pinkney et al. 2013).

4.2.5.5 Benthic Invertebrate Bioassay and Index of Biotic Integrity

A series of 20 sediment locations collected in 2000 as part of the Velinsky et al. (2001) sediment study were evaluated using a sediment triad approach comprised of chemical analysis, direct toxicity tests, and measures of benthic community health (McGee et al. 2009; McGee and Pinkney 2002). Sample locations were distributed from Bladensburg down to the confluence with the Potomac River, excluding the Washington Channel. Physical and chemical analyses included grain size, TOC content, trace metals (aluminum, cadmium, chromium, copper, iron, mercury, nickel, lead, silver, and zinc), 81 PCB congeners or groups of congeners, select organochlorine pesticides, and PAHs. A 10-day survival and growth test using *Hyalella azteca* (an amphipod) and *Chironomus dilutus* (a midge) measured direct toxicity of surficial sediment (top 3 to 4 cm). None of the sediment samples affected survival and only one sample adversely affected growth. Benthic community health was described using the Benthic Index of Biotic Integrity (B-IBI).

The study did not demonstrate any clear relationship between benthic community health and contaminant concentrations. Overall levels of contaminants, measured as the mean probable effect concentration (PEC) quotient, were highest near the O Street CSS outfall, decreasing both downstream and upstream of this point. The PEC quotient was not significantly correlated with any measure of benthic community health or toxicity. About 40 percent of the sample locations were considered "degraded," indicated by an B-IBI of less than 3. Both the amphipod and the midge exposed to this sample showed inhibited growth; in addition, contaminant levels were high, and measures of benthic community health were low. Subsequent analyses using toxicity identification evaluation suggested that the adverse impacts may have been caused by organic compounds (McGee et al. 2009). To the extent practicable, the results of this study will be incorporated into the RI to reflect representative conditions in 2000.

4.2.6 Bathymetric Data

Bathymetric data characterizes the spatial variation of the sediment surface also referred to as the "mud line." To support this investigation, Tetra Tech conducted a bathymetric survey during September and October, 2013 (Appendix A).

Prior to Tetra Tech bathymetric survey, the existing bathymetric data for the tidal Anacostia River were limited the river reach extending from approximately the downstream limit of the Southeast Federal Center to the 11th Street Bridge (approximately 80 percent of Reach R2 [**Figure 4.1**]). The Washington Navy Yard and the O Street Outfall investigations conducted prior to the placement of the experimental active sediment caps (described in **Section 2.6**) both included a bathymetric survey of all or a portion of this reach. The O Street Outfall survey was limited to the immediate vicinity of the outfall while the Navy Yard survey encompassed the entire area. Bathymetric data were unavailable for either the Washington Channel or other portions of the tidal Anacostia River.

4.2.7 Data Gap Assessment for Environmental Media

The review of existing information in the literature and databases led to the identification of several data gaps to be filled before or during the RI and NRDA processes. At this time, data gaps exist in the following three general areas:

- Bathymetric and utility survey data, (completed in 2013 and 2014, respectively)
- Collection of sediment, pore water, and surface water samples for chemical and physical property tests, and
- Collection of biological samples for risk assessment and NRDA purposes.

These data needs are described in the following subsections along with the rationale and priority for acquisition.

4.2.7.1 Bathymetric Survey Data

With the exception of the Washington Navy Yard and the adjacent pilot test for the active capping site near the O Street Outfall, existing river bottom elevation data at the start of the RI were inadequate with regard to accuracy and coverage. A bathymetric survey of the river bottom was conducted in September and October, 2013 to locate the sediment sample locations both horizontally and vertically with relation to the river. A report discussing the bathymetric survey results is included as Appendix A. Survey information was used to establish riverbed topography and sample elevations in relation to the waterway and the project vertical datum and to complete a geomorphic analysis to assist in the finalization of sediment sampling locations. The geomorphic analysis is summarized in Appendix B. The accurate bathymetry allowed more objective delineation of areas of deposition and erosion and enabled the definition of specific geomorphic units. The initial sample locations (defined in the January 29, 2014 version of the WP) were revised to ensure that all units were represented by sampling without over or under sampling any one unit. With regard to the FS, the bathymetric survey data will be used to support the development of potential remedial alternatives (estimation of dredging and capping quantities) and evaluate logistical options with regard to site access.

4.2.7.2 Collection of Sediment, Pore Water, and Surface Water Samples

As discussed in **Section 2**, previous sediment sampling events on the Anacostia River have ranged from comprehensive campaigns encompassing the entire estuary to smaller, targeted efforts at discrete areas within the tidal footprint. Discrete sampling has generally been performed in conjunction with investigations at the environmental cleanup sites that border the river.

The most comprehensive sampling effort in the river was the 2000 ANS sampling event. ANS primarily sampled the river in transects from the mouth at the Potomac River to the upper tidal limit north of the DC, Maryland border. Selection of transect locations does not appear to have been based on any site specific conditions, such as potential source areas or areas of likely sediment deposition. ANS collected surface sediments with a petit Ponar grab sampler. Samples were composited from several grabs at each location from the top 3 to 4 cm of sediment.

For the sites where previous environmental investigations have been completed, the existing characterization data ranges from extensive at sites undergoing active cleanup (e.g., the Washington Navy Yard and CSX Benning Yard) to sites with limited (Pepco Benning Road) or minimal data (Poplar Point). At some data-limited sites such as Pepco Benning Road, investigations are ongoing at the date of this WP. Reduced sampling will occur near the environmental cleanup sites where extensive sediment characterization sampling exists or will be performed to minimize duplication of effort and cost while providing complimentary data.

Regulatory involvement at the environmental sites will help to foster an appropriate level of sediment investigation coordination at each site so that the objectives of this WP are achieved. It should be noted that the lead regulatory agency (e.g., U.S. EPA Region 3, NPS, etc.) and DDOE's regulatory role may vary by site. At the Washington Navy Yard and CSX sites, the sites most advanced with respect to characterization, the characterization completed to date appears generally consistent with the objectives for this investigation. Both sites, however, require additional review with regard to potential remaining data gaps. The planned investigation at the Pepco site appears to be congruent with this WP. Although the broad objectives of the WGL East Station OU2 RI/FS include the characterization of sediments in the adjacent Anacostia River, specific details regarding the extent of this investigation are under discussion. Information regarding planned sediment investigations is currently unavailable for the Kenilworth Park Landfill and Poplar Point. For this WP, sampling locations are defined within the river segments adjacent to the WGL and the Kenilworth Park landfill sites. These sample locations, however, will be adjusted if WGL or NPS (oversight authority for the Kenilworth Park Landfill) finalize the respective work plans for these sites prior to the commencement of field work for this WP.

Although the existing post-2000 sediment characterization data set is invaluable with regard to estimating the current nature and extent of contamination, additional samples need to be collected throughout the project area to achieve the DQOs within most river reaches. Outside the third-party-investigated environmental cleanup sites, there are substantially fewer data points. The focus of the sample design in this work plan is this larger portion of the river.

Surface Sediment. Current assessments of depth-based variations in constituent concentrations, essentially limited to the Washington Navy Yard (CH2M Hill 2011a), indicate the absence of specific trends for most constituents. The absence of a trend suggests that, outside of random variation between surface versus shallow subsurface concentrations, no systematic increase or decrease was observed. Surface sediment samples will be collected from a percentage of the ANS locations to verify that the results from that 2000 sampling effort are generally representative of current conditions. As discussed in the data usability section, the ANS 2000 data is a key component of the current site

database; should the sampling results for the planned effort show a poor correlation to the ANS 2000 data and the existence of a consistent trend between the two sample horizons, an additional surface sediment sampling phase will be necessary. Selection of the ANS re-sample points (approximately 20 percent of the new sample locations) will be spread within the project area to achieve adequate spatial coverage, and biased toward likely sediment deposition areas, as identified from the bathymetric survey results. New surface sediment sampling locations will be sited near contaminant source areas, primarily the MS4 outfalls, CSS outfalls, and tributaries. Surface sediment sampling will also be conducted to improve overall spatial coverage, particularly in Washington Channel and Kingman Lake, and will focus on depositional areas. In addition, a portion of the surface sediment samples will be tested under laboratory conditions for direct toxicity to benthic invertebrates (either amphipod or midge) as described in **Section 5.2**.

Subsurface Sediment. As discussed in **Section 4.2.2**, subsurface sediment data are limited to the near shore areas adjacent to the Washington Navy Yard and the Fort Dupont Creek outfall downstream from CSX Benning Yard. To address this major data gap, subsurface sampling will be performed at most surface sediment samples throughout the study area.

Sediment Pore Water. Sediment pore water data was generally not collected in any of the investigations which served as data sources for the project database. Pore water data is necessary for assessing the general condition of the benthic habitat and provides a more direct measure of contaminant bioavailability. Pore water data is thus an important input to both the ERA and NRDA. In addition, pore water data will be used to assess potential zones of groundwater influx and to support remedy assessment in the FS, particularly with regard to the consideration of geochemical conditions in the evaluation of sediment capping options.

Surface Water. Few surface water samples have been collected and analyzed in the tidal Anacostia River. Surface water samples will be collected to support the evaluation of direct contact and ingestion in the HHRA and as a component of daily dose to ecological receptors in the BERA. The surface water data will also support the calibration and validation of an updated surface water quality model for the river.

4.2.7.3 Biological Sample Collection

Targeted collection of invertebrates, fish, and turtles from the tidal Anacostia River will support the ERA, HHRA, and NRDA. The only available data on body burdens (tissue concentrations) in biota are fish fillets collected to support fish consumption advisories (Pinckney 2009) and to evaluate contamination at Washington Navy Yard (CH2M Hill 2011a). Fish sampling will be coordinated to address the data needs of all three investigations (ERA, HHRA, and NRDA) to the extent possible. Fish fillets of the species and sizes allowable under angling regulations were collected under a separate DDOE effort in 2013; those data will be used to evaluate exposure in the HHRA. Whole fish of species and sizes representative of food sources for birds and mammals will be sampled for the ERA to support food chain analyses. All fish data will be used in the NRDA. Benthic and epibenthic invertebrates will also be collected from numerous locations in the Anacostia River, principally to support the ERA and NRDA. The body burden of benthic and epibenthic invertebrates is an important line of evidence in the ERA for three reasons: (1)

invertebrates are key components of the ecological food web; (2) they are directly exposed to both sediment and water; and (3) they are known to bioaccumulate contaminants. If available, turtle and crayfish tissue concentrations will also be evaluated in the HHRA. As discussed in **Section 5.2**, a large number of sample locations is required to achieve adequate spatial coverage of the project area.

4.2.7.4 Sediment Geotechnical Properties

Insufficient data regarding the engineering properties of the sediment are currently available. Geotechnical data are necessary in the evaluation of remedial alternatives analysis and design. The data will be used to determine the range of equipment and the capacity of the sediments to support such equipment. Specific analysis parameters will include Atterberg limits, percent solids, and specific gravity. Additional engineering property tests, such as in-situ shear strength, laboratory consolidation, column settling, or column consolidation may also be required during later project phases.

4.3 Sources, Pathways, and Source Control

The sampling and other characterization activities discussed in this plan will focus on closing data gaps identified regarding contaminant sources, migration pathways, and source control. Potential sources addressed by the investigation are discussed in **Section 4.3.1**. Source control efforts and remaining data gaps are discussed in **Sections 4.3.2** and **4.3.3**.

4.3.1 Potential Sources

As noted in the CSM discussion in Section 3, the most significant potentially ongoing sources of sediment contamination to the tidal Anacostia River are the environmental sites, CSS outfalls, MS4 outfallss, and tributaries which collectively deliver dissolved PCBs, PAHs, pesticides, metals and suspended sediments laden with these contaminants and pathogenic bacteria. In addition, these constituents in surface water in both total and dissolved phases are hazardous to biota, human ingestion, and human contact.

4.3.2 Institutional and Source Control Efforts

Institutional control efforts include the imposition of an advisory for human consumption of fish from the Anacostia River. The source control efforts that have so far been implemented include localized hydraulic control of contaminated groundwater discharge and the DC Water Capitol project directed at curbing CSS outfall discharges.

An institutional control that has been in place since 1989 is the issuance of a fish consumption advisory. The advisory was issued in response to observed levels of PCB and chlordane that exceeded Food and Drug Administration action levels. Through signage, web-postings, and other means, the District government conducts an active campaign to warn anglers of the hazards of consuming fish from the river. However, frequently, the warnings are unheeded by the general population.

The characterization of the nature and extent of contaminated groundwater is underway or in the planning phase for many of the environmental cleanup sites that border the river and, in some cases, groundwater source control measures have been implemented. A groundwater pump and treat system has been operating since 1976 and dense nonaqueous phase liquid (DNAPL) recovery has been occurring at the WGL East Station since 1995. In addition, groundwater pump and treat remediation and NAPL

recovery was conducted at the former Steuart Petroleum Company facility located on the western shoreline of the Anacostia River adjacent to South Capitol Street Bridge. Depending on the results of planned or ongoing investigations at the Washington Navy Yard and the other sites along the river, additional groundwater remediation operations may be conducted.

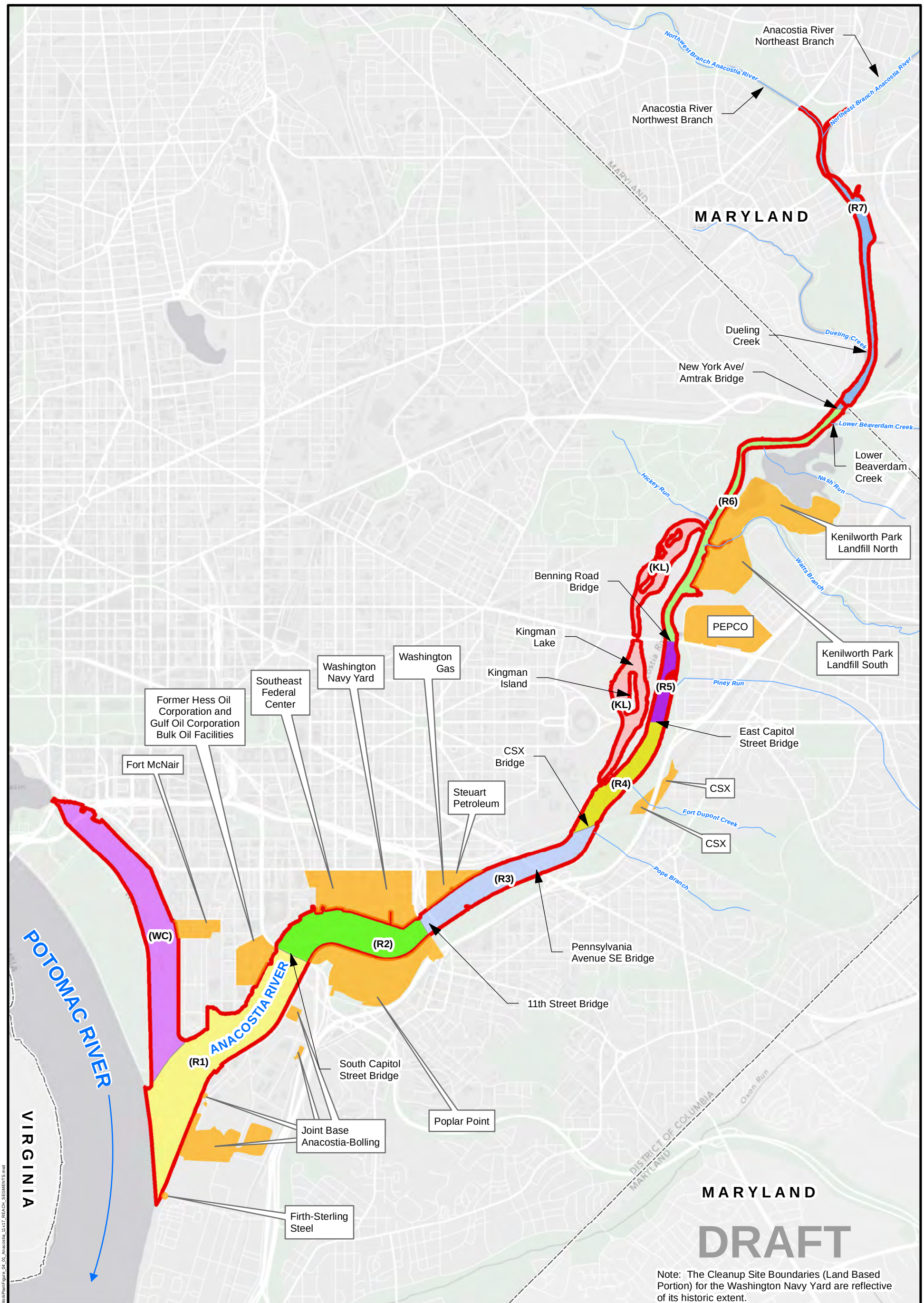
An additional source control effort is the ongoing DC Water project to minimize CSS outfall discharges through the containment and treatment of storm water flows. As a result of inadequate storm water and sewage system infrastructure, CSS outfall discharges have been sources of contamination to the river for decades. As noted in **Section 3.1.2.2**, in accordance with a 2004 consent decree between EPA and DC Water, DC Water has developed the Long Term Control Plan for addressing CSS outfall discharges. As part of this plan, DC Water initiated construction in 2011 on a tunnel and pumping system that will substantially reduce CSS outfall discharges by collecting and storing excess storm water flows for treatment at the Blue Plains facility (DC Water 2012).

4.3.3 Data Gap Assessment for Contaminant Sources

Data gaps exist regarding sources, pathways, and source control, as discussed previously. Data gaps associated with tissue concentrations in invertebrates and fish were discussed previously (**Section 4.2.5**). Data gaps regarding the potentially significant sources of groundwater contamination will be addressed through the investigation and remediation of the environmental cleanup sites. With regard to sources of contaminated sediment and surface water, a major focus of the sampling planned for the RI will be to characterize the potential contributions from the various outfalls and tributaries.

4.4 Define Sediment Management Areas

Based on preliminary analysis of the physical site conditions and waterway setting, sediment management during the RI will be defined for the river reaches as shown in **Figure 4.1**. The reaches are defined on a preliminary basis consistent with observations regarding site geography; final sediment area designations will be based on further evaluation and discussion with DDOE. The reaches are defined consistent with the study area subdivisions presented in **Section 4.2**.



Note: The Cleanup Site Boundaries (Land Based Portion) for the Washington Navy Yard are reflective of its historic extent.

Legend

- SEDIMENT STUDY AREA
- CLEANUP SITE BOUNDARY (LAND BASED PORTION)
- WASHINGTON DC BOUNDARY

RIVER REACH

- WASHINGTON CHANNEL
- (R1) - S. CAPITOL ST BRIDGE TO MOUTH OF RIVER
- (R2) - 11TH ST. BRIDGE TO S. CAPITOL ST BRIDGE
- (R3) - CSX BRIDGE TO 11TH ST. BRIDGE
- (R4) - E. CAPITOL ST BRIDGE TO CSX BRIDGE
- (R5) - BENNING RD. BRIDGE TO E. CAPITOL ST BRIDGE
- (R6) - AMTRAK BRIDGE TO BENNING RD. BRIDGE
- (R7) - UPPER TIDAL LIMIT TO AMTRAK BRIDGE
- KINGMAN LAKE

N W E S

0 1,500 3,000 Feet

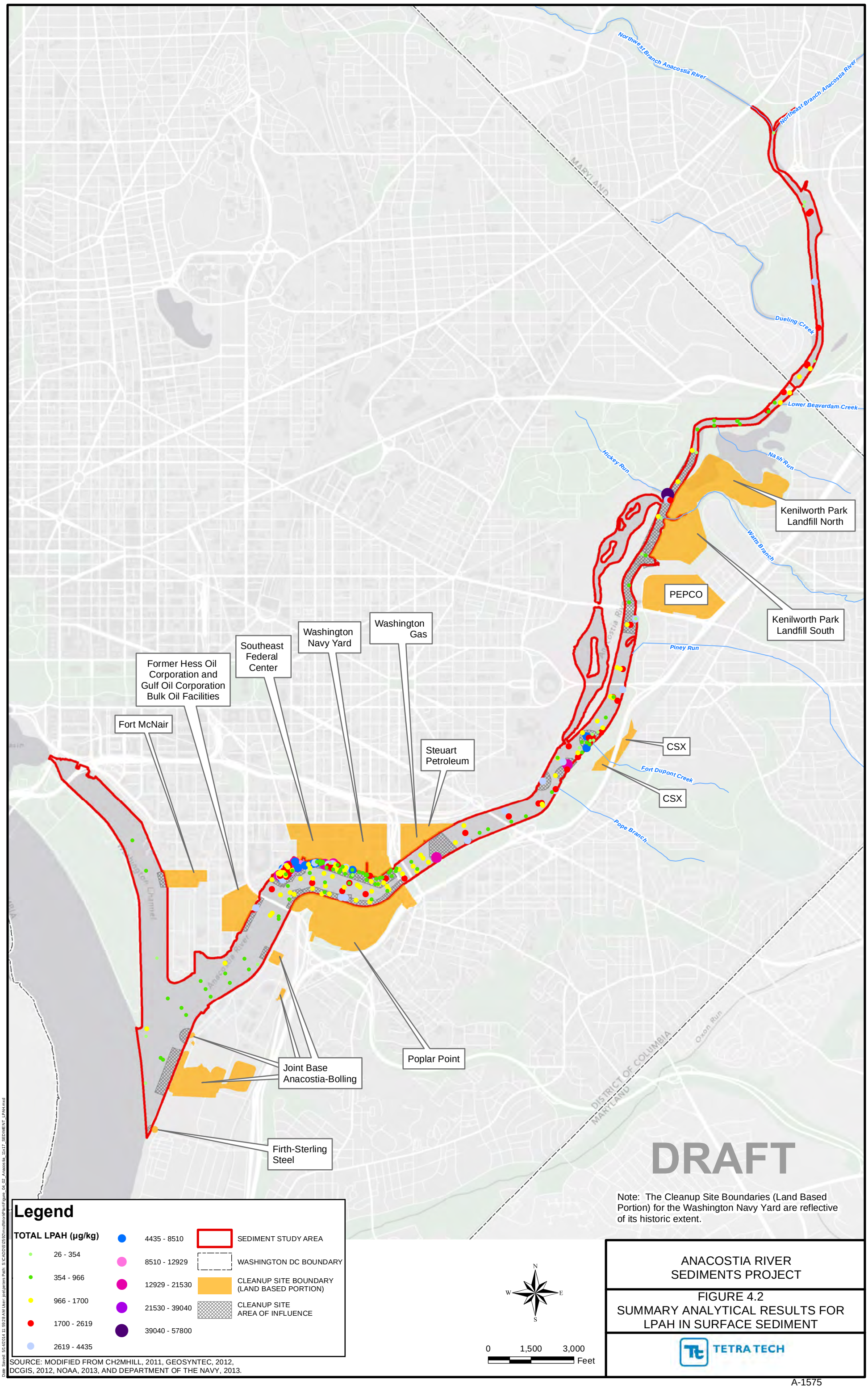
SOURCE: MODIFIED FROM DCGIS, 2012.

ANACOSTIA RIVER SEDIMENTS PROJECT

FIGURE 4.1
LOCATIONS OF RIVER REACHES

TETRA TECH

Date Saved: 9/14/2014 1:20:06 PM User: joel.peters Path: S:\CADD\S\259\2\mxd\WorkPlan\Figure_04_01_Anacostia_11x17_REACH_SEGMENTS.mxd



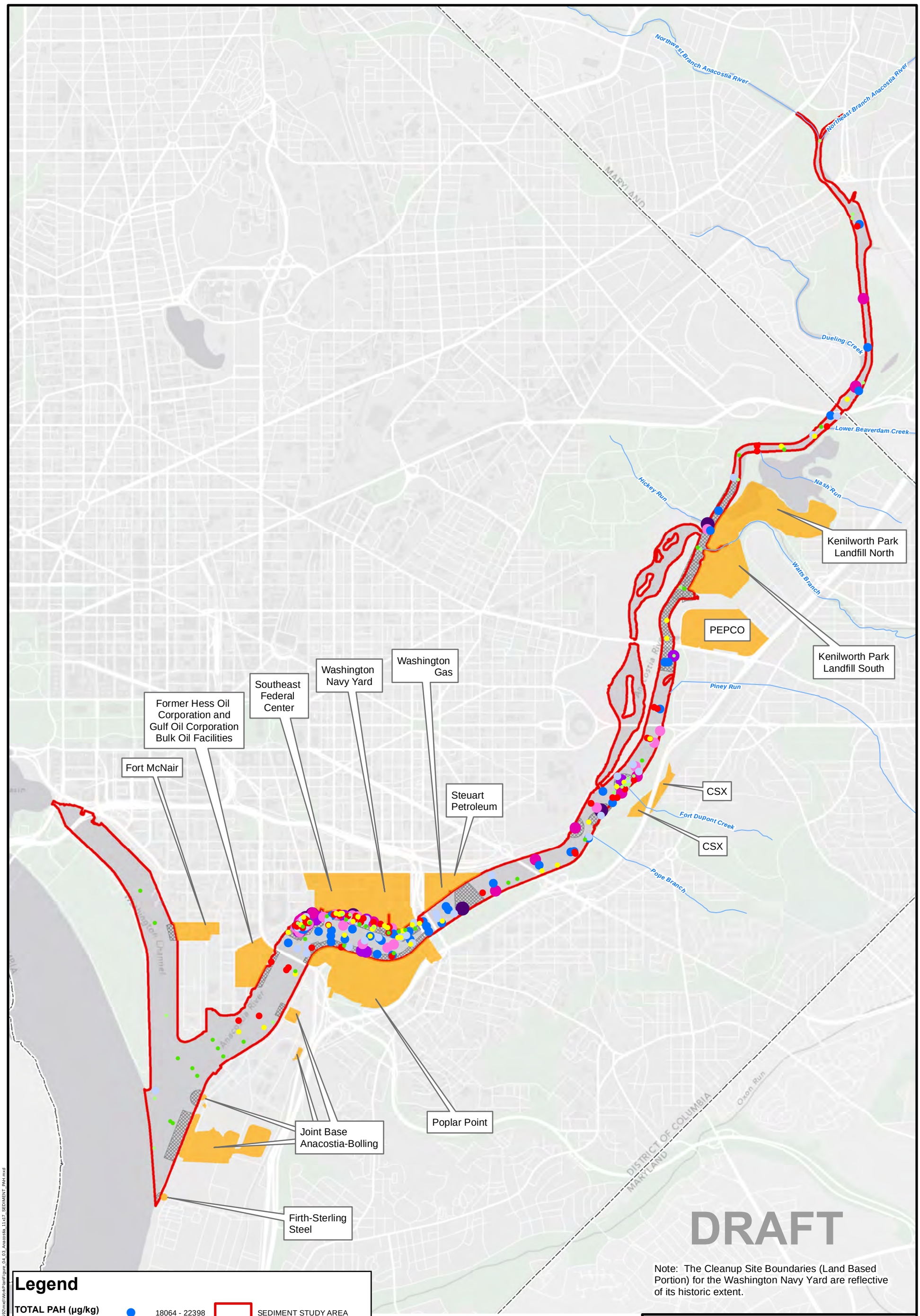
SOURCE: MODIFIED FROM CH2MHILL, 2011, GEOSYNTEC, 2012, DCGIS, 2012, NOAA, 2013, AND DEPARTMENT OF THE NAVY, 2013.

ANACOSTIA RIVER SEDIMENTS PROJECT

FIGURE 4.2
SUMMARY ANALYTICAL RESULTS FOR LPAH IN SURFACE SEDIMENT

TETRA TECH

Date Saved: 5/14/2014 11:59:28 AM User: jpelperters Path: S:\CADD\S\2529\mxd\Work\Plan\Figure_04_02_Anacostia_11x17_SEDIMENT_LPAH.mxd



SOURCE: MODIFIED FROM CH2MHILL, 2011, GEOSYNTEC, 2012, DCGIS, 2012, NOAA, 2013, AND DEPARTMENT OF THE NAVY, 2013.

ANACOSTIA RIVER SEDIMENTS PROJECT

FIGURE 4.3
SUMMARY ANALYTICAL RESULTS FOR TOTAL PAH IN SURFACE SEDIMENT

TETRA TECH

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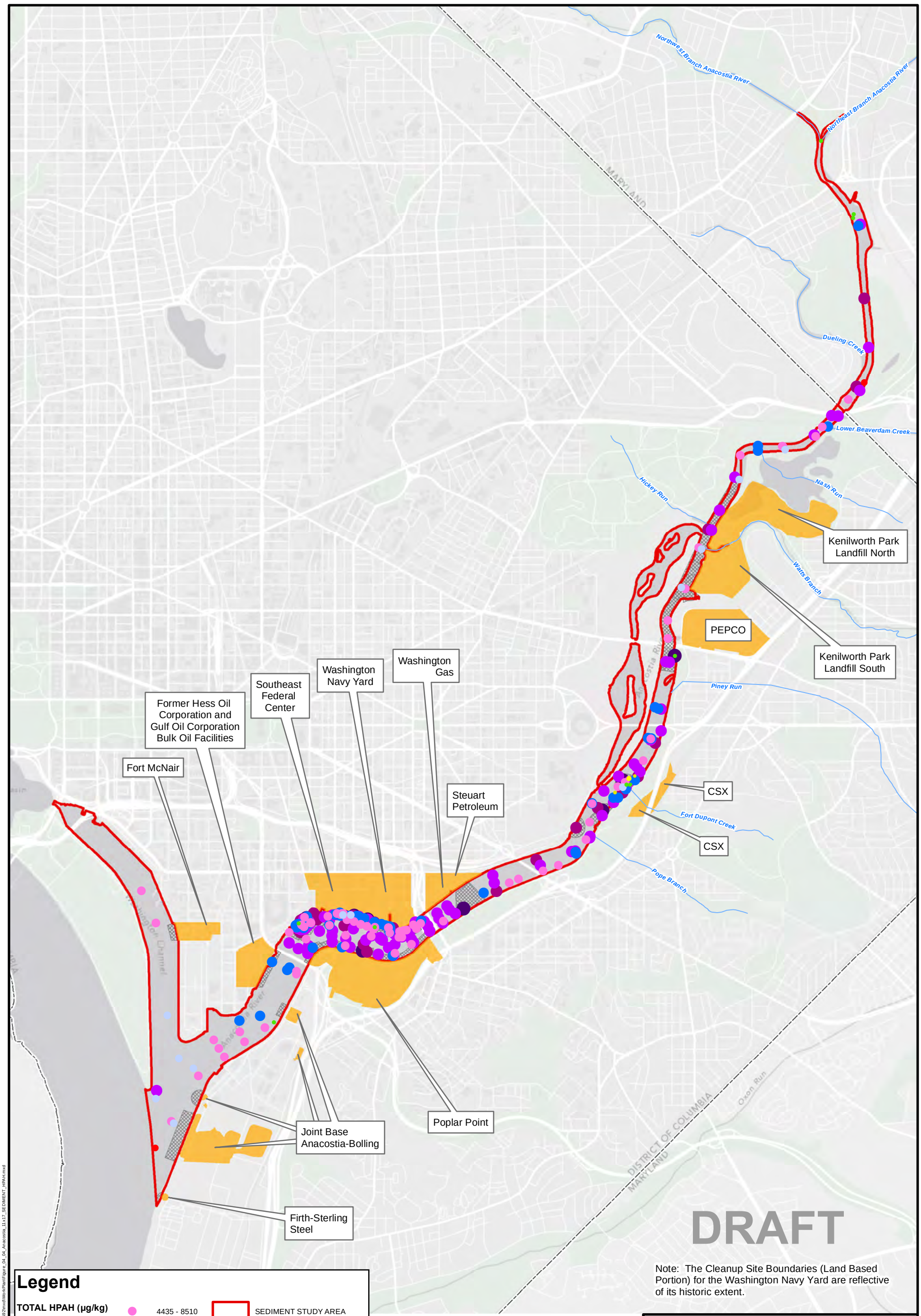

Note: The Cleanup Site Boundaries (Land Based Portion) for the Washington Navy Yard are reflective of its historic extent.

SOURCE: MODIFIED FROM CH2MHILL, 2011, GEOSYNTEC, 2012, DCGIS, 2012, NOAA, 2013, AND DEPARTMENT OF THE NAVY, 2013.

ANACOSTIA RIVER SEDIMENTS PROJECT

FIGURE 4.4
SUMMARY ANALYTICAL RESULTS FOR HPAH IN SURFACE SEDIMENT

TETRA TECH

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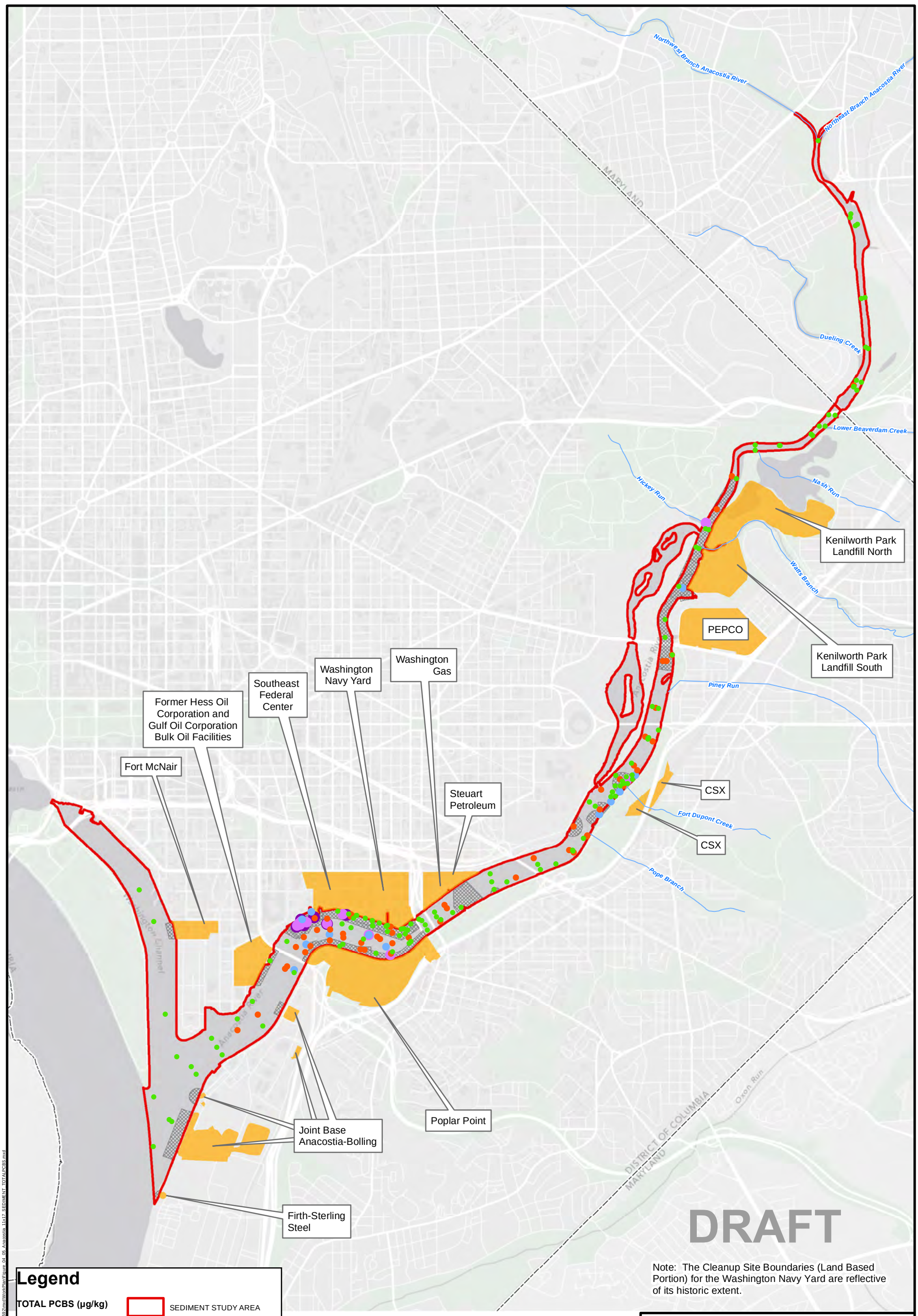
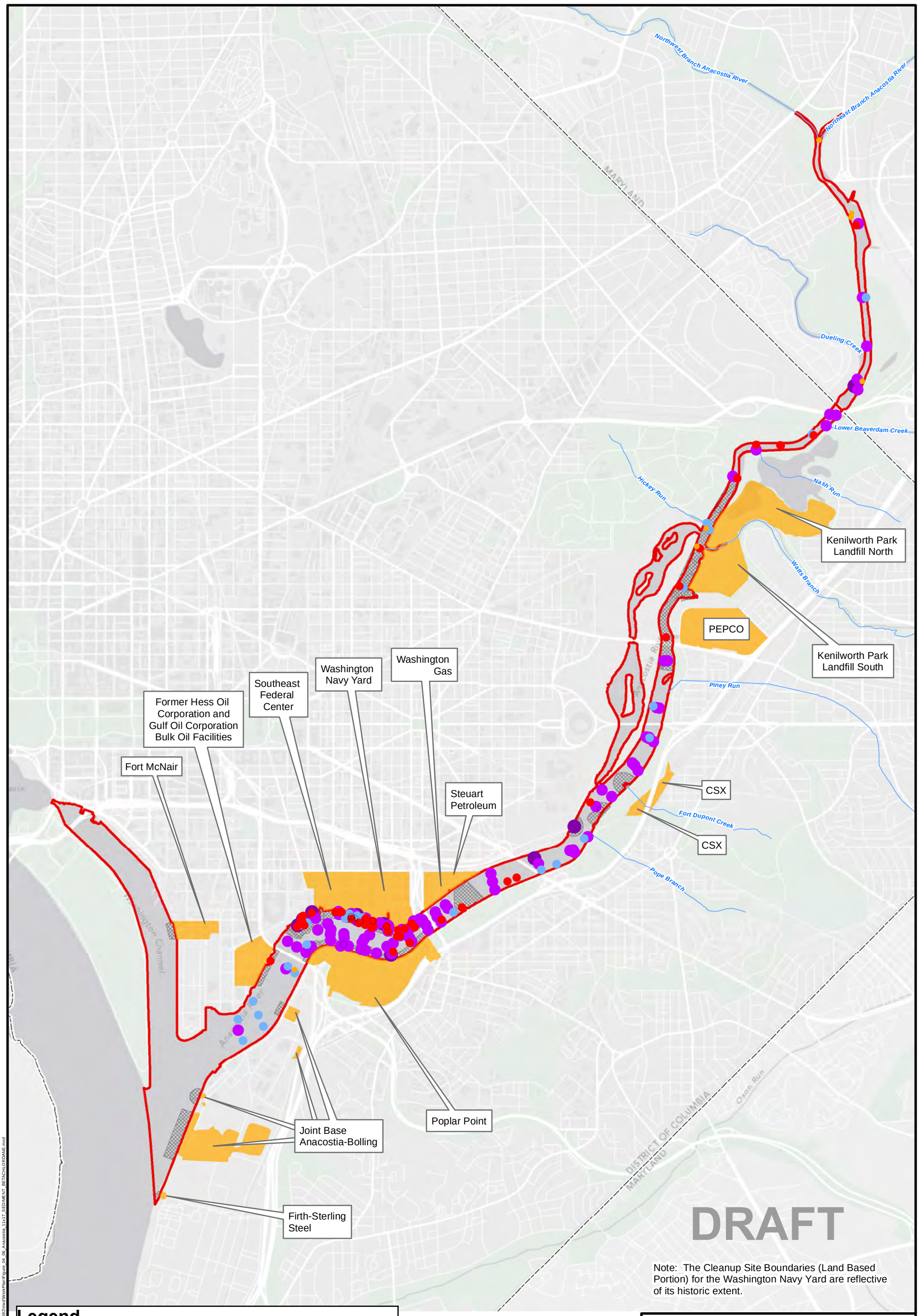


SOURCE: MODIFIED FROM CH2MHILL, 2011, GEOSYNTEC, 2012, DCGIS, 2012, NOAA, 2013, AND DEPARTMENT OF THE NAVY, 2013.

ANACOSTIA RIVER SEDIMENTS PROJECT

FIGURE 4.5
SUMMARY ANALYTICAL RESULTS FOR TOTAL PCBS IN SURFACE SEDIMENT

TETRA TECH



Legend

NON-DETECT

CHLORDANE, BETA- (µg/kg)

- 0.170 - 0.179
- 0.179 - 3.24
- 3.24 - 10.00
- 10.00 - 15.00
- 15.00 - 30.91
- 30.91 - 66.12

SEDIMENT STUDY AREA

WASHINGTON DC BOUNDARY

CLEANUP SITE BOUNDARY (LAND BASED PORTION)

CLEANUP SITE AREA OF INFLUENCE

N W E S

0 1,500 3,000 Feet

SOURCE: MODIFIED FROM CH2MHILL, 2011, GEOSYNTEC, 2012, DCGIS, 2012, NOAA, 2013, AND DEPARTMENT OF THE NAVY, 2013.

ANACOSTIA RIVER SEDIMENTS PROJECT

FIGURE 4.6
SUMMARY ANALYTICAL RESULTS FOR BETA CHLORDANE IN SURFACE SEDIMENT

TETRA TECH

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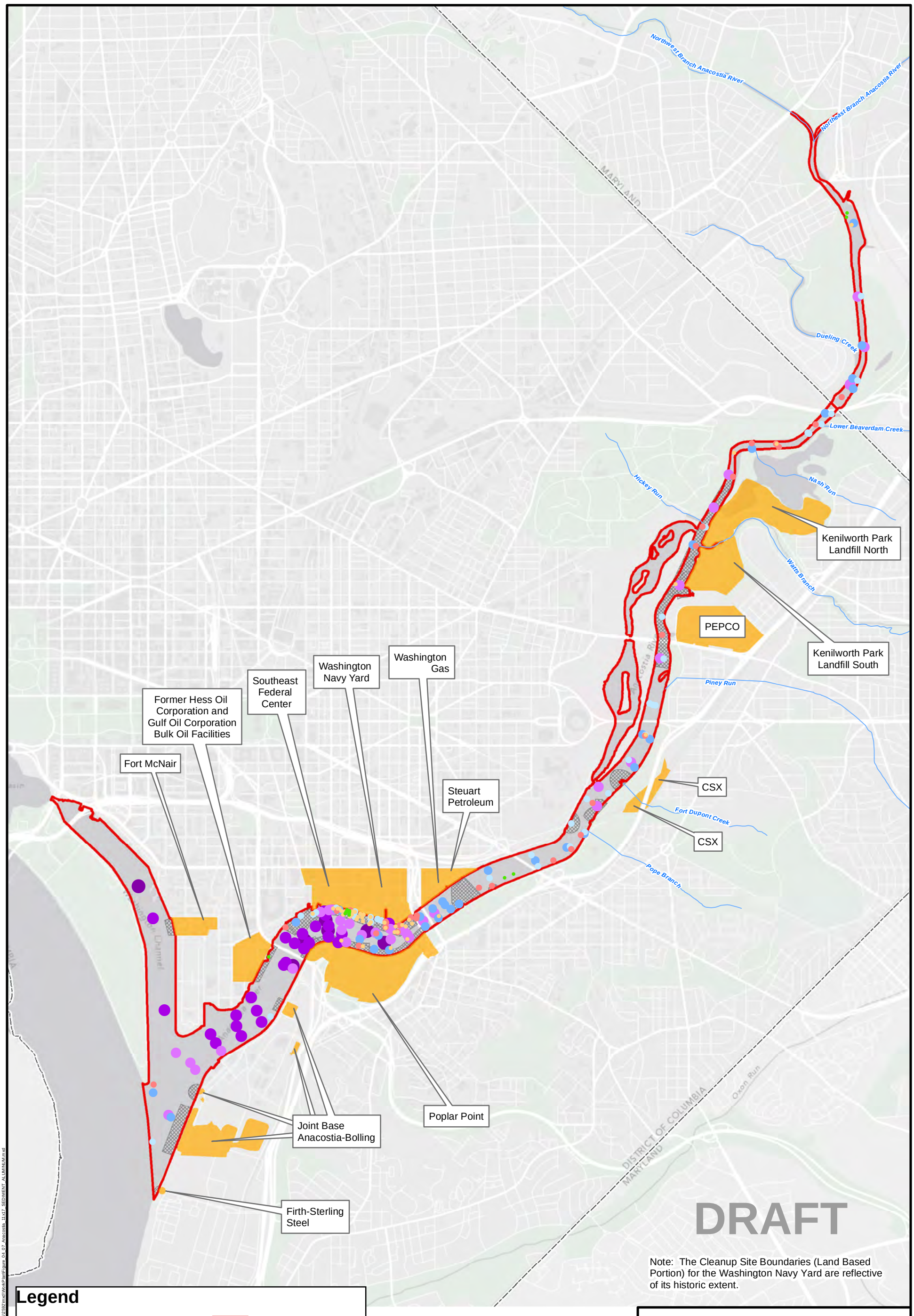


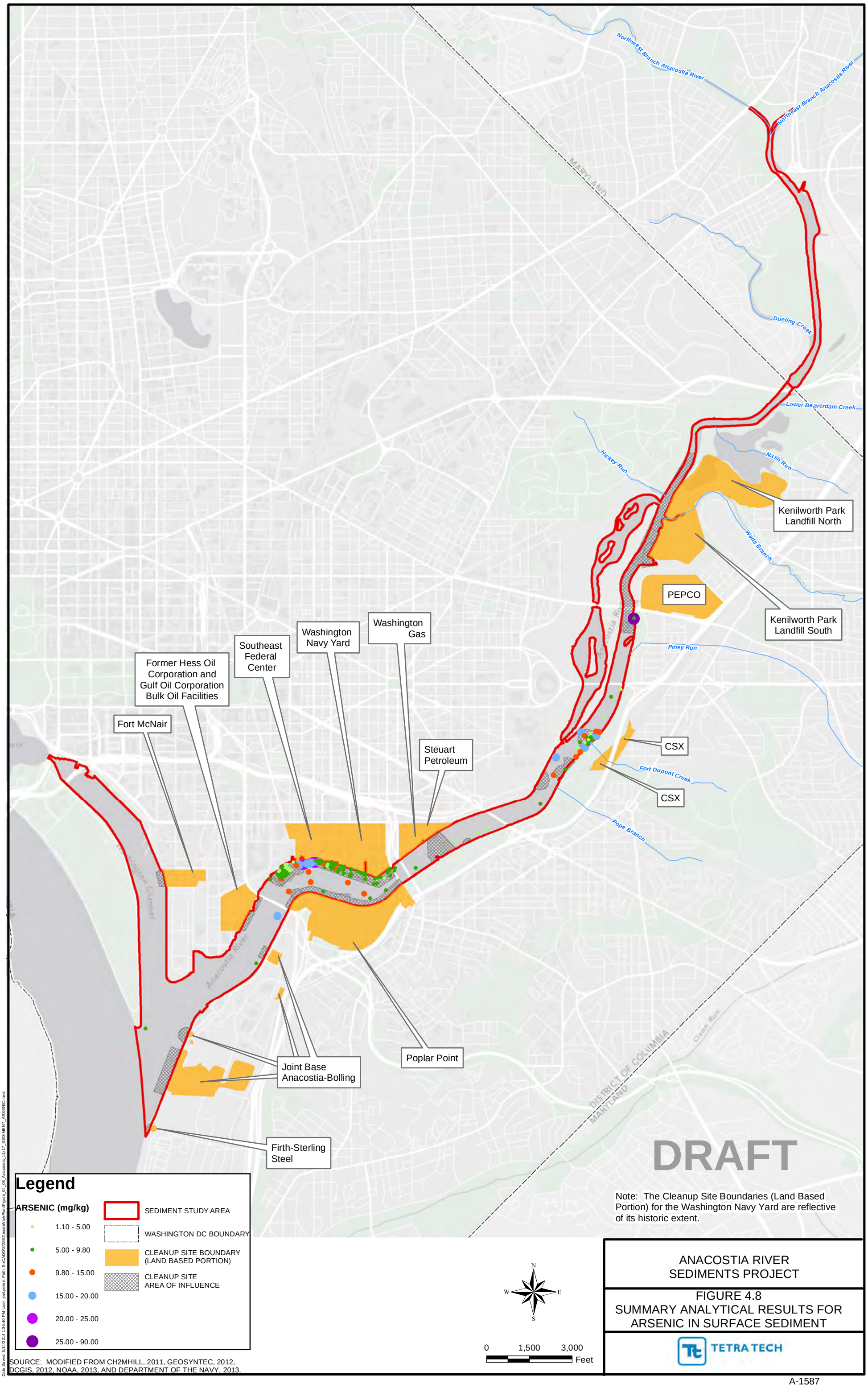
SOURCE: MODIFIED FROM CH2MHILL, 2011, GEOSYNTEC, 2012, DCGIS, 2012, NOAA, 2013, AND DEPARTMENT OF THE NAVY, 2013.

ANACOSTIA RIVER SEDIMENTS PROJECT

FIGURE 4.7
SUMMARY ANALYTICAL RESULTS FOR ALUMINUM IN SURFACE SEDIMENT

TETRA TECH

Date Saved: 5/14/2014 1:35:24 PM User: petersPath: S:\CADD\S2592\mxd\WorkPlan\Figure_04_07_Anacostia_11x17_SEDIMENT_ALUMINUM.mxd



Note: The Cleanup Site Boundaries (Land Based Portion) for the Washington Navy Yard are reflective of its historic extent.

SOURCE: MODIFIED FROM CH2MHILL, 2011, GEOSYNTEC, 2012, DCGIS, 2012, NOAA, 2013, AND DEPARTMENT OF THE NAVY, 2013.

ANACOSTIA RIVER SEDIMENTS PROJECT

FIGURE 4.8
SUMMARY ANALYTICAL RESULTS FOR ARSENIC IN SURFACE SEDIMENT

TETRA TECH

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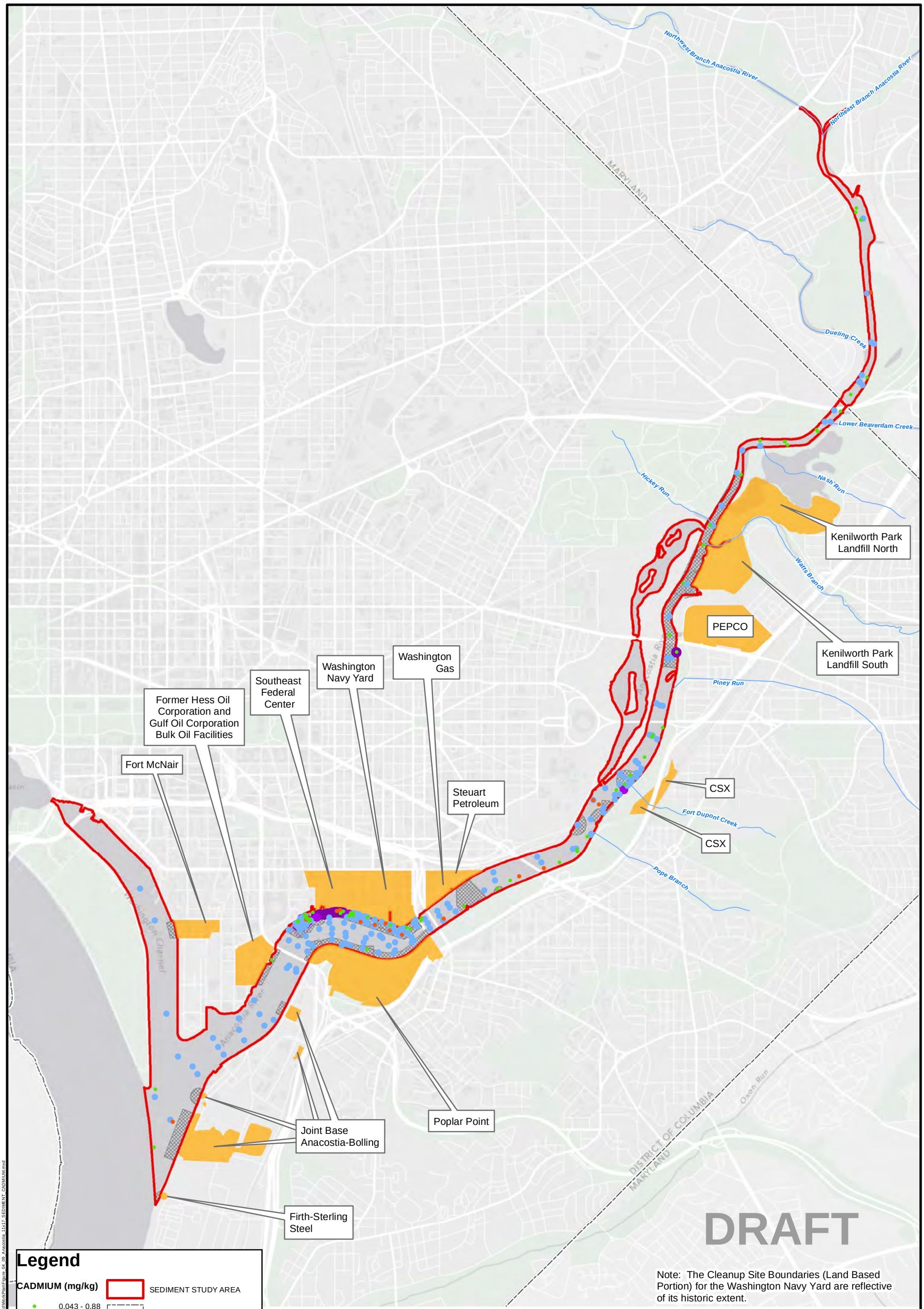

SOURCE: MODIFIED FROM CH2MHILL, 2011, GEOSYNTEC, 2012, DCGIS, 2012, NOAA, 2013, AND DEPARTMENT OF THE NAVY, 2013.

ANACOSTIA RIVER SEDIMENTS PROJECT

FIGURE 4.9
SUMMARY ANALYTICAL RESULTS FOR CADMIUM IN SURFACE SEDIMENT

TETRA TECH

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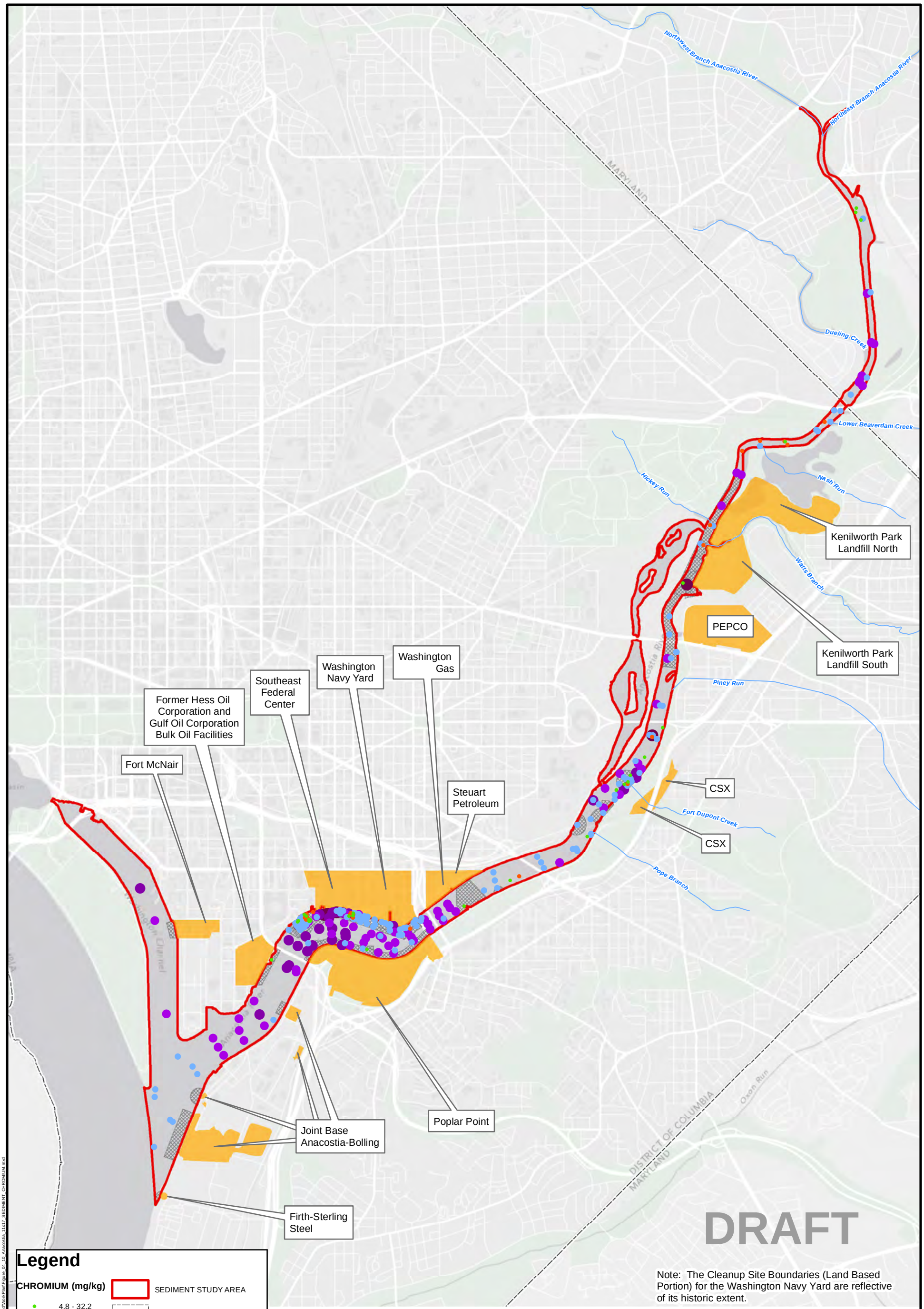


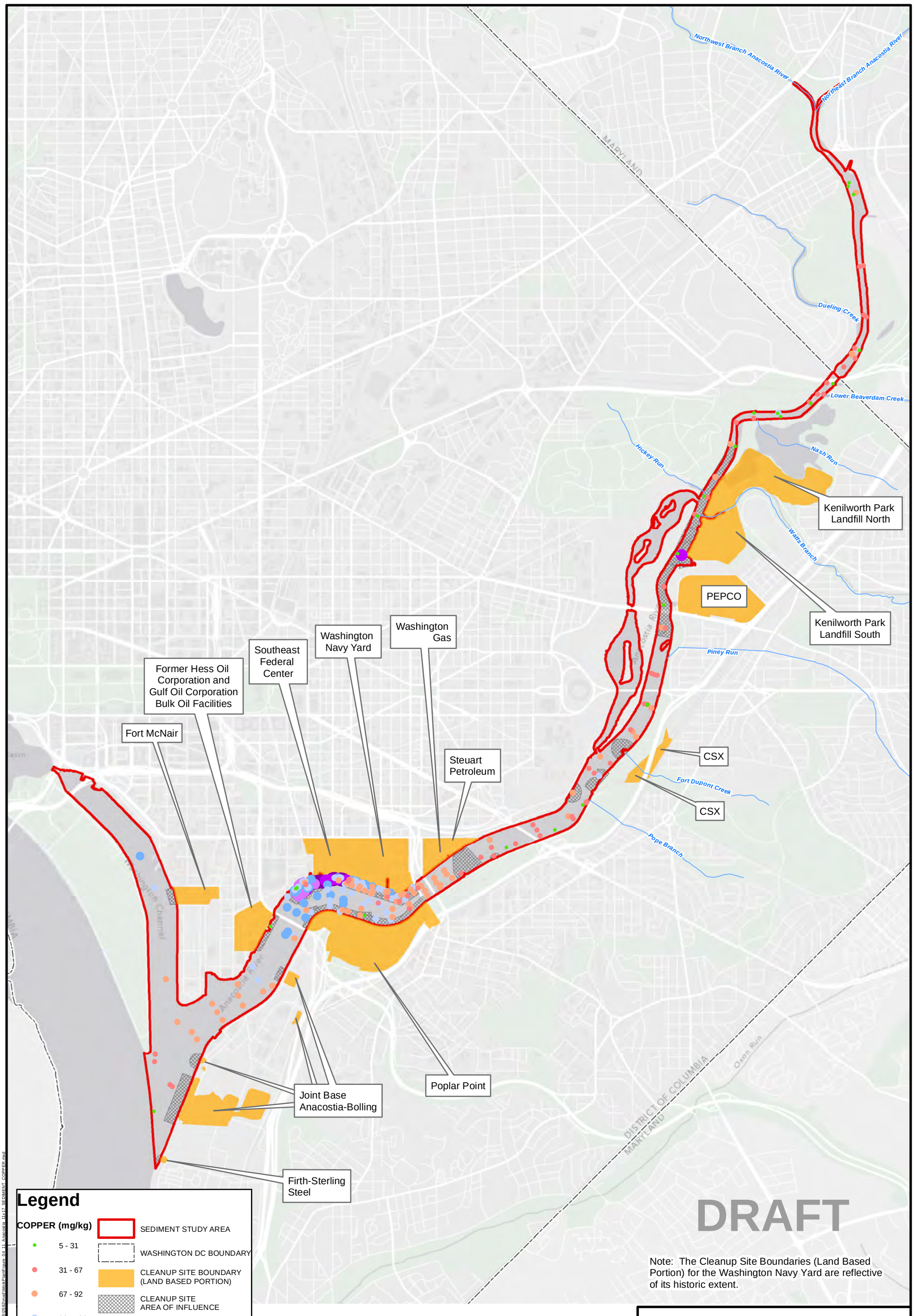
SOURCE: MODIFIED FROM CH2MHILL, 2011, GEOSYNTEC, 2012, DCGIS, 2012, NOAA, 2013, AND DEPARTMENT OF THE NAVY, 2013.

ANACOSTIA RIVER SEDIMENTS PROJECT

FIGURE 4.10
SUMMARY ANALYTICAL RESULTS FOR CHROMIUM IN SURFACE SEDIMENT

TETRA TECH

Date Saved: 5/14/2014 1:39:05 PM User: joel.peters Path: S:\CADD\S\259\2\mxd\WorkPlan\Figure_04_10_Anacostia_11x17_SEDIMENT_CHROMIUM.mxd



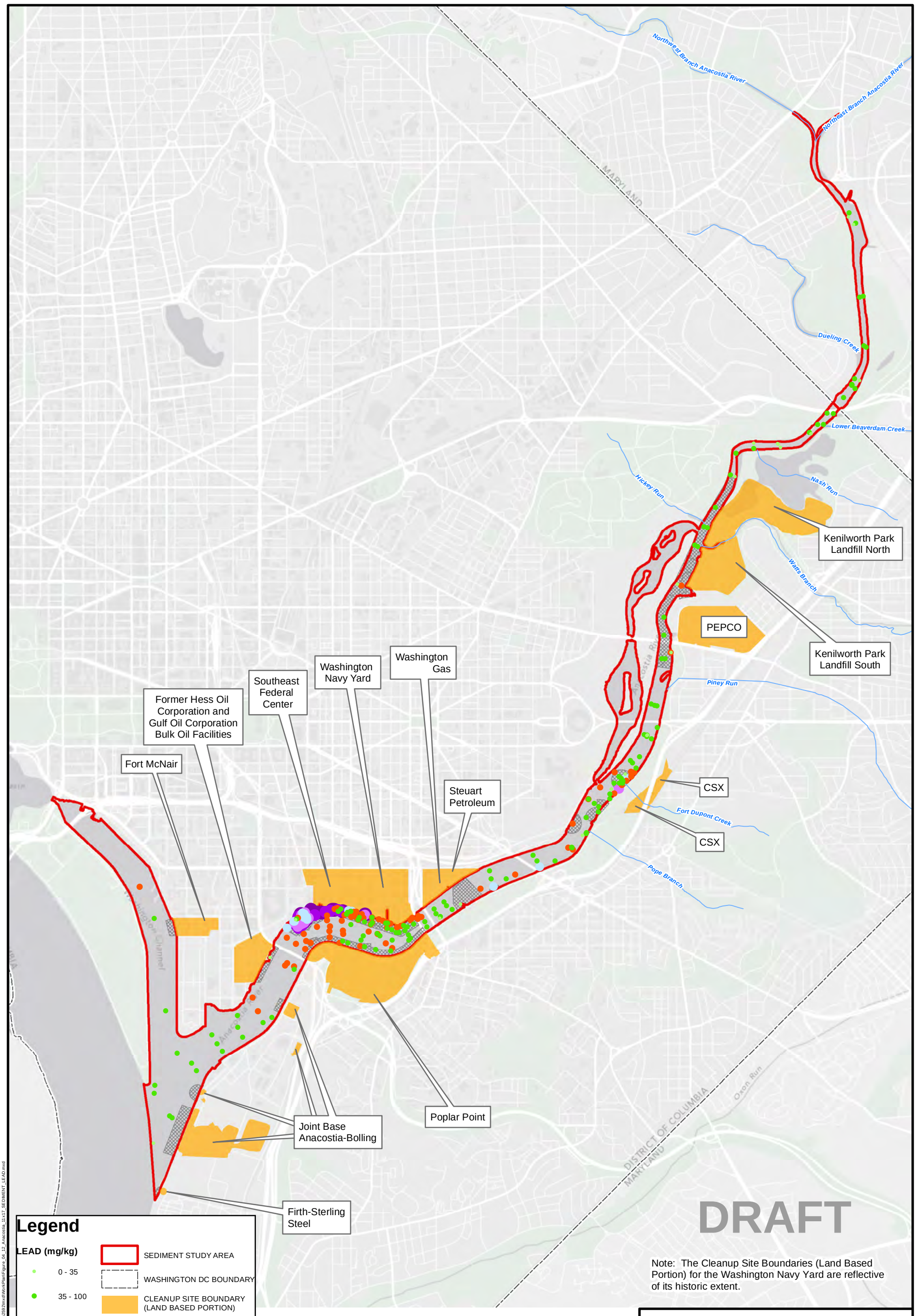
Note: The Cleanup Site Boundaries (Land Based Portion) for the Washington Navy Yard are reflective of its historic extent.

SOURCE: MODIFIED FROM CH2MHILL, 2011, GEOSYNTEC, 2012, DCGIS, 2012, NOAA, 2013, AND DEPARTMENT OF THE NAVY, 2013.

ANACOSTIA RIVER SEDIMENTS PROJECT

FIGURE 4.11
SUMMARY ANALYTICAL RESULTS FOR COPPER IN SURFACE SEDIMENT

TETRA TECH



Note: The Cleanup Site Boundaries (Land Based Portion) for the Washington Navy Yard are reflective of its historic extent.

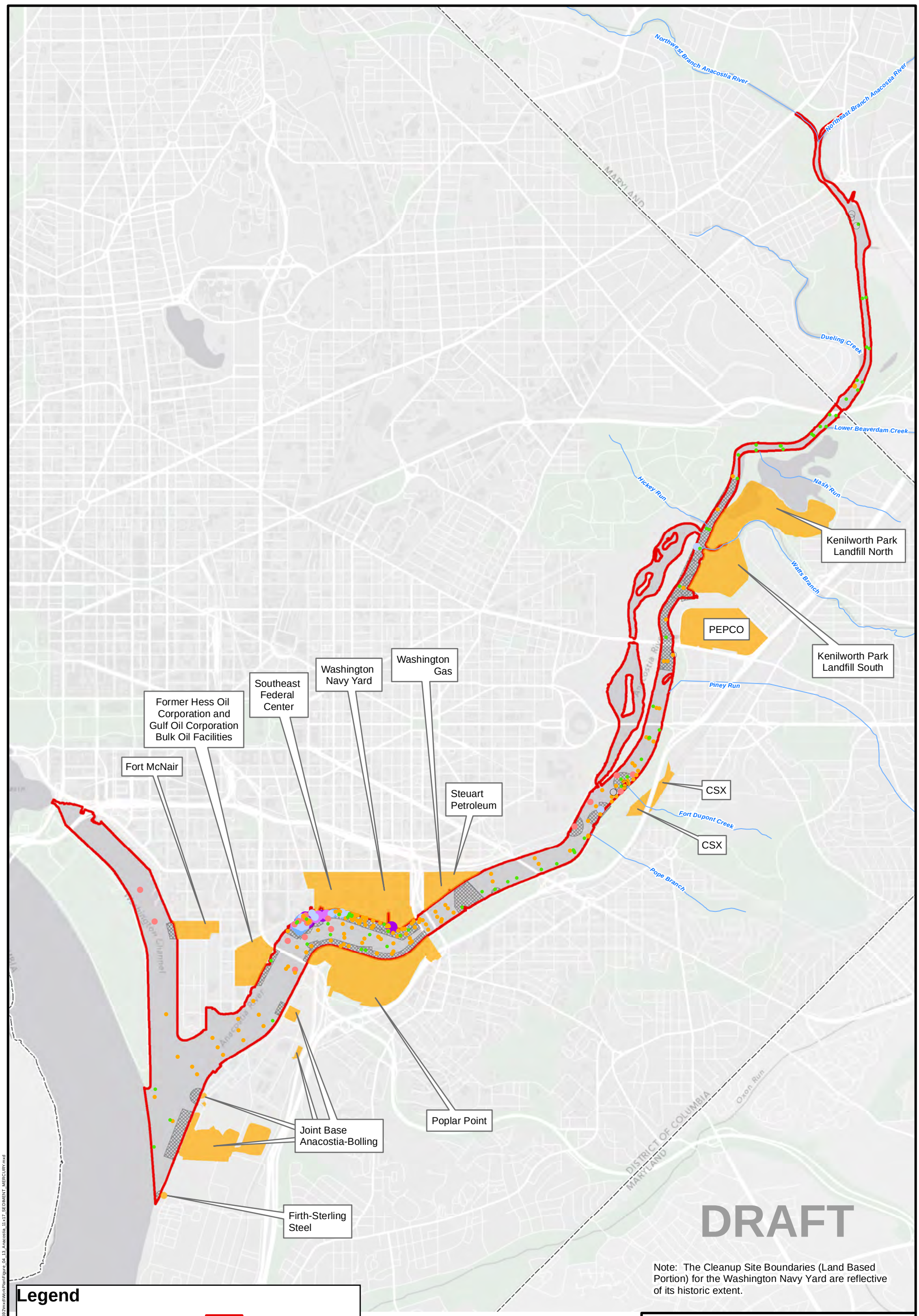
SOURCE: MODIFIED FROM CH2MHILL, 2011, GEOSYNTEC, 2012, DCGIS, 2012, NOAA, 2013, AND DEPARTMENT OF THE NAVY, 2013.

ANACOSTIA RIVER SEDIMENTS PROJECT

FIGURE 4.12
SUMMARY ANALYTICAL RESULTS FOR LEAD IN SURFACE SEDIMENT

TETRA TECH

Date Saved: 5/14/2014 1:41:46 PM User: jose.peters Path: S:\CADD\S\2592\mxd\WorkPlan\Figure_04_12_Anacostia_11x17_SEDIMENT_LEAD.mxd



Note: The Cleanup Site Boundaries (Land Based Portion) for the Washington Navy Yard are reflective of its historic extent.

Legend

- NON-DETECT
- MERCURY (mg/kg)
  - 0.009 - 0.18
  - 0.18 - 0.40
  - 0.40 - 0.89
  - 0.89 - 1.51
  - 1.51- 2.20
  - 2.20 - 3.20
  - 3.20 - 6.00
  - 6.00 - 10.70
- SEDIMENT STUDY AREA
- WASHINGTON DC BOUNDARY
- CLEANUP SITE BOUNDARY (LAND BASED PORTION)
- CLEANUP SITE AREA OF INFLUENCE

N W E S

0 1,500 3,000 Feet

SOURCE: MODIFIED FROM CH2MHILL, 2011, GEOSYNTEC, 2012, DCGIS, 2012, NOAA, 2013, AND DEPARTMENT OF THE NAVY, 2013.

ANACOSTIA RIVER SEDIMENTS PROJECT

FIGURE 4.13
SUMMARY ANALYTICAL RESULTS FOR MERCURY IN SURFACE SEDIMENT

TETRA TECH

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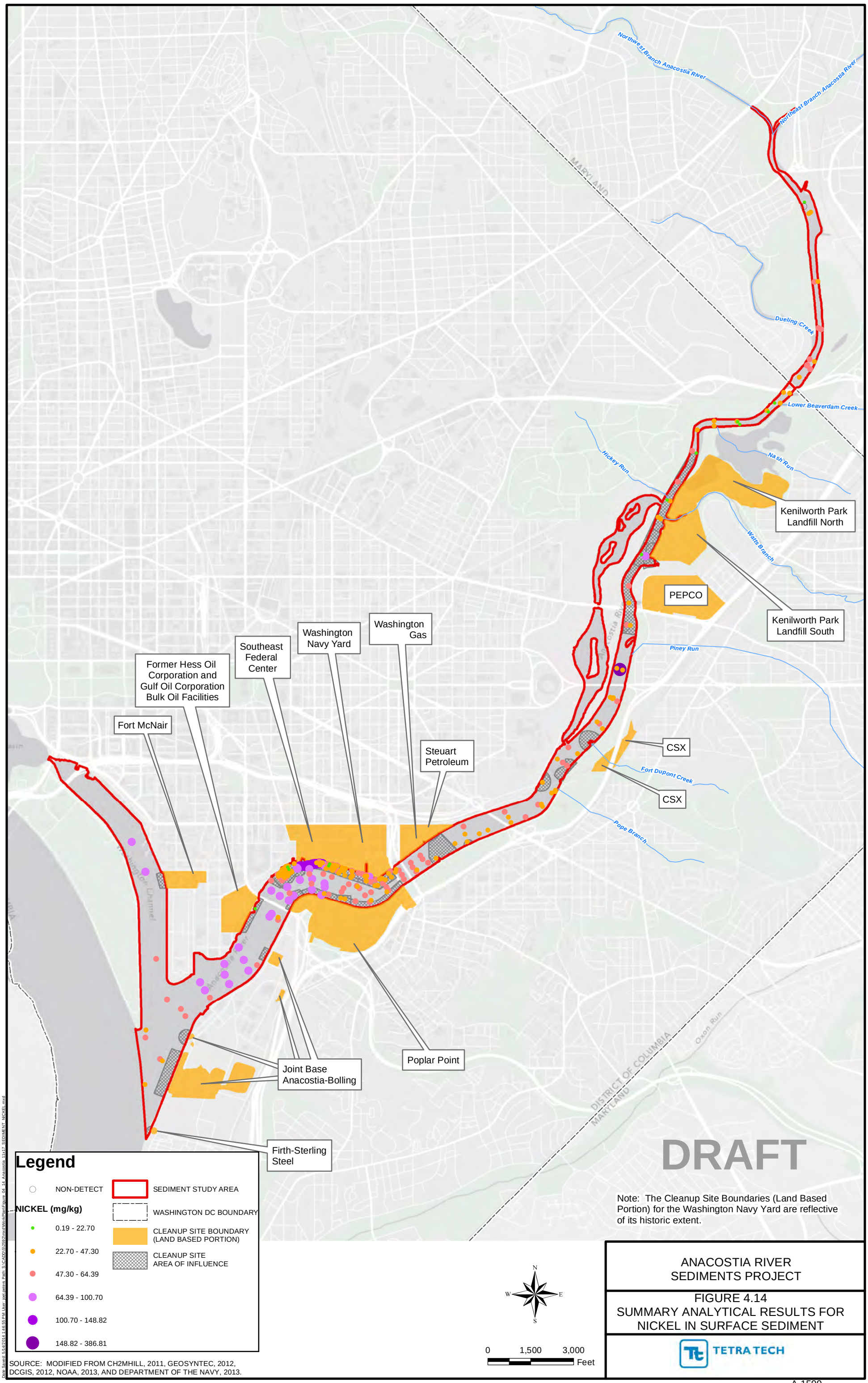


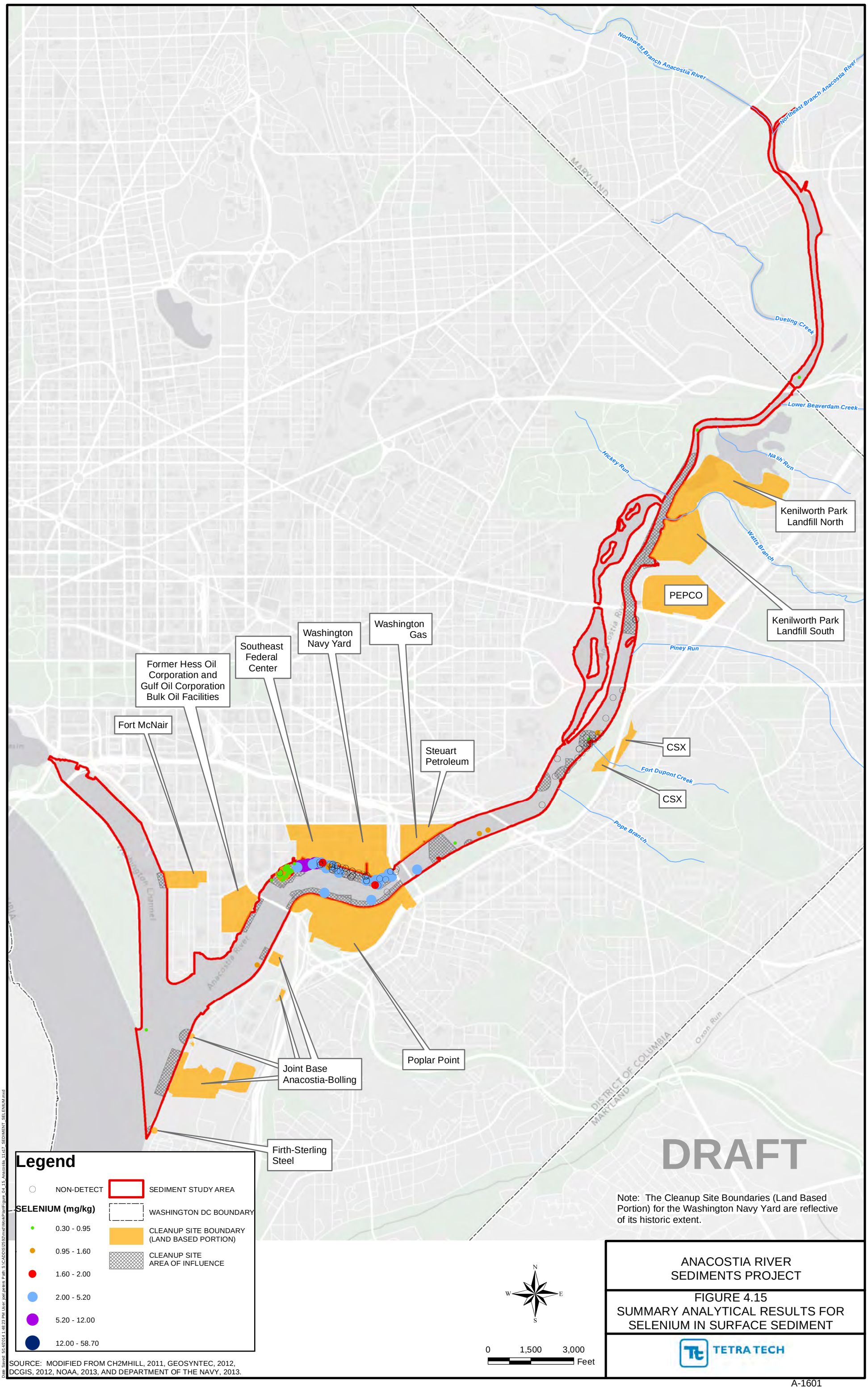
SOURCE: MODIFIED FROM CH2MHILL, 2011, GEOSYNTEC, 2012, DCGIS, 2012, NOAA, 2013, AND DEPARTMENT OF THE NAVY, 2013.

ANACOSTIA RIVER SEDIMENTS PROJECT

FIGURE 4.14
SUMMARY ANALYTICAL RESULTS FOR NICKEL IN SURFACE SEDIMENT

TETRA TECH

Date Saved: 5/14/2014 1:46:55 PM User: joel.peters Path: S:\CADD\SY259\mxd\WorkPlan\Figure_04_14_Anacostia_11x17_SEDIMENT_NICKEL.mxd



SOURCE: MODIFIED FROM CH2MHILL, 2011, GEOSYNTEC, 2012, DCGIS, 2012, NOAA, 2013, AND DEPARTMENT OF THE NAVY, 2013.

ANACOSTIA RIVER SEDIMENTS PROJECT

FIGURE 4.15
SUMMARY ANALYTICAL RESULTS FOR SELENIUM IN SURFACE SEDIMENT

TETRA TECH

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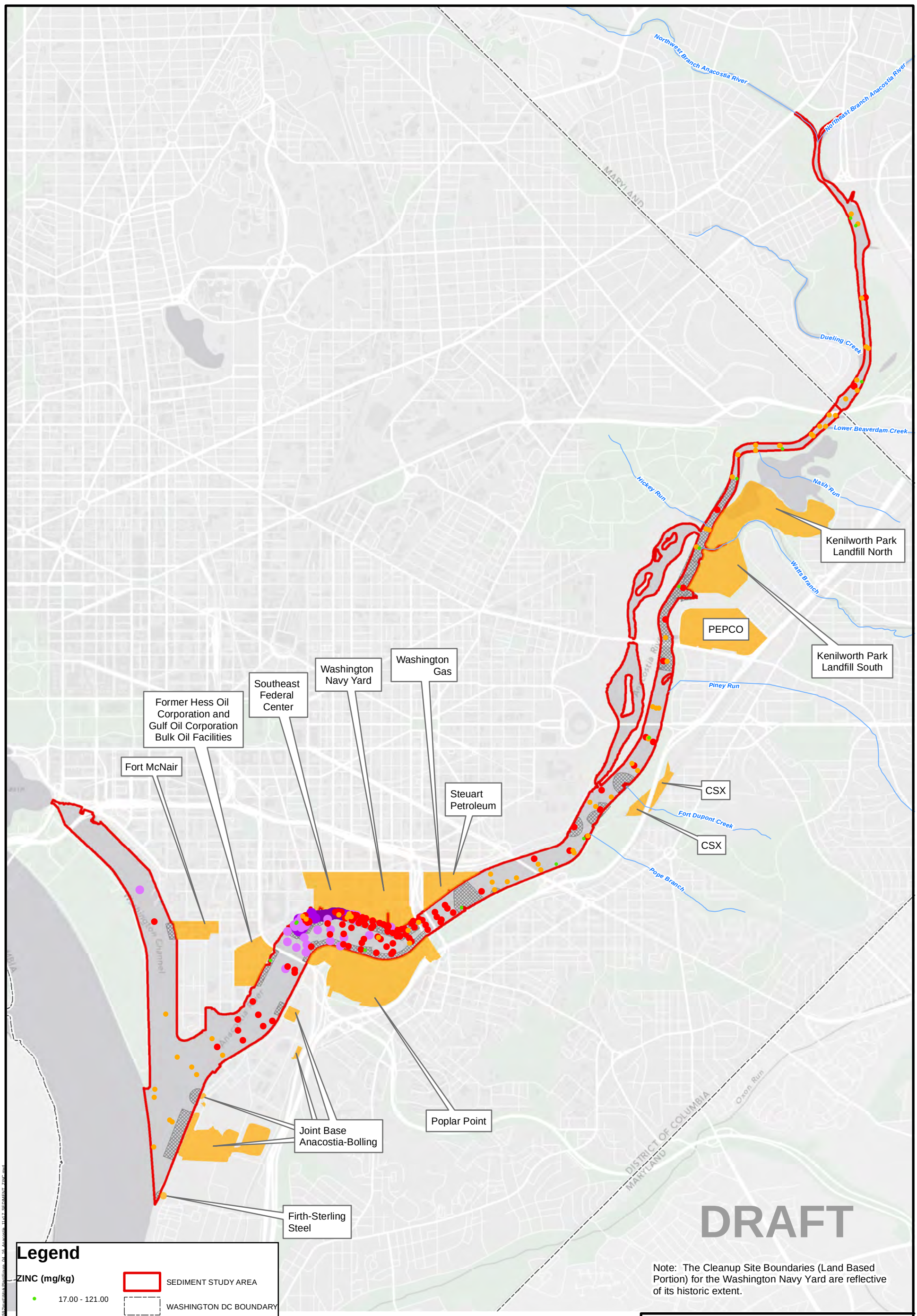


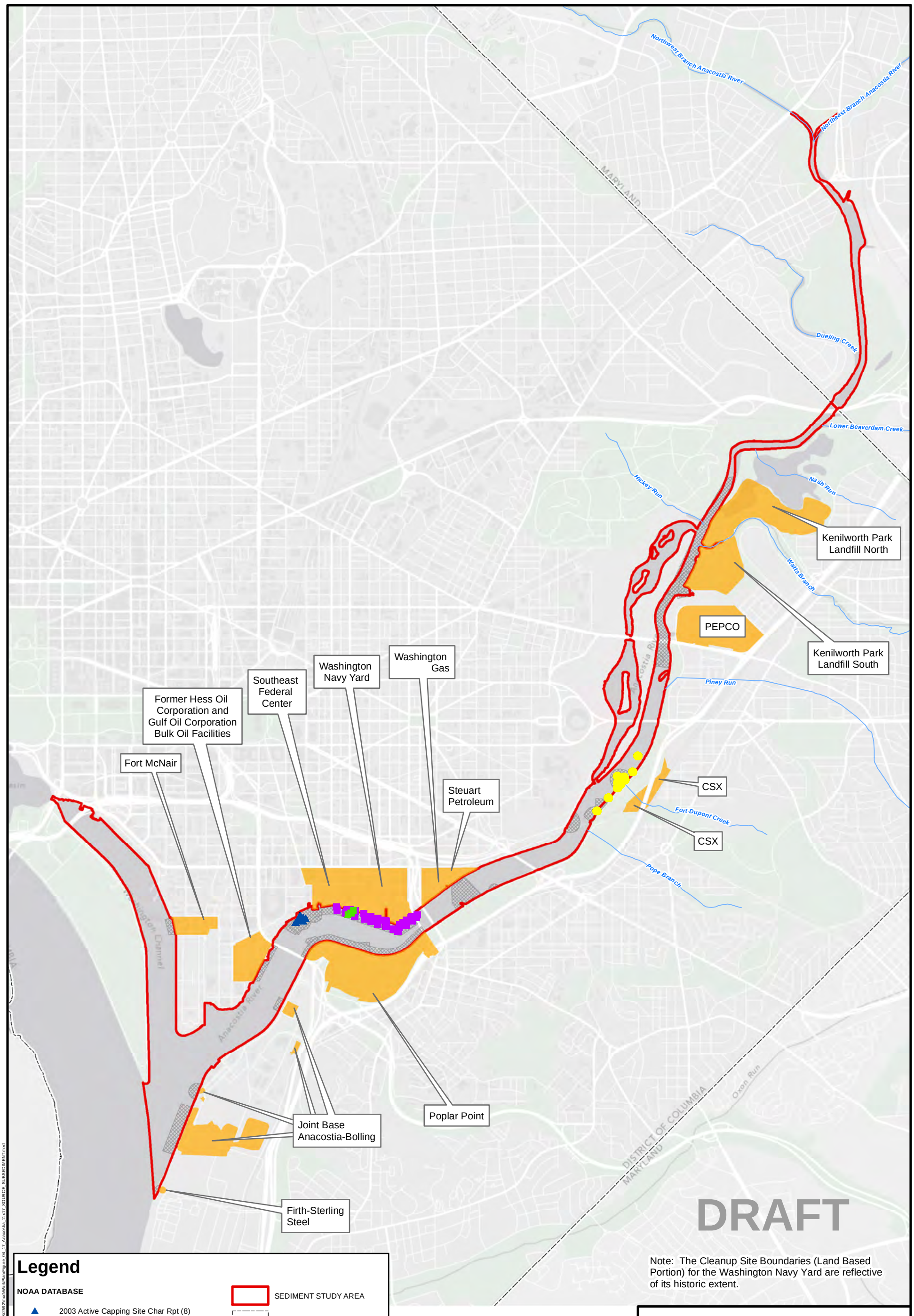
Note: The Cleanup Site Boundaries (Land Based Portion) for the Washington Navy Yard are reflective of its historic extent.

SOURCE: MODIFIED FROM CH2MHILL, 2011, GEOSYNTEC, 2012, DCGIS, 2012, NOAA, 2013, AND DEPARTMENT OF THE NAVY, 2013.

ANACOSTIA RIVER SEDIMENTS PROJECT

FIGURE 4.16
SUMMARY ANALYTICAL RESULTS FOR ZINC IN SURFACE SEDIMENT

TETRA TECH



Note: The Cleanup Site Boundaries (Land Based Portion) for the Washington Navy Yard are reflective of its historic extent.

Legend

NOAA DATABASE

- 2003 Active Capping Site Char Rpt (8)

NIRIS DATABASE

- 2002 WA Navy Yard Pier No. 5 (16)
- 2006, 2009 Washington Navy Yard Sed/Tiss (70)

CSX DATABASE

- 2011 CSX Sediment Study (38)

- SEDIMENT STUDY AREA
- WASHINGTON DC BOUNDARY
- CLEANUP SITE BOUNDARY (LAND BASED PORTION)
- CLEANUP SITE AREA OF INFLUENCE

N W E S

0 1,500 3,000 Feet

SOURCE: MODIFIED FROM CH2MHILL, 2011, GEOSYNTEC, 2012, DCGIS, 2012, AND DEPARTMENT OF THE NAVY, 2013.

ANACOSTIA RIVER SEDIMENTS PROJECT

FIGURE 4.17
PREVIOUS SUBSURFACE SEDIMENT SAMPLING LOCATIONS

TETRA TECH

Date Saved: 5/14/2014 2:54:40 PM User: jpeter.peters Path: S:\CADD\S2592\mxd\WorkPlan\Figure_04_17_Anacostia_11x17_SOURCE_SUBSEDIMENT.mxd

5.0 REMEDIAL INVESTIGATION

The RI will address the goals outlined in **Table 4.1**. Additional sampling is necessary to validate previous sampling, identify potential sources of COCs in the environmental media, allocate contamination to specific sources where possible, and evaluate the potential for risk to human health and the environment. Additional data is also required to support the NRDA process and provide information needed to assess remedial options in a FS. The sampling approach for sediment, fish and turtle tissue, and benthic invertebrate data gaps will be dynamic in that the sampling performed will be tailored to the conditions observed in the field. A set of implementation plans including a FSP, QAPP, Health and Safety plan have been developed to detail the sampling and analytical methods and quality control criteria and procedures that will be used.

The RI will consist of the collection of samples from surface sediment, subsurface sediment, surface sediment pore water, surface water, and invertebrate, fish, and turtle tissue. In addition, sediment samples will be collected to conduct benthic invertebrate toxicity tests. **Table 5.1** (below) summarizes the number of samples planned for each environmental medium and indicates the report section in which sampling activities for each medium are discussed. (Turtles will be collected opportunistically.)

TABLE 5.1
Summary of Planned Sampling Activities for the RI

Environmental Medium	Number of Planned Samples	Section
Surface Sediment	134	5.1.2
Subsurface Sediment	243	5.1.2
Surface Sediment Pore Water	19	5.1.3
Benthic Invertebrate Characterization (Toxicity Test and Tissue Analysis)	42	5.1.4 and 5.1.5
Surface Water	14	5.2
Fish Tissue	46	5.3

Table 5.2 lists the Maryland state plane coordinates for each sampling location and shows the various media that will sampled at each location. In addition, **Table 5.3** summarizes for each medium the laboratory analyses that will be conducted.

5.1 Sediment Characterization

Building upon historical databases, the RI sampling program is designed to gather the majority of the remaining data needed for the RI and risk assessments, as well as initiate some NRDA data collection. The overall RI objectives that the sediment sampling efforts will support include:

- Identify and evaluate direct and indirect, known and unknown sources of significant contamination,

- Define the horizontal and vertical extent of contamination in surface and subsurface sediment,
- Identify surface and buried sources of contamination that pose a potential risk to human health or the environment,
- Assess what sources can be controlled by early actions such as the removal of an unanticipated contaminant hot spot that presents an immediate threat to human health or the environment,
- Update the watershed sediment/surface water model, and
- Collect data to understand contaminant fate and transport in the river system to adequately support remediation decisions.

The following types of data will be collected during sediment sampling:

- Surface sediment chemistry to characterize the nature and extent of contamination, evaluate potential contaminant sourcing processes, support the ERA and the HHRA, and support the planned FS,
- Sediment bioassays to support the assessment of benthic risks for the ERA,
- Subsurface sediment chemistry and physical data to characterize the nature and extent of contamination, and
- Surface and subsurface sediment physical data to augment the available sediment chemistry data and support the planned FS.

Sediment sample locations are shown on **Figure 5.1**. The analyses planned at each location along with overall sampling objective (RI, NRDA, or both), summary of rationale, and location description are shown on **Table 5.4**.

5.1.1 Bathymetric Survey

As noted in Section 4.0, a bathymetric survey was conducted covering the entire study area. The survey was performed in September and October, 2013 and is documented in a report included as Appendix A. The bathymetric survey provided a basis for understanding the depth of the water column and the configuration of the river bottom and was used to prepare a contour map of the top of the sediment surface in and around the investigation areas. The surveying systems that were used included a multibeam echo sounder for the deeper water areas and a multichannel sweep system to efficiently survey areas with shallower water. A separate buried utility survey was conducted following standard utility notification procedures. The procedures used for the utility survey are discussed in the FSP; the utility survey was completed prior to the commencement of surface or subsurface sediment sampling.

5.1.2 Physical and Chemical Sediment Sampling

Sediment samples will be collected from the sediment surface at approximately 134 locations within the project area to laterally characterize the nature and extent of contamination. Sample locations are shown in **Figure 5.1**. The surface sediment sample interval is defined as 0 to 0.5 foot below the sediment surface. The sampling locations shown on **Figure 5.1** reflect the bathymetric survey results and associated analyses of the data generated by this survey. In addition, samples in close proximity to utilities will be relocated as necessary to ensure that sample collection can proceed safely.

Surface grab samples will be collected using a petite Ponar sampler from the top 0.5 foot of sediment at each sampling location to characterize the surface sediments, to validate previous sample results, to fill existing data gaps, and to characterize the sediments near MS4 and CSS outfalls as appropriate. If obstructions such as boulders or debris are encountered at a specific station, the location of the station may be changed to collect sediment samples as required.

Nearshore surface sediment samples will be collected within areas where fishing or nearshore recreation is documented or observed, including Kingman and Heritage Islands Recreational Areas, Bladensburg Waterfront Park, and Anacostia Park. The purpose of these sample locations is to evaluate the potential risk to anglers or other recreationalists who may be exposed to nearshore sediment during low tides. Fourteen samples are anticipated; however, sample numbers and locations may be adjusted based on field observations of human activity.

During this phase of work, the surface sediment samples will be logged for visual and physical observations. A portion of the sample will be placed in a pan, inspected for sediment type, color, odor, obvious signs of biota and other notable features, and then returned to the river. The remainder of the sample will then be prepared for shipment to the laboratory.

Field personnel will record field observations of the physical characteristics of the sediment encountered at each sampling station and also important observations regarding the physical characteristics of the study area.

Deep sediment core samples will be collected from 83 stations (**Figure 5.1**) at depths up to 10 feet below the sediment surface to characterize the sediment profile at each location. Based on field screening, up to three sediment horizons will be selected from each core for sampling. Field screening will consist of visual inspection of the core samples for indications of potential contamination including abnormal discoloration or odors, elevated photoionization detector (PID) readings, or other indications suggesting the presence of contamination. The 10 foot depth is based on historical subsurface sampling (Velinsky et al. 2011). If field screening at a given sampling point indicates the potential that contamination extends to depths greater than 10 feet, sampling will continue to greater depths to the extent that the field sampling equipment will permit. Some locations may not achieve 10 feet because of shallow sediment depth or the presence of an obstruction to drilling. Locations that show significant contamination at depth may be evaluated further in a follow-up sampling phase. The sediment cores will be collected using a vessel equipped to advance a 2-4 inch diameter Vibracore™ sampler (or equivalent) to the target depth below the sediment surface, or to refusal, whichever is encountered first.

Field personnel will record field observations of the subsurface sampling event to include:

- Sample station designation
- Location coordinates recorded with a Global Positioning System (GPS) unit
- Water surface elevation
- Depth to sediment
- Depth core was advanced

- Depth of sediment recovered
- Sediment core logging for sediment stratigraphy

All sediment samples will be submitted for the following physical and chemical analyses (Table 5.3):

- Grain size by sieve and hydrometer
- TOC
- PP List
- PCB congeners (all shallow sediment samples and selected deep sediment samples as noted below)

Several specialized analyses will be conducted on a subset (20%) of the sediment samples:

- PCB congeners (deep sediment samples)
- Dioxins and furans (shallow and deep sediment samples)
- AVS/SEM (shallow and deep sediment samples)
- Moisture content/percent solids (deep sediment samples)
- Bulk density (shallow and deep sediment samples)
- Atterberg Limits (shallow and deep sediment samples)

It is estimated that up to 249 discrete interval subsurface sediment samples will be collected for laboratory analysis. The locations of the specialized analyses will be determined by site specific conditions within the project area, such as likely contaminant sources or fluvial geomorphological features. The specific locations will be outlined in the FSP.

5.1.3 Sediment Pore Water Sampling

Pore water within the surface sediment will be sampled at 19 locations (**Figure 5.2**) to a depth of 0-0.5 feet below the sediment surface. Sample locations were selected to provide spatial coverage of all reaches of the river within the Study Area. The 19 locations will correspond to selected benthic invertebrate exposure sampling locations that are in close proximity to outfalls and areas were elevated PAH concentrations in surface sediment were previously identified. Pore water collection locations will be co-located at selected surface sediment locations as noted in **Tables 5.1 and 5.5**. Sample locations will be recorded with a GPS unit.

All pore water samples will be collected ex situ via laboratory-based extraction and submitted for the following chemical analyses:

- TOC
- Dissolved organic carbon
- PP List except VOCs; also, if a limited sample volume is available for a given sample, the parameter list will be prioritized and reduced accordingly as will be detailed in the FSP.

5.1.4 Sediment Sampling for Benthic Invertebrate Toxicity Tests

Benthic invertebrate characterization sampling will be conducted at 42 of the 134 surface sampling locations. The benthic exposure sampling locations are listed in **Table 5.5** and shown in **Figure 5.2**.

Surface sediment will be collected for toxicity testing from at least half of the benthic exposure sampling locations; benthic invertebrates will be collected where available at the remaining locations. Benthic invertebrates will be collected at locations where they are encountered in sufficient numbers to support tissue analysis, as determined through field judgment. If insufficient benthic invertebrates are present at any given sampling location, sediment will be collected for toxicity testing. Sample points were selected to achieve three goals simultaneously: (1) general spatial coverage of all reaches of the river; (2) biased to include inlets, outfalls, and bridges; and (3) biased toward shallower waters away from people, closer to vegetated habitat where animals might be more likely to forage at low tide.

Direct toxicity tests provide a measure of survival, growth, and reproduction of invertebrates that are in direct contact with sediment. Results will provide both direct and indirect evidence of potential impact to support the ERA and NRDA: (1) The extent of direct toxicity to organisms exposed to surficial sediment is a measure of injury to the aquatic ecosystem and a line of evidence in the ERA; and (2) the potential adverse effect on the availability of typical invertebrate species in the aquatic food web, which is an indirect measure of injury to high trophic level predators, including humans. For example, if benthic invertebrate prey sources are in decline because of toxic effects of sediments, then other organisms (fish, turtles, birds, and mammals) that prey on the invertebrates may experience adverse effects such as increased foraging effort, decreased nutrition, or other indirect effects.

Surficial sediment samples will be collected for lab-based toxicity testing using the amphipod (*Hyalella azteca*) and midge (*Chironomus dilutus*). Effects of surface sediments on growth and reproduction of *Hyallella azteca* will be measured using a 42-day direct exposure test (TT-BRF/TX-SOP-O-065). Effects of surface sediment on survival of Chironomus dilutus will be measured using a 10-day direct exposure test (TT-BRF/TX-SOP-O-019).

5.1.5 Sampling for Benthic and Epibenthic Invertebrates

Organisms may not only experience direct toxic effects of sediment contaminants, but may also accumulate contaminants in their tissues. Tissue concentrations of field-collected organisms serve dual purposes as indicators of direct exposure and uptake by benthic invertebrates, and as measures of potential transfer of contaminants from the sediment to other organisms in the aquatic ecosystem. Tissue concentrations in organisms collected from the Anacostia River will be used in both the ERA and the NRDA.

Collecting benthic and epibenthic invertebrates in the field from specific locations is more difficult than collecting sediment because organisms may not be distributed as expected. The purpose of analyzing field-collected organisms is to measure concentrations of contaminants that might actually be transferred to predators at the site. Although laboratory-based bioaccumulation tests on collected sediments may be simpler to conduct, the results are difficult to link to the actual transfer of contaminants from sediment to invertebrates in the river. Tissue concentrations in field-collected organisms represent lifetime exposure under environmentally variable conditions.

Invertebrate samples will be collected opportunistically at approximately half of the locations listed in **Table 5.5** and shown in **Figure 5.2**. During collection of surface sediment samples, the availability of

invertebrate tissue will be qualitatively evaluated and a decision made whether adequate volume of invertebrate tissue can be obtained within 30 minutes of sampling.

Field-collected tissue samples are the most direct measure of actual ingestion exposure to higher trophic level predators. For example, fish, turtles, birds, and mammals are exposed to whatever chemicals are in the bodies of the benthic organisms they eat. Whenever possible, field-collected tissue concentrations will be used in food chain models to represent dietary exposure to chemicals. However, field-collected tissue samples are limited by two factors: (1) the confounding of multiple sources of contaminants to the benthic organism and (2) the absence of benthic organisms in some locations.

Field-collected tissues may not be available in all sediment locations. Some existing reports indicate that portions of the Anacostia River may have few benthic invertebrates (whether naturally or as a result of contamination).

The field tissue data provide a measure of potential exposure of organisms to contaminants in sediment and other media. The laboratory toxicity tests can support evaluation of the cause of scarce benthic invertebrate populations in certain areas. In summary, laboratory and field data will be integrated in the ERA and NRDA to support rational, defensible conclusions about complete exposure pathways leading to injury and risk.

5.1.6 Approach to Estimating Background and Ambient Concentrations in Sediment

Sediments in the study area contain naturally-occurring (background) concentrations of metals as well as ambient concentrations of many ubiquitous anthropogenic chemicals. The ERA and HHRA require that chemical concentrations at a site be evaluated within the context of background/ambient concentrations so that site-specific incremental risk can be characterized. Likewise, background/ambient concentrations must be considered in the development of remedial alternatives in the FS.

In urban ecosystems such as the tidal Anacostia River, identifying unimpacted background sampling locations for sediment is problematic because sediments in the river are derived from urbanized areas upstream. Background metals concentrations in sediments will be derived from the published literature to the extent practicable. If necessary, background metals concentrations will be measured directly in deep cores from within the study area.

Ambient concentrations of organic constituents such as PCBs, PAHs, and pesticides in sediment represent contributions from multiple sources, including the known environmental sites within the study area, CSOs, atmospheric deposition, tributaries, surface runoff, and other sources. Background concentrations of organic chemicals that do not naturally occur are assumed to be zero, excepting PAHs. Total ambient PAH concentrations may represent both naturally occurring background concentrations resulting from events such as fires and anthropogenic sources such as petroleum releases. Ambient concentrations of organic COCs will be estimated based on literature reviews and limited upstream sampling, if necessary.

5.2 Surface Water Sampling

Nearshore surface water samples will be collected from within 1 foot of the surface within areas where fishing or nearshore recreation is documented or observed, including Kingman and Heritage Islands

Recreational Areas, Bladensburg Waterfront Park, Anacostia Park, and the Haines Point waterfront bordering Washington Channel. Sampling locations are shown on **Figure 5.3**. The surface water samples will be collocated with the 14 nearshore sediment samples described in **Section 5.1.2** above. Where necessary, surface water sample locations will be adjusted as needed in response to site specific conditions. The purpose of these sample locations is to evaluate the potential risk to anglers or other recreationalists who may be exposed to nearshore surface water while fishing, boating, swimming, or participating in other activities on the river. A minimum of 14 samples are anticipated; however, the number of samples and sample locations may be adjusted based on field observations of actual or potential human activity. Sample locations are shown in **Figure 5.3**. Sample locations will be recorded with a GPS unit. All surface water samples will be submitted for the following chemical analyses:

- Field parameters (pH, temperature, specific conductivity, oxidation/reduction potential, dissolved oxygen)
- TOC
- PP List
- Dioxin-like PCB congeners
- Dioxins and furans

5.3 Fish, Turtle, and Crayfish Tissue Sampling and Analysis

Fish and turtle tissue concentrations provide evidence that these organisms were exposed to contaminated surface water, sediment, or prey items. Because fish and turtles move around, individual samples do not provide a definitive link to a particular location; however, they do provide an overview of injury and risk within the range of the individuals. Fish tissue sampling will be conducted at 42 locations. Up to six common snapping turtles will be collected opportunistically throughout the tidal Anacostia River. Sample locations are shown on **Figure 5.3**. Sample location descriptions and rationale are provided in **Table 5.6**.

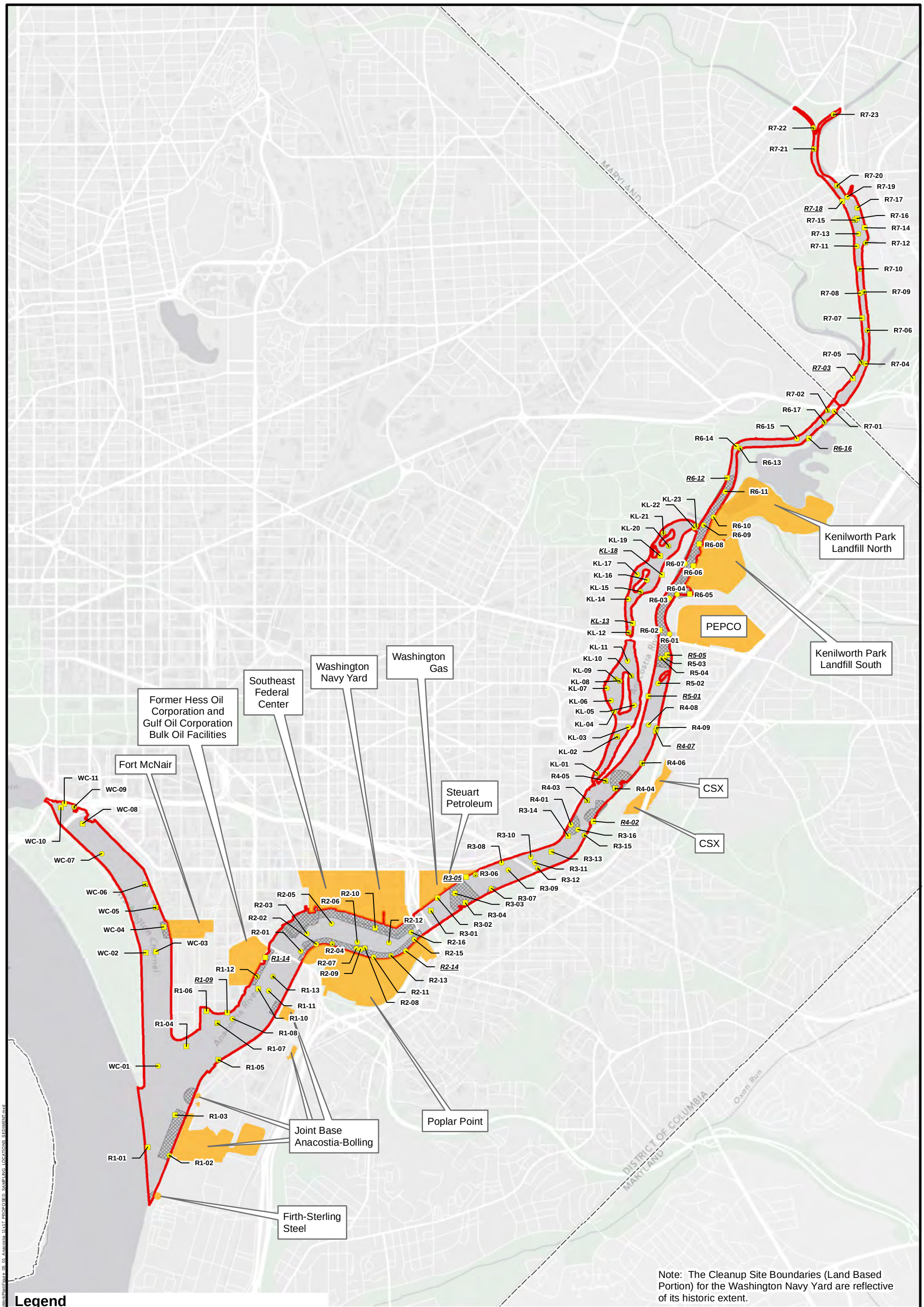
At each fish sampling location, one to three types of fish samples will be collected (based on availability). Ideally, fish from three feeding guilds (forage fish, mid-level predator, and top predator) will be collected. However, existing data suggest that top predators (such as catfish and largemouth bass) are absent from some reaches of the river. Forage fish include herring, banded killifish, and topminnows. Mid-level predators are represented by various species of sunfish, including bluegill and pumpkinseed.

Although crayfish are epibenthic invertebrates, their size and behavior make them more likely to be collected during fish sampling than during benthic invertebrate sampling. Crayfish will be collected using baited minnow traps in designated locations. In addition, crayfish will be collected wherever they become available in the field. They are likely to be captured in seines and minnow traps, as well as during electroshocking.

Fish and crayfish samples will be evaluated in the BERA in two ways: (1) risk to these species directly will be estimated by comparing tissue concentrations with effect levels, and (2) tissue concentrations will be incorporated into estimates of food chain transfer to piscivorous birds and mammals (such as the green heron, osprey, cormorant, otter, and raccoon). (See **Section 7.0** for discussion of typical birds and

mammals in the Anacostia River.) Fish and crayfish tissue data will also be used in the HHRA and to support injury determination in the NRDA.

Fish sampling locations were selected to provide spatial coverage of all reaches of the river within the Study Area. Within each reach of the river, sample locations were biased toward outfalls (where contaminants are expected). Sampling will also occur where the presence of contaminants is generally unknown such as inlets and backwater areas. Sample collection locations may be shifted in the field to accommodate logistical requirements of the selected sample collection methods. For example, in mid-summer, dissolved oxygen concentrations in the river often drop to levels that cause physiological stress to fish (Galli et al. 2010). The field team will monitor dissolved oxygen concentrations in the field and avoid collecting fishes when stresses related to low oxygen are severe. Details will be provided in the FSP.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MARYLAND
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Kenilworth Park Landfill South
PEPCO
CSX
CSX
Steuart Petroleum
Washington Gas
Washington Navy Yard
Southeast Federal Center
Former Hess Oil Corporation and Gulf Oil Corporation Bulk Oil Facilities
Fort McNair
Joint Base Anacostia-Bolling
Poplar Point
Firth-Sterling Steel
DISTRICT OF COLUMBIA
MARYLAND
Oxon Run
Legend
BENTHIC TISSUE SAMPLING LOCATION
PROPOSED SHALLOW SEDIMENT SAMPLE
PROPOSED SHALLOW/DEEP SEDIMENT SAMPLE
CLEANUP SITE BOUNDARY (LAND BASED PORTION)
SEDIMENT STUDY AREA
CLEANUP SITE AREA OF INFLUENCE
WASHINGTON DC BOUNDARY
R1-5
Italics underlined sample name indicates sample is for human health-pedestrian access to riverbank.
SOURCE: MODIFIED FROM CH2MHILL, 2011, AND DCGIS, 2012.
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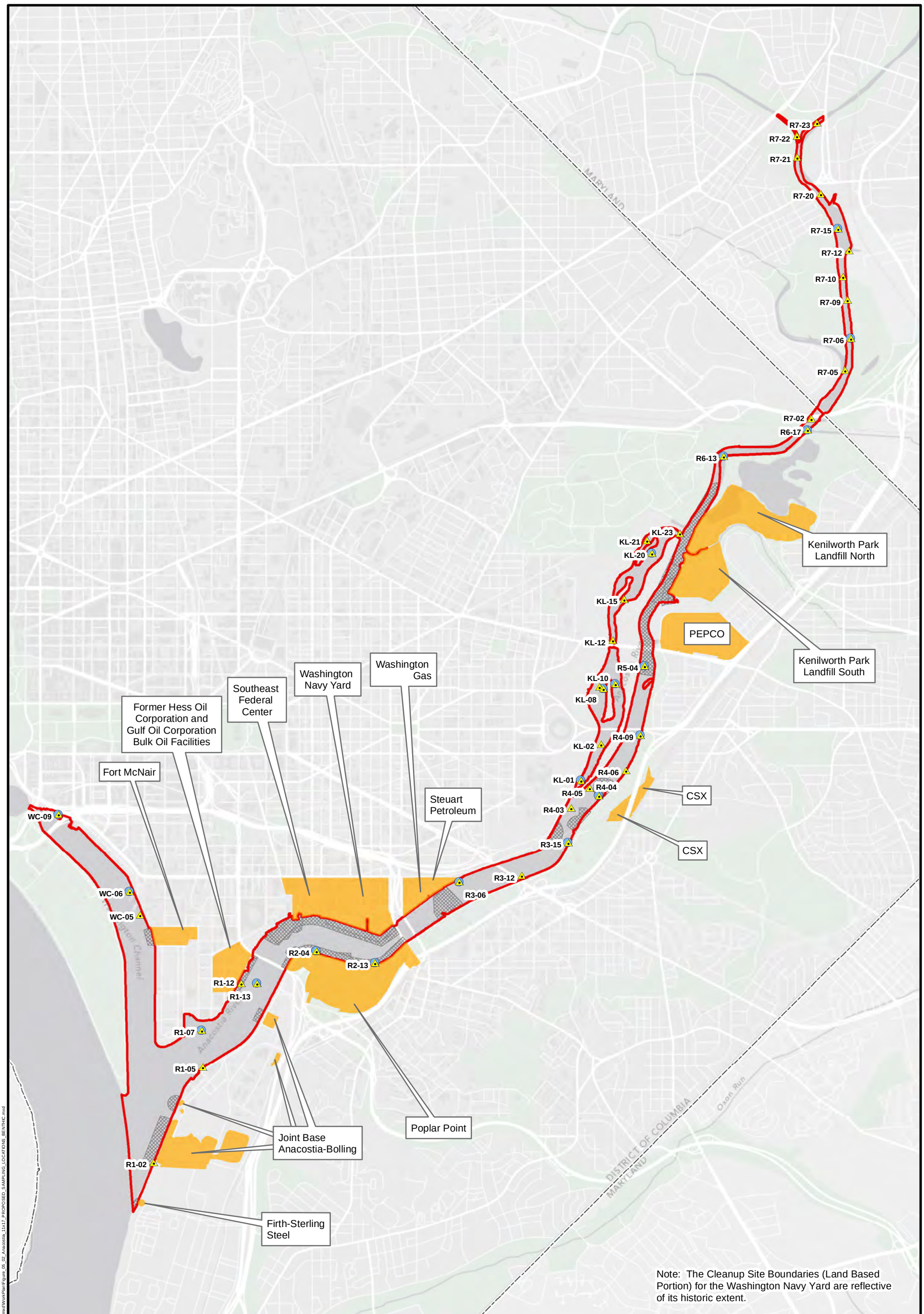
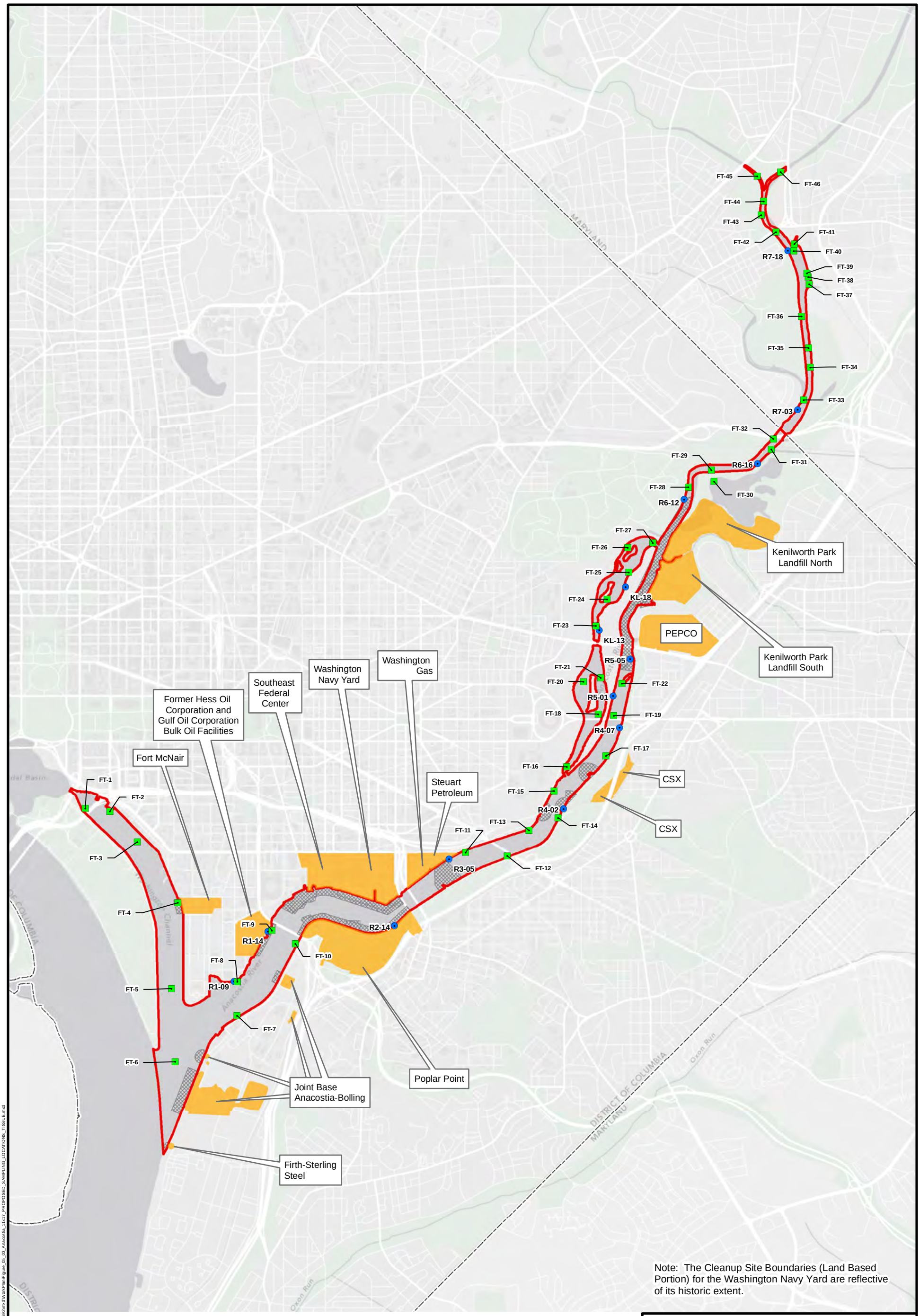
Note: The Cleanup Site Boundaries (Land Based Portion) for the Washington Navy Yard are reflective of its historic extent.
ANACOSTIA RIVER SEDIMENTS PROJECT
FIGURE 5.1
PROPOSED SEDIMENT SAMPLING LOCATIONS
TETRA TECH



ANACOSTIA RIVER SEDIMENTS PROJECT

FIGURE 5.2
PROPOSED BENTHIC INVERTEBRATE EXPOSURE AND PORE WATER SAMPLING LOCATIONS IN SURFACE SEDIMENT

TETRA TECH



Note: The Cleanup Site Boundaries (Land Based Portion) for the Washington Navy Yard are reflective of its historic extent.

DRAFT

Legend

- FISH, TURTLE, AND CRAYFISH TISSUE SAMPLING LOCATION
- SURFACE WATER SAMPLING LOCATION
- CLEANUP SITE BOUNDARY (LAND BASED PORTION)
- SEDIMENT STUDY AREA
- CLEANUP SITE AREA OF INFLUENCE
- WASHINGTON DC BOUNDARY

N W E S

0 1,500 3,000 Feet

SOURCE: MODIFIED FROM CH2MHILL, 2011, AND DCGIS, 2012.

ANACOSTIA RIVER SEDIMENTS PROJECT

FIGURE 5.3
PROPOSED FISH, TURTLE, AND CRAYFISH TISSUE AND SURFACE WATER SAMPLING LOCATIONS

TETRA TECH

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Location	Reach	X-Coordinate [1]	Y-Coordinate [1]	Surface Sediment	Deep Sediment	Pore Water [2]	Benthic Invertebrate Exposure [3,4]	Surface Water	Location Description
WC-01	Washington Channel	1306571.141	434149.7805	X	X				Mouth of Washington Channel
WC-02		1306177.219	437870.9329	X					West side of Washington Channel, on slope between bank and thalweg
WC-03		1306501.448	437909.7493	X					Center of Washington Channel, midway between two existing sample points
WC-04		1306765.405	438723.2308	X					Outfall F-073-094
WC-05		1306496.674	439361.6329	X			X		Adjacent to marina dock
WC-06		1306148.096	440122.1954	X		X	X		Adjacent to marina dock
WC-07		1304719.151	441131.3595	X	X				Center of Washington Channel, midway between WC-1 and existing sample point
WC-08		1304089.044	442105.7179	X					Mid-channel offshore from Outfall F-518-460
WC-09		1303807.9	442659.5706	X	X	X	X		Outfall F-477-703 North of I-395 Bridge
WC-10		1303387.437	442636.4703	X					Mid-channel offshore from WC-4 and WC-1A
WC-11		1303494.849	442771.9954	X					Outfall F-290-057 North of I-395 Bridge
R1-01	South Capitol Street Bridge to Mouth of River	1306236.071	431493.3401	X					HPAH hotspot at mouth of Anacostia River
R1-02		1306943.121	431216.7027	X	X		X		Adjacent to Outfall F-128-495
R1-03		1307128.961	432537.8226	X					Offshore near confluence of Washington Channel and Anacostia River
R1-04		1307503.001	434786.4372	X					Confluence of Washington Channel and Anacostia River
R1-05		1308553.474	434363.6579	X			X	X	North band at Outfall F-937-544
R1-06		1308162.219	435955.1766	X				X	Fort McNair Marina
R1-07		1308518.621	435565.1705	X		X	X		Near south bank, just upstream from confluence with Washington Channel
R1-08		1309013.268	435706.586	X	X				HPAH hotspot southeast of R1-5
R1-09		1308844.168	435901.5977	X					Characterization for human health (pedestrian access to riverbank)
R1-10		1309866.54	436686.8232	X					Slope northwest of thalweg between utility corridors
R1-11		1310198.262	436619.3199	X	X				Center channel, coverage of unsampled portion of channel
R1-12		1309819.198	437098.9628	X	X		X		West bank near F-093-544 coverage of unsampled portion of channel
R1-13		1310347.145	437101.6353	X	X	X	X		Thalweg between utility corridors, coverage of unsampled portion of channel
R1-14		1310087.616	437724.286	X					Characterization for human health (pedestrian access to riverbank)
R2-01	11th Street Bridge to South Capitol Street Bridge	1311262.801	437920.7088	X	X				Overlap with year 2000 data point; east shoreline at Poplar Point
R2-02		1311771.699	438150.0731	X	X				East shoreline at Poplar Point
R2-03		1311460.364	438502.545	X	X				Center channel, offshore from R2-2
R2-04		1312290.873	438175.1813	X	X	X	X		East shoreline at Poplar Point, at Sewer Outfall F-897-104
R2-05		1312271.118	438831.2628	X	X				Center channel from R2-4

Location	Reach	X-Coordinate [1]	Y-Coordinate [1]	Surface Sediment	Deep Sediment	Pore Water [2]	Benthic Invertebrate Exposure [3,4]	Surface Water	Location Description
R2-06	11th Street Bridge to South Capitol Street Bridge, Continued	1313113.443	438222.9819	X	X				Center channel from R2-05 and adjacent to year 2000 point
R2-07		1313084.979	438008.1068	X	X				East shoreline at Poplar Point, overlap with year 2000 point, adjacent to F-417-217
R2-08		1313364.695	438029.7225	X	X				Thalweg depression northwest of R2-9, northeast of R2-15
R2-09		1313227.334	437989.9015	X	X				Outfall F-417-217; overlap with year 2000 sampling point
R2-10		1313703.081	438695.3161	X					Upstream of docks at Navy Yard, near north bank
R2-11		1313649.284	437730.725	X	X				Adjacent to F-008-706
R2-12		1314149.796	438212.1092	X	X				Center channel adjacent to year 2000 point
R2-13		1314221.072	437781.2335	X	X	X	X		Adjacent to NPDES 005
R2-14		1314704.189	437927.5695	X	X			X	Characterization for human health (pedestrian access to riverbank)
R2-15		1314982.036	438309.7912	X	X				Adjacent to NPDES 006
R2-16		1314887.401	438551.4911	X	X				Center channel from R2-8
R3-01	CSX Bridge to 11th Street Bridge	1315533.37	439246.5624	X					Thalweg, near southwest corner of Washington Gas
R3-02		1315750.988	439670.3168	X					Nearshore off of Washington Gas
R3-03		1316322.142	439825.0221	X					Mid channel forming transect with R3-16
R3-04		1316658.203	439509.358	X					Near shoreline opposite from Washington Gas, forming transect with R3-16
R3-05		1316692.834	440365.1788	X					Characterization for human health (pedestrian access to riverbank)
R3-06		1316990.141	440441.4596	X	X	X	X		Adjacent to F-405-220
R3-07		1317511.893	439986.2002	X	X				Outfall F-124-260 and a HPAH hotspot
R3-08		1317851.607	440825.6327	X	X				Adjacent to NPDES 018
R3-09		1318074.869	440586.0757	X	X			X	Center channel from R3-7
R3-10		1318815.528	441017.1725	X	X				Transect near Pennsylvania Ave. Bridge near year 2000 point
R3-11		1318946.525	440835.106	X	X				Transect near Pennsylvania Ave. Bridge near year 2000 point
R3-12		1319040.521	440649.3909	X	X		X		Transect near Pennsylvania Ave. Bridge near year 2000 point
R3-13		1319488.581	441192.246	X					Downstream of CSX railroad bridge near northwest bank
R3-14		1320045.969	441701.8485	X					Upstream of Pennsylvania Ave. Bridge near secondary thalweg along northwest bank
R3-15		1320574.629	441738.7819	X	X	X	X		Transect near CSX Bridge near year 2000 point; near Fort Davis tributary (F-238-290)
R3-16		1320354.203	441916.5843	X	X				Transect near CSX Bridge near year 2000 point
R4-01	East Capitol Street Bridge to CSX Bridge	1320136.133	442070.0674	X	X				Transect near CSX Bridge near year 2000 point
R4-02		1320858.304	442189.2779	X					Characterization for human health (pedestrian access to riverbank)

Location	Reach	X-Coordinate [1]	Y-Coordinate [1]	Surface Sediment	Deep Sediment	Pore Water [2]	Benthic Invertebrate Exposure [3,4]	Surface Water	Location Description
R4-03	East Capitol Street Bridge to CSX Bridge, Continued	1320659.665	442878.7468	X			X		HPAH hotspot downstream from Kingman Lake confluence
R4-04		1321583.004	443272.631	X		X	X	X	East bank between Fort Dupont Creek outfall and CSX railroad bridge
R4-05		1321276.776	443524.2972	X			X	X	Northwest bank upstream of mouth of Kingman Slough
R4-06		1322464.619	444102.633	X			X		East bank north of Fort Dupont Creek Outfall
R4-07		1322908.5	445147.8984	X					Characterization for human health (pedestrian access to riverbank)
R4-08		1322678.191	445359.2928	X	X				Transect near East Capitol St. Bridge
R4-09		1322939.667	445264.976	X	X	X	X		Transect near East Capitol St. Bridge; near Chaplin tributary (F-903-371) and 2000 point
R5-01	Benning Road Bridge to East Capitol Street Bridge	1322669.696	446301.1005	X					Characterization for human health (pedestrian access to
R5-02		1322989.863	446724.8169	X	X				Adjacent to F-090-064
R5-03		1323202.587	447537.7795	X	X				Transect downstream from year 2000 transect
R5-04		1323088.742	447545.017	X	X	X	X	X	Transect downstream from year 2000 transect
R5-05		1323288.111	447654.7041	X				X	Characterization for human health (pedestrian access to riverbank)
R6-01	Amtrak Bridge to Benning Road Bridge	1323367.744	448339.7195	X	X				At mouth of inlet for outfall at southwest boundary of the Pepco site
R6-02		1323051.993	448462.6424	X					Center channel off of Pepco site; near ANS 2000 sample (concentration 1119 ug/kg)
R6-03		1323359.567	449513.8193	X	X				Mid-channel off of Pepco site
R6-04		1323624.264	449636.8555	X	X				At south side of mouth of inlet for outfall at northwest boundary of the Pepco site
R6-05		1324027.789	449656.7436	X					Mouth of outfall at northwest boundary of the Pepco site
R6-06		1324156.594	450575.13	X				X	Nearshore sediment bar off of Kenilworth Park South Landfill, in transect with R6-17
R6-07		1323886.803	450657.811	X	X			X	West bank near Kenilworth Park South Landfill
R6-08		1324338.196	451289.4064	X					Bar at mouth of Watts Branch; near ANS 2000 sample (concentration 599 ug/kg)
R6-09		1324492.666	451916.022	X	X				Mouth of Hickey Run near existing elevated year 2000 point
R6-10		1324813.523	452180.8646	X	X				Nearshore off of Kenilworth Park North Landfill
R6-11		1325197.375	453023.1304	X	X				Center channel near Kenilworth Park North Landfill
R6-12		1325258.147	453465.2087	X					Characterization for human health (pedestrian access to riverbank)
R6-13		1325683.15	454437.3665	X	X	X	X		Sharp meander upstream of Kenilworth Park North Landfill
R6-14		1325563.316	454493.5088	X					Sharp meander upstream of Kenilworth Park North Landfill

Location	Reach	X-Coordinate [1]	Y-Coordinate [1]	Surface Sediment	Deep Sediment	Pore Water [2]	Benthic Invertebrate Exposure [3,4]	Surface Water	Location Description
R6-15	Amtrak Bridge to Benning Road Bridge, Continued	1327553.264	454747.3011	X	X				North bank between year 2000 transects
R6-16		1327937.661	454774.1439	X					Characterization for human health (pedestrian access to riverbank)
R6-17		1328448.823	455305.2344	X	X	X	X		Confluence with Lower Beaverdam Creek
R7-01	Upper tidal limit to Amtrak Bridge	1328775.804	455658.7114	X	X				Transect at New York Ave. Bridge near existing year 2000 point
R7-02		1328565.246	455676.7888	X	X		X		Transect at New York Ave. Bridge near existing year 2000 point
R7-03		1329395.839	456733.454	X					Characterization for human health (pedestrian access to riverbank)
R7-04		1329806.313	457215.4543	X	X				Transect near confluence with Dueling Creek
R7-05		1329671.034	457266.8231	X	X		X		Transect near confluence with Dueling Creek
R7-06		1329865.322	458314.494	X	X	X	X		Center channel downstream from unnamed wetland tributary
R7-07		1329696.624	458706.5218	X					West bank near Colmar Manor Community Park
R7-08		1329646.698	459534.3696	X	X				Near year 2000 transect
R7-09		1329751.484	459572.2662	X	X		X		Near year 2000 transect
R7-10		1329600.396	460333.4974	X			X		Center channel midway between R7-7 and R7-8
R7-11		1329526.858	461067.1295	X	X				Located near year 2000 point; transect with R7-9
R7-12		1329807.263	461192.2365	X	X		X		Confluence with unnamed tributary at outfall PG-TMP-13
R7-13		1329574.114	461482.5736	X	X				Thalweg near Bladensburg marina
R7-14		1329767.955	461680.8407	X					Adjacent to shoreline at Bladensburg marina
R7-15		1329448.831	461927.0388	X		X	X		Center channel sediment bar; near year 2000 transect
R7-16		1329519.907	461985.3588	X				X	Center channel sediment bar; near year 2000 transect
R7-17		1329536.434	462326.3941	X	X			X	North of mid-channel bar to the north of Bladensburg marina
R7-18		1329042.264	462536.0083	X					Characterization for human health (pedestrian access to riverbank)
R7-19		1329200.445	462692.0558	X	X				Confluence with unnamed tributary at outfall PG-TMP-5
R7-20		1328871.497	463063.7053	X			X		Southeast of Bladensburg Road Bridge along northeast bank
R7-21		1328108.678	464267.813	X			X		Center channel sediment bar
R7-22		1328090.808	464964.2467	X	X		X		Upstream on Northwest Branch
R7-23		1328750.168	465398.5888	X	X		X		Upstream on Northeast Branch near year 2000 point
KL-01	Kingman Lake	1320995.014	443771.9317	X	X	X	X		Downstream near mouth of Kingman Lake
KL-02		1321654.712	444968.4281	X	X		X		South of East Capitol St. Bridge
KL-03		1322018.352	445278.2842	X	X				Adjacent to East Capitol St. Bridge
KL-04		1321552.082	445797.8949	X	X				Downstream from F-284-041

Location	Reach	X-Coordinate [1]	Y-Coordinate [1]	Surface Sediment	Deep Sediment	Pore Water [2]	Benthic Invertebrate Exposure [3,4]	Surface Water	Location Description
KL-05	Kingman Lake, Continued	1322217.611	446004.1532	X					East channel north of East Capitol Street and south of Benning Road
KL-06		1321454.341	446147.3617	X	X				Downstream from unnamed outfall on west bank
KL-07		1321308.963	446556.6408	X	X				Downstream from F-611-365
KL-08		1321732.488	446797.5549	X	X	X	X		Mud flat north of East Capitol St. Bridge, near footbridge
KL-09		1321600.826	446856.7148	X	X		X		Main channel of west arm between E. Capitol St and Benning Rd
KL-10		1322120.131	446957.9466	X	X	X	X		East channel north of East Capitol Street and south of Benning Road
KL-11		1321995.513	447449.6967	X	X				Main channel south of Benning Road
KL-12		1322030.583	448388.8869	X	X		X		Downstream from F-991-021
KL-13		1322163.392	448695.4592	X					Characterization for human health (pedestrian access to riverbank)
KL-14		1322026.698	449482.1329	X	X				Downstream from F-052-384
KL-15		1322417.952	449733.9056	X	X		X		Channel in northern silted-in portion of Kingman Lake
KL-16		1322634.732	450112.0202	X	X				Channel in northern silted-in portion of Kingman Lake
KL-17		1322314.84	450294.875	X	X				Channel in northern silted-in portion of Kingman Lake
KL-18		1323122.949	450277.1857	X					Characterization for human health (pedestrian access to riverbank)
KL-19		1323062.988	450899.532	X					Mud flat in northern silted-in portion of Kingman Lake
KL-20		1323328.334	451244.0482	X	X	X	X	X	Channel in northern silted-in portion of Kingman Lake
KL-21		1323166.515	451661.4347	X	X		X		Channel in northern silted-in portion of Kingman Lake
KL-22		1324181.805	451822.5546	X	X				Upstream mouth of Kingman Lake
KL-23		1324240.658	451899.588	X	X		X		Mudflat adjacent to upstream mouth of Kingman Lake

Notes

1. X and Y coordinates are presented in North American Datum 83.
2. Pore water will be collected from surface sediment samples and will be laboratory-extracted.
3. It is assumed that half of the 42 benthic invertebrate sampling locations will yield adequate invertebrate tissue for chemical analysis (150 grams).
4. If no benthic invertebrates or a limited number benthic invertebrates are observed at a benthic invertebrate sampling location, only a sample for toxicity testing will be collected.
5. Fish tissue sampling locations are not mutually exclusive with sediment sampling locations, and fish tissue sample locations are summarized on Table 4.2.

Media	Number of Samples	Analysis[1]
Sediment	**Surface sediment**: 134 samples (0-0.5 feet bss)	**All Samples** • Priority pollutants • 209 PCB congeners • Alkylated polycyclic aromatic hydrocarbons (PAHs)2 • Grain size • Total organic carbon • Moisture content/percent solids • Oxidation/Reduction Potential • pH **42 Benthic Exposure Samples** • PCDD/PCDF • Acid volatile sulfides/simultaneously extracted metals (AVS/SEM) • Bulk density • Atterberg limits
	Subsurface sediment: 243 samples (3 samples from each 10-foot core collected at 81 locations)	**All Samples** • Priority pollutants • Grain size • Total organic carbon **42 Benthic Exposure Sample Locations** • 209 PCB congeners • PCDD/PCDF • Moisture content/percent solids • Bulk density • Atterberg limits
Pore water	19 samples with pore water extraction performed in the laboratory	• Priority pollutants (except VOCs) • Alkylated PAHs • PCDD/PCDF • Total organic carbon • Dissolved organic carbon • Specific Conductance • Oxidation/Reduction Potential • pH
Surface Water	14 samples	• TAL metals plus mercury (total and dissolved) • Semi-volatile organic compounds (SVOCs) • Pesticides • PCB Aroclors • 209 PCB Congeners • PCDD/PCDF • Common ions[3] • Total organic carbon • Total suspended solids • Total dissolved solids • Field parameters (pH, specific conductance,

Media	Number of Samples	Analysis[1]
		oxidation/reduction potential, dissolved oxygen, turbidity)
Fish, Crayfish, and Turtle Tissue	46 samples collected for use in ecological risk assessment (ERA) and/or human health risk assessment (HHRA)	• TAL metals plus mercury • PCB Aroclors • 209 PCB Congeners • Total Chlordane • Total DDTs • Dieldrin • Heptachlor epoxide • SVOCs • PCDD/PCDF • Lipids • Moisture content
Benthic Invertebrate Tissue	Estimated 21 samples collocated with surficial sediment locations (dependent on recovery of invertebrates in sediment).	• TAL metals plus mercury • PCB Aroclors • 209 PCB Congeners • Total Chlordane • Total DDTs • Dieldrin • Heptachlor epoxide • SVOCs • Alkylated PAHs • PCDD/PCDF • Lipids • Moisture content
Toxicity Testing	Estimated 21 surficial sediment samples collocated with surficial sediment locations analyzed for chemical constituents (see Row 1 of this table; benthic exposure samples)	• 42-day *Hyalella azteca* direct exposure test • 10-day *Chironomus dilutus* direct exposure test

1. Analysis Methods:
   - Priority pollutants analyses methods (sediment and water): VOCs by EPA Method 8260C, SVOCs by EPA Method 8270D LL, metals by EPA Method 6020A, mercury by EPA Method 7471B, pesticides by EPA Method 8081B LL, PCB Aroclors by EPA Method 8082A LL, dioxins and furans by EPA Method 1613B, total cyanide by EPA Method 9014.
   - Alkylated PAHs (sediment and water): analyzed by EPA Method 8270M
   - PCB congeners (sediment and water): analyzed by EPA Method 1668A
   - Common ions methods (water): sulfate, nitrate, and chloride by EPA Method 300.0; alkalinity by EPA Method 2520B; hardness by EPA Method 2340.
   - Total organic carbon: EPA Method 5310C (water); Lloyd Kahn (sediment)
   - AVS/SEM (sediment): EPA Method AVS/SEM
2. Alkylated PAHs: 34 alkylated PAHs as defined in EPA (2003): Procedures for the derivation of equilibrium partitioning sediment benchmarks for the protection of benthic organisms: PAH mixtures, EPA 600-R-02-013.
3. Common ions include sulfate, nitrate, chloride, alkalinity, and hardness.

Location	Reach	Characterization Objective [1]	Pore Water[2]	Deep Sediment	Rationale	Proximate to Existing Sample	Location Description
WC-01	Washington Channel	RI		X	Spatial Coverage	N	Mouth of Washington Channel
WC-02		RI			Spatial Coverage		West side of Washington Channel, on slope between bank and thalweg
WC-03		RI			Spatial Coverage	N	Center of Washington Channel, midway between two existing sample points
WC-04		RI			Outfall	N	Outfall F-073-094
WC-07		RI		X	Spatial Coverage	N	Center of Washington Channel, midway between WC-1 and existing sample point
WC-08		RI			Spatial Coverage	N	Mid-channel offshore from Outfall F-518-460
WC-09		RI/NRDA	X	X	Outfall	N	Outfall F-477-703 North of I-395 Bridge
WC-10		RI			Spatial Coverage	N	Mid-channel offshore from WC-4 and WC-1A
WC-11		RI			Outfall	N	Outfall F-290-057 North of I-395 Bridge
WC-05		NRDA			Spatial Coverage	N	Adjacent to marina dock
WC-06		NRDA	X		Spatial Coverage	N	Adjacent to marina dock
R1-01	South Capitol Street Bridge to Mouth of River	RI			Verification	Y	HPAH hotspot at mouth of Anacostia River
R1-02		RI/NRDA		X	Outfall	N	Adjacent to Outfall F-128-495
R1-03		RI			Spatial Coverage		Offshore near confluence of Washington Channel and Anacostia River
R1-04		RI			Spatial Coverage		Confluence of Washington Channel and Anacostia River
R1-06		RI			Spatial Coverage	N	Fort McNair Marina
R1-08		RI		X	Verification	Y	HPAH hotspot southeast of R1-5
R1-09		RI			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)
R1-10		RI			Spatial Coverage		Slope northwest of thalweg between utility corridors
R1-11		RI		X	Spatial Coverage	N	Center channel, coverage of unsampled portion of channel
R1-12		RI/NRDA		X	Outfall	N	West bank near F-093-544 coverage of unsampled portion of channel
R1-13		RI/NRDA	X	X	Spatial Coverage	N	Thalweg between utility corridors, coverage of unsampled portion of channel

Location	Reach	Characterization Objective [1]	Pore Water[2]	Deep Sediment	Rationale	Proximate to Existing Sample	Location Description
R1-14	South Capitol Street Bridge to Mouth of River, Continued	RI			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)
R1-05		NRDA			Outfall	N	North band at Outfall F-937-544
R1-07		NRDA	X		Spatial Coverage	N	Near south bank, just upstream from confluence with Washington Channel
R2-01	11th Street Bridge to South Capitol Street Bridge	RI		X	Verification	Y	Overlap with year 2000 data point; east shoreline at Poplar Point
R2-02		RI		X	Spatial Coverage	N	East shoreline at Poplar Point
R2-03		RI		X	Spatial Coverage	N	Center channel, offshore from R2-2
R2-04		RI/NRDA	X	X	Outfall	Y	East shoreline at Poplar Point, at Sewer Outfall F-897-104
R2-05		RI		X	Spatial Coverage	N	Center channel from R2-4
R2-06		RI		X	Verification	Y	Center channel from R2-05 and adjacent to year 2000 point
R2-07		RI		X	Outfall, Verification	Y	East shoreline at Poplar Point, overlap with year 2000 point, adjacent to F-417-217
R2-08		RI		X	Spatial Coverage	N	Thalweg depression northwest of R2-9, northeast of R2-15
R2-09		RI		X	Outfall, Verification	Y	Outfall F-417-217; overlap with year 2000 sampling point
R2-10		RI			Verification		Upstream of docks at Navy Yard, near north bank
R2-11		RI		X	Outfall	N	Adjacent to F-008-706
R2-12		RI		X	Verification	Y	Center channel adjacent to year 2000 point
R2-13		RI/NRDA	X	X	Outfall	N	Adjacent to NPDES 005
R2-14		RI		X	Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)
R2-15		RI		X	Outfall	N	Adjacent to NPDES 006
R2-16		RI		X	Spatial Coverage	N	Center channel from R2-8
R3-01	CSX Bridge to 11th Street Bridge	RI			Verification	Y	Thalweg, near southwest corner of Washington Gas
R3-02		RI			Spatial Coverage	N	Nearshore off of Washington Gas
R3-03		RI			Spatial Coverage	N	Mid channel forming transect with R3-16
R3-04		RI			Spatial Coverage	N	Near shoreline opposite from Washington Gas, forming transect with R3-16

Location	Reach	Characterization Objective [1]	Pore Water[2]	Deep Sediment	Rationale	Proximate to Existing Sample	Location Description
R3-05	CSX Bridge to 11th Street Bridge, Continued	RI			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)
R3-06		RI/NRDA	X	X	Outfall	N	Adjacent to F-405-220
R3-07		RI		X	Verification, Outfall	Y	Outfall F-124-260 and a HPAH hotspot
R3-08		RI		X	Outfall	N	Adjacent to NPDES 018
R3-09		RI		X	Spatial Coverage	N	Center channel from R3-7
R3-10		RI		X	Verification	Y	Transect near Pennsylvania Ave. Bridge near year 2000 point
R3-11		RI		X	Verification	Y	Transect near Pennsylvania Ave. Bridge near year 2000 point
R3-12		RI/NRDA		X	Verification	Y	Transect near Pennsylvania Ave. Bridge near year 2000 point
R3-13		RI			Spatial Coverage		Downstream of CSX railroad bridge near northwest bank
R3-14		RI			Spatial Coverage		Upstream of Pennsylvania Ave. Bridge near secondary thalweg along northwest bank
R3-15		RI/NRDA	X	X	Verification, Outfall	Y	Transect near CSX Bridge near year 2000 point; near Fort Davis tributary (F-238-290)
R3-16		RI		X	Spatial Coverage	Y	Transect near CSX Bridge near year 2000 point
R4-01	East Capitol Street Bridge to CSX Bridge	RI		X	Verification	Y	Transect near CSX Bridge near year 2000 point
R4-02		RI			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)
R4-07		RI			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)
R4-08		RI		X	Spatial Coverage	N	Transect near East Capitol St. Bridge
R4-09		RI/NRDA	X	X	Verification, Outfall	Y	Transect near East Capitol St. Bridge; near Chaplin tributary (F-903-371) and 2000 point
R4-03		NRDA			Verification	Y	HPAH hotspot downstream from Kingman Lake confluence

Location	Reach	Characterization Objective [1]	Pore Water[2]	Deep Sediment	Rationale	Proximate to Existing Sample	Location Description
R4-04	East Capitol Street Bridge to CSX Bridge, Continued	NRDA	X		Spatial Coverage	N	East bank between Fort Dupont Creek outfall and CSX railroad bridge
R4-05		NRDA			Spatial Coverage		Northwest bank upstream of mouth of Kingman Slough
R4-06		NRDA			Spatial Coverage	N	East bank north of Fort Dupont Creek Outfall
R5-01	Benning Road Bridge to East Capitol Street Bridge	RI			Spatial Coverage	N	Characterization for human health
R5-02		RI		X	Outfall	N	Adjacent to F-090-064
R5-03		RI		X	Verification	Y	Transect downstream from year 2000 transect
R5-04		RI/NRDA	X	X	Verification	Y	Transect downstream from year 2000 transect
R5-05		RI			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)
R6-01	Amtrak Bridge to Benning Road Bridge	RI		X	Spatial Coverage	N	At mouth of inlet for outfall at southwest boundary of the Pepco site
R6-02		RI			Spatial Coverage	Y	Center channel off of Pepco site; near ANS 2000 sample (concentration 1119 ug/kg)
R6-03		RI		X	Spatial Coverage	N	Mid-channel off of Pepco site
R6-04		RI		X	Spatial Coverage	N	At south side of mouth of inlet for outfall at northwest boundary of the Pepco site
R6-05		RI			Spatial Coverage	N	Mouth of outfall at northwest boundary of the Pepco site
R6-06		RI			Spatial Coverage	N	Nearshore sediment bar off of Kenilworth Park South Landfill, in transect with R6-17
R6-07		RI		X	Spatial Coverage	N	West bank near Kenilworth Park South Landfill
R6-08		RI			Spatial Coverage	Y	Bar at mouth of Watts Branch; near ANS 2000 sample (concentration 599 ug/kg)
R6-09		RI		X	Verification	Y	Mouth of Hickey Run near existing elevated year 2000 point
R6-10		RI		X	Spatial Coverage	N	Nearshore off of Kenilworth Park North Landfill
R6-11		RI		X	Spatial Coverage	N	Center channel near Kenilworth Park North Landfill

Location	Reach	Characterization Objective [1]	Pore Water[2]	Deep Sediment	Rationale	Proximate to Existing Sample	Location Description
R6-12	Amtrak Bridge to Benning Road Bridge, Continued	RI			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)
R6-13		RI/NRDA	X	X	Spatial Coverage	N	Sharp meander upstream of Kenilworth Park North Landfill
R6-14		RI			Spatial Coverage		Sharp meander upstream of Kenilworth Park North Landfill
R6-15		RI		X	Spatial Coverage	N	North bank between year 2000 transects
R6-16		RI			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)
R6-17		RI/NRDA	X	X	Verification, Outfall	Y	Confluence with Lower Beaverdam Creek
R7-01	Upper tidal limit to Amtrak Bridge	RI		X	Verification	Y	Transect at New York Ave. Bridge near existing year 2000 point
R7-02		RI/NRDA		X	Verification	Y	Transect at New York Ave. Bridge near existing year 2000 point
R7-03		RI			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)
R7-04		RI		X	Spatial Coverage	N	Transect near confluence with Dueling Creek
R7-05		RI/NRDA		X	Spatial Coverage	N	Transect near confluence with Dueling Creek
R7-06		RI/NRDA	X	X	Spatial Coverage	N	Center channel downstream from unnamed wetland tributary
R7-07		RI			Spatial Coverage		West bank near Colmar Manor Community Park
R7-08		RI		X	Verification	Y	Near year 2000 transect
R7-09		RI/NRDA		X	Spatial Coverage	Y	Near year 2000 transect
R7-11		RI		X	Spatial Coverage	Y	Located near year 2000 point; transect with R7-9
R7-12		RI/NRDA		X	Outfall	N	Confluence with unnamed tributary at outfall PG-TMP-13
R7-13		RI		X	Spatial Coverage	N	Thalweg near Bladensburg marina
R7-14		RI			Spatial Coverage	N	Adjacent to shoreline at Bladensburg marina
R7-15		RI/NRDA	X		Verification	Y	Center channel sediment bar; near year 2000 transect
R7-16		RI			Verification	Y	Center channel sediment bar; near year 2000 transect

Location	Reach	Characterization Objective [1]	Pore Water[2]	Deep Sediment	Rationale	Proximate to Existing Sample	Location Description
R7-17	Upper tidal limit to Amtrak Bridge, Continued	RI		X	Spatial Coverage	N	North of mid-channel bar to the north of Bladensburg marina
R7-18		RI			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)
R7-19		RI		X	Outfall	N	Confluence with unnamed tributary at outfall PG-TMP-5
R7-21		RI/NRDA			Spatial Coverage	N	Center channel sediment bar
R7-22		RI/NRDA		X	Spatial Coverage	N	Upstream on Northwest Branch
R7-23		RI/NRDA		X	Spatial Coverage	Y	Upstream on Northeast Branch near year 2000 point
R7-10		NRDA			Spatial Coverage	N	Center channel midway between R7-7 and R7-8
R7-20		NRDA			Spatial Coverage	N	Southeast of Bladensburg Road Bridge along northeast bank
KL-01	Kingman Lake	RI/NRDA	X	X	Spatial Coverage	N	Downstream near mouth of Kingman Lake
KL-02		RI/NRDA		X	Spatial Coverage	N	South of East Capitol St. Bridge
KL-03		RI		X	Spatial Coverage	N	Adjacent to East Capitol St. Bridge
KL-04		RI		X	Outfall	N	Downstream from F-284-041
KL-05		RI			Spatial Coverage		East channel north of East Capitol Street and south of Benning Road
KL-06		RI		X	Outfall	N	Downstream from unnamed outfall on west bank
KL-07		RI		X	Outfall	N	Downstream from F-611-365
KL-08		RI/NRDA	X	X	Spatial Coverage	N	Mud flat north of East Capitol St. Bridge, near footbridge
KL-09		RI/NRDA		X	Spatial Coverage	N	Main channel of west arm between E. Capitol St and Benning Rd
KL-10		RI/NRDA	X	X	Spatial Coverage	N	East channel north of East Capitol Street and south of Benning Road
KL-11		RI		X	Spatial Coverage	N	Main channel south of Benning Road
KL-12		RI/NRDA		X	Outfall	N	Downstream from F-991-021
KL-13		RI			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)
KL-14		RI		X	Outfall	N	Downstream from F-052-384

Location	Reach	Characterization Objective [1]	Pore Water[2]	Deep Sediment	Rationale	Proximate to Existing Sample	Location Description
KL-15	Kingman Lake, Continued	RI/NRDA		X	Spatial Coverage	N	Channel in northern silted-in portion of Kingman Lake
KL-16		RI		X	Spatial Coverage	N	Channel in northern silted-in portion of Kingman Lake
KL-17		RI		X	Spatial Coverage	N	Channel in northern silted-in portion of Kingman Lake
KL-18		RI			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)
KL-19		RI			Spatial Coverage	N	Mud flat in northern silted-in portion of Kingman Lake
KL-20		RI/NRDA	X	X	Spatial Coverage	N	Channel in northern silted-in portion of Kingman Lake
KL-21		RI/NRDA		X	Spatial Coverage	N	Channel in northern silted-in portion of Kingman Lake
KL-22		RI		X	Spatial Coverage	N	Upstream mouth of Kingman Lake
KL-23		RI/NRDA		X	Spatial Coverage	N	Mudflat adjacent to upstream mouth of Kingman Lake

Notes

1. Characterization Objective: RI - Remedial investigation (including ecological and human health risk assessments); NRDA - Natural Resources Damage Assessment.
2. Pore water will be collected from surface sediment samples and will be laboratory-extracted.

Location	Reach	Characterization Objective [1]	Pore Water[2]	Location
WC-09	Washington Channel	RI/NRDA	X	Outfall F-477-703 North of I-395 Bridge
WC-06		NRDA	X	Adjacent to marina dock
WC-05		NRDA		Adjacent to marina dock
R1-02	South Capitol Street Bridge to Mouth of River	RI/NRDA		Adjacent to Outfall F-128-495
R1-05		NRDA		North band at Outfall F-937-544
R1-07		NRDA	X	Near south bank, just upstream from confluence with Washington Channel
R1-12		RI/NRDA		West bank near F-093-544 coverage of unsampled portion of channel
R1-13		RI/NRDA	X	Thalweg between utility corridors, coverage of unsampled portion of channel
R2-04	11th Street Bridge to South Capitol Street Bridge	RI/NRDA	X	East shoreline at Poplar Point, at Sewer Outfall F-897-104
R2-13		RI/NRDA	X	Adjacent to NPDES 005
R3-06	CSX Bridge to 11th Street Bridge	RI/NRDA	X	Adjacent to F-405-220
R3-12		RI/NRDA		Transect near Pennsylvania Ave. Bridge near year 2000 point
R3-15		RI/NRDA	X	Transect near CSX Bridge near year 2000 point; near Fort Davis tributary (F-238-290)
R4-09	East Capitol Street Bridge to CSX Bridge	RI/NRDA	X	Transect near East Capitol St. Bridge; near Chaplin tributary (F-903-371) and 2000 point
R4-03		NRDA		HPAH hotspot downstream from Kingman Lake confluence
R4-04		NRDA	X	East bank between Fort Dupont Creek outfall and CSX railroad bridge
R4-05		NRDA		Northwest bank upstream of mouth of Kingman Slough
R4-06		NRDA		East bank north of Fort Dupont Creek Outfall
R5-04	Benning Road Bridge to East Capitol Street Bridge	RI/NRDA	X	Transect downstream from year 2000 transect
R6-13	Amtrack Bridge to Benning Road	RI/NRDA	X	Sharp meander upstream of Kenilworth Park North Landfill
R6-17		RI/NRDA	X	Confluence with Lower Beaverdam Creek
R7-02	Upper tidal limit to Amtrak Bridge	RI/NRDA		Transect at New York Ave. Bridge near existing year 2000 point
R7-05		RI/NRDA		Transect near confluence with Dueling Creek
R7-06		RI/NRDA	X	Center channel downstream from unnamed wetland tributary
R7-09		RI/NRDA		Near year 2000 transect
R7-12		RI/NRDA		Confluence with unnamed tributary at outfall PG-TMP-13
R7-15		RI/NRDA	X	Center channel sediment bar; near year 2000 transect

Location	Reach	Characterization Objective [1]	Pore Water[2]	Location
R7-21	Upper tidal limit to Amtrak Bridge, Continued	RI/NRDA		Center channel sediment bar
R7-23		RI/NRDA		Upstream on Northeast Branch near year 2000 point
R7-22		RI/NRDA		Upstream on Northwest Branch
R7-10		NRDA		Center channel midway between R7-7 and R7-8
R7-20		NRDA		Southeast of Bladensburg Road Bridge along northeast bank
KL-01	Kingman Lake	RI/NRDA	X	Downstream near mouth of Kingman Lake
KL-02		RI/NRDA		South of East Capitol St. Bridge
KL-08		RI/NRDA	X	Mud flat north of East Capitol St. Bridge, near footbridge
KL-09		RI/NRDA		Main channel of west arm between E. Capitol St and Benning Rd
KL-10		RI/NRDA	X	East channel north of East Capitol Street and south of Benning Road
KL-12		RI/NRDA		Downstream from F-991-021
KL-15		RI/NRDA		Channel in northern silted-in portion of Kingman Lake
KL-20		RI/NRDA	X	Channel in northern silted-in portion of Kingman Lake
KL-21		RI/NRDA		Channel in northern silted-in portion of Kingman Lake
KL-23		RI/NRDA		Mudflat adjacent to upstream mouth of Kingman Lake

Notes:

1. Characterization Objective: RI - Remedial investigation (including ecological and human health risk assessments); NRDA - Natural Resources Damage Assessment.
2. Pore water will be laboratory-extracted.

Location	Medium	Reach	Characterization Objective [1,2]	Ecological and Human Health Risk Assessment Rationale	Location
T-26-F	Tissue	Washington Channel	ERA/NRDA	ERA samples collected opportunistically at this location	Between Francis Case and 14th Street Bridges
T-25-F	Tissue	Washington Channel	ERA/NRDA	ERA samples collected opportunistically at this location	Near boat slips on east bank
T-23-F	Tissue	Washington Channel	ERA/NRDA	ERA samples collected opportunistically at this location	Near boat slips on east bank
T-20-F	Tissue	Washington Channel	ERA/NRDA	Spatial coverage	East bank Washington Channel near Titanic Memorial
T-19-F	Tissue	Washington Channel	ERA/NRDA	Spatial coverage	Center of Washington Channel near the National War College
T-33-F	Tissue	South Capitol Street Bridge to Mouth of River	ERA/NRDA	Contaminants may be elevated, and fish may congregate near bridge	Below 11th Street Bridge, east bank at pier
T-32-F	Tissue	South Capitol Street Bridge to Mouth of River	ERA/NRDA	Contaminants may be elevated, and fish may congregate near bridge	Below 11th Street Bridge, west bank at pier
T-30-F	Tissue	South Capitol Street Bridge to Mouth of River	ERA/NRDA	ERA samples collected opportunistically at this location	West bank at pier
T-28-F	Tissue	South Capitol Street Bridge to Mouth of River	ERA/NRDA	ERA samples collected opportunistically at this location	East bank at pier
T-17-F	Tissue	South Capitol Street Bridge to Mouth of River	ERA/NRDA	Spatial coverage	At confluence with Potomac
R1-5-SW	Surface water	South Capitol Street Bridge to Mouth of River	HHRA	Potential human recreational exposure	Colocated with surface sediment sample R1-5
R1-6-SW	Surface water	South Capitol Street Bridge to Mouth of River	HHRA	Potential human recreational exposure	Colocated with surface sediment sample R1-6
R2-14-SW	Surface water	11th Street Bridge to South Capitol Street Bridge	HHRA	Potential human recreational exposure	Colocated with surface sediment sample R2-14

Location	Medium	Reach	Characterization Objective [1,2]	Ecological and Human Health Risk Assessment Rationale	Location
T-38-F	Tissue	CSX Bridge to 11th Street Bridge	ERA/NRDA	Contaminants may be elevated, and fish may congregate near bridge	Below Pennsylvania Avenue Bridge, east bank
T-35-F	Tissue	CSX Bridge to 11th Street Bridge	ERA/NRDA	ERA samples collected opportunistically at this location	Boat slips on west bank below Pennsylvania Avenue Bridge
R3-9-SW	Surface water	CSX Bridge to 11th Street Bridge	HHRA	Potential human recreational exposure	Colocated with surface sediment sample R3-9
T-39-F	Tissue	East Capitol Street Bridge to CSX Bridge	ERA/NRDA	ERA samples collected opportunistically at this location	Boat slips on west bank
T-44-F	Tissue	East Capitol Street Bridge to CSX Bridge	ERA/NRDA	Spatial coverage	Main stem east bank
T-43-F	Tissue	East Capitol Street Bridge to CSX Bridge	ERA/NRDA	Spatial coverage	Main stem west bank
T-41-F	Tissue	East Capitol Street Bridge to CSX Bridge	ERA/NRDA	ERA samples collected opportunistically at this location	Below railroad bridge; fishing pier on east bank
R4-4-SW	Surface water	East Capitol Street Bridge to CSX Bridge	HHRA	Potential human recreational exposure	Colocated with surface sediment sample R4-4
R4-5-SW	Surface water	East Capitol Street Bridge to CSX Bridge	HHRA	Potential human recreational exposure	Colocated with surface sediment sample R4-5
T-51-F	Tissue	Benning Road Bridge to East Capitol Street Bridge	ERA/NRDA	Spatial coverage	Adjacent to F-090-064
T-47-F	Tissue	Benning Road Bridge to East Capitol Street Bridge	ERA/NRDA	Contaminants may be elevated, and fish may congregate near bridge	Near Whitney Street Memorial Bridge; main stem
R5-4-SW	Surface water	Benning Road Bridge to East Capitol Street Bridge	HHRA	Potential human recreational exposure	Colocated with surface sediment sample R5-4
R5-5-SW	Surface water	Benning Road Bridge to East Capitol Street Bridge	HHRA	Potential human recreational exposure	Colocated with surface sediment sample R5-5

Location	Medium	Reach	Characterization Objective [1,2]	Ecological and Human Health Risk Assessment Rationale	Location
T-66-F	Tissue	Amtrak Bridge to Benning Road Bridge	ERA/NRDA	Contaminants may be elevated, and fish may congregate near RR bridge; shallow tributary drains into river on east bank	Downstream of the railroad bridge; on east bank at mouth of tributary
T-64-F	Tissue	Amtrak Bridge to Benning Road Bridge	ERA/NRDA	Foraging area for green heron and other birds; likely fish nursery area and crayfish habitat	In channels within within mudflats on east bank (below Kenilworth Gardens)
T-62-F	Tissue	Amtrak Bridge to Benning Road Bridge	ERA/NRDA	Foraging area for green heron and other birds; likely fish nursery area and crayfish habitat	In main channel at entrance to mudflats (below Kenilworth Gardens)
R6-6-SW	Surface water	Amtrak Bridge to Benning Road Bridge	HHRA	Potential human recreational exposure	Colocated with surface sediment sample R6-6
R6-7-SW	Surface water	Amtrak Bridge to Benning Road Bridge	HHRA	Potential human recreational exposure	Colocated with surface sediment sample R6-7
T-60-F	Tissue	Amtrak Bridge to Benning Road Bridge	ERA/NRDA	Spatial coverage	Upstream from Kenilworth Park Landfill and confluence of Hickey Run
T-92-F	Tissue	Upper tidal limit to Amtrak Bridge	ERA/NRDA	Spatial coverage	Near Anacostia Tributary Trail (ATT) bridge
T-91-F	Tissue	Upper tidal limit to Amtrak Bridge	ERA/NRDA	Spatial coverage	Upstream on Northeast Branch, below Baltimore Avenue Bridge
T-90-F	Tissue	Upper tidal limit to Amtrak Bridge	ERA/NRDA	Spatial coverage	Sandbar accessible from ATT
T-89-F	Tissue	Upper tidal limit to Amtrak Bridge	ERA/NRDA	Narrow channel west of sandbar may provide refuge for fish away from main channel	Shoreline channel next to sandbar accessible from ATT
T-88-F	Tissue	Upper tidal limit to Amtrak Bridge	ERA/NRDA	Spatial coverage	Near Bladensburg Bridge

Location	Medium	Reach	Characterization Objective [1,2]	Ecological and Human Health Risk Assessment Rationale	Location
T-87-F	Tissue	Upper tidal limit to Amtrak Bridge	ERA/NRDA	Shallow area of apparent sediment deposition may be attractive to forage fish and their predators	Shallow narrow inlet on east bank near ATT bridge
T-86-F	Tissue	Upper tidal limit to Amtrak Bridge	ERA/NRDA	ERA samples collected opportunistically at this location	East bank south of ATT bridge; in deeper channel
T-85-F	Tissue	Upper tidal limit to Amtrak Bridge	ERA/NRDA	ERA samples collected opportunistically at this location	Piers associated with Bladensburg Waterfront Park
T-84-F	Tissue	Upper tidal limit to Amtrak Bridge	ERA/NRDA	ERA samples collected opportunistically at this location	Piers associated with Bladensburg Waterfront Park
T-83-F	Tissue	Upper tidal limit to Amtrak Bridge	ERA/NRDA	ERA samples collected opportunistically at this location	Piers associated with Bladensburg Waterfront Park
T-77-F	Tissue	Upper tidal limit to Amtrak Bridge	ERA/NRDA	Spatial coverage	Open channel
T-74-F	Tissue	Upper tidal limit to Amtrak Bridge	ERA/NRDA	Tidal channels within marsh may be attractive to forage fish and their predators	Near mouth of the tidal channels providing access to marsh on east bank
T-71-F	Tissue	Upper tidal limit to Amtrak Bridge	ERA/NRDA	Tidal channels within marsh may be attractive to forage fish and their predators	Near mouth of the tidal channels providing access to marsh on east bank
T-70-F	Tissue	Upper tidal limit to Amtrak Bridge	ERA/NRDA	The tributary appears very shallow at low tide, good habitat for forage fish (and crayfish) and their vertebrate predators	On west bank, downstream of small tributary with pier
T-68-F	Tissue	Upper tidal limit to Amtrak Bridge	ERA/NRDA	Contaminants may be elevated, and fish may congregate near bridge	Downstream of Route 50 bridge; on west bank
R7-16-SW	Surface water	Upper Tidal Limit to Amtrak Bridge	HHRA	Potential human recreational exposure	Colocated with surface sediment sample R7-16

Location	Medium	Reach	Characterization Objective [1,2]	Ecological and Human Health Risk Assessment Rationale	Location
R7-17-SW	Surface water	Upper Tidal Limit to Amtrak Bridge	HHRA	Potential human recreational exposure	Colocated with surface sediment sample R7-17
T-59-F	Tissue	Kingman Lake	ERA/NRDA	Shallow area off the main channel may suppoer forage fish and crayfish and their predators	North entrance to Kingman Channel
T-58-F	Tissue	Kingman Lake	ERA/NRDA	Forage area for numerous birds, including osprey	West backwater of Kingman Lake
T-56-F	Tissue	Kingman Lake	ERA/NRDA	Forage area for numerous birds, including osprey	West backwater of Kingman Lake
T-55-F	Tissue	Kingman Lake	ERA/NRDA	Spatial coverage in side channel	West backwater of Kingman Lake
T-53-F	Tissue	Kingman Lake	ERA/NRDA	Spatial coverage in side channel	North of Benning Road bridge
T-49-F	Tissue	Kingman Lake	ERA/NRDA	Quiet backwater may provide good foraging habitat for birds and mammals	Western tidal slough in Kingman Lake area
T-48-F	Tissue	Kingman Lake	ERA/NRDA	Contaminants may be elevated, and fish may congregate near bridge	Near Whitney Street Memorial Bridge, Kingman Lake
T-46-F	Tissue	Kingman Lake	ERA/NRDA	Quieter side channel may provide habitat for fishes	Ingress/egress to Kingman Lake from main Anacostia River
T-3-F	Tissue	Kingman Lake	ERA/NRDA	ERA samples collected opportunistically at this location	At pier in Kingman Lake
KL-20-SW	Surface water	Kingman Lake	HHRA	Potential human recreational exposure	Colocated with surface sediment sample KL-20
KL-25-SW	Surface water	Kingman Lake	HHRA	Potential human recreational exposure	Colocated with surface sediment sample KL-25

Notes:

1. Characterization Objective: ERA - Ecological Risk Assessment; HHRA - Human Health Risk Assessment; NRDA - Natural Resource Damage Risk Assessment.

2. All HHRA and ERA samples will be appropriate for inclusion in the NRDA dataset at a later date.

6.0 DATA EVALUATION AND REPORTING

This section describes the processes used to ensure the analytical data generated during the field effort are verified, validated, and documented. This section also addresses the synthesis of these data into the project database, the tasks to identify and document potential remaining data gaps and associated reporting, and the objectives moving forward for updating and revising the watershed model.

6.1 Data Evaluation

Field sampling will be conducted in accordance with the FSP which will address the required numbers, types, and locations of samples and the required types of field and laboratory analyses needed to achieve the project DQOs. The FSP will also indicate the procedures to be used to document sample collection including the chain of custody (CC) and laboratory analyses request documents. CCs and other field documentation will be reviewed on a daily basis to ensure accuracy and completeness. Any discrepancies will be resolved before samples are delivered to the laboratory.

Detailed DQOs will be defined along with quality control criteria and limits in the QAPP. Sampling and analytical methods were selected to meet the project DQOs and quality control criteria. Analytical data collected during this investigation will be verified and validated in accordance with USEPA Region 3 protocols (validation protocols). Validation of fixed-base laboratory analytical data will be performed at an acceptance level sufficient for risk assessment Level 4. Data verification is the process of evaluating the completeness, correctness, and conformance and compliance of a specific data set against method and procedural requirements. Data validation is an analyte- and sample-specific process to determine the analytical quality of a data set. Data quality flags as assigned by the analytical laboratory will be independently reviewed against the validation protocols. Individual values may be flagged as non-detect, detected and qualified (e.g., biased high, biased low, estimated, etc.), or rejected. An analysis result flagged as rejected cannot be used.

Following validation, the data will be incorporated into the project database. An initial goal will be to compare the surface sediment sampling results from the current event with the results from the ANS 2000 sampling event. The results of this comparison will verify usability of the ANS 2000 data for use in assessing the nature and extent of contamination and other project objectives. RI Data Report.

The data from the current sampling will be spatially evaluated to identify any potential remaining data gaps and to quantify zones of elevated concentrations. An RI Data Report will be prepared that will discuss project objectives, field data collection procedures, and analytical methods and summarize the data collection results. In the reporting and discussion of aggregated PCB and PAH results, the report will specify the method of calculation of the specific aggregation. For example, total PCB congeners will be calculated as the sum of the concentrations determined for the 209 PCB congeners; total PCB Aroclors will be the sum of the concentrations determined for the seven PP Aroclors. Similarly, total PAH will be determined as the sum of the 16 PP PAH concentrations. The Data Report will also include a discussion of data validation conducted in accordance with the approved QAPP. The report will also document the

management and disposal of investigation-derived wastes. Data tables will be used to denote locations where screening criteria are exceeded.

The data report will include:

- A summary of field activities and methods, including a discussion of any discrepancies with the sampling and analysis plan and the effect of such changes upon data usability.
- Rules for data reduction and use.
- Tabulated chemical, physical, and biological data.
- A sample identification matrix that relates sample identification numbers to sample locations.
- Maps showing actual sample locations.
- Field logs.
- Laboratory data sheets.

Lastly, the report will provide conclusions and recommendations regarding potential remaining data gap closure and associated strategies for moving forward to the RI Summary Report.

6.2 RI Summary Report

An RI Summary Report will be prepared that synthesizes the results of all investigations conducted during the RI. All data will be reported in tabular form, and various map overlays and other plots will be used to present the information. The pertinent features of the RI report will be a description of the investigations conducted, discussion of the nature and extent of contamination identified, characterization of potential migration pathways, evaluation of contaminant fate and transport, and incorporation of the baseline human health and ecological risk assessments. The RI portion of the report outline will follow the EPA guidance.

The RI Summary Report will include a summary of the historical data along with the data collected under this work plan. The RI Summary Report will include updates to the conceptual site model, the TAM/WASP model and current findings for the known environmental cleanup sites. The RI summary report will define the nature and extent of the contamination in the River, identify hot spots, summarize the sources of contamination and source control, and provide an evaluation of contaminant fate and transport including the results from the update of the TAM/WASP model.

The RI will evaluate the risk implications of potential exposure to sediments (surface and subsurface), surface water, and biota. This discussion will be based on the results of the baseline ERA and HHRA (and data used in these assessments) and subsurface sediment chemistry data.

The major topics of the RI will include:

- Environmental setting and previous investigations;
- Nature and extent of contamination;
- Contamination sources, pathways, and source control;
- Fate and transport of sediment and sediment-associated chemicals;
- Summaries of the risks identified in the baseline ERA and the HHRA

Ecological risk assessment and human health risk assessment summary reports will be prepared as attachments to the RI report, or as separate reports. These reports will summarize the findings for the ecological and human health risks from contaminants in the sediments, surface water, pore water and biota in the river. More information on the ecological and human health risk assessments are presented in **Sections 7 and 8** of this work plan.

6.3 Watershed Model Update and Revision

Once verification and validation of the RI data are complete, the data can be used to support efforts to update the hydrodynamic and fate and transport model for the tidal Anacostia River. As discussed in Behm and others (2003), the calibration process can include adjusting chemical load inputs (contributions from CSS outfalls, MS4 outfalls, tributaries, groundwater seepage, etc.), sediment/water partitioning coefficients, and other fate and transport parameters to achieve the best possible match between predicted water column, fish tissue, and sediment concentrations and observed concentrations. In addition, updating the watershed model may involve computer code modifications to allow treatment of a greater range of system processes (e.g., emulsification, photo-oxidation, biodegradation, etc.) that can be important in accessing the fate and transport of sediment contaminants. Alternatively, other computer modeling approaches may potentially be considered to augment the TAM/WASP model should the addition of these processes be deemed necessary by watershed stakeholders.

7.0 ECOLOGICAL RISK ASSESSMENT

The primary objective of the ERA is to determine whether site contaminants pose a current or potential risk to ecological receptors in the absence of remediation. The ERA will be used to determine whether remediation is necessary at the site, provide justification for performing remedial action, and determine which exposure pathways must be remediated. The areas to be addressed in the ERA include the Anacostia River (bank-to-bank) sediments, surface water, and related biota within the study area. Areas adjacent to the environmental cleanup sites may be excluded from the ERA because other entities may be responsible for characterization and assessment in these areas, as appropriate. On **Figure 1.1**, the excluded areas are denoted as "Area of Influence." As part of the RI, the ERA will be based on data collected during the RI field activities and other data available from other reliable sources, including historical data and data from the known environmental sites that are found to be usable based on the project DQOs.

This technical approach was based on both site specific and programmatic information, including the following: review of field investigations conducted on the Anacostia River; a review of supporting data on the river ecosystem; EPA guidance on ERAs; and knowledge of and experience with best practices in ERAs.

The physical characteristics and known environmental condition of the tidal Anacostia River are described in **Section 2.0**. The ecological CSM is presented in **Section 3.2**. Together, these discussions provide a context for the technical approach. General approaches to the SLERA and BERA are presented below.

7.1 SLERA

The SLERA will be conducted consistent with Steps 1 and 2 of EPA's 8-step ERA guidance for Superfund sites (EPA 1997a), discussions with DDOE staff, and applicable DDOE guidance. Two steps are involved in conducting a SLERA: (1) problem formulation and (2) screening level exposure estimate and risk calculation. Upon completion of Steps 1 and 2, the site must be evaluated for one of the three possible decisions summarized below.

1. There is enough information to conclude that potential ecological risks negligible and therefore no further action is warranted at the site on the basis of ecological risk.
2. The information is not adequate to make a decision at this point, and the ERA process will proceed to a BERA.
3. The information indicates a potential for adverse ecological effects, and a focused BERA is warranted.

Although many studies have been conducted on the tidal Anacostia River and evidence of ecological risk has been reported, completion of Steps 1 and 2 of the ERA process is a necessary element of the RI. It is reasonable to assume that the SLERA will support a decision that a BERA should be conducted (#2 above) because no formal BERA has addressed all the components of the tidal Anacostia ecosystem. The

following sections discuss problem formulation and screening-level exposure estimates and risk calculations for the SLERA.

7.1.1 Problem Formulation

The objective of the problem formulation step is to collect sufficient information concerning the Anacostia River Site to develop a CSM. The preliminary CSM, introduced in **Section 3.2**, includes a fate and transport diagram (**Figure 3.1**) that traces movements of contaminants through the ecosystem and identifies potential exposure pathways and receptors. One of the major goals of the CSM is to identify complete exposure pathways and receptors at potential risk.

7.1.1.1 Habitat Assessment

The purpose of the habitat assessment is to gather data necessary to identify potential ecological receptors and to support the development of a conceptual site model. The assessment will summarize existing information on habitat within the study area from other studies and the published literature. It will include the identification of the state and federal threatened and endangered species and DDOE species of concern likely to be present at the study site.

7.1.1.2 Assessment Endpoints

Assessment endpoints for a SLERA are focused on adverse effects on all potential ecological receptors. Key receptor groups associated with the Anacostia River include benthic invertebrates, fish, freshwater turtles, and semi-aquatic avian and mammalian receptors that may be exposed to contaminants in sediment, water, and food items in the river. Typical species and exposure pathways for ecological receptors in the Anacostia River are discussed in **Section 3.2.2** (Conceptual Site Model). Fate and transport mechanisms, ecotoxicological properties, habitats, and receptors at the site all influenced the selection of the assessment endpoints. The survival, growth, and reproduction of key organisms are considered ecological values to be protected. The general ecological management goal that will guide selection of assessment endpoints is summarized below:

- Ensure adequate protection of ecological systems within the tidal Anacostia River by protecting them from the deleterious effects of acute and chronic exposures to site-related COC.

The specific assessment endpoints for the SLERA are summarized below:

- Ensure adequate protection of the aquatic communities in the Anacostia River by protecting them from the deleterious effects of acute and chronic exposures to site-related COCs in sediment, surface water, and prey.
- Ensure adequate protection of the aquatic-dependent vertebrate populations (turtles, birds, and mammals) associated with the Anacostia River by protecting them from the deleterious effects of acute and chronic exposures due to uptake of site-related COCs in sediment, surface water, and prey.
- Ensure adequate protection of threatened and endangered species and species of special concern and their habitats in the Anacostia River by protecting them from the deleterious direct and indirect effects of acute and chronic exposures to site-related COCs.

"Adequate protection" generally is defined as protection of the growth, reproduction, and survival of local populations of typical species that are not listed under the Endangered Species Act. That is, the focus is on ensuring the sustainability of the local population rather than on protection of every individual in the population. Risk to federal- and state-listed threatened and endangered species will be evaluated in the ERA at the level of the individual, as required by the Endangered Species Act.

7.1.2 Measurement Endpoint

Measurement endpoints were selected to represent the species or communities of the Anacostia River ecosystem that can be directly evaluated. A measurement endpoint is "a measurable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint and is a measure of biological effects (such as mortality, reproduction, or growth)" (EPA 1997a). It is anticipated that receptors will be exposed to COCs primarily through direct contact with and ingestion of sediment, surface water, and food items. The inhalation pathway is considered minimal and will not be evaluated. Measurement endpoints in a SLERA are generally numeric criteria that can be used to support decisions about the potential for unacceptable risk. Ecological screening values (ESV) identified as measurement endpoints for the SLERA are discussed below for sediment, surface water, pore water, and biota.

7.1.2.1 Sediment

Potential risk to aquatic invertebrates and fish will be evaluated by comparing the concentrations of chemicals in sediment with toxicity benchmarks for aquatic organisms. No federal or state standards have been developed for chemicals in sediment. The chemical concentrations in sediments from the Anacostia River will be compared with the EPA Region 3 Freshwater Sediment Screening Benchmarks (**Table 2.5**) and available regional background concentrations.

7.1.2.2 Surface Water and Pore Water

Potential risk to aquatic invertebrates, fish, and freshwater turtles will be evaluated by comparing the maximum concentration of each chemical in surface water and pore water with toxicity benchmarks for aquatic organisms. Measurement endpoints for aquatic organisms exposed to surface water and pore water in the Anacostia River will be the District's aquatic life water quality standards (DC 2010).

Potential risk to aquatic receptors is indicated by surface water concentrations that exceed the water quality standards for chronic exposures (DC 2010). Chemicals with no District standards will be evaluated using EPA's national water quality standards. When constituent-specific criteria are not provided by either of these sources, the EPA Region 3 Freshwater Screening Benchmarks (EPA 2013b) will be used. Constituents for which no aquatic life criteria are available from any of the sources identified above will be carried forward into the BERA, as applicable, for further risk evaluation. These standards are not intended to be used as primary direct screening values for pore water. However, comparison of pore water concentrations with water quality standards can be considered as a separate line of evidence in evaluating potential risk to aquatic organisms.

7.1.2.3 Food Chain Model

For birds and mammals, ingested doses rather than direct toxicity are more typically evaluated in the ERA. Sediment and surface water direct toxicity criteria do not take into account the potential exposure of birds and mammals to chemicals within their food taken from the Anacostia River. Screening

benchmarks will consist of toxicity reference values (TRV) derived from the toxicological literature on reproductive and physiological effects of contaminants. Daily ingested doses will be estimated based on chemical concentrations in sediment, surface water, and prey in the river and information on natural history of avian and mammalian receptors. The measurement endpoint for birds and mammals will be a daily ingested dose of chemicals calculated using a food chain model (FCM). Dose estimates will then be compared with TRVs to assess potential risk, as described below.

The FCM assumes exposure to COCs primarily through ingestion of contaminated environmental sediment, surface water, and prey. Exposure models estimate the mass of a COC ingested daily by a receptor per kilogram of body weight per day (the daily COC dose). Estimates of exposure generally are based on knowledge of the spatial and temporal distribution of both COCs and receptors, and on specific natural and life history characteristics that influence exposure to COCs. Maximum detected concentrations of chemicals in surface sediment and surface water samples will be used in FCMs to estimate doses to avian and mammalian receptors in the SLERA.

Daily doses will be estimated for each COC and representative receptor when adequate data are available and these models are appropriate. Dose estimates will then be compared with a high and low TRV to estimate the potential adverse biological effects on the receptor. No observed adverse effect level (NOAEL) and lowest observed adverse effect level (LOAEL) TRVs will be used as low and high benchmarks, respectively, to evaluate potential risks to birds and mammals. The NOAEL TRV will represent the highest dose at which no adverse effects are expected to occur (*de minimis* risk). A receptor could potentially receive a daily dose that exceeds the NOAEL TRV and still not experience an adverse effect; thus, NOAEL TRVs are conservative and have the potential to over-estimate risk. The LOAEL TRV represents the lowest dose at which adverse effects have been detected. While typically less conservative than NOAEL TRVs, LOAEL TRVs are generally more representative of a natural toxicological response with meaningful ecological ramifications. The risk to each representative species will be characterized using a hazard quotient (HQ) approach based on this comparison.

The total exposure from ingestion for each receptor of concern will be calculated as the sum of the dietary exposure estimates. The following generic equation will be adapted for each representative receptor:

$$\mathrm{Dose}_{\mathrm{total}} = \frac{([\mathrm{IR}_{\mathrm{prey}} \times \mathrm{C}_{\mathrm{prey}}] + [\mathrm{IR}_{\mathrm{sed}} \times \mathrm{C}_{\mathrm{sed}}] + [\mathrm{IR}_{\mathrm{sw}} \times \mathrm{C}_{\mathrm{sw}}]) \times \mathrm{SUF}}{\mathrm{BW}}$$

where

$\mathrm{Dose}_{\mathrm{total}}$	=	Estimated dose from ingestion (mg/kg-day)
$\mathrm{IR}_{\mathrm{prey}}$	=	Ingestion rate of prey (kg/day)
$\mathrm{C}_{\mathrm{prey}}$	=	Concentration in DW of COC in prey (mg/kg)
$\mathrm{IR}_{\mathrm{sed}}$	=	Ingestion rate of sediment (kg/day)
$\mathrm{C}_{\mathrm{sed}}$	=	Concentration in DW of COC in sediment (mg/kg)
$\mathrm{IR}_{\mathrm{sw}}$	=	Ingestion rate of surface water (L/day)

C_{sw}	=	Concentration of COC in surface water (mg/L)
SUF	=	Site use factor (unitless)
BW	=	Adult body weight (kg)

The risk estimates developed in the SLERA will ensure that the assessment does not indicate little or no risk when a risk actually exists. Therefore, conservative assumptions will be used in this analysis in the absence of site- or species-specific data, such as maximum concentrations, site use factors of unity, and other conservative assumptions. Ecological receptors were selected based on species distributions reported in the literature (AWTA 2002; Galli et al. 2010; NPS 2010). Exposure will be assessed within the context of the following linear food chains to evaluate potential ecological effects on secondary consumer birds and mammals:

- Surface Water and Sediment → Benthos and Aquatic Life → Mink
- Surface Water and Sediment → Benthos and Aquatic Life → Green Heron

Site-specific prey data may not be available for use in the dose calculation described above. Therefore, bioaccumulation models will be used to estimate the concentrations of COCs in prey tissue based on the concentrations of COCs in sediment. Sediment-to-biota bioaccumulation models for benthic invertebrates and fish may be used, either as simple bioaccumulation factors (BAF) that can be multiplied by the concentration in the sediment or as regression models that incorporate the concentration in sediment to estimate the COC concentration in prey. Biota-sediment accumulation factors (BSAF) that incorporate the percent lipid in tissue and TOC in sediment may also be incorporated into the food chain models as appropriate.

Updated ecological sediment screening level BAFs, BSAFs, and regressions will be used whenever available. Additional regression models and simple BAFs (Bechtel-Jacobs Company, LLC 1998; Sample and Arenal 1999; Sample, Opresko, and Suter 1996; Baes, Sharp, Sjoreen, and Shor 1984; EPA 2005) will be chosen if no regression is available. A regression model will be applied only if the model is significant (the slope differs significantly [$p < 0.05$] from 0) and the coefficient of determination (R^2) is greater than or equal to 0.6. If these criteria are not met, another regression model, BAF, or BSAF will be selected to estimate bioaccumulation.

7.1.3 SLERA Exposure Estimates and Risk Calculations

The maximum concentration is considered a conservative estimate of the exposure point concentration (EPC) in the SLERA. In general, an estimate of exposure is compared with a relevant toxicologically-based screening value to yield an HQ representing potential risk, as shown in the equation below:

$$HQ = \frac{EPC}{ESV} \text{ or } \frac{Dose}{TRV}$$

An HQ threshold value of 1.0 will be used to identify COCs. Although probabilities cannot be specified based on a point-estimate approach, an HQ of less than 1.0 is generally regarded as indicating a low probability of adverse ecological effects. A constituent with an HQ greater than 1.0 is present at levels above its threshold concentration but may or may not pose actual risk.

7.1.4 SLERA Summary and Conclusions

One of the final objectives of the SLERA is to identify potential ecological risks that should be further characterized and refined in the BERA. EPA guidance has identified this as a risk management decision point. The SLERA will present a summary of the procedures used, the potential risks identified, and a discussion of the uncertainties associated with the results. Based on the results of the SLERA and the uncertainties, a risk management recommendation will be provided on whether a BERA is needed to support a final risk management decision. Based on review of existing data and prior studies, it is anticipated that a BERA will be conducted immediately following the SLERA. In the BERA, exposure assumptions are refined to reflect more realistic field conditions. Additional data may be collected in the BERA to measure field conditions that affect exposure, effects, and related risks.

7.2 BERA

Steps 3 through 8 of the ERA guidance constitute a BERA (EPA 1997a). The three principal phases of a BERA are problem formulation, study design and implementation, and risk characterization.

7.2.1 Problem Formulation – Refinement

The objective of the BERA problem formulation is to establish the risk assessment goals and focus, characterize potential ecological effects, update the CSM, refine exposure pathways, and establish the assessment endpoints.

As an initial step in BERA problem formulation, COCs identified during the SLERA will be re-evaluated to focus the BERA on COCs most likely to drive a remedial action. COCs that pose a negligible risk based on low magnitude (HQ near 1.0), low frequency of detection (less than 5 percent), or minimal difference from background may be eliminated from further consideration in the BERA.

Tetra Tech will review the recent toxicity literature for the COCs retained in the BERA to identify whether there are more relevant TRVs based on the NOAELs and LOAELs for site-specific receptors. The toxicity mechanism and function (acute or chronic) for each TRV also will be identified. The goal is to identify TRVs that are more appropriate for the species and exposure pathways expected at the site. Observations and biota collected during the field sample phase will be used to provide realistic adjustments to the conservative default assumptions of the SLERA.

Potentially complete exposure pathways identified in the SLERA CSM will be refined based on site-specific conditions. The fate and transport of each COC significantly affects potential exposure and effects at the site.

To complete the CSM for the BERA, measurement and assessment endpoints will be reviewed and modified as needed. Available literature will be reviewed to refine assumptions on distribution and abundance of species; conservation status; and natural history of key species (such as foraging behavior, habitat use, home range, and other site-specific information). Potential or known presence of federal- and state-identified threatened and endangered species and DDOE species of special concern will be evaluated.

The BERA endpoints will focus on specific exposure pathways for a variety of receptors. In the riverine habitats of the Anacostia River, these endpoints may include the following:

- Function and viability of the aquatic community (benthic invertebrates, fish, turtles);
- Function and viability of omnivorous mammals along the shoreline (represented by the mink and river otter);
- Function and viability of carnivorous birds along the shoreline (represented by the green heron and osprey).

Omnivorous and carnivorous birds and mammals are important consumers at the site and play a role in structuring the riverine community. Adverse effects on these top predators may initiate a cascade of adverse ecosystem effects because the loss of top predators generally leads to disruption of lower trophic levels.

7.2.2 Measurement Endpoints and Study Design

Measurement endpoints identified in the SLERA will be re-evaluated and revised as appropriate for the BERA, based on field observations and literature reviews.

The next step in the BERA will be to prepare a study design to clearly identify the lines of evidence and the measurement endpoints needed to evaluate risk to assessment endpoints. The following sections discuss the aquatic habitat study design and the FCM.

7.2.2.1 Sediment

The conservative sediment criteria and guidelines used in the SLERA will be reviewed and modified in the BERA, if appropriate. In cases where the conservative guidelines are retained, the full range of sediment exposure concentrations will be evaluated using probabilistic statistics rather than simply comparing the maximum sediment concentration with a toxicity benchmark.

Laboratory bioassays will provide a measure of direct toxicity to standardized test organisms under controlled exposure conditions. Bioassay results will be compared with both laboratory control samples and reference samples (if available). (The determination of reference sediment locations is still under review.)

7.2.2.2 Surface Water

The same measurement endpoints for surface water used in the SLERA will be used in the BERA because they are regulatory standards for the protection of aquatic life.

Estimated doses may be refined to reflect more realistic exposure scenarios in the Anacostia River. For example, site use factors and ingestion rates may be modified to represent a more typical exposure rather than the maximum exposure scenario for receptors that are not protected under the Endangered Species Act. Comparison with acute rather than chronic water quality standards can reflect more realistic exposure scenarios for typical species in the river.

7.2.2.3 Prey Tissue

The FCM used in the SLERA is based on maximum sediment and water concentrations and modeled tissue concentrations to estimate doses. To make the FCM more site specific and realistic, tissues of organisms from the Anacostia River will be analyzed for target chemicals. Where available, benthic invertebrates, such as crayfish and clams, will be collected. Fishes of a species and size likely to be eaten by birds and mammals will also be analyzed (see **Section 5.3**) It is anticipated that both pelagic and demersal fish species (such as killifish, sunfish, herring, and catfish) will be collected.

Collocated sediment and tissue samples can be analyzed to derive site-specific BSAFs for use in the BERA. If field-collected tissue samples are unavailable, it may be necessary to collect site-specific sediments for bioaccumulation testing in the laboratory to derive estimates of BSAFs in a later phase of the BERA.

7.2.2.4 Bioassays

Laboratory bioassays provide an independent line of evidence in the BERA. As mentioned above, such direct toxicity tests can provide a better understanding of the toxicity associated with sediment from a specific area than a simple review of sediment chemistry. However, bioassays are not always definitive, and toxic effects are not always well correlated with sediment chemistry. A 42-day amphipod test will measure effects on survival, growth, and reproduction. A 10-dat chironomid test will measure effects on survival. Bioassay results will be evaluated as one line of evidence contributing to the risk characterization.

7.2.3 Risk Characterization

Risk characterization focuses on the causal relationship between exposure and effects. The characterization will incorporate what is known about potential exposure pathways to representative receptors in the Anacostia River with evidence of chemical concentrations in sediment, water, and biota. Risk characterization consists of two parts: (1) risk estimation and (2) risk description.

Risk estimation is a quantitative process in which exposure concentrations are compared with effect levels appropriate to the receptor and medium being evaluated. The resulting HQs are numerical estimates of risk, given the assumptions stated elsewhere in the BERA. Risk estimates are calculated for individual chemicals and receptors, and do not take into account multiple exposures or indirect effects. For some receptors, more than one risk estimate will be calculated based on different exposure or effect assumptions. For example, risk estimates can be calculated for surface water concentrations using both acute and chronic standards. For sediment, risk estimates can be prepared for samples at discrete depths. The particular assumptions that prevail for each type of risk estimate will be explained in the BERA.

Risk description is a more qualitative evaluation of the numerical risk estimates and other factors that influence the realization of risk for each receptor. In the risk description, chemicals of greatest concern, or “risk drivers,” are identified based on the magnitude of the risk estimate and the confidence level in the exposure assessment. Risk to federal- and state-identified threatened and endangered species will be discussed at the level of the individual, as required by the Endangered Species Act.

7.2.4 Uncertainty Analysis

It is critical that the risk managers understand the uncertainties associated with the risk estimates provided in the BERA. The uncertainty analysis will discuss a variety of topics including the limitations of the sampling data, use of toxicity benchmarks, food chain modeling, bioaccumulation data, bioavailability, site use factors, body weight and ingestion rates, development of TRVs, individual and population variations, and risk characterization.

7.2.5 BERA Summary and Conclusions

Overall risks to the selected ecological receptors will be presented using a weight-of-evidence approach. This approach considers the various COCs present, the uncertainties associated with the data collection methods, toxicity data, and risk estimation methods. It will also evaluate the consistency between laboratory and field data and the impact of each line of evidence on the estimated risks. Presentation of the estimated risks based on both NOAEL and LOAEL TRVs will provide risk managers with an understanding of the potential range of risks for the ecological receptors and will allow them to develop site-specific remediation goals.

8.0 HUMAN HEALTH RISK ASSESSMENT

The primary objective of the HHRA is to determine whether site contaminants pose a current or potential risk to human health in the absence of remediation. The HHRA will be used to determine whether remediation is necessary at the site, provide justification for performing remedial action, and determine what exposure pathways must be remediated. The areas to be addressed in the risk assessment include the Anacostia River (bank-to-bank) sediments, surface water, and related biota within the study area. The anticipated significant exposure pathways that will be considered are ingestion of contaminated tissue (fish, turtle, and crayfish, as available) and surface water and direct contact with contaminated surface water and sediment. As noted in **Section 1.4**, the assessment of risks to human health resulting from exposure to potential contaminants in the soil on Kingman and Heritage Islands is outside of the scope of this investigation.

Tetra Tech will conduct HHRA activities consistent with EPA and District of Columbia (DC) guidance. The primary guidance documents to be used in preparing the HHRA are listed below. This list is not comprehensive, and other EPA and District guidance documents, as well as documents prepared by other organizations, will be used as appropriate.

1. EPA. 1989. Risk Assessment Guidance for Superfund (RAGS), Volume 1: Human Health Evaluation Manual (Part A)." Interim Final. Office of Emergency and Remedial Response (OERR). Washington, D.C. EPA 540-1-89-002. December.
2. EPA. 1991. "RAGS, Volume I: Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors." Interim Final. Office of Solid Waste and Emergency Response (OSWER) Directive 9285.6-03. March 25.
3. EPA. 1992b. "Guidance for Data Usability in Risk Assessment (Part A) Final." OERR. Publication 9285.7-09A. April.
4. EPA. 1997b. "Exposure Factors Handbook." Volumes I through III. Office of Research and Development. EPA 600-P-95-002Fa, -Fb, and -Fc. August.
5. EPA. 2001. RAGS, Volume 1 – Human Health Evaluation Manual Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments. Final. Office of Superfund Remediation and Technology Innovation. Publication 9285.7-47. December.
6. EPA. 2002a. "Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites." OSWER 9285.6-10. December.
7. EPA. 2003. "Human Health Toxicity Values in Superfund Risk Assessments." OSWER Directive 9285.7-53. December.
8. EPA. 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. OSWER. EPA 540-R-99-005. July.

9. EPA. 2005. “Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens.” Risk Assessment Forum. EPA 630-R-03-003F. March.

10. EPA. 2010. “ProUCL Version 4.1 User Guide.” Draft. ORD. EPA 600-R-07-041. May.

11. EPA. 2011. “Exposure Factors Handbook: 2011 Edition.” Office of Research and Development (ORD). EPA 600-R-090-052F. September12.

12. EPA. 2013c. “User’s Guide for Regional Screening Levels (May 2013).”

13. EPA. 2013d. “Regional Screening Level (RSL) Fish Ingestion Table, (May 2013).”

As described in EPA’s RAGS, the risk assessment will be conducted in four basic steps: (1) data evaluation and identification of COC, (2) exposure assessment, (3) toxicity assessment, and (4) risk and hazard characterization. In addition, the HHRA will include a discussion and evaluation of significant sources of uncertainties in the risk assessment process as applied at the Anacostia Site. Each of these risk assessment elements is summarized below.

8.1 Data Evaluation and Identification of COCs

The HHRA will be based primarily on available medium-specific analytical results associated with RI activities. These RI results will be as supplemented by historical analytical results collected by other individuals and organizations at sites associated with the tidal Anacostia River; contaminants from these other sites may have contributed to contamination in the tidal Anacostia River. In these investigations numerous sediment, surface water, pore water, biota, and other samples have been or will be collected.

The cumulative analytical results will be evaluated in accordance with EPA’s Guidance for Data Usability in Risk Assessment (Part A) Final (EPA 1992a) to determine whether the data may be used in a quantitative risk assessment. The evaluation process will be documented as part of HHRA activities.

Medium-specific COCs will be selected following the process described in EPA’s RAGS. The first step is to identify all chemicals positively detected in at least one sample, including (1) chemicals with no data qualifiers and (2) chemicals with data qualifiers indicating known identities but estimated concentrations (for example, J-qualified data). As discussed in RAGS, this initial list of chemicals may be reduced based on the following factors:

- Evaluation of detection frequency (chemicals detected in less than 5 percent of samples and not potentially site-related will not be retained as COCs),
- Evaluation of essential nutrients, and
- Use of a concentration-toxicity screen (the more conservative [lower] of chemical-, receptor-, and medium-specific levels among EPA Regional Screening Levels [RSL] [EPA 2013b], EPA fish ingestion RSLs [EPA 2013d], maximum contaminant levels [MCL] [EPA 2012], federal and District water quality criteria [EPA 2013a], and other medium-specific levels as appropriate).

After consideration of these factors, those chemicals with maximum detected concentrations exceeding screening levels or for which screening levels are not available will be retained as medium-specific COCs. To ensure that elevated detection limits (DL) do not result in inappropriate exclusion of chemicals from

further evaluation, one-half of the maximum detected DL of a constituent not detected in a given medium will be compared to the appropriate screening level. The results of these comparisons may result in inclusion of a non-detected chemical as a COC or discussion of the potential impact of excluding such a chemical as part of the uncertainty discussion.

In EPA's RAGS (1989), background screening was a secondary step in the COC selection process. However, consistent with EPA's evolving stance regarding the use of background in risk assessments (EPA 2002b), more recent EPA guidance eliminates the consideration of background screening in the selection of COCs. The primary contaminants associated with the Anacostia site include PAHs, PCBs, dioxins and furans, pesticides, and metals. Concentrations of COCs in upstream medium-specific samples will be qualitatively compared to site-specific concentrations to provide context for and inform the interpretation of HHRA results by risk managers.

8.2 Exposure Assessment

The exposure assessment presents the methods used to estimate the types and magnitudes of potential human exposure to COCs in various media. EPA's RAGS defines exposure as human contact with a chemical or physical agent. The exposure assessment consists of three fundamental steps: (1) exposure setting characterization (including characterizing the site and potential receptors), (2) exposure pathway identification through a CSM, and (3) exposure quantification. Each of these steps is briefly discussed below.

8.2.1 Exposure Setting Characterization

The exposure setting consists of the physical setting (including natural and man-made features), land uses, and the populations living near the site. This information forms the foundation for selecting potential receptors, exposure pathways, and exposure parameters (for example, how often a receptor may visit the site). The environmental setting of the Anacostia River is described in **Section 2.0** of this WP.

8.2.2 Exposure Pathway Identification

Exposure pathways to be considered in the HHRA will be identified through a human health CSM. The CSM links potential or actual contaminant releases to potential human exposures. Specifically, the CSM identifies (1) potential contaminant sources and mechanisms of release, (2) potential receptors and exposure pathways, and (3) exposure scenarios. **Figure 3.1** presents the generalized CSM for the Anacostia site. This generalized CSM will be updated to reflect specific conditions, receptors, pathways, etc. which are identified as relevant and important to the HHRA. The human health CSM will be included as part of the draft HHRA.

Consistent with EPA's RAGS, the Anacostia Site HHRA will consider only complete (or potentially complete) exposure pathways. An exposure pathway generally consists of four elements: a source and mechanism of chemical release, (2) a retention or transport medium (or media in cases involving media transfer of chemicals), (3) a point of potential human contact with the contaminated medium, and (4) an exposure route (for example, ingestion). Based on an initial review, the primary human health receptors are persons engaged in recreational activities. Additionally, workers engaged in construction and utility

installation/repair activities may be exposed to site-related contamination if the activities are located immediately adjacent to or extend into the river. A preliminary list of potential human receptors for consideration in the HHRA is presented below:

- **Recreational receptors** – this group of receptors includes persons (adult, youth, and child) engaged in recreational activities (including fishing, swimming, boating, and hiking) in or along the Anacostia River in the study area. It is important to remember that the HHRA (and the RI in general) is focused on the area within the river from bank to bank; that is, the HHRA will not be evaluating potential exposure to contaminated soil and sediment outside the banks. Also, recreational receptors include friends and relatives of persons who catch fish and other biota (such as turtles, clams, or crayfish) from the Anacostia River who may be exposed through ingestion of contaminated biota tissue only.
- **Subsistence Receptors** – this group of receptors includes persons (adult, youth, and child) who rely on fish and other organisms from the Anacostia River for the majority of their protein. Reports in the public media indicate that as many as 17,000 individuals may be considered subsistence fishers that rely on the Anacostia River (Anacostia Watershed Society 2012). According to EPA, concern about fish and shellfish safety is higher for subsistence anglers, as they exhibit some of the highest consumption rates (http://cfpub.epa.gov/eroe/index.cfm?fuseaction=list.listBySubTopic&ch=47&s=287).
- **Construction and Utility Workers** – this group of receptors (adults only) includes persons engaged in construction and utility installation/repair activities that requires exposure to sediment and surface water within the banks of the Anacostia River in the study area.

All receptors are assumed to be exposed under both current and future land use conditions. In fact, for the purposes of the draft HHRA, current and future land use conditions for the Anacostia site are expected to be similar in the sense that activities that currently occur in and along the river (for example, swimming, boating, and fishing) are expected to also take place in the future. However, the frequency and locations at which these activities occur may change in response to the construction of planned developments along the river.

The primary exposure scenarios expected at the site involve exposures to chemicals in sediment, surface water, and biota. Potential exposure scenarios include the following:

- Direct contact (incidental ingestion of and dermal contact with) chemicals in sediment and surface water. Potential human exposure to sediment by recreational receptors is assumed to be limited to shallow depths as encountered while receptors are engaged in expected recreational activities in and along the river such as swimming, boating, and fishing. The risk assessment will assess potential exposure to sediment 0 to 6 inches deep, but will acknowledge the potential for limited contact to somewhat deeper sediment (up to about 12 inches deep).Construction and utility workers may be exposed to deeper sediments.
- Ingestion of chemicals in biotic tissue (assumed to be primarily fish tissue, but may also include other species such as crayfish, clams, and turtles). For the purposes of the draft HHRA, most human receptors are assumed to consume only fillets and not the whole fish (EPA 1997c 1998).

It should be noted that fish tissue samples are generally processed to reflect typical consumption patterns This HHRA will use fish tissue samples collected by DDOE in 2013 to support fish consumption advisories for the local population. However, some subsistence anglers may ingest other portions of the fish or the whole fish. If warranted, the HHRA will estimate concentrations in fish tissues ingested by subsistence anglers using available fish fillet data and conversion factors available in the literature.

8.2.3 Exposure Quantification

Receptor-specific exposures will be quantified using standard exposure dose equations that consider a variety of parameters including medium-specific COC concentration (referred to as the exposure point concentration [EPC]), contact rate, the frequency and duration of exposure, and receptor-specific body weight. Consistent with EPA guidance, exposures will be quantified under both reasonable maximum exposure (RME) conditions (the maximum exposure reasonably assumed to occur) and central tendency exposure (CTE) conditions (the typical or average exposure).

Exposure parameters are based on standard default values or recommendations (not available for all receptors) as modified based on site-specific conditions.

For most receptors, medium-specific EPCs will be selected as the lesser of the 95 percent upper confidence limit (UCL) of the mean and the maximum detected concentration at each exposure point. The 95 UCL will be calculated using EPA's Pro UCL, Version 4.1 (EPA 2010). EPCs for construction workers will be based on maximum detected concentrations at each exposure point.

In addition to quantifying exposures based on direct medium measurements, the Anacostia Site HHRA may also conduct modeling to fill data gaps. As necessary, based on the identification of volatile COCs, modeling will be conducted to evaluate the migration of VOCs into the air inside construction trenches. Such modeling will be evaluated using a methodology developed by the Virginia Department of Environmental Quality (VDEQ) as part of its "Voluntary Remediation Program Risk Assessment Guidance" (VDEQ 2013).

EPA-derived algorithms will be used to calculate chronic daily intakes for each exposure route. The generic equations for calculating chemical intake are provided below (EPA 1989, 2009a):

$$\text{I (oral or dermal)} = \frac{C \times CR \times EF \times ED}{BW \times AT}$$

$$\text{I (inhalation)} = \frac{C \times ET \times EF \times ED}{AT}$$

Where:

I = Intake: the amount of chemical at the exchange boundary from oral or dermal exposure (milligrams per kilogram [mg/kg]-day for oral and dermal exposure; milligrams per cubic meter [mg/m^3] for inhalation exposure)

C = Chemical concentration within the exposure medium: the EPC (for example, mg/kg for soil)

CR = Contact rate: the amount of contaminated medium contacted orally or dermally per unit of time or event; may be the ingestion rate or dermal contact rate (for example, milligrams per day [mg/day] for the ingestion rate of soil). The contact rate is not applicable to inhalation exposures.

ET = Exposure time: number of hours of exposure (hours per day [hr/day]); exposure time is applicable only to inhalation exposures.

EF = Exposure frequency: how often the exposure occurs (days per year)

ED = Exposure duration: the number of years a receptor comes in contact with the contaminated medium (years)

BW = Body weight: the average body weight of the receptor over the exposure period (kilograms); applicable only to oral and dermal exposures

AT = Averaging time: the period over which exposure is averaged (days for oral and dermal exposures; hours for inhalation exposures).

For carcinogens, the averaging time is 25,550 days (oral and dermal exposures) and 613,200 hours (inhalation exposures) on the basis of a lifetime exposure of 70 years, which represents the average life expectancy.

For noncarcinogens, the averaging time is the exposure duration expressed in days (ED x 365 days/year) for oral and dermal exposures and in hours (ED x 365 days/year x 24 hr/day) for inhalation exposures.

Pathway-specific variations of the generic equations above will be used to calculate intakes of COCs. The proposed receptor-specific exposure parameters used in variations of these equations will be presented in tabular format.

Also, EPA guidance regarding evaluation of risk from early-life exposure to carcinogens recommends a different approach to estimating chemical intake for carcinogenic chemicals with a mutagenic mode of action (EPA 2005). This guidance will be incorporated and used to modify the above equations consistent with EPA's RSL User's Guide (EPA 2013c).

8.3 Toxicity Assessment

The toxicity assessment identifies the toxicity factors that will be used to quantify potential adverse effects (including both carcinogenic and noncarcinogenic effects) on human health associated with potential exposure to site-specific COCs. COC-specific toxicity factors will be identified from EPA's RSL tables (EPA 2013b), which list toxicity values selected in accordance with EPA's revised recommended toxicity value hierarchy (EPA 2003), summarized below.

- Tier 1 – EPA's Integrated Risk Information System (IRIS) (EPA 2013e)
- Tier 2 – EPA's provisional peer-reviewed toxicity values (PPRTV)
- Tier 3 – Other EPA and non-EPA sources of toxicity information, including, but not limited to, (1) the California Environmental Protection Agency (CalEPA) toxicity values, (2) the Agency for Toxic Substances and Disease Registry (ATSDR) minimal risk levels (MRL), and EPA's Health Effects Assessment Summary Tables (HEAST).

Chronic noncarcinogenic toxicity factors will be used for all receptors, with one exception. Because construction workers typically are expected to be exposed at a single site for a period of time less than 7 years (often 1 year or less), subchronic toxicity factors will be used for construction workers.

8.4 Risk Characterization

Risk characterization combines the exposure estimates calculated in the exposure assessment with the toxicity factors identified in the toxicity assessment to calculate COC-, exposure pathway-, and receptor-specific carcinogenic risks (risks) and noncarcinogenic hazards (hazards). Risks and hazards will be calculated following standardized methods described in EPA's RAGS (EPA 1989) and summarized below.

8.4.1 Characterization of Cancer Risk

Risks associated with exposure to chemicals classified as carcinogens are estimated as the incremental probability that an individual will develop cancer over a lifetime as a direct result of an exposure (EPA 1989). The estimated risk is expressed as a unitless probability.

Three steps are used in estimating cancer risks for chemicals classified as carcinogens. First, the chemical intake is multiplied by the chemical-specific slope factor (SF) (oral and dermal exposure) or the chemical-specific inhalation unit risk (IUR) (inhalation exposure) to derive a cancer risk estimate for a single chemical and pathway. The calculation is based on the following relationship:

- Chemical-Specific Cancer Risk (oral or dermal) = Intake (mg/kg-day) x SF $(\text{mg/kg-day})^{-1}$
- Chemical-Specific Cancer Risk (inhalation) = Intake (milligrams per cubic meter [mg/m^3]) x 10^3 (micrograms [µg]/milligram [mg]) x IUR (micrograms per cubic meter [$\mu\text{g/m}^3$])$^{-1}$

Second, the individual chemical cancer risks are assumed additive to estimate the cancer risk associated with exposure to multiple carcinogens for a single exposure pathway, as follows:

- Pathway-Specific Cancer Risk = ∑ Chemical-Specific Cancer Risk

Third, pathway-specific risks are summed to estimate the total cancer risk for each receptor.

8.4.2 Hazard

The potential for exposure that may result in adverse health effects other than cancer is evaluated by comparing the intake with a reference dose (RfD) (oral and dermal exposure) and with a reference concentration (RfC) (inhalation exposure) of each chemical not classified as a carcinogen, and of each carcinogen known to cause adverse health effects other than cancer. When calculated for a single chemical, the comparison yields a ratio termed the HQ:

$$HQ\ (\text{oral or dermal}) = \frac{\text{Intake (mg/kg-day)}}{\text{RfD (mg/kg-day)}}$$

$$HQ\ (\text{inhalation}) = \frac{\text{Intake (mg/m}^3\text{)}}{\text{RfC (mg/m}^3\text{)}}$$

The HQs for all chemicals are summed to evaluate the potential for adverse health effects other than cancer from concurrent exposures to multiple chemicals, yielding a hazard index (HI) as follows:

$$HI = \sum HQ$$

Pathway-specific HIs are then summed to estimate a total HI for each receptor. An HI less than 1 indicates that adverse noncancer health effects are not expected. If the total HI exceeds 1, further evaluation in the form of a segregation of the HI via a target organ analysis may be performed to assess whether the noncancer HIs are a concern (EPA 1989). Target organ HIs greater than 1 may indicate a potential adverse effect. However, a target organ analysis will not be conducted in cases where the total HI exceeds 1 and the HQ for an individual COC also exceeds 1 because the HQ results for the individual COC already indicate that concern may be warranted.

8.4.3 Lead

EPA provides separate methods for assessing risk from exposure to lead (EPA 2013b). Consistent with the sources of screening values to be used in the HHRA (see **Section 8.1**), potential risks from exposure to lead in sediment by child, youth, and adult recreational receptors and adult construction and utility workers will be characterized by comparing the average concentration of lead in sediment at each exposure area to the EPA RSLs (EPA 2013b). Specifically, risks to recreational receptors will be characterized by initially comparing the average lead concentration in sediment to the residential soil RSL of 400 mg/kg, which was calculated using the Integrated Exposure Uptake Biokinetic (IEUBK) model and default assumptions (EPA 2009b). Similarly, potential risks from exposure to lead in sediment by adult construction and utility workers will initially be screened by comparing average lead concentrations in sediment to the industrial soil RSL of 800 mg/kg, which was calculated using the Adult Lead Model (ALM) (EPA 2009c, d). As necessary, average lead concentrations in sediment will be compared to receptor-specific screening levels calculated using the most recent version of EPA's IEUBK model and the ALM (2009b, 2009c).

8.5 Uncertainty Assessment

The risks and hazards calculated as part of the Anacostia Site HHRA are subject to various degrees of uncertainty from a variety of sources associated with all the major phases of the HHRA process. The uncertainty assessment will identify and discuss the nature of the uncertainty (including direction [overestimation or underestimation] and magnitude) associated with the most significant sources of site-specific uncertainty (including particular assumptions and data limitations).

9.0 NATURAL RESOURCE DAMAGE ASSESSMENT PROCESS

This section provides a brief summary of the NRDA process and how, for the Anacostia contaminated sediment project, the NRDA process relates to the Remedial Investigation (RI). The NRDA process is separate from remediation and clean-up activities. The goal of NRDA is to make the public "whole" for injuries to, or the loss of, natural resources and associated services provided by those resources.

The NRDA process is determined by the type of discharge or release to the environment. If natural resources are injured by a discharge or a release of a mixture of oil and hazardous substances, DOI regulations are used. If damages are from discharges or oil, NOAA regulations are used for the assessment.

Section 301(c) of the CERCLA requires the promulgation of regulations for the assessment of damages for injury to, destruction of, or loss of natural resources resulting from a discharge of oil or release of a hazardous substance. The responsibility for this rulemaking was delegated to the DOI by Executive Order 12580 (January 23, 1987).

CERCLA and Oil Pollution Act (OPA) authorize the United States, States (including the District of Columbia) and Indian Tribes to act on behalf of the public as Natural Resource Trustees for natural resources under their respective trusteeship (CERCLA 107(f)(1) and OPA 1006(c)). Regulations require the Trustees to coordinate the assessment effort, with the lead response agency where response activity is planned or underway at a particular site (40 CFR 11.23(f)). Where there are multiple Trustees, 40 CFR 615(a) provides for those Trustees to cooperate and coordinate their activities. This may include the formation of a Trustee Council and the designation of a lead administrative Trustee for the site, which will facilitate communication between the remedial activities and natural resource Trustees. Trustees must coordinate their activities with other Trustees, response agencies and potentially responsible parties when operations are conducted concurrently (15 CFR 990.14).

The NRDA process as called out under 43 CFR 11 and includes several components and steps:

- Pre-assessment Screening,
- Assessment Plan,
- Assessment Implementation phase (Type A procedures or Type B procedures), and
- Post-Assessment phase.

After the Trustees have formed the Trustee Council and assigned roles where appropriate, the Pre-assessment Screen phase will involve the preliminary collection of data and the determination of the likelihood of a successful damage claim, including:

a) the finding if an injury has occurred,
b) that the damage can be linked to releases, and
c) that responsible parties can be identified.

The Assessment Plan will confirm that damage to resources have occurred and determine the assessment procedures to be used, either a Type A assessment (simplified) or a Type B assessment (site specific studies). Included in the Assessment Plan, phases are the methods for quantification of the injury that has occurred and the determination of the appropriate restoration action.

The Assessment Implementation phase involves the collection of data to determine and quantify the injury and to determine the damage. The Implementation phase will determine a baseline for the resources and quantify the reduction of the resources and/or services compared to the baseline from the impacts. Trustees will report results of the assessment Implementation Phase in the Post-assessment Phase. Restoration alternatives will be proposed with the identification of a preferred alternative or multiple alternatives based on several factors including, but not limited to:

- technical feasibility,
- cost to benefits comparison, and
- consistency with cleanup response actions conducted or planned.

Although the NRDA process is separate from remedial clean-up activities, data collected as part of the RI may be used in the NRDA assessments. To that end, NRDA considerations have been incorporated into the RI sampling plan. Data collected as part of the RI may be used in the NRDA process once the Trustees initiate the NRDA Pre-assessment Screening. As the NRDA process is initialized the Trustees will determine the NRDA plan(s) to determine, assess the damage, and develop the proposed restoration. The Trustees will also coordinate the NRDA activities with the response action and the identified responsible parties.

10.0 SCHEDULE

This section provides a summary of the schedule for the Anacostia River contaminated sediments project through the completion of the RI. **Table 10.1** lists the major milestones for the project and the due dates relative to the sequence of tasks.

TABLE 10.1
Summary of Deliverables for the Anacostia River Sediment Project

Task	Due Date or Duration
Draft Remedial Investigation Work Plan Submitted for Public Review and Comment	January 29, 2014
Draft Community Involvement Work Plan Submitted for Public Review and Comment	March 7, 2014
Public Comment Period for Draft Remedial Investigation Work Plan and Community Relations Plan Completed	February 12, 2014
Final Remedial Investigation Work Plan Completed	June 10, 2014
Draft Site Plans (FSP/QAPP/HASP) Submitted for Public Review and Comment	No public review
Public Comment Period for Draft Site Plans (FSP/QAPP/HASP) Completed	No public review
Final Site Plans (FSP/QAPP/HASP)	June 11, 2014
Pre-field Start-up Public Meeting	June 17, 2014
Remedial Investigation Field Work Start-up	June 23, 2014*
Remedial Investigation Data Report	60 days after receipt of laboratory analyses results from the field investigation
Draft Remedial Investigation Report	90 days after approval of the RI Data Report
Final Remedial Investigation Report	45 days after receipt of comments on the Draft RI Report

* Assumes that requisite environmental permits (NPS permit outstanding as of June 6, 2014) can be obtained and project funding is in place.

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APPENDIX A
DECEMBER 9, 2013 ANACOSTIA RIVER BATHYMETRIC SURVEY 2013, TECHNICAL MEMORANDUM

Anacostia River
Bathymetric Survey 2013

Technical Memorandum

December 9, 2013

Prepared by:

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A-1678

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Acronyms and Abbreviations

AHRS	Altitude heading reference system
CORS	Continuously Operating Reference Station
CTD	conductivity, temperature, depth
DGPS	Differential Global Positioning System
GPS	Global Positioning System
HIPS	Hydrographic Information Processing System
MBE	multibeam echosounder
MRU	motion reference unit
NAD83	North American Datum 1983
NAVD88	North American Vertical Datum 1988
QA	quality assurance
QC	quality control
R/V	Research Vessel
RTK	real-time kinematic
SBE	single beam echosounder
USACE	United States Army Corps of Engineers
UTM	Universal Transverse Mercator Coordinate System
VCF	Vessel Configuration File
WGS84	World Geodetic System 1984

1.0 Overview

Tetra Tech, Inc. (Tetra Tech) conducted a high-resolution multibeam echosounder (MBE), multi-channel sweep, and single beam echosounder (SBE) bathymetric survey for the District Department of the Environment in September and October 2013. These systems were used to map site bathymetry in the Anacostia River from the confluence of the Potomac River and split of the east and west branches of the Anacostia River upriver of the Bladensburg Waterfront Park (refer to Figure 1) in support of ongoing sediment transport studies and remedial investigations (charts of the river provided in Appendix A). Table 1 lists the personnel and their roles in the survey.

Table 1. Survey Team

Name	Project Role
Robert Feldpausch	Project Manager / Principal Hydrographer
Kyle Enright	Project Field Lead / Hydrographer
Burton Bridge	ASCM Hydrographer / Programmer
Michael Reed	Hydrographer
Lou Schwartz	Survey Vessel Captain
Onthonio Whyte	Survey Vessel Captain

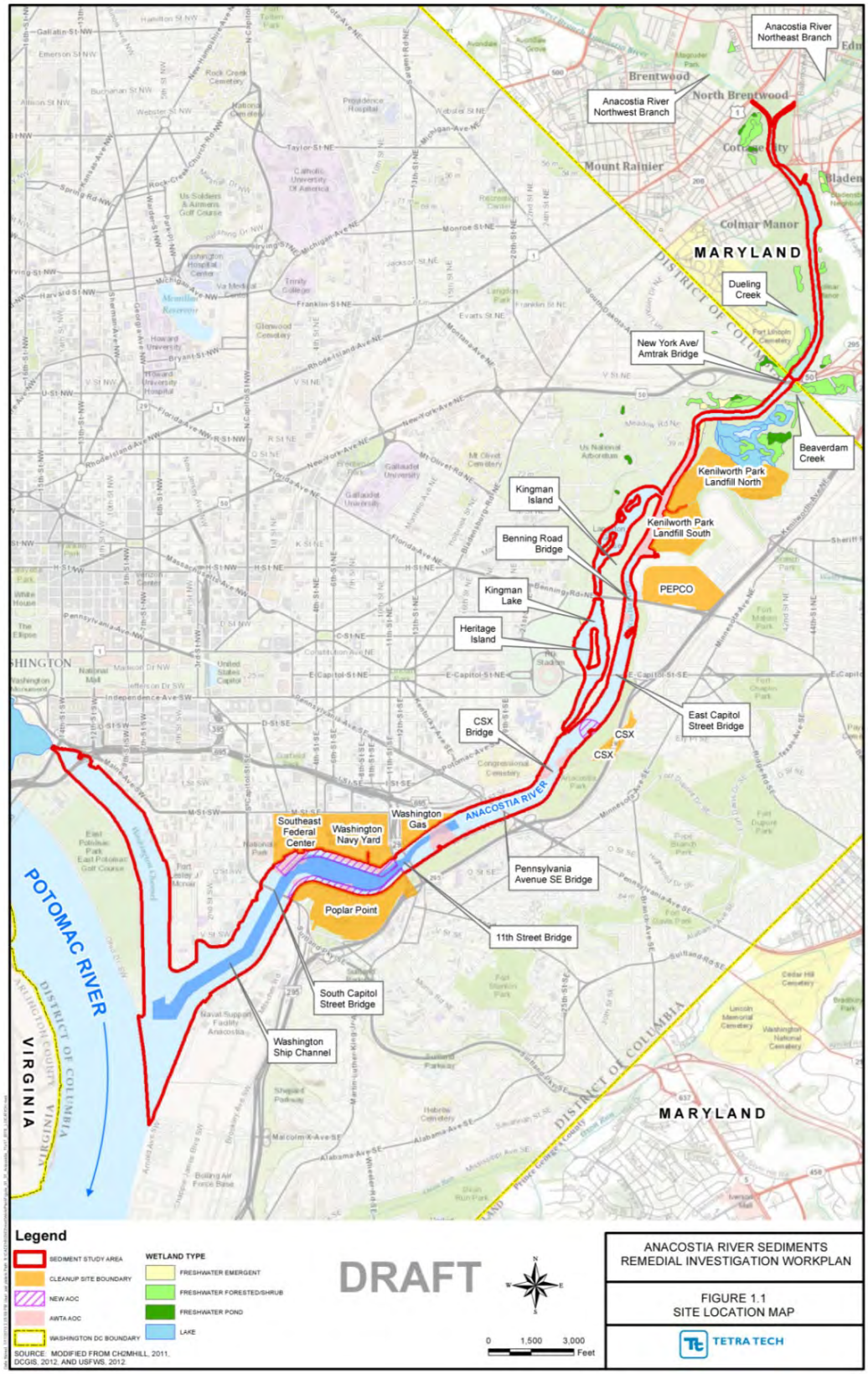


Figure 1. Survey Area

2.0 System Setup

Tetra Tech configured their 34-foot power cat (the Research Vessel [R/V] Ugle Duckling) with a MBE system (refer to Figure 2 and Figure 3) to map the deeper portions of the survey area. Tetra Tech also configured their 18-foot jet boat (the Research Vessel [R/V] MIJITT) with multi-channel sweep and a single SBE system for the shallower waters of the Anacostia (refer to Figure 4 and Figure 5). Much of the survey area was too shallow (approximately 6 feet) to be safely accessed with the larger vessel. Also, the MBE systems have swath coverage proportionate to water depth and cannot, therefore, be used efficiently in very shallow water.

Figure 2. RESON SeaBat 7125 Multibeam Survey Vessel – R/V Ugle Duckling

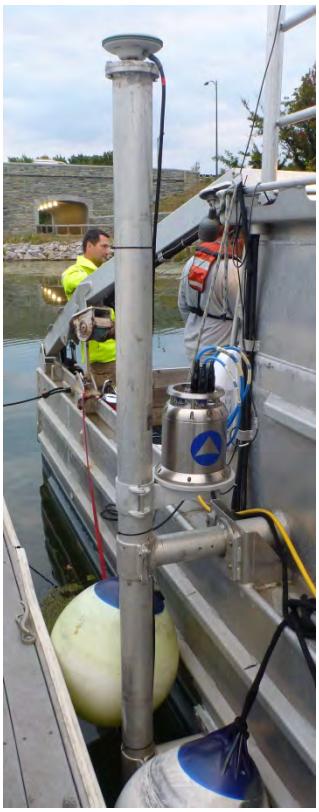


Figure 3. Side mount pole with Lieca RTK GPS, PHINS motion reference unit and MBE below the waterline

Figure 4. Ross Smart Single Beam Sweep Survey Vessel – R/V MIJITT

Figure 5. Single Beam Survey Vessel – R/V MIJITT

The RESON SeaBat MBE sonar head, Leica real-time kinematic (RTK) Global Positioning System (GPS), and IXSea PHINS attitude heading reference system (AHRS) were all fixed to a side-mount pole on the larger survey vessel. This type of installation reduces lever arm measurement errors as well as any motion-induced errors within the reduced lever arms.

The MBE used for the survey was a RESON SeaBat 7125, one of the highest resolution commercial multibeam sonar available. The 400-kHz 7125 ultra-high-resolution multibeam systems both provide a 1-degree beamwidth along track and a 0.5-degree beamwidth across track at nadir. The SeaBat 7125 uses 256 dynamically focused receiver beams and measure a 130-degree swath, assuming outer beams can be accepted into final data deliverables. This system provides extremely high-resolution data that, when used in conjunction with comparable accuracy motion, heading, and position sensors, can show very fine detail in the morphology of the river bottom and in the structure of man-made objects.

Tetra Tech utilized a Ross 875-X for the shallow water survey, the unit is a compact SBE system that can utilize one to six (multi-channel sweep) transducers. This configuration operates a shallow water

mapping system that is more efficient than an MBE system when collecting data with 1 to 6 feet of water under the transducers.

Tetra Tech used a high-quality motion reference unit (MRU), the IXSEA PHINS 6000. The unit provides very high-resolution roll, pitch, heave and heading, and when integrated with the Lieca RTK GPS system, provides accurate position data, even during short GPS dropouts.

The equipment used for the survey is shown in Table 2. Data collection and navigation software for the bathymetry survey was HYPACK®/HYSWEEP® v. 2013.

Table 2. Survey Equipment

Sensor Type	Manufacturer and Model
Multibeam Sonar	Reson SeaBat 7125
Single Beam Sonar(s)	Odom 3 degree 200kHz single frequency transducer
Single Beam acquisition system	Ross Smart Sweep 875-X
Motion Reference Unit (MRU)	IXSEA PHINS 6000
Heading	IXSEA PHINS 6000
Elevation	IXSEA PHINS 6000 / Leica 1230 RTK GPS
Position	IXSEA PHINS 6000 / Leica 1230 RTK GPS
Sound Speed Profilers	Seabird MicroCat SBE-37 and YSI CastAway CTD

2.1 Vessel Offsets

The MRU was used to define the origin and orientation of the X, Y, and Z axes of the vessel's local reference frame. Table 3, Table 4 and Table 5 show the offsets, in meters, used for the HYPACK and HYSWEEP hardware setup. These measurements were also utilized in the CARIS Hydrographic Information Processing System v7.1 (HIPS) Vessel Configuration File (VCF) for multibeam data processing. Offsets were derived from positions hand-measured and verified by Tetra Tech personnel.

Table 3. R/V Ugle Duckling Sensor Offsets (meters)

Sensor	Across (Starboard Positive)	Along (Forward Positive)	Vertical (Down Positive)
Multibeam Sonar (SeaBat 7125)	0.20	0.24	2.53
Motion Sensor/Navigation (PHINS 6000)	0.00	0.00	0.00
GPS Tide (Leica RTK antenna)	0.21	0.00	-1.13
Redundant Position (Trimble Ag DGPS)	-0.45	1.95	-2.28

Table 4. R/V MIJITT Sweep Sensor Offsets (meters)

Sensor	Across (Starboard Positive)	Along (Forward Positive)	Vertical (Down Positive)
Single Beam Sonar (Odom Transducer 1)	-3.81	0.32	0.97
Single Beam Sonar (Odom Transducer 2)	-2.29	0.32	1.00
Single Beam Sonar (Odom Transducer 3)	-0.77	0.32	0.98
Single Beam Sonar (Odom Transducer 4)	0.78	0.32	1.00
Single Beam Sonar (Odom Transducer 5)	2.30	0.32	1.01
Motion Sensor/Navigation (PHINS 6000)	0.00	0.00	0.00
Redundant Position (Trimble Ag DGPS)	-0.50	0.27	-1.65
GPS Tide (Leica RTK antenna)	0.00	0.27	-1.65

Table 5. R/V MIJITT SBE Sensor Offsets (in meters)

Sensor	Across (Starboard Positive)	Along (Forward Positive)	Vertical (Down Positive)
Single Beam Sonar (Odom Transducer 1)	0.00	0.00	0.00
Redundant Position (Trimble Ag DGPS)	-0.50	-0.11	-2.16
GPS Tide (Leica RTK antenna)	0.00	-0.11	-2.16

2.2 Geodesy Settings

Horizontal (X, Y) positioning data for the project were collected in UTM Zone 18 North. Elevation data were converted from the GPS WGS84 ellipsoid to North American Vertical Datum 1988 (NAVD-88) using the National Geodetic Survey (NGS) Geoid12a. Table 6 presents the geodesy settings used.

Table 6. Survey Geodesy Settings

Parameter	Setting
Datum	WGS 84
Projection	UTM Zone 18 North
Horizontal Datum	UTM North
Vertical Datum	NAVD-88
Ellipsoid	WGS84
Distance Unit	meters
Depth Unit	meters
Geoid Model	12a

2.3 GPS Control and Validation

Vertical and horizontal positioning was achieved using high-accuracy GPS systems with RTK corrections. RTK corrections were collected via a cellular Internet connection from the Leica SmartNet system that used Continuously Operating Reference Stations (CORS) in Maryland and Virginia. A Leica 1230 GPS, identical to the system utilized on the survey vessel, was used to verify the functionality and accuracy of the RTK GPS positioning. Each survey day a control point established by NOAA or the United States Army Corps of Engineers (USACE), was occupied and positional data were logged (refer to Appendix B for monument data sheets). Appendix C shows the results of the QC point to point comparison at the time of point occupation.

2.4 Survey Procedures

Surveys were conducted to document the elevations of bottom sediments in the Anacostia River. A RESON SeaBat 7125 multibeam sonar was used to provide the highest possible resolution in the areas where water depth could support its use. In shallower areas, the multi-channel single-beam sweep was utilized. In areas of restricted navigation, a single SBE was used to collect bathymetric data.

The support sensors used to measure vessel attitude (roll, pitch, and heave), position, heading, and sound speed through the water column were selected to ensure that the associated accuracies were commensurate with the accuracy and resolution of the sonar.

RTK GPS was used for height (Z), as well as position (X and Y), to compensate for changes in water surface elevation, vessel squat and settlement, and varying draft caused by changes in vessel loading. The use of RTK GPS for height is typically known as "RTK tides." With RTK tides, any changes in the elevation of the water surface are recorded and compensated for in real time and in the post-processed sounding data.

2.5 Multibeam Calibration — Patch Test Results

A standard patch test, also known as an installation calibration test, was carried out to calculate the angular offsets between the multibeam echosounder and the MRU. The installation calibration process is used to derive the roll, pitch, and yaw angular offsets between the multibeam sonar and the local reference frame defined by the MRU internal origin. The installation calibration test is also used to determine latency in the positioning equipment. The sonar and acquisition computer are time-synchronized by the Leica RTK GPS; as a result, no latency was detected between sensors (see Table 7).

Table 7. Multibeam Patch Test Results

Vessel	Sonar Head	Latency	Roll	Pitch	Yaw	Dates Valid
R/V Ugle Duckling	1	0.00	1.6	0.0	-5.0	09/20 – 10/04

2.6 Daily Quality Control Procedures

On each day, two types of QC procedures were performed: a bar check to confirm the sonar's ability to record accurate depth measurements, and a water level check to verify accurate vertical referencing of the data. Appendix D shows the results of these QC procedures.

2.7 Sound Speed Casts

Changes in sound speed through the water column affect the MBE's individual beams in both the angle and distance calculated from the propagation times. To compensate for these effects, data processing must model the effects as a function of beam launch angle and time. To implement these calculations, sound speed profiles are recorded through the water column using conductivity, temperature, depth (CTD) sensors from which sound speeds versus depths are derived.

Sound speed casts were performed at least once for each survey day and for each patch test. The Anacostia River is a tidally influenced river and, therefore, required more than the minimum CTD profiles collected. Additional efforts were made to take casts throughout the day with varying tides and weather conditions.

3.0 Bathymetry Results

Final charts from the bathymetric survey of the Anacostia River are provided in Appendix A.

3.1 Bathymetry Repeatability / Accuracy

Accuracy and precision are a function of the positioning and attitude measurements errors, timing errors, water depth, and water sound speed profile.

Appendix E provides a comparison of surfaces created against cross line data collected and MBE against the sweep datasets for the purpose of additional QA/QC. The data were found to meet and/or exceed Special Order IHO (refer to Table 8) and Navigation and Dredging Support Surveys for Hard and Soft Bottoms per USACE standards (EM 1110-2-1003 01/01/2002 Table 3-1).

Table 8. IVS Cross-Check Anaylsis Data Printout

Statistics*	Value
4569391	# Number of Points of Comparison
-5.013825	# Data Mean
-5.013208	# Reference Mean
-0.000617	# Mean
-0.001343	# Median
0.028883	# Std. Deviation
-10.990000	# Data Z - Range
-10.920000	# Ref. Z - Range
[-0.57, 1.09]	# Diff Z - Range
0.058383	# Mean + 2*stddev
0.059109	# Median + 2*stddev
0.501725	# Ord 1 Error Limit
1.002701	# Ord 2 Error Limit
0.251148	# Special Order Error Limit
0.000012	# Ord 1 P-Statistic
0.000000	# Ord 2 P-Statistic
0.000255	# Special Order P-Statistic
53	# Ord 1 - # Rejected
1	# Ord 2 - # Rejected
1165	# Special Order - # Rejected
1	**# Order 1 Survey ACCEPTED**
1	**# Order 2 Survey ACCEPTED**
1	**# Special Order Survey ACCEPTED**

*Units in meters

4.0 Data Collection Challenges

4.1 Government Shutdown

The federal government shutdown from 10/01/13 to 10/16/13 affected survey progress to a small degree. The effect on survey progress was mostly an impact at the marinas and boat launches operated by the federal government. Of the boat launches available to the team during the mapping effort, Columbia Island, Anacostia River Park, Buzzard Point Park, and Bladensburg Waterfront Park, only the latter was open and accessible. This prevented full demobilization of the Ugle Duckling from Columbia Island Marina. Also the MIJITT was restricted to the lower portion of the river until water levels dropped and allowing partial breakdown and transit underneath the CSX Railroad Bridge. CSX was not able to move their bridge within the 48-hour notice posted on their sign (refer to Figure 6).

Figure 6. CSX RR Bridge operations sign

4.2 Water Level Observations

The water levels of the river were heavily influenced by the tide (refer to Figure 7). This posed challenges as the times for high and low tides shift slightly from day to day. Tetra Tech planned for this as much as possible by prioritizing coverage in areas that would be too shallow or not accessible during

any time other than at high tide. This is especially true for all the data collected in Kingman Lake. The recorded tidal data at the Naval Shipyard is presented graphically below in Figure 8.

Figure 7. Low tide conditions above the Bladensburg Marina (a good deal of this area was surveyed at high tide)

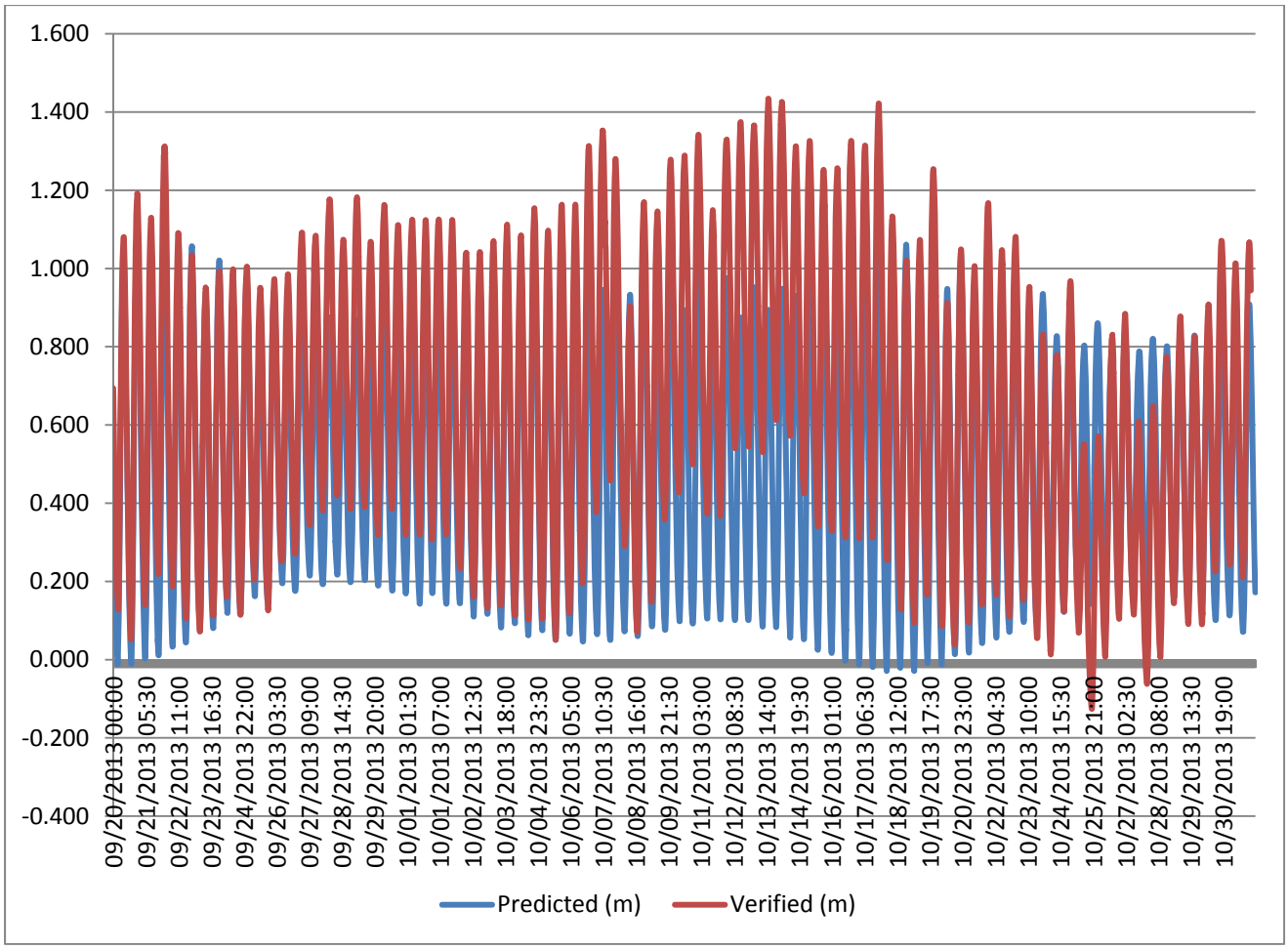
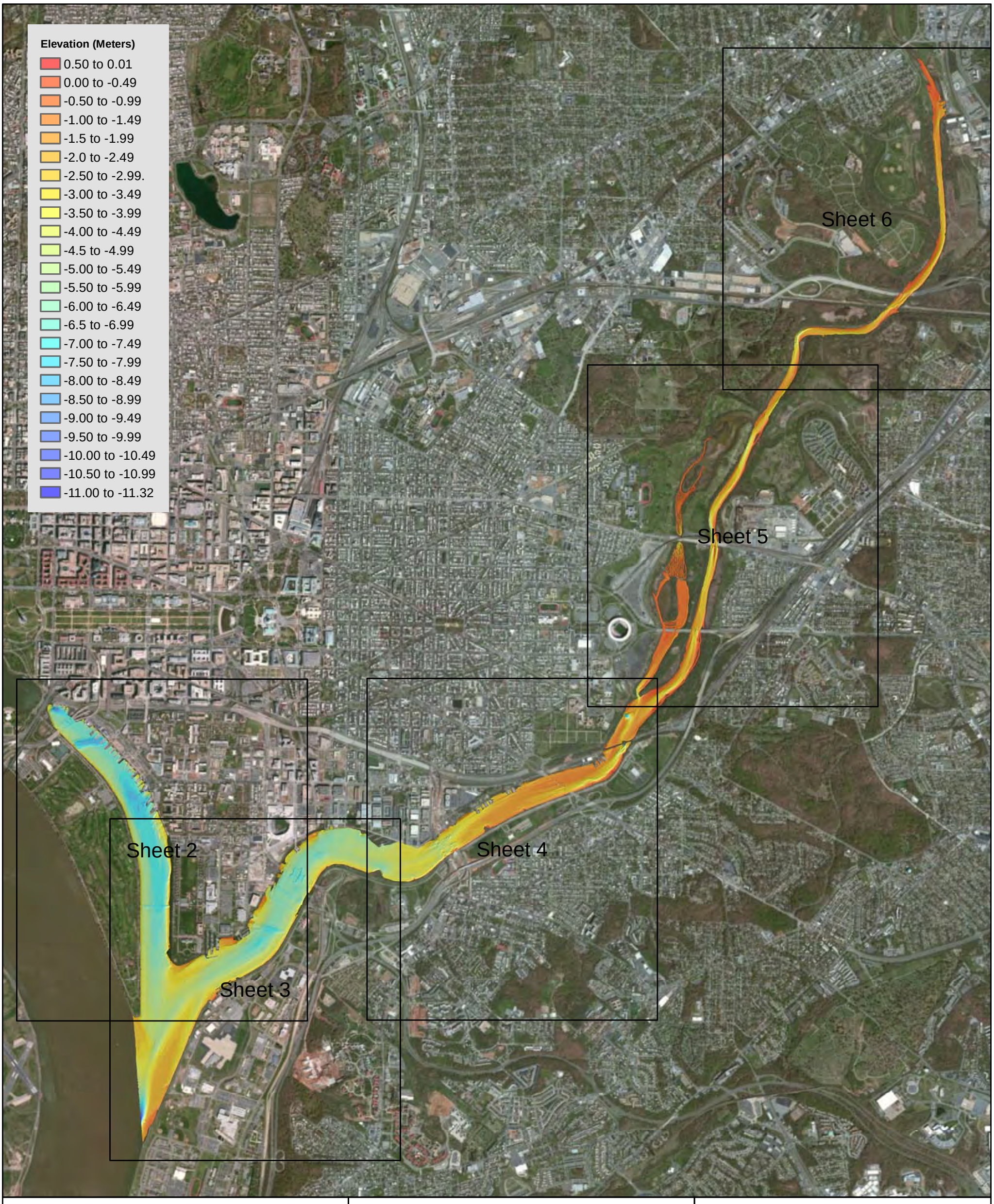


Figure 8. NOAA Tidal Station 8594900 records from 09/20/13 to 10/31/13

Appendix A

Anacostia River Bathymetry 2013



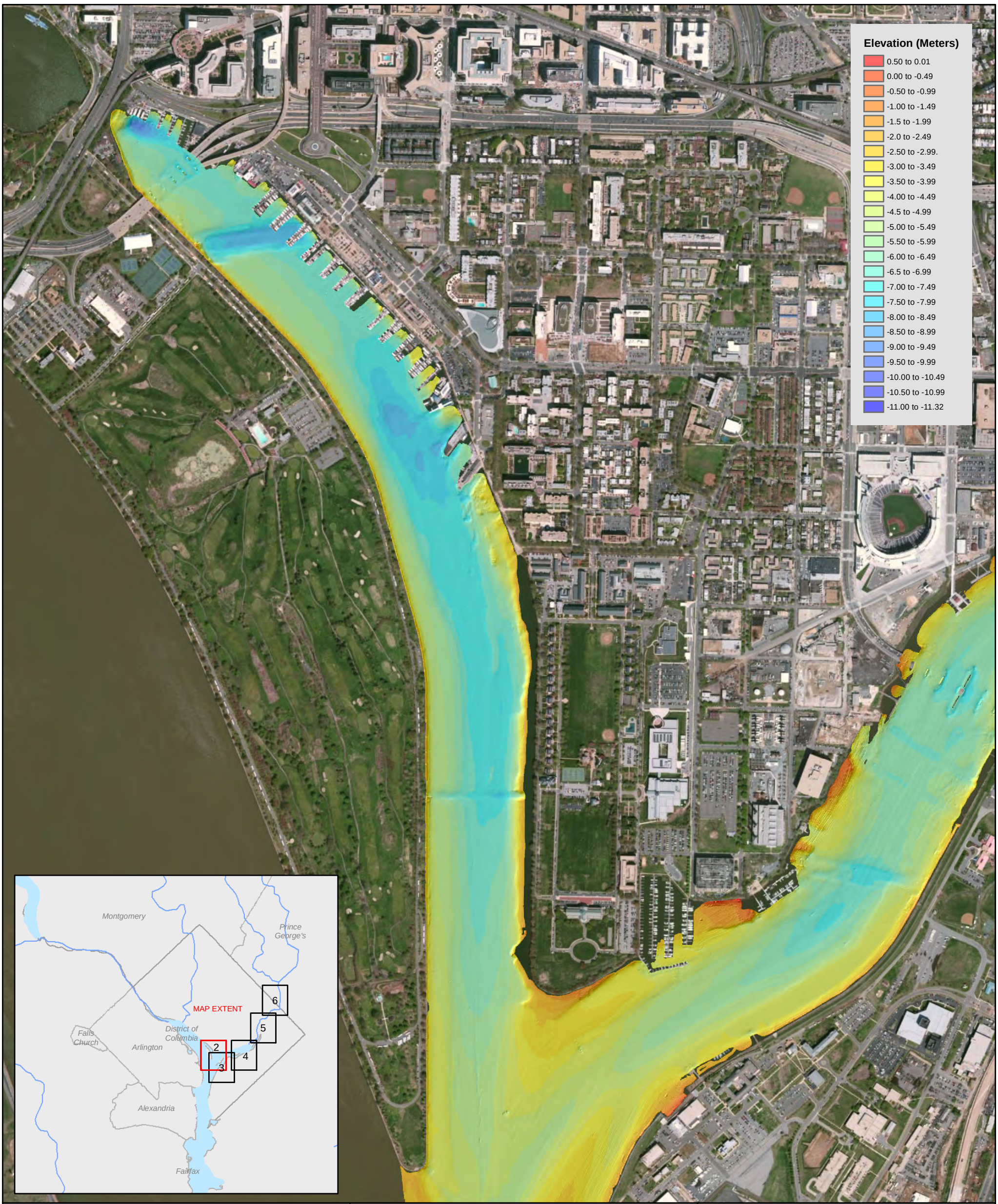
Geodetic Settings		Survey Equipment		2013 Multibeam Bathymetry Data Anacostia River Survey		
Horizontal Datum	WGS 84	**Multibeam Sonar**	RESON Seabat 7125	**Tetra Tech** **Marine Mapping Group** **19803 North Creek Parkway** **Bothell, WA 98011**		
Vertical Datum	NAVD88 g12a	**Positioning System**	Leica 1230 RTK GPS / IXSEA PHINS 6000			
Coordinate System	UTM 18 North	**Heading Sensor**	IXSEA PHINS 6000			
Horizontal Units	Meters	**Motion Sensor**	IXSEA PHINS 6000	Data Acquisition:	K. Enright / M. Reed	
Vertical Units	Meters	**Sound Speed Profilers**	YSI Castaway CTD/ Seabird SBE 37	Data Processing:	K. Enright / M. Reed	
Vertical Control	See note 6.	**Dates Surveyed**	9/25/13 - 10/31/13	Drafted by:	J. MacLachlan	Sheet: 1 of 6
Horizontal Control	See note 6.			Reviewed by:	R. Feldpausch	

N

0 500 1,000
Meters

Notes:
1. Multibeam bathymetry data collected using Hypack/Hysweep 2013.
2. Multibeam bathymetry processing performed using CARIS HIPS and Sips, Hypack MBMax, IVS3D Fledermaus and Tetra Tech developed software.
3. Charts and other data products developed in ArcGIS 10 and IVS3D Fledermaus.
4. The bathymetry data represents conditions in the river at the time of collection. Bedforms are expected to change over time due to the varying water flows in the river.
5. Bathymetric surfaces derived using a one meter CARIS uncertainty grid. This gridding method takes into account calculated position and measurement uncertainty values for individual soundings as well as sonar beam footprint.
6. Horizontal and vertical control established by NOAA and USACE

A-1695



Geodetic Settings		Survey Equipment		2013 Multibeam Bathymetry Data Anacostia River Survey		
Horizontal Datum	WGS 84	**Multibeam Sonar**	RESON Seabat 7125	Tetra Tech Marine Mapping Group 19803 North Creek Parkway Bothell, WA 98011		
Vertical Datum	NAVD88 g12a	**Positioning System**	Leica 1230 RTK GPS / IXSEA PHINS 6000			
Coordinate System	UTM 18 North	**Heading Sensor**	IXSEA PHINS 6000			
Horizontal Units	Meters	**Motion Sensor**	IXSEA PHINS 6000	Data Acquisition:	K. Enright / M. Reed	
Vertical Units	Meters	**Sound Speed Profilers**	YSI Castaway CTD/ Seabird SBE 37	Data Processing:	K. Enright / M. Reed	
Vertical Control	See note 6.	**Dates Surveyed**	9/25/13 - 10/31/13	Drafted by:	J. MacLachlan	Sheet: 2 of 6
Horizontal Control	See note 6.			Reviewed by:	R. Feldpausch	

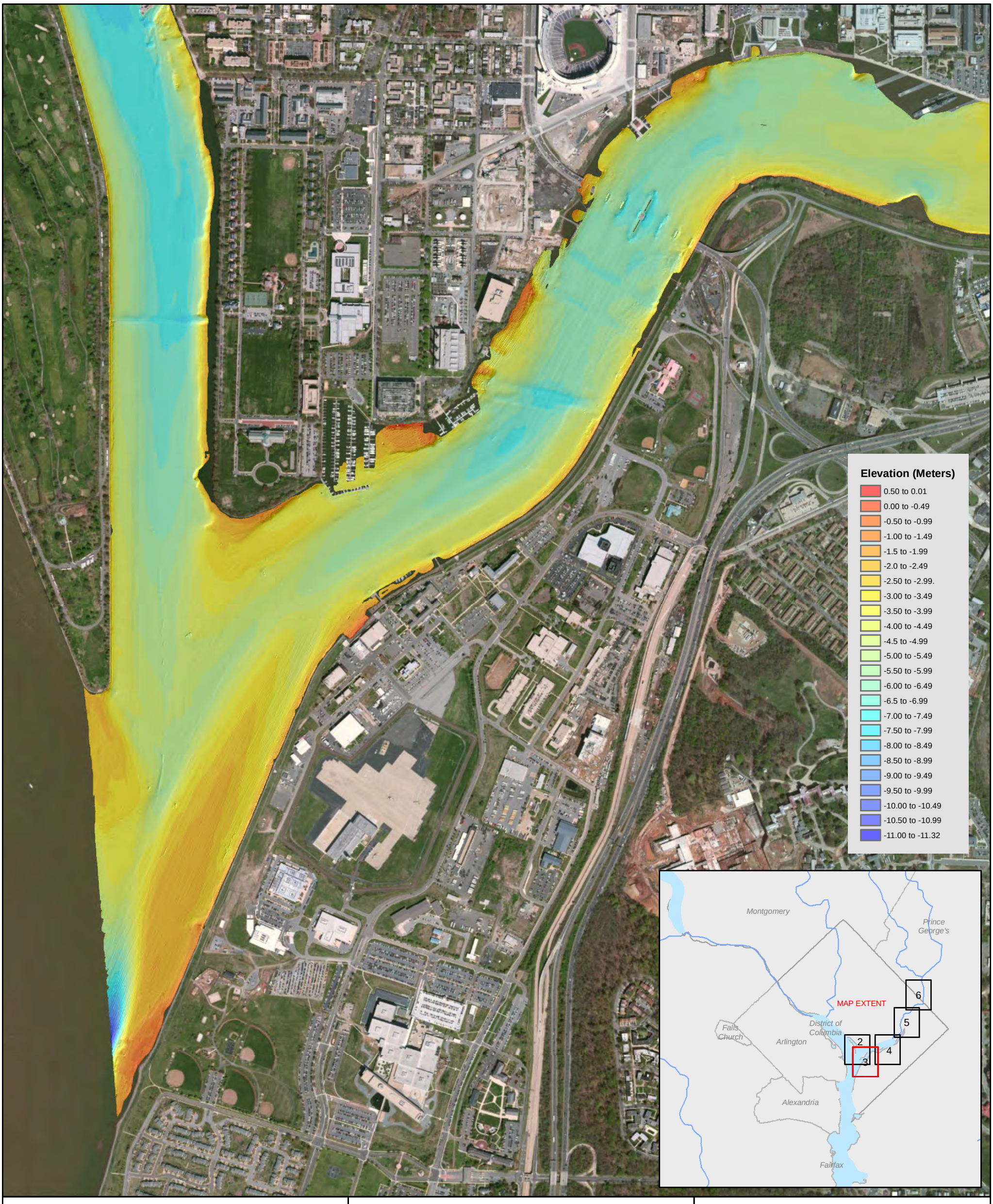
N

0 100 200 300 400

Meters

Notes:
1. Multibeam bathymetry data collected using Hypack/Hysweep 2013.
2. Multibeam bathymetry processing performed using CARIS HIPS and Sips, Hypack MBMax, IVS3D Fledermaus and Tetra Tech developed software.
3. Charts and other data products developed in ArcGIS 10 and IVS3D Fledermaus.
4. The bathymetry data represents conditions in the river at the time of collection. Bedforms are expected to change over time due to the varying water flows in the river.
5. Bathymetric surfaces derived using a one meter CARIS uncertainty grid. This gridding method takes into account calculated position and measurement uncertainty values for individual soundings as well as sonar beam footprint.
6. Horizontal and vertical control established by NOAA and USACE

A-1696



Geodetic Settings		Survey Equipment		2013 Multibeam Bathymetry Data Anacostia River Survey		
Horizontal Datum	WGS 84	**Multibeam Sonar**	RESON Seabat 7125	Tetra Tech Marine Mapping Group 19803 North Creek Parkway Bothell, WA 98011		
Vertical Datum	NAVD88 g12a	**Positioning System**	Leica 1230 RTK GPS / IXSEA PHINS 6000			
Coordinate System	UTM 18 North	**Heading Sensor**	IXSEA PHINS 6000			
Horizontal Units	Meters	**Motion Sensor**	IXSEA PHINS 6000	Data Acquisition:	K. Enright / M. Reed	
Vertical Units	Meters	**Sound Speed Profilers**	YSI Castaway CTD/ Seabird SBE 37	Data Processing:	K. Enright / M. Reed	
Vertical Control	See note 6.	**Dates Surveyed**	9/25/13 - 10/31/13	Drafted by:	J. MacLachlan	Sheet: 3 of 6
Horizontal Control	See note 6.			Reviewed by:	R. Feldpausch	

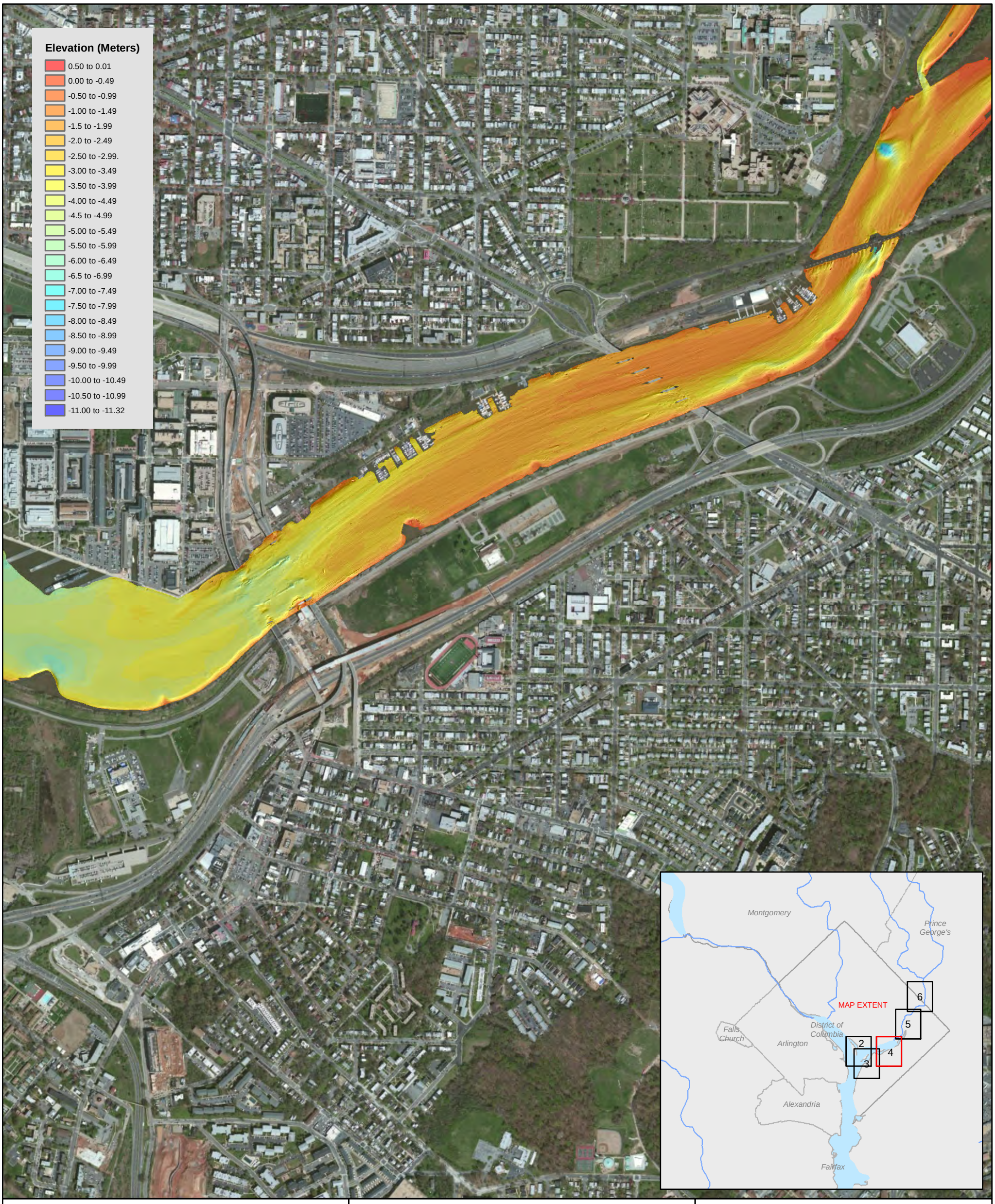
N

0 100 200 300 400

Meters

Notes:
1. Multibeam bathymetry data collected using Hypack/Hysweep 2013.
2. Multibeam bathymetry processing performed using CARIS HIPS and Sips, Hypack MBMax, IVS3D Fledermaus and Tetra Tech developed software.
3. Charts and other data products developed in ArcGIS 10 and IVS3D Fledermaus.
4. The bathymetry data represents conditions in the river at the time of collection. Bedforms are expected to change over time due to the varying water flows in the river.
5. Bathymetric surfaces derived using a one meter CARIS uncertainty grid. This gridding method takes into account calculated position and measurement uncertainty values for individual soundings as well as sonar beam footprint.
6. Horizontal and vertical control established by NOAA and USACE

A-1697



Geodetic Settings		Survey Equipment		2013 Multibeam Bathymetry Data Anacostia River Survey		
Horizontal Datum	WGS 84	**Multibeam Sonar**	RESON Seabat 7125	Tetra Tech Marine Mapping Group 19803 North Creek Parkway Bothell, WA 98011		
Vertical Datum	NAVD88 g12a	**Positioning System**	Leica 1230 RTK GPS / IXSEA PHINS 6000			
Coordinate System	UTM 18 North	**Heading Sensor**	IXSEA PHINS 6000			
Horizontal Units	Meters	**Motion Sensor**	IXSEA PHINS 6000	Data Acquisition:	K. Enright / M. Reed	
Vertical Units	Meters	**Sound Speed Profilers**	YSI Castaway CTD/ Seabird SBE 37	Data Processing:	K. Enright / M. Reed	
Vertical Control	See note 6.	**Dates Surveyed**	9/25/13 - 10/31/13	Drafted by:	J. MacLachlan	Sheet: 4 of 6
Horizontal Control	See note 6.			Reviewed by:	R. Feldpausch	

N

0 100 200 300 400

Meters

Notes:
1. Multibeam bathymetry data collected using Hypack/Hysweep 2013.
2. Multibeam bathymetry processing performed using CARIS HIPS and Sips, Hypack MBMax, IVS3D Fledermaus and Tetra Tech developed software.
3. Charts and other data products developed in ArcGIS 10 and IVS3D Fledermaus.
4. The bathymetry data represents conditions in the river at the time of collection. Bedforms are expected to change over time due to the varying water flows in the river.
5. Bathymetric surfaces derived using a one meter CARIS uncertainty grid. This gridding method takes into account calculated position and measurement uncertainty values for individual soundings as well as sonar beam footprint.
6. Horizontal and vertical control established by NOAA and USACE

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Geodetic Settings		Survey Equipment		2013 Multibeam Bathymetry Data Anacostia River Survey		
Horizontal Datum	WGS 84	**Multibeam Sonar**	RESON Seabat 7125			
Vertical Datum	NAVD88 g12a	**Positioning System**	Leica 1230 RTK GPS / IXSEA PHINS 6000	**Tetra Tech** **Marine Mapping Group** **19803 North Creek Parkway** **Bothell, WA 98011**	TETRA TECH	
Coordinate System	UTM 18 North	**Heading Sensor**	IXSEA PHINS 6000			
Horizontal Units	Meters	**Motion Sensor**	IXSEA PHINS 6000	Data Acquisition:	K. Enright / M. Reed	
Vertical Units	Meters	**Sound Speed Profilers**	YSI Castaway CTD/ Seabird SBE 37	Data Processing:	K. Enright / M. Reed	
Vertical Control	See note 6.	**Dates Surveyed**	9/25/13 - 10/31/13	Drafted by:	J. MacLachlan	Sheet: 5 of 6
Horizontal Control	See note 6.			Reviewed by:	R. Feldpausch	

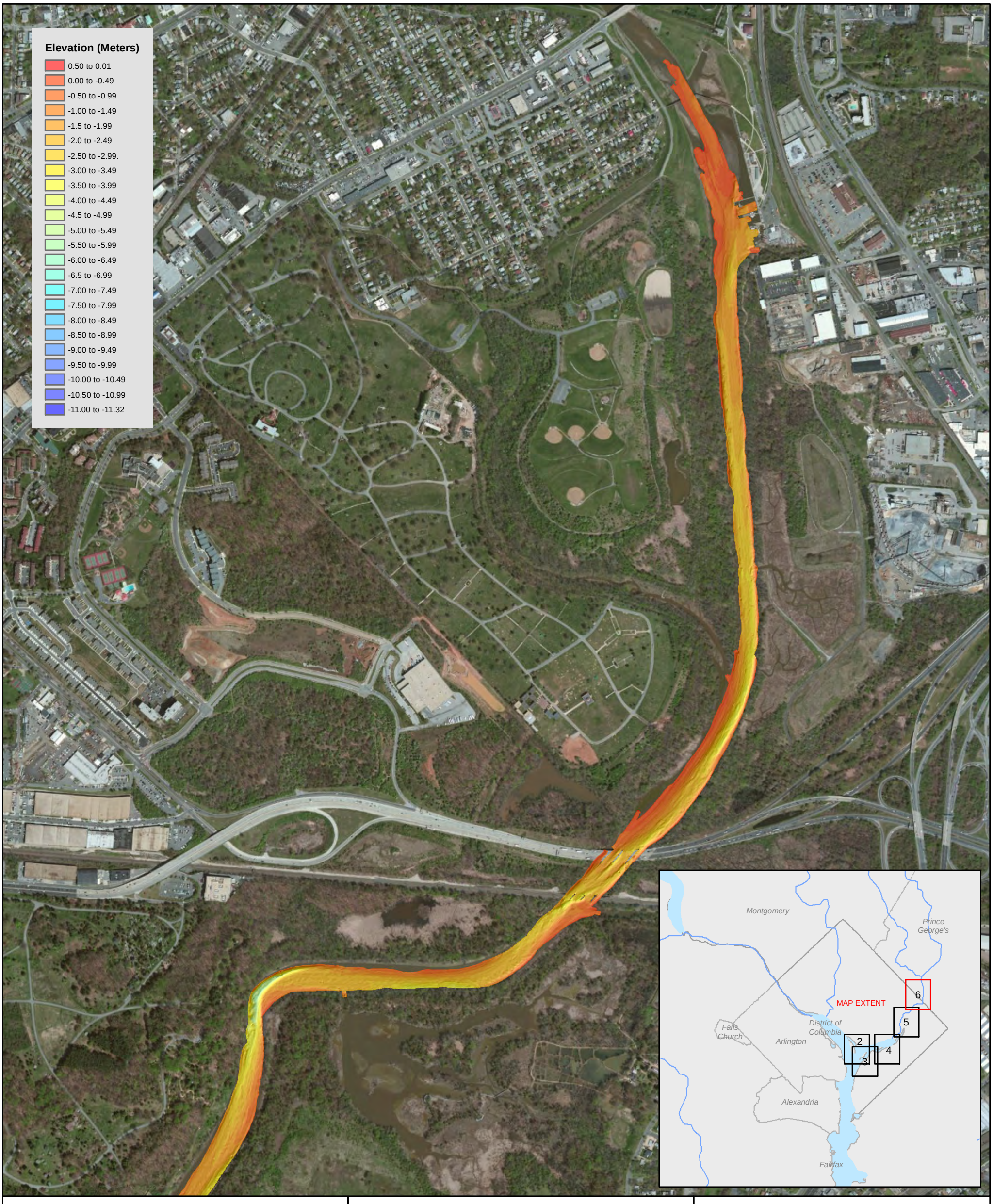
N

0 100 200 300 400

Meters

Notes:
1. Multibeam bathymetry data collected using Hypack/Hysweep 2013.
2. Multibeam bathymetry processing performed using CARIS HIPS and Sips, Hypack MBMax, IVS3D Fledermaus and Tetra Tech developed software.
3. Charts and other data products developed in ArcGIS 10 and IVS3D Fledermaus.
4. The bathymetry data represents conditions in the river at the time of collection. Bedforms are expected to change over time due to the varying water flows in the river.
5. Bathymetric surfaces derived using a one meter CARIS uncertainty grid. This gridding method takes into account calculated position and measurement uncertainty values for individual soundings as well as sonar beam footprint.
6. Horizontal and vertical control established by NOAA and USACE

A-1699



Geodetic Settings		Survey Equipment		2013 Multibeam Bathymetry Data Anacostia River Survey		
Horizontal Datum	WGS 84	**Multibeam Sonar**	RESON Seabat 7125	Tetra Tech Marine Mapping Group 19803 North Creek Parkway Bothell, WA 98011		
Vertical Datum	NAVD88 g12a	**Positioning System**	Leica 1230 RTK GPS / IXSEA PHINS 6000			
Coordinate System	UTM 18 North	**Heading Sensor**	IXSEA PHINS 6000			
Horizontal Units	Meters	**Motion Sensor**	IXSEA PHINS 6000	Data Acquisition:	K. Enright / M. Reed	
Vertical Units	Meters	**Sound Speed Profilers**	YSI Castaway CTD/ Seabird SBE 37	Data Processing:	K. Enright / M. Reed	
Vertical Control	See note 6.	**Dates Surveyed**	9/25/13 - 10/31/13	Drafted by:	J. MacLachlan	Sheet: 6 of 6
Horizontal Control	See note 6.			Reviewed by:	R. Feldpausch	

N

0 100 200 300 400

Meters

Notes:
1. Multibeam bathymetry data collected using Hypack/Hysweep 2013.
2. Multibeam bathymetry processing performed using CARIS HIPS and Sips, Hypack MBMax, IVS3D Fledermaus and Tetra Tech developed software.
3. Charts and other data products developed in ArcGIS 10 and IVS3D Fledermaus.
4. The bathymetry data represents conditions in the river at the time of collection. Bedforms are expected to change over time due to the varying water flows in the river.
5. Bathymetric surfaces derived using a one meter CARIS uncertainty grid. This gridding method takes into account calculated position and measurement uncertainty values for individual soundings as well as sonar beam footprint.
6. Horizontal and vertical control established by NOAA and USACE

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Appendix B

Published Control Monuments

SURVEY DATASHEET (Version 1.0)

PID: BBBQ23

Designation: 104-1A

Stamping: 104-1A 2010

Stability: May hold, commonly subject to ground movement

Setting: Object surrounded by mass of concrete

Description: From the intersection of Md. Rtes. 202 and 450, in Bladensburg, Prince Georges Co., Md., go westerly on Md. Rte. 450 for 0.8 miles, turn left into Bladensburg Waterfront Park. Go 0.40 miles to the end of the parking area. Monument "104-1A" is in a conc. walk, west of the bathroom, S 49.6 ft. from a light pole in the SW most grass island, near the boat ramp, S 2.2 ft. from the 3rd conc. post and E 2.8 ft. from the 2nd conc. post, beginning from the SW most conc. post nearest the water.

Observed: 2010-01-05T14:12:00Z See Also Original

Source: OPUS - page5 1209.04

Close-up View

REF_FRAME:	EPOCH:	SOURCE:	UNITS:	SET PROFILE	DETAILS
NAD_83(2011)	2010.0000	NAVD88 (Computed using GEOID12A)	m		

LAT:	38° 56' 1.01655"	± 0.003	m
LON:	-76° 56' 17.33516"	± 0.002	m
ELL HT:	-29.671	± 0.010	m
X:	1122767.906	± 0.005	m
Y:	-4839401.637	± 0.009	m
Z:	3986568.404	± 0.004	m
ORTHO HT:	2.523	± 0.023	m

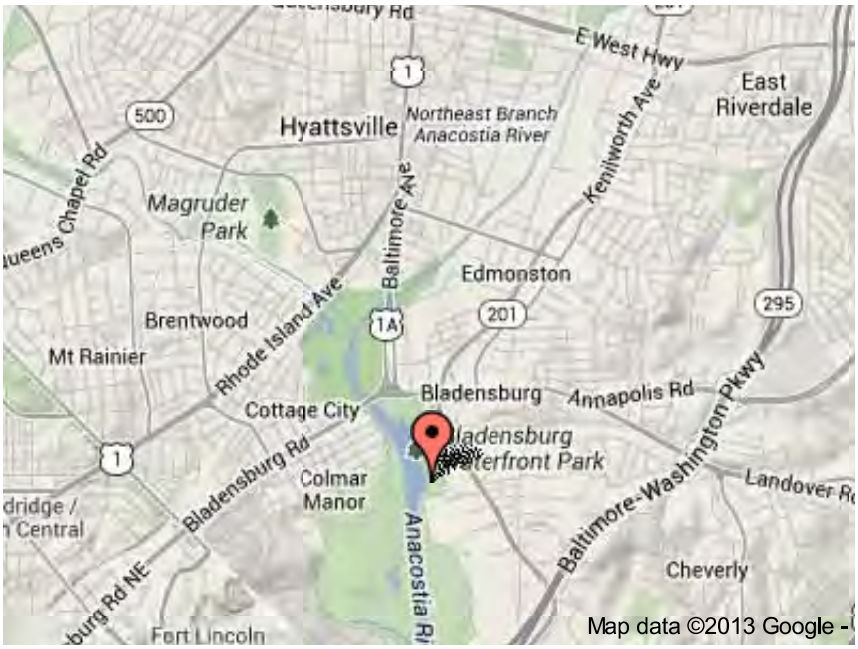
	UTM 18	SPC 1900(MD)
NORTHING:	4311195.813m	140638.743m
EASTING:	332008.791m	405362.696m
CONVERGENCE:	-1.21825511°	0.03882002°
POINT SCALE:	0.99994751	0.99995036
COMBINED FACTOR:	0.99995217	0.99995502

CONTRIBUTED BY

dennis.a.warren

US Army Corps of Engineers

Horizon View



The numerical values for this position solution have satisfied the quality control criteria of the National Geodetic Survey. The contributor has

A-1702

verified that the information submitted is accurate and complete.

A-1703

The NGS Data Sheet

See file dsdata.txt for more information about the datasheet.

```
PROGRAM = datasheet95, VERSION = 8.3
1         National Geodetic Survey,   Retrieval Date = OCTOBER 17, 2013
 HV9068 ***********************************************************************
 HV9068  TIDAL BM     -  This is a Tidal Bench Mark.
 HV9068  DESIGNATION -  859 4900 4
 HV9068  PID          -  HV9068
 HV9068  STATE/COUNTY-  DC/DISTRICT OF COLUMBIA
 HV9068  COUNTRY      -  US
 HV9068  USGS QUAD    -  WASHINGTON WEST (1983)
 HV9068
 HV9068                        *CURRENT SURVEY CONTROL
 HV9068  ___________________________________________________________________
 HV9068* NAD 83(2011) POSITION- 38 52 30.94084(N) 077 01 16.35964(W)   ADJUSTED
 HV9068* NAD 83(2011) ELLIP HT-   -29.706 (meters)        (06/27/12)   ADJUSTED
 HV9068* NAD 83(2011) EPOCH   -  2010.00
 HV9068* NAVD 88 ORTHO HEIGHT -     2.438  (meters)       8.00  (feet) ADJUSTED
 HV9068  ___________________________________________________________________
 HV9068  NAD 83(2011) X  -  1,116,664.709 (meters)                     COMP
 HV9068  NAD 83(2011) Y  - -4,844,988.678 (meters)                     COMP
 HV9068  NAD 83(2011) Z  -  3,981,527.159 (meters)                     COMP
 HV9068  LAPLACE CORR    -         -2.88  (seconds)                    DEFLEC12A
 HV9068  GEOID HEIGHT    -        -32.14  (meters)                     GEOID12A
 HV9068  DYNAMIC HEIGHT  -          2.437 (meters)        8.00  (feet) COMP
 HV9068  MODELED GRAVITY -    980,097.4   (mgal)                      NAVD 88
 HV9068
 HV9068  VERT ORDER      -  FIRST     CLASS II
 HV9068
 HV9068  FGDC Geospatial Positioning Accuracy Standards (95% confidence, cm)
 HV9068  Type                                          Horiz  Ellip  Dist(km)
 HV9068  ----------------------------------------------------------------
 HV9068  NETWORK                                        0.35   0.76
 HV9068  ----------------------------------------------------------------
 HV9068  MEDIAN LOCAL ACCURACY AND DIST (067 points)   0.58   1.31     46.88
 HV9068  ----------------------------------------------------------------
 HV9068  NOTE: Click here for information on individual local accuracy
 HV9068  values and other accuracy information.
 HV9068
 HV9068
 HV9068.The horizontal coordinates were established by GPS observations
 HV9068.and adjusted by the National Geodetic Survey in June 2012.
 HV9068
 HV9068.NAD 83(2011) refers to NAD 83 coordinates where the reference
 HV9068.frame has been affixed to the stable North American tectonic plate. See
 HV9068.NA2011 for more information.
 HV9068
 HV9068.The horizontal coordinates are valid at the epoch date displayed above
 HV9068.which is a decimal equivalence of Year/Month/Day.
 HV9068
```

A-1704

```
HV9068.The orthometric height was determined by differential leveling and
HV9068.adjusted by the NATIONAL GEODETIC SURVEY
HV9068.in April 2010.
HV9068
HV9068.No vertical observational check was made to the station.
HV9068
HV9068.This Tidal Bench Mark is designated as VM 458
HV9068.by the CENTER FOR OPERATIONAL OCEANOGRAPHIC PRODUCTS AND SERVICES.
HV9068
HV9068.Photographs are available for this station.
HV9068
HV9068.The X, Y, and Z were computed from the position and the ellipsoidal ht.
HV9068
HV9068.The Laplace correction was computed from DEFLEC12A derived deflections.
HV9068
HV9068.The ellipsoidal height was determined by GPS observations
HV9068.and is referenced to NAD 83.
HV9068
HV9068.The dynamic height is computed by dividing the NAVD 88
HV9068.geopotential number by the normal gravity value computed on the
HV9068.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
HV9068.degrees latitude (g = 980.6199 gals.).
HV9068
HV9068.The modeled gravity was interpolated from observed gravity values.
HV9068
HV9068. The following values were computed from the NAD 83(2011) position.
HV9068
HV9068;                    North         East     Units Scale Factor Converg.
HV9068;UTM  18      - 4,304,875.813   324,665.105   MT  0.99997857   -1 16 08.0
HV9068
HV9068!             -  Elev Factor  x  Scale Factor =   Combined Factor
HV9068!UTM  18      -   1.00000466  x   0.99997857  =   0.99998323
HV9068
HV9068                          SUPERSEDED SURVEY CONTROL
HV9068
HV9068  NAD 83(2007)-  38 52 30.94126(N)    077 01 16.36052(W) AD(2002.00) 0
HV9068  ELLIP H (02/10/07)  -29.689  (m)                       GP(2002.00)
HV9068  NAD 83(1991)-  38 52 30.94097(N)    077 01 16.36034(W) AD(       ) A
HV9068  ELLIP H (02/12/02)  -29.685  (m)                       GP(       ) 4 1
HV9068  NAVD 88 (02/12/02)    2.43   (m)            8.0    (f) LEVELING    3
HV9068  NAVD 88 (02/03/93)    2.429  (m)            7.97   (f) SUPERSEDED  1 2
HV9068  NGVD 29 (08/12/92)    2.666  (m)            8.75   (f) ADJUSTED    1 2
HV9068
HV9068.Superseded values are not recommended for survey control.
HV9068
HV9068.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
HV9068.See file dsdata.txt to determine how the superseded data were derived.
HV9068
HV9068_U.S. NATIONAL GRID SPATIAL ADDRESS: 18SUJ2466504875(NAD 83)
HV9068
HV9068_MARKER: DJ = TIDAL STATION DISK
HV9068_SETTING: 37 = SET IN A MASSIVE RETAINING WALL
HV9068_SP_SET: SEAWALL
HV9068_STAMPING: NO 4 1973
HV9068_MARK LOGO: NOS
HV9068_MAGNETIC: N = NO MAGNETIC MATERIAL
HV9068_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
```

```
HV9068_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
HV9068+SATELLITE: SATELLITE OBSERVATIONS - April 05, 2012
HV9068
HV9068  HISTORY     - Date     Condition        Report By
HV9068  HISTORY     - 1973     MONUMENTED       NOS
HV9068  HISTORY     - 19920512 GOOD             NGS
HV9068  HISTORY     - 20000224 GOOD             NGS
HV9068  HISTORY     - 20020902 GOOD             INDIV
HV9068  HISTORY     - 20081124 GOOD             NGS
HV9068  HISTORY     - 20100314 GOOD             GEOCAC
HV9068  HISTORY     - 20120405 GOOD             NGS
HV9068
HV9068                          STATION DESCRIPTION
HV9068
HV9068'DESCRIBED BY NATIONAL GEODETIC SURVEY 1992
HV9068'IN WASHINGTON, D.C., AT 6TH AND WATER STREET, IN A CONCRETE SEAWALL
HV9068'ALONG THE EAST BANK OF THE WASHINGTON CHANNEL, 25.5 M (83.7 FT)
HV9068'NORTHWEST OF THE CENTER OF THE NORTH GATE LEADING TO THE SPIRIT OF
HV9068'WASHINGTON CRUISES (PIER 4), 13.6 M (44.6 FT) SOUTHWEST OF THE CENTER
HV9068'OF WATER STREET, 3.7 M (12.1 FT) NORTHWEST OF THE NORTHWEST CORNER OF
HV9068'THE THIRD BRICK PILLAR NORTHWEST OF THE NORTHWEST GATE, AND LEVEL
HV9068'WITH THE STREET.
HV9068
HV9068                          STATION RECOVERY (2000)
HV9068
HV9068'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 2000 (MLM)
HV9068'THE STATION IS LOCATED IN WASHINGTON, D.C., ON THE NORTHEAST SIDE OF
HV9068'THE WASHINGTON CHANNEL IN TOP OF THE CONCRETE SEAWALL ON THE SOUTHWEST
HV9068'SIDE OF WATER STREET, BETWEEN THE THIRD AND FOURTH BRICK PILLARS
HV9068'(SEAWALL FENCE SUPPORTS) , NORTHEAST OF THE ENTRANCE TO DOCKING PIER
HV9068'NUMBER 4 FOR THE SPIRIT OF WASHINGTON CRUISE SHIP. OWNERSHIP--CITY OF
HV9068'WASHINGTON, D.C.  TO REACH FROM THE POLICE AND FIRE STATION AT THE
HV9068'SOUTH END OF WATER STREET WHICH RUNS ALONG THE NORTHEAST SIDE OF THE
HV9068'WASHINGTON CHANNEL IN WASHINGTON, D.C., GO NORTHWESTERLY ON WATER
HV9068'STREET FOR 0.16 KM (0.10 MI) TO THE PARKING LOT FOR THE SPIRIT OF
HV9068'WASHINGTON CRUISE SHIP AT PIER 4 AND THE STATION IN TOP OF THE
HV9068'CONCRETE SEAWALL BETWEEN THE THIRD AND FOURTH BRICK PILLARS (SEAWALL
HV9068'FENCE SUPPORTS) ON TOP OF THE SEAWALL.  THE STATION IS AN NOS TIDAL
HV9068'STATION DISK SET IN A DRILL HOLE IN THE TOP OF THE SEAWALL.  LOCATED
HV9068'22.34 M (73.29 FT) NORTHEAST OF THE NORTHEAST FACE OF THE FIRST BRICK
HV9068'PILLAR (SEAWALL FENCE SUPPORT) AT THE NORTHEAST SIDE OF THE ENTRANCE
HV9068'TO THE LOADING DOCK OF THE PIER FOR THE CRUISE SHIP, SPIRIT OF
HV9068'WASHINGTON, 21.88 M (71.78 FT) NORTHEAST OF TIDAL STATION NO.  5
HV9068'LOCATED IN TOP OF THE SEAWALL NEAR THE BASE OF THE BRICK PILLAR
HV9068'DESCRIBED ABOVE, 4.45 M (14.60 FT) SOUTHEAST OF THE SOUTHEAST FACE OF
HV9068'THE FOURTH BRICK PILLAR (SEAWALL FENCE SUPPORT) , (ONE OF FOUR) ,
HV9068'LOCATED NORTHEAST OF THE ENTRANCE DOCK FOR THE CRUISE SHIP, AND 8 CM
HV9068'NORTHEAST OF THE SEAWALL FENCE.
HV9068
HV9068                          STATION RECOVERY (2002)
HV9068
HV9068'RECOVERY NOTE BY INDIVIDUAL CONTRIBUTORS 2002 (APC)
HV9068'RECOVERED IN GOOD CONDITION.
HV9068
HV9068                          STATION RECOVERY (2008)
HV9068
HV9068'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 2008 (DBC)
```

```
HV9068'RECOVERED AS DESCRIBED.
HV9068
HV9068                          STATION RECOVERY (2010)
HV9068
HV9068'RECOVERY NOTE BY GEOCACHING 2010 (LPC)
HV9068'RECOVERED IN GOOD CONDITION.
HV9068
HV9068                          STATION RECOVERY (2012)
HV9068
HV9068'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 2012 (DRD)
HV9068'RECOVERED IN GOOD CONDITION.

*** retrieval complete.
Elapsed Time = 00:00:05
```

Appendix C

Positioning QC Check Results

Date: September 23, 2013 **Time: 14:28**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: P. Klingseis

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: HV9942
Description: Brass Disk

Owner: National Ocean Survey

	Easting	Northing	Elevation
Control Coordinates	**332,632.5080**	**4,309,582.7700**	**6.1000**
Tetra Tech Observed	**332,632.531**	**4,309,582.777**	**6.161**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.023**	**0.007**	**0.061**
RMS 2D Error		**0.024**	
RMS 3D Error			**0.043**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Brass disk located in proximity to the north side of the intersection of Tuxedo Road and Kenilworth Avenue in a grassy area. Brass disk is mounted in a concrete monument.

Date: September 23, 2013 **Time: 15:38**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: P. Klingseis

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: HV9068
Description: Brass Disk

Owner: National Ocean Survey

	Easting	Northing	Elevation
Control Coordinates	**324,665.1050**	**4,304,875.8130**	**2.4380**
Tetra Tech Observed	**324,665.122**	**4,304,875.804**	**2.474**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.017**	**0.009**	**0.036**
RMS 2D Error		**0.018**	
RMS 3D Error			**0.028**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Brass disk located in a seawall along Water Street in the Southwest Waterfront.

Date: September 24, 2013 **Time: 15:29**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: P. Klingseis

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: HV9068
Description: Brass Disk

Owner: National Ocean Survey

	Easting	Northing	Elevation
Control Coordinates	**324,665.1050**	**4,304,875.8130**	**2.4380**
Tetra Tech Observed	**324,665.124**	**4,304,875.811**	**2.474**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.019**	**0.002**	**0.036**
RMS 2D Error		**0.019**	
RMS 3D Error			**0.028**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Brass disk located in a seawall along Water Street in the Southwest Waterfront.

Date: September 25, 2013 **Time: ND**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: P. Klingseis

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: HV9068
Description: Brass Disk

Owner: National Ocean Survey

	Easting	Northing	Elevation
Control Coordinates	**324,665.1050**	**4,304,875.8130**	**2.4380**
Tetra Tech Observed	**ND**	**ND**	**ND**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**#VALUE!**	**#VALUE!**	**#VALUE!**
RMS 2D Error		**#VALUE!**	
RMS 3D Error			**#VALUE!**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: No quality control data collected on September 25, 2013.

Date: September 26, 2013 **Time: 11:29**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: P. Klingseis

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: HV9068
Description: Brass Disk

Owner: National Ocean Survey

	Easting	Northing	Elevation
Control Coordinates	**324,665.1050**	**4,304,875.8130**	**2.4380**
Tetra Tech Observed	**324,665.122**	**4,304,875.789**	**2.491**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.017**	**0.024**	**0.053**
RMS 2D Error		**0.024**	
RMS 3D Error			**0.042**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Brass disk located in a seawall along Water Street in the Southwest Waterfront.

Date: September 27, 2013 **Time: 11:41**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: P. Klingseis

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: HV9068
Description: Brass Disk

Owner: National Ocean Survey

	Easting	Northing	Elevation
Control Coordinates	**324,665.1050**	**4,304,875.8130**	**2.4380**
Tetra Tech Observed	**324,665.120**	**4,304,875.817**	**2.495**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.015**	**0.004**	**0.057**
RMS 2D Error		**0.015**	
RMS 3D Error			**0.036**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Brass disk located in a seawall along Water Street in the Southwest Waterfront.

Date: September 28, 2013 **Time: 11:46**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: P. Klingseis

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: HV9068
Description: Brass Disk

Owner: National Ocean Survey

	Easting	Northing	Elevation
Control Coordinates	**324,665.1050**	**4,304,875.8130**	**2.4380**
Tetra Tech Observed	**324,665.126**	**4,304,875.803**	**2.483**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.021**	**0.010**	**0.045**
RMS 2D Error		**0.022**	
RMS 3D Error			**0.035**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Brass disk located in a seawall along Water Street in the Southwest Waterfront.

Date: September 30, 2013 **Time: 10:37**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: P. Klingseis

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: HV9068
Description: Brass Disk

Owner: National Ocean Survey

	Easting	Northing	Elevation
Control Coordinates	**324,665.1050**	**4,304,875.8130**	**2.4380**
Tetra Tech Observed	**324,665.085**	**4,304,875.808**	**2.478**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.020**	**0.005**	**0.040**
RMS 2D Error		**0.020**	
RMS 3D Error			**0.031**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Brass disk located in a seawall along Water Street in the Southwest Waterfront.

Date: October 1, 2013 **Time: 12:13**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: P. Klingseis

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: HV9068
Description: Brass Disk

Owner: National Ocean Survey

	Easting	Northing	Elevation
Control Coordinates	**324,665.1050**	**4,304,875.8130**	**2.4380**
Tetra Tech Observed	**324,665.119**	**4,304,875.798**	**2.479**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.014**	**0.015**	**0.041**
RMS 2D Error		**0.018**	
RMS 3D Error			**0.031**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Brass disk located in a seawall along Water Street in the Southwest Waterfront.

Date: October 2, 2013 **Time: 12:05**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: P. Klingseis

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: HV9068
Description: Brass Disk

Owner: National Ocean Survey

	Easting	Northing	Elevation
Control Coordinates	**324,665.1050**	**4,304,875.8130**	**2.4380**
Tetra Tech Observed	**324,665.121**	**4,304,875.803**	**2.492**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.016**	**0.010**	**0.054**
RMS 2D Error		**0.017**	
RMS 3D Error			**0.036**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Brass disk located in a seawall along Water Street in the Southwest Waterfront.

Date: October 3, 2013 **Time: 11:44**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: P. Klingseis

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: HV9068
Description: Brass Disk

Owner: National Ocean Survey

	Easting	Northing	Elevation
Control Coordinates	**324,665.1050**	**4,304,875.8130**	**2.4380**
Tetra Tech Observed	**324,665.123**	**4,304,875.807**	**2.475**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.018**	**0.006**	**0.037**
RMS 2D Error		**0.018**	
RMS 3D Error			**0.029**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Brass disk located in a seawall along Water Street in the Southwest Waterfront.

Date: October 4, 2013 **Time: 12:09**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: P. Klingseis

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: HV9068
Description: Brass Disk

Owner: National Ocean Survey

	Easting	Northing	Elevation
Control Coordinates	**324,665.1050**	**4,304,875.8130**	**2.4380**
Tetra Tech Observed	**324,665.118**	**4,304,875.808**	**2.493**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.013**	**0.005**	**0.055**
RMS 2D Error		**0.013**	
RMS 3D Error			**0.035**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Brass disk located in a seawall along Water Street in the Southwest Waterfront.

Date: October 8, 2013 **Time: 13:54**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: P. Klingseis

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: HV9068
Description: Brass Disk

Owner: National Ocean Survey

	Easting	Northing	Elevation
Control Coordinates	**324,665.1050**	**4,304,875.8130**	**2.4380**
Tetra Tech Observed	**324,665.123**	**4,304,875.798**	**2.456**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.018**	**0.015**	**0.018**
RMS 2D Error		**0.021**	
RMS 3D Error			**0.026**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Brass disk located in a seawall along Water Street in the Southwest Waterfront.

Date: October 9, 2013 **Time: 10:28**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: P. Klingseis

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: HV9068
Description: Brass Disk

Owner: National Ocean Survey

	Easting	Northing	Elevation
Control Coordinates	**324,665.1050**	**4,304,875.8130**	**2.4380**
Tetra Tech Observed	**324,665.113**	**4,304,875.805**	**2.460**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.008**	**0.008**	**0.022**
RMS 2D Error		**0.010**	
RMS 3D Error			**0.017**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Brass disk located in a seawall along Water Street in the Southwest Waterfront.

Date: October 10, 2013 **Time: 15:13**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: P. Klingseis

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: HV9068
Description: Brass Disk

Owner: National Ocean Survey

	Easting	Northing	Elevation
Control Coordinates	**324,665.1050**	**4,304,875.8130**	**2.4380**
Tetra Tech Observed	**324,665.109**	**4,304,875.801**	**2.502**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.004**	**0.012**	**0.064**
RMS 2D Error		**0.009**	
RMS 3D Error			**0.039**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Brass disk located in a seawall along Water Street in the Southwest Waterfront.

Date: October 11, 2013 **Time: 11:10**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: P. Klingseis

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: HV9068
Description: Brass Disk

Owner: National Ocean Survey

	Easting	Northing	Elevation
Control Coordinates	**324,665.1050**	**4,304,875.8130**	**2.4380**
Tetra Tech Observed	**324,665.107**	**4,304,875.792**	**2.497**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.002**	**0.021**	**0.059**
RMS 2D Error		**0.015**	
RMS 3D Error			**0.040**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Brass disk located in a seawall along Water Street in the Southwest Waterfront.

Date: October 12, 2013 **Time: 10:23**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: P. Klingseis

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: HV9068
Description: Brass Disk

Owner: National Ocean Survey

	Easting	Northing	Elevation
Control Coordinates	**324,665.1050**	**4,304,875.8130**	**2.4380**
Tetra Tech Observed	**324,665.101**	**4,304,875.798**	**2.458**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.004**	**0.015**	**0.020**
RMS 2D Error		**0.012**	
RMS 3D Error			**0.020**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Brass disk located in a seawall along Water Street in the Southwest Waterfront.

Date: October 13, 2013 **Time: 10:20**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: P. Klingseis

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: HV9068
Description: Brass Disk

Owner: National Ocean Survey

	Easting	Northing	Elevation
Control Coordinates	**324,665.1050**	**4,304,875.8130**	**2.4380**
Tetra Tech Observed	**324,665.109**	**4,304,875.801**	**2.502**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.004**	**0.012**	**0.064**
RMS 2D Error		**0.009**	
RMS 3D Error			**0.039**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Brass disk located in a seawall along Water Street in the Southwest Waterfront.

Date: October 14, 2013 **Time: 12:34**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: J. Gallo

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: HV9068
Description: Brass Disk

Owner: National Ocean Survey

	Easting	Northing	Elevation
Control Coordinates	**324,665.1050**	**4,304,875.8130**	**2.4380**
Tetra Tech Observed	**324,665.129**	**4,304,875.800**	**2.490**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.024**	**0.013**	**0.052**
RMS 2D Error		**0.026**	
RMS 3D Error			**0.041**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Brass disk located in a seawall along Water Street in the Southwest Waterfront.

Date: October 15, 2013 **Time: 12:17**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: J. Gallo

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: HV9068
Description: Brass Disk

Owner: National Ocean Survey

	Easting	Northing	Elevation
Control Coordinates	**324,665.1050**	**4,304,875.8130**	**2.4380**
Tetra Tech Observed	**324,665.118**	**4,304,875.791**	**2.490**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.013**	**0.022**	**0.052**
RMS 2D Error		**0.020**	
RMS 3D Error			**0.039**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Brass disk located in a seawall along Water Street in the Southwest Waterfront.

Date: October 16, 2013 **Time: 12:00**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: P. Klingseis

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: HV9068
Description: Brass Disk

Owner: National Ocean Survey

	Easting	Northing	Elevation
Control Coordinates	**324,665.1050**	**4,304,875.8130**	**2.4380**
Tetra Tech Observed	**324,665.107**	**4,304,875.791**	**2.473**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.002**	**0.022**	**0.035**
RMS 2D Error		**0.016**	
RMS 3D Error			**0.030**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Brass disk located in a seawall along Water Street in the Southwest Waterfront.

Date: October 17, 2013 **Time: 12:27**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: K. Enright

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: HV9068
Description: Brass Disk

Owner: National Ocean Survey

	Easting	Northing	Elevation
Control Coordinates	**324,665.1050**	**4,304,875.8130**	**2.4380**
Tetra Tech Observed	**324,665.115**	**4,304,875.807**	**2.485**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.010**	**0.006**	**0.047**
RMS 2D Error		**0.011**	
RMS 3D Error			**0.030**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Brass disk located in a seawall along Water Street in the Southwest Waterfront.

Date: October 22, 2013 **Time: 06:56**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: K. Enright

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: BBBQ23
Description: Aluminum

Owner: USACE

	Easting	Northing	Elevation
Control Coordinates	**332,008.7910**	**4,311,195.8130**	**2.5230**
Tetra Tech Observed	**332,008.768**	**4,311,195.810**	**2.552**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.023**	**0.003**	**0.029**
RMS 2D Error		**0.023**	
RMS 3D Error			**0.029**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Aluminum disk located along concrete curb near Bladensburg Waterfront Park office. USACE disk.

Date: October 22, 2013 **Time: 11:56**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: K. Enright

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: HV9068
Description: Brass

Owner: National Ocean Survey

	Easting	Northing	Elevation
Control Coordinates	**324,665.1050**	**4,304,875.8130**	**2.4380**
Tetra Tech Observed	**324,665.121**	**4,304,875.805**	**2.487**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.016**	**0.008**	**0.049**
RMS 2D Error		**0.017**	
RMS 3D Error			**0.033**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Brass disk located in a seawall along Water Street in the Southwest Waterfront.

Date: October 23, 2013 **Time: 07:32**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: K. Enright

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: BBBQ23
Description: Aluminum

Owner: USACE

	Easting	Northing	Elevation
Control Coordinates	**332,008.7910**	**4,311,195.8130**	**2.5230**
Tetra Tech Observed	**332,008.775**	**4,311,195.816**	**2.557**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.016**	**0.003**	**0.034**
RMS 2D Error		**0.016**	
RMS 3D Error			**0.026**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Aluminum disk located along concrete curb near Bladensburg Waterfront Park office. USACE disk.

Date: October 24, 2013 **Time: 07:05**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: K. Enright

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: BBBQ23
Description: Aluminum

Owner: USACE

	Easting	Northing	Elevation
Control Coordinates	**332,008.7910**	**4,311,195.8130**	**2.5230**
Tetra Tech Observed	**332,008.772**	**4,311,195.814**	**2.549**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.019**	**0.001**	**0.026**
RMS 2D Error		**0.019**	
RMS 3D Error			**0.024**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Aluminum disk located along concrete curb near Bladensburg Waterfront Park office. USACE disk.

Date: October 25, 2013 **Time: 08:45**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: K. Enright

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: BBBQ23
Description: Aluminum

Owner: USACE

	Easting	Northing	Elevation
Control Coordinates	**332,008.7910**	**4,311,195.8130**	**2.5230**
Tetra Tech Observed	**332,008.772**	**4,311,195.813**	**2.555**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.019**	**0.000**	**0.032**
RMS 2D Error		**0.019**	
RMS 3D Error			**0.027**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Aluminum disk located along concrete curb near Bladensburg Waterfront Park office. USACE disk.

Date: October 27, 2013 **Time: 18:30**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: K. Enright

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: BBBQ23
Description: Aluminum

Owner: USACE

	Easting	Northing	Elevation
Control Coordinates	**332,008.7910**	**4,311,195.8130**	**2.5230**
Tetra Tech Observed	**332,008.817**	**4,311,195.866**	**2.505**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.026**	**0.053**	**0.018**
RMS 2D Error		**0.046**	
RMS 3D Error			**0.060**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Aluminum disk located along concrete curb near Bladensburg Waterfront Park office. USACE disk.
Defective omni bubble level on survey rod, human error increased, part on order.

Date: October 28, 2013 **Time: 06:40**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: K. Enright

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: BBBQ23
Description: Aluminum

Owner: USACE

	Easting	Northing	Elevation
Control Coordinates	**332,008.7910**	**4,311,195.8130**	**2.5230**
Tetra Tech Observed	**332,008.755**	**4,311,195.835**	**2.492**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.036**	**0.022**	**0.031**
RMS 2D Error		**0.039**	
RMS 3D Error			**0.046**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Aluminum disk located along concrete curb near Bladensburg Waterfront Park office. USACE disk.
Defective omni bubble level on survey rod, human error increased, part on order.

Date: October 29, 2013 **Time: 07:10**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: K. Enright

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: BBBQ23
Description: Aluminum

Owner: USACE

	Easting	Northing	Elevation
Control Coordinates	**332,008.7910**	**4,311,195.8130**	**2.5230**
Tetra Tech Observed	**332,008.789**	**4,311,195.813**	**2.503**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.002**	**0.000**	**0.020**
RMS 2D Error		**0.002**	
RMS 3D Error			**0.012**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Aluminum disk located along concrete curb near Bladensburg Waterfront Park office. USACE disk. Have replacement level for remainder of project.

Date: October 31, 2013 **Time: 12:35**

Tt GPS POSITION ACCURACY VERIFICATION LOG SHEET

Location: *Washington DC* Client: District Department of the Environment

Project: 2013 Anacostia River Bathymetric Survey

GPS Technician: K. Enright

GPS Correction Type: RTK Correction Source: **Leica SmartNet**

GPS Correction Message RTCM v3 Network Station: **RTCM3_iMAX**

Control Point: BBBQ23
Description: Aluminum

Owner: USACE

	Easting	Northing	Elevation
Control Coordinates	**332,008.7910**	**4,311,195.8130**	**2.5230**
Tetra Tech Observed	**332,008.764**	**4,311,195.805**	**2.490**
Accuracy Threshold	**0.033**	**0.033**	**0.065**
1D Difference	**0.027**	**0.008**	**0.033**
RMS 2D Error		**0.028**	
RMS 3D Error			**0.034**

Geodesy:	
Projection:	UTM 18 North
Horizontal Datum:	North American Datum of 1983 (NAD83)
Vertical Datum:	North American Vertical Datum of 1988 (NAVD 88) geoid 12a
Horizontal Units:	Meters
Vertical Units:	Meters

Notes: Aluminum disk located along concrete curb near Bladensburg Waterfront Park office. USACE disk.

Appendix D

Daily Bar Check and Water Level Quality Control

Daily Bar Check
R/V Uglee Duckling MBE

Note: Hysweep bar check results are stored within each hypack project as "Barcheck.txt"

Project Avg.	**0.04**
Project Stdv.	**0.02**
Project Min	**0.01**
Project Max	**0.06**

Date	time'	Bar Depth (m)	Meas. Depth (m)	Sonar Draft (m)	Pitch Corr.	Corr. Depth	Diff.	ABS(Diff.)	Notes
09/25/13	11:38	2.74	4.20	1.08	0.00	2.75	-0.01	0.01	
09/26/13	10:50	2.44	3.84	1.09	0.00	2.40	0.04	0.04	
09/27/13	n/a	3.05	4.46	1.10	0.00	3.03	0.02	0.02	
09/28/13	n/a	3.05	4.47	1.05	0.00	2.99	0.06	0.06	
09/30/13	11:26	2.44	3.85	1.08	0.01	2.40	0.04	0.04	
10/01/13	11:28	2.44	3.86	1.08	0.01	2.41	0.03	0.03	
10/02/13	11:15	2.44	3.85	1.07	0.00	2.39	0.05	0.05	
10/03/13	11:14	2.44	3.83	1.08	0.00	2.38	0.06	0.06	
10/04/13	11:38	2.44	3.87	1.07	0.00	2.41	0.03	0.03	

Daily Bar Check
R/V MIJITT Single Beam / Single Beam Sweep

Note: Hysweep bar check results are stored within each hypack project as "Barcheck.txt"

Project Avg.	**0.03**
Project Stdv.	**0.01**
Project Min	**0.00**
Project Max	**0.06**

Date	time'	Speed of Sound (ft/s)	Bar Depth (m)	Meas. Depth (m)	Sonar Draft (m)	Corr. Depth	Diff.	ABS(Diff.)	Notes
10/08/13									
Ducer 1	18:32	1489.7	1.52	1.25	0.31	1.56	0.04	0.04	
Ducer 2	18:32	1489.7	1.52	1.25	0.31	1.56	0.04	0.04	
Ducer 3	18:32	1489.7	1.52	1.22	0.31	1.53	0.01	0.01	
Ducer 4	18:32	1489.7	3.51	3.25	0.31	3.56	0.05	0.05	
Ducer 5	18:32	1489.7	3.66	3.38	0.31	3.69	0.04	0.04	
10/09/13									
Ducer 1	11:50	1489.5	3.20	2.93	0.31	3.24	0.04	0.04	
Ducer 2	11:50	1489.5	3.44	3.14	0.31	3.45	0.01	0.01	
Ducer 3	11:50	1489.5	3.69	3.35	0.31	3.66	-0.03	0.03	
Ducer 4	11:50	1489.5	3.96	3.69	0.31	4.00	0.04	0.04	
Ducer 5	11:50	1489.5	4.15	3.78	0.31	4.09	-0.06	0.06	

Date	time'	Speed of Sound (ft/s)	Bar Depth (m)	Meas. Depth (m)	Sonar Draft (m)	Corr. Depth	Diff.	ABS(Diff.)	Notes
10/10/13									
Ducer 1	13:13	1469.0	3.38	3.08	0.31	3.39	0.01	0.01	
Ducer 2	13:13	1469.0	3.60	3.32	0.31	3.63	0.04	0.04	
Ducer 3	13:13	1469.0	3.87	3.51	0.32	3.83	-0.05	0.05	
Ducer 4	13:13	1469.0	4.11	3.84	0.32	4.16	0.05	0.05	
Ducer 5	13:13	1469.0	4.30	3.96	0.32	4.28	-0.02	0.02	
10/11/13									
Ducer 1	n/a	1473.8	2.93	2.56	0.37	2.93	0.00	0.00	
Ducer 2	n/a	1473.8	3.14	2.85	0.32	3.17	0.03	0.03	
Ducer 3	n/a	1473.8	3.41	3.08	0.32	3.40	-0.02	0.02	
Ducer 4	n/a	1473.8	3.69	3.41	0.32	3.73	0.05	0.05	
Ducer 5	n/a	1473.8	3.84	3.54	0.32	3.86	0.02	0.02	
10/13/13									
Ducer 1	n/a	1473.8	3.32	3.01	0.36	3.37	0.05	0.05	
Ducer 2	n/a	1473.8	3.57	3.27	0.32	3.59	0.03	0.03	
Ducer 3	n/a	1473.8	3.80	3.43	0.32	3.75	-0.05	0.05	
Ducer 4	n/a	1473.8	4.08	3.83	0.31	4.14	0.05	0.05	
Ducer 5	n/a	1473.8	4.24	3.97	0.31	4.28	0.04	0.04	
10/14/13									
Ducer 1	11:26	1473.9	3.54	3.23	0.29	3.52	-0.01	0.01	
Ducer 2	11:26	1473.9	3.75	3.51	0.29	3.80	0.05	0.05	
Ducer 3	11:26	1473.9	4.02	3.69	0.30	3.99	-0.04	0.04	
Ducer 4	11:26	1473.9	4.24	3.96	0.31	4.27	0.04	0.04	
Ducer 5	11:26	1473.9	4.45	4.15	0.32	4.47	0.02	0.02	

Date	time'	Speed of Sound (ft/s)	Bar Depth (m)	Meas. Depth (m)	Sonar Draft (m)	Corr. Depth	Diff.	ABS(Diff.)	Notes
10/15/13									
Ducer 1	11:11	1473.6	3.66	3.35	0.32	3.67	0.02	0.02	
Ducer 2	11:11	1473.6	3.90	3.63	0.31	3.94	0.04	0.04	
Ducer 3	11:11	1473.6	4.15	3.78	0.31	4.09	-0.06	0.06	
Ducer 4	11:11	1473.6	4.36	4.05	0.31	4.36	0.01	0.01	
Ducer 5	11:11	1473.6	4.54	4.24	0.32	4.56	0.02	0.02	
10/16/13									
Ducer 1	12:02	1472.6	3.60	3.37	0.28	3.65	0.05	0.05	
Ducer 2	12:02	1472.6	3.81	3.54	0.28	3.82	0.01	0.01	
Ducer 3	12:02	1472.6	4.08	3.72	0.31	4.03	-0.06	0.06	
Ducer 4	12:02	1472.6	4.30	3.93	0.32	4.25	-0.05	0.05	
Ducer 5	12:02	1472.6	4.48	4.21	0.32	4.53	0.05	0.05	
10/17/13									
Ducer 1	11:42	1474.9	3.78	3.49	0.31	3.80	0.02	0.02	
Ducer 2	11:42	1474.9	4.02	3.69	0.31	4.00	-0.03	0.03	
Ducer 3	11:42	1474.9	4.24	3.96	0.31	4.27	0.04	0.04	
Ducer 4	11:42	1474.9	4.54	4.18	0.32	4.50	-0.05	0.05	
Ducer 5	11:42	1474.9	4.72	4.45	0.32	4.77	0.05	0.05	
10/22/13									
Ducer 1	13:28	1464.1	2.68	2.44	0.30	2.74	0.06	0.06	
Ducer 2	13:28	1464.1	2.71	2.44	0.32	2.76	0.05	0.05	
Ducer 3	13:28	1464.1	2.71	2.41	0.32	2.73	0.02	0.02	
Ducer 4	13:28	1464.1	2.74	2.41	0.32	2.73	-0.02	0.02	
Ducer 5	13:28	1464.1	2.71	2.41	0.33	2.74	0.03	0.03	

Date	time'	Speed of Sound (ft/s)	Bar Depth (m)	Meas. Depth (m)	Sonar Draft (m)	Corr. Depth	Diff.	ABS(Diff.)	Notes
10/23/13									
Ducer 1	12:04	1460.6	2.04	1.80	0.28	2.08	0.04	0.04	
Ducer 2	12:04	1460.6	2.07	1.80	0.29	2.09	0.02	0.02	
Ducer 3	12:04	1460.6	2.07	1.74	0.29	2.03	-0.05	0.05	
Ducer 4	12:04	1460.6	2.04	1.77	0.32	2.09	0.05	0.05	
Ducer 5	12:04	1460.6	2.04	1.74	0.35	2.09	0.05	0.05	
10/24/13									
Ducer 1	12:16	1452.1	1.83	1.49	0.37	1.86	0.03	0.03	
Ducer 2	12:16	1452.1	1.86	1.52	0.38	1.90	0.04	0.04	
Ducer 3	12:16	1452.1	1.86	1.55	0.32	1.87	0.02	0.02	
Ducer 4	12:16	1452.1	1.83	1.58	0.29	1.87	0.05	0.05	
Ducer 5	12:16	1452.1	1.83	1.58	0.29	1.87	0.05	0.05	
10/25/13									
Ducer 1	13:25	1444.1	1.86	1.62	0.27	1.89	0.03	0.03	
Ducer 2	13:25	1444.1	1.89	1.62	0.30	1.92	0.03	0.03	
Ducer 3	13:25	1444.1	1.89	1.58	0.32	1.90	0.02	0.02	
Ducer 4	13:25	1444.1	1.89	1.55	0.36	1.91	0.02	0.02	
Ducer 5	13:25	1444.1	1.86	1.52	0.38	1.90	0.04	0.04	
10/27/13									
Ducer 1	12:34	1449.0	1.92	1.71	0.27	1.98	0.06	0.06	
Ducer 2	12:34	1449.0	1.95	1.70	0.29	1.99	0.04	0.04	
Ducer 3	12:34	1449.0	1.95	1.68	0.31	1.99	0.04	0.04	
Ducer 4	12:34	1449.0	1.95	1.64	0.34	1.98	0.02	0.02	
Ducer 5	12:34	1449.0	1.95	1.61	0.37	1.98	0.03	0.03	

Date	time'	Speed of Sound (ft/s)	Bar Depth (m)	Meas. Depth (m)	Sonar Draft (m)	Corr. Depth	Diff.	ABS(Diff.)	Notes
10/28/13									
Ducer 1	11:56	1450.8	1.95	1.71	0.26	1.97	0.02	0.02	
Ducer 2	11:56	1450.8	1.98	1.71	0.29	2.00	0.02	0.02	
Ducer 3	11:56	1450.8	1.95	1.67	0.30	1.97	0.02	0.02	
Ducer 4	11:56	1450.8	1.95	1.64	0.34	1.98	0.02	0.02	
Ducer 5	11:56	1450.8	1.95	1.60	0.39	1.99	0.04	0.04	
10/29/13									
Ducer 1	13:06	1451.5	2.01	1.77	0.26	2.03	0.02	0.02	
Ducer 2	13:06	1451.5	2.04	1.77	0.29	2.06	0.02	0.02	

Daily Water Level Check

Project Avg.	0.001
Project Stdv	0.040
Project Min	-0.067
Project Max	0.062

Date	Time	Unit	Leica Rover Waterline Ht.(w/geoid)	-HYPACK Tide corr	INS Draft	Corr. Tide (No Pitch)	Diff (no pitch)	ABS(Diff)
9/25/2013	11:47	Hysweep	-0.162	1.341	-1.450	-0.109	-0.054	0.054
		Lieca	-0.162	1.225	-1.450	-0.225	0.062	0.062
9/26/2013	10:45	Hysweep	-0.111	1.396	-1.440	-0.044	-0.067	0.067
		Lieca	-0.111	1.286	-1.440	-0.154	0.043	0.043
9/27/2013	10:45	Lieca	0.054	1.579	-1.481	0.098	-0.045	0.045
9/28/2013	12:19	Hysweep	0.045	1.558	-1.480	0.078	-0.033	0.033
		Lieca	0.045	1.573	-1.480	0.093	-0.048	0.048
9/30/2013	11:05	Hysweep	0.552	1.981	-1.480	0.501	0.050	0.050
		Lieca	0.552	1.993	-1.480	0.514	0.038	0.038
10/1/2013	11:28	Hysweep	0.627	2.012	-1.430	0.582	0.045	0.045
		Lieca	0.627	2.012	-1.430	0.582	0.045	0.045
10/2/2013	11:10	Hysweep	0.654	2.088	-1.440	0.648	0.006	0.006
		Lieca	0.654	2.103	-1.440	0.663	-0.009	0.009
10/3/2013	11:13	Hysweep	0.680	2.164	-1.460	0.704	-0.024	0.024
		Lieca	0.680	2.164	-1.460	0.704	-0.024	0.024

Date	Time	Unit	Leica Rover Waterline Ht.(w/geoid)	-HYPACK Tide corr	INS Draft	Corr. Tide (No Pitch)	Diff (no pitch)	ABS(Diff)
10/4/2013	11:38	Hysweep	0.653	2.118	-1.460	0.658	-0.005	0.005
		Lieca	0.653	2.118	-1.460	0.658	-0.005	0.005
10/8/2013	19:24	Lieca	-1.220	-0.518	-0.710	-1.228	0.008	0.008
10/9/2013	11:47	Hysweep	-0.036	0.643	-0.710	-0.067	0.031	0.031
		Lieca	-0.036	0.643	-0.710	-0.067	0.031	0.031
10/10/2013	13:22	Hysweep	0.535	1.173	-0.695	0.479	0.056	0.056
		Lieca	0.535	1.173	-0.695	0.479	0.056	0.056
10/11/2013	11:36	leica	-0.014	0.741	-0.700	0.041	-0.055	0.055
10/13/2013	10:29	leica	0.506	1.143	-0.680	0.463	0.043	0.043
10/14/2013	11:22	leica	0.594	1.311	-0.730	0.581	0.013	0.013
10/15/2013	11:44	Leica	0.631	0.682	-0.660	0.682	-0.051	0.051
10/16/2013	12:48	Leica	0.551	0.586	-0.670	0.586	-0.035	0.035
10/17/2013	11:52	Leica	0.906	0.940	-0.690	0.940	-0.034	0.034
10/22/2013	13:24	Leica	0.548	0.596	-0.710	0.596	-0.048	0.048
10/23/2013	12:55	Leica	0.057	0.762	-0.700	0.062	-0.005	0.005
10/24/2013	12:24	Leica	-0.309	0.320	-0.660	-0.340	0.031	0.031
10/25/2013	13:07	Leica	-0.320	0.308	-0.670	-0.362	0.042	0.042
10/27/2013	12:34	Leica	1.339	2.032	-0.710	1.322	-0.017	0.017
10/28/2013	11:56	Leica	1.346	2.021	-0.690	1.331	-0.015	0.015
10/29/2013	13:06	Leica	1.485	2.138	-0.690	1.448	-0.037	0.037
10/31/2013	17:45	Leica	-0.230	-0.490	0.220	-0.270	0.040	0.040

Appendix E

Surface to Crossline Comparison Statistics

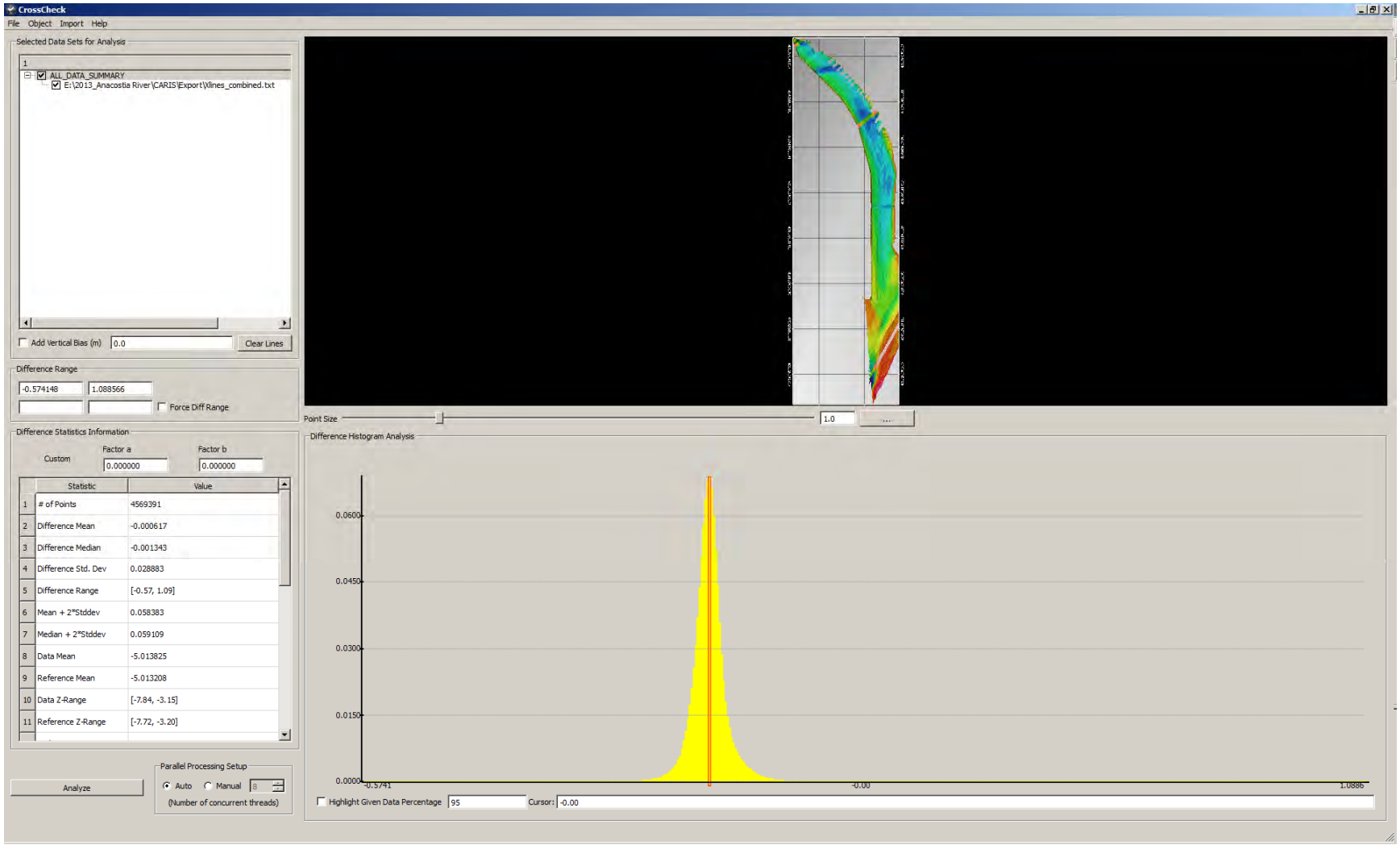


Figure E-1. Fledermaus Surface Statistics Comparing Final Deliverable Surface to Cross Line Data (all units are in meters)

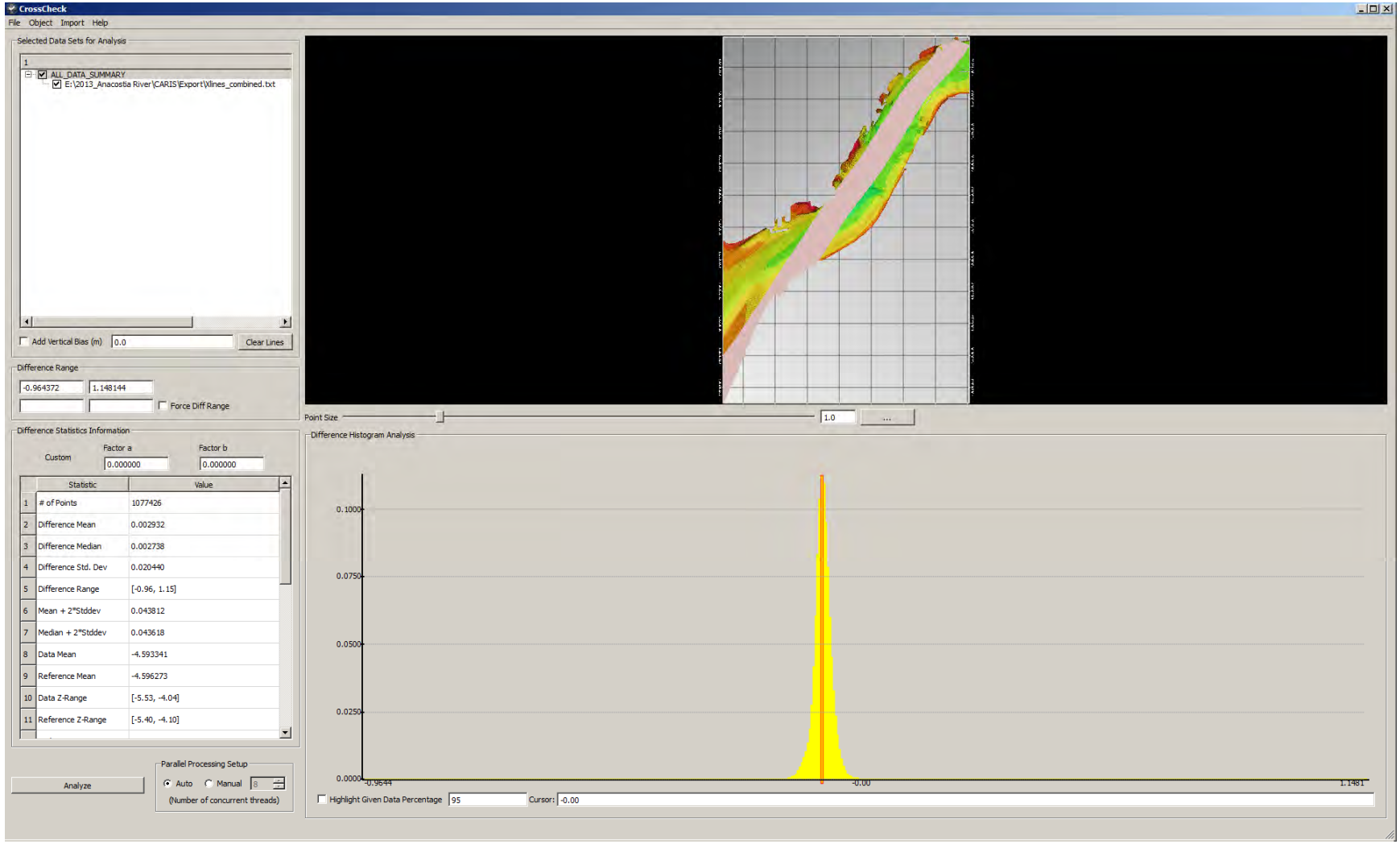


Figure E-2. Fledermaus Surface Statistics Comparing Final Deliverable Surface to Cross Line Data (all units are in meters)

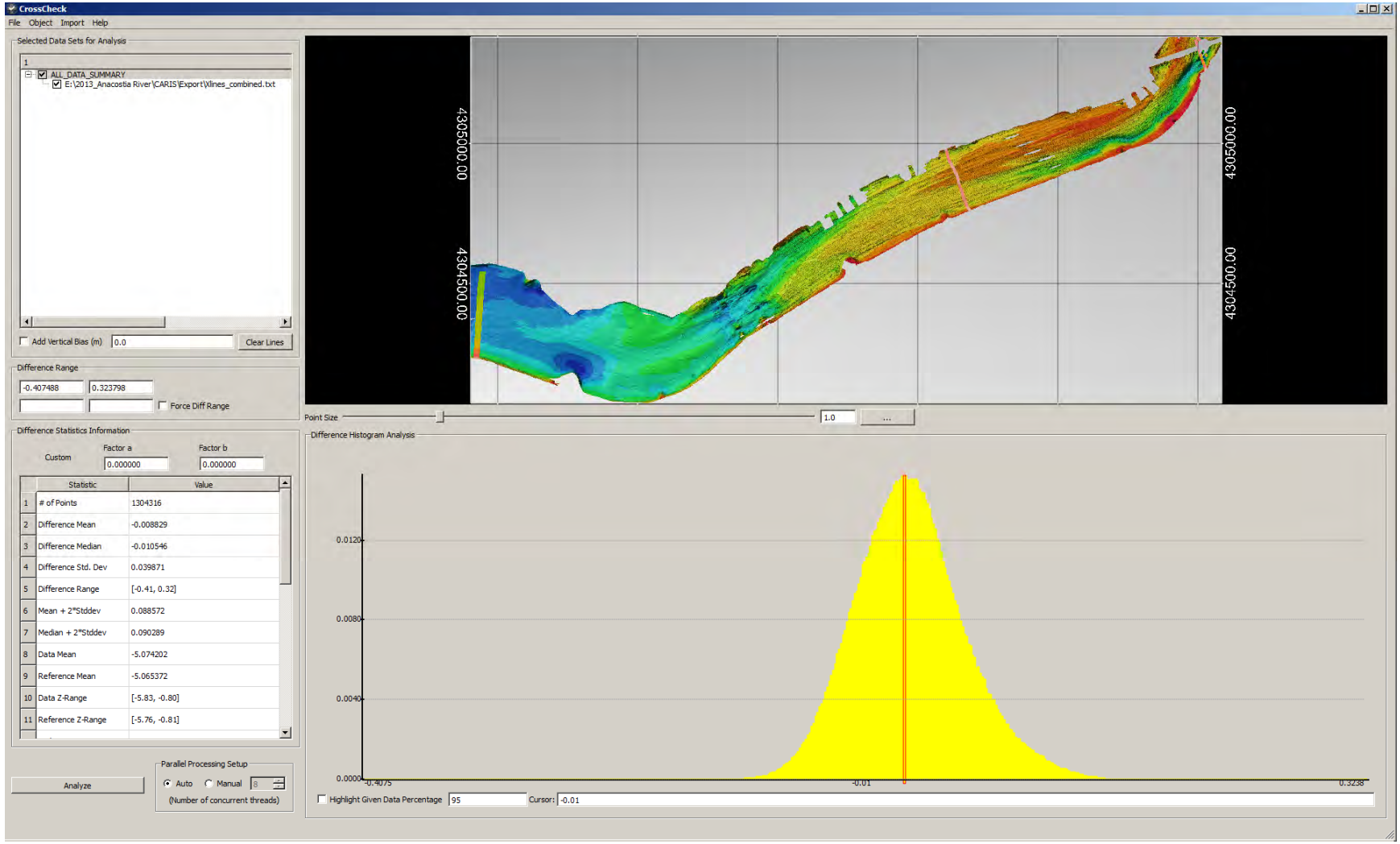


Figure E-3. Fledermaus Surface Statistics Comparing Final Deliverable Surface to Cross Line Data (all units are in meters)

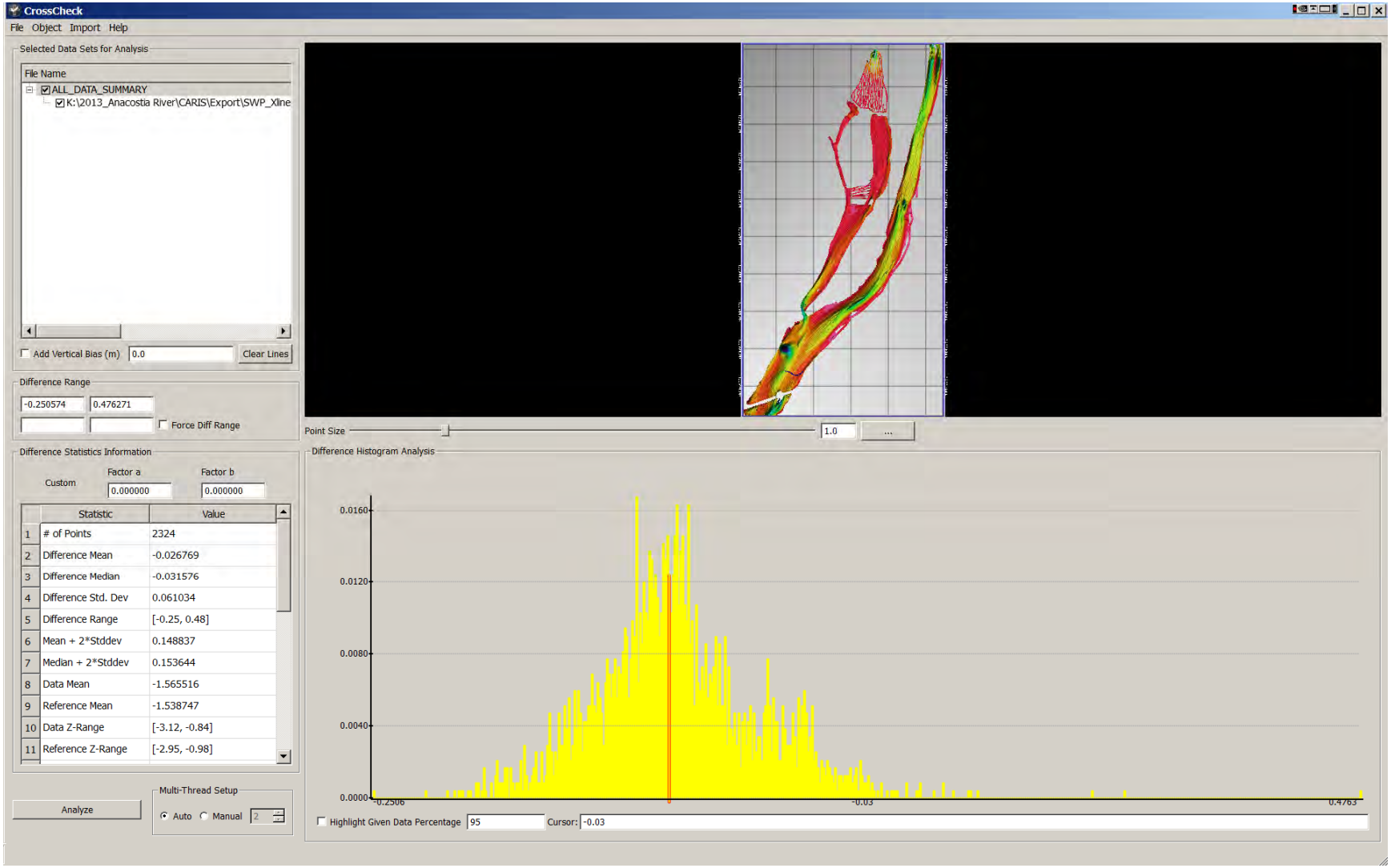


Figure E-4. Fledermaus Surface Statistics Comparing Final Deliverable Surface to Cross Line Data (all units are in meters)

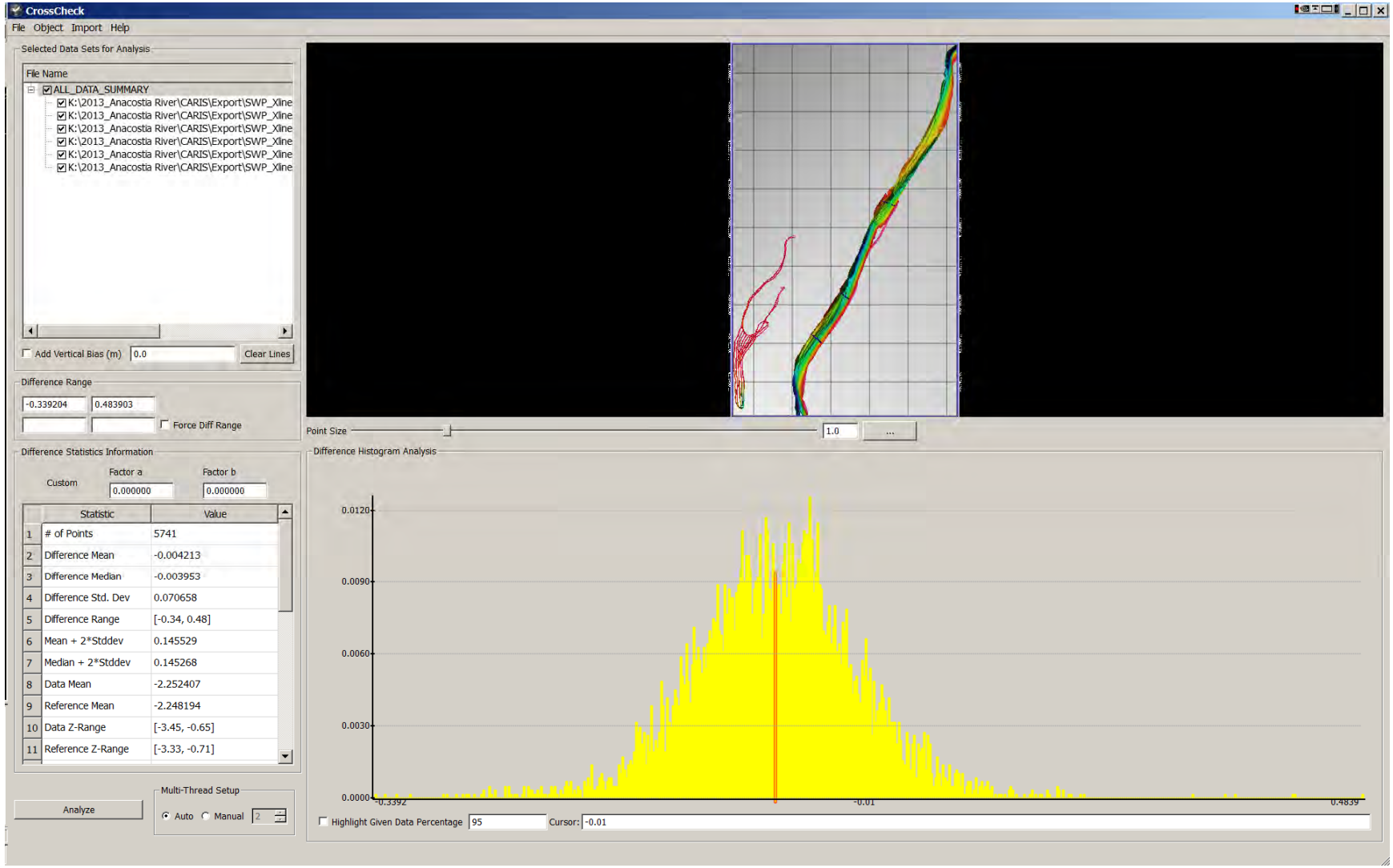


Figure E-5. Fledermaus Surface Statistics Comparing Final Deliverable Surface to Cross Line Data (all units are in meters)

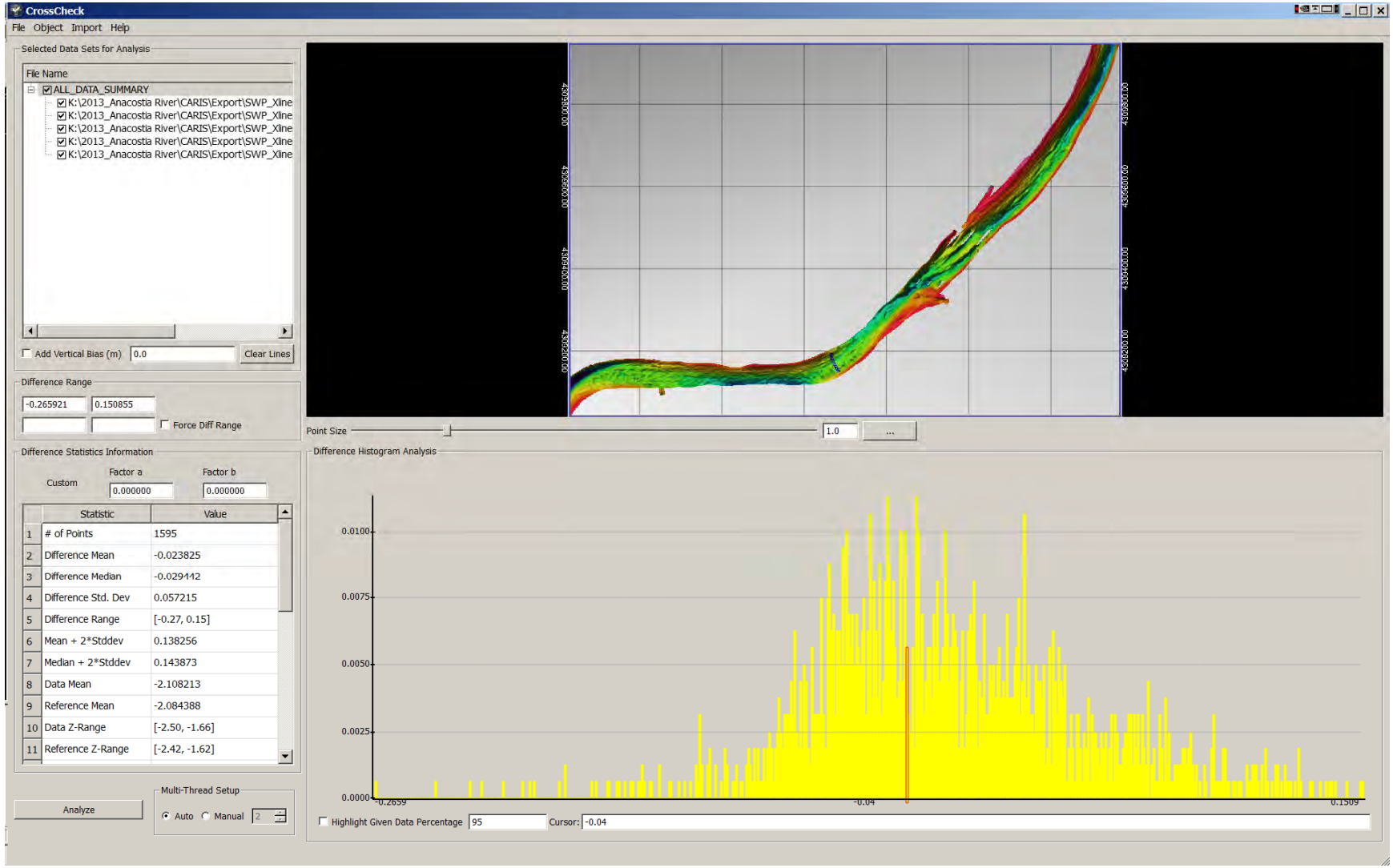


Figure E-6. Fledermaus Surface Statistics Comparing Final Deliverable Surface to Cross Line Data (all units are in meters)

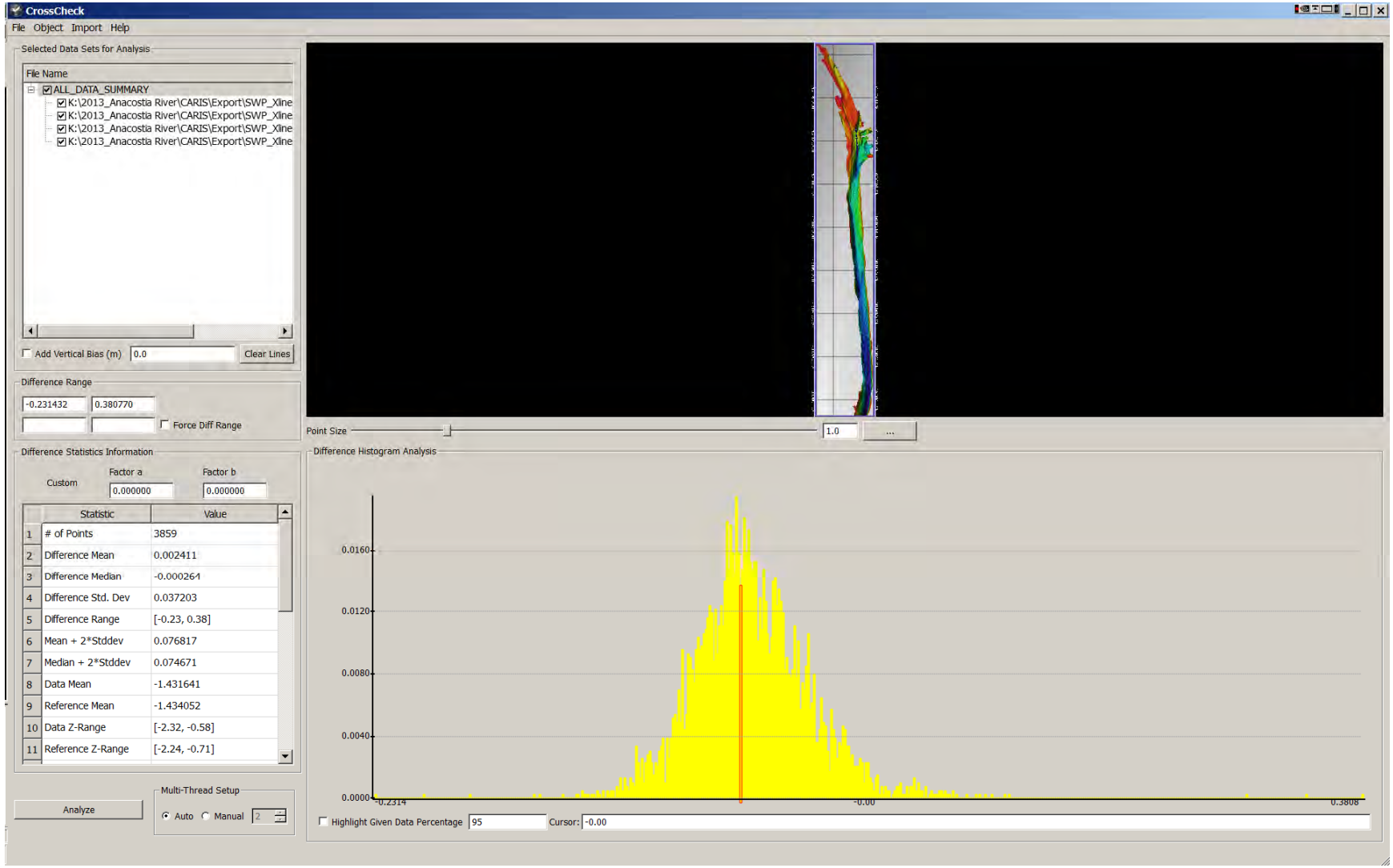


Figure E-7. Fledermaus Surface Statistics Comparing Final Deliverable Surface to Cross Line Data (all units are in meters)

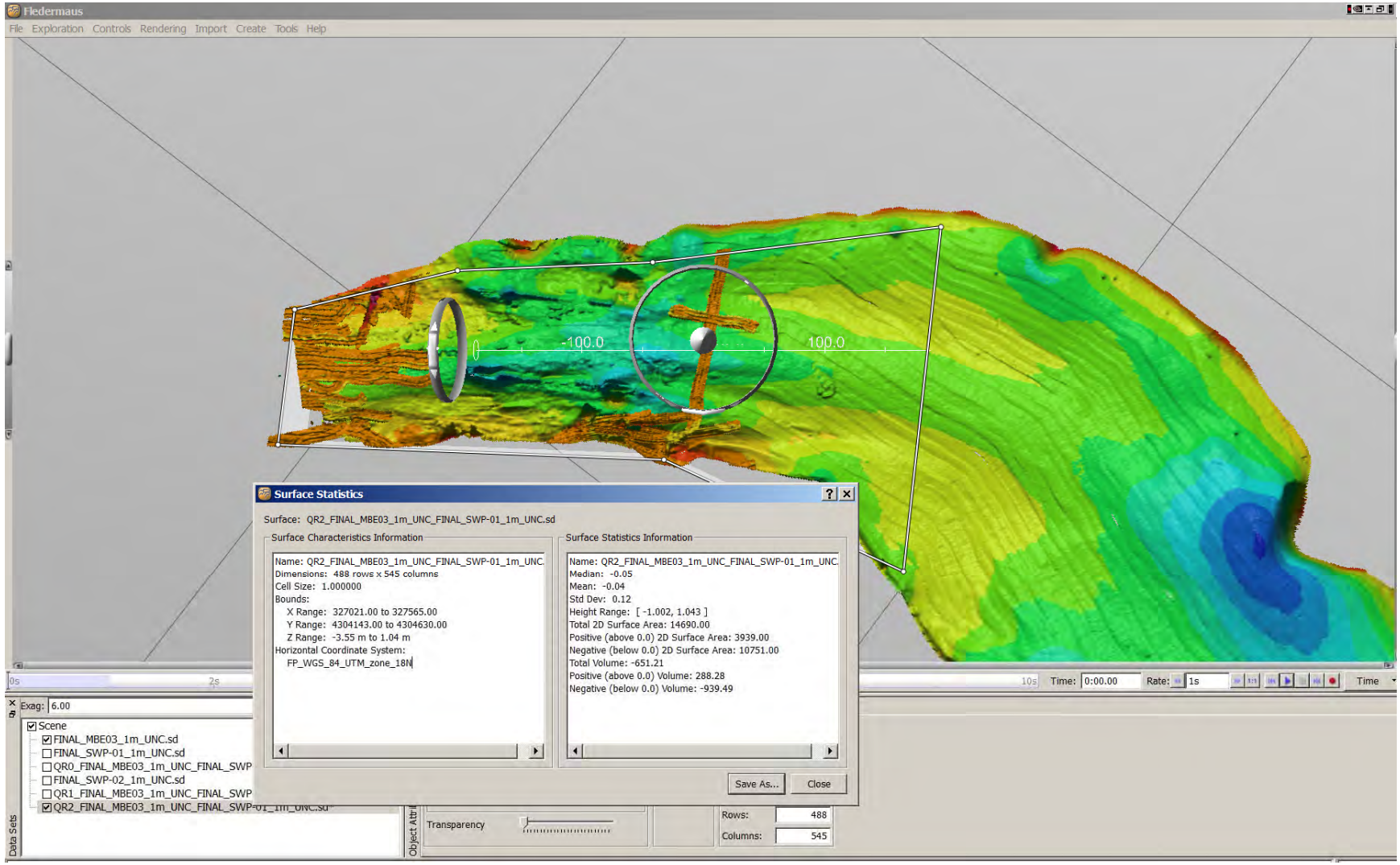


Figure E-8. Fledermaus Surface Statistics Comparing MBE data to SBE data within overlapping areas (all units are in meters)

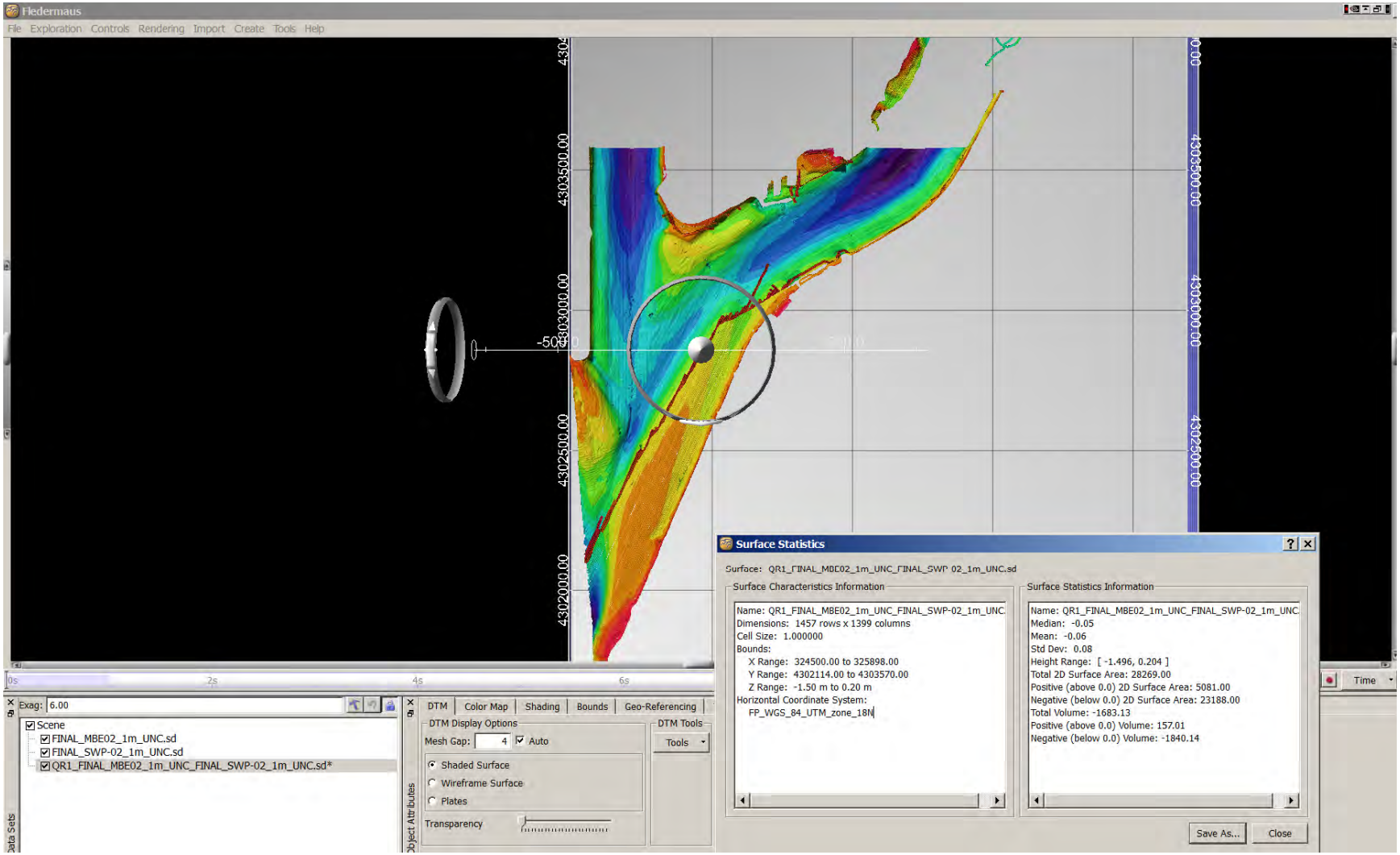


Figure E-9. Fledermaus Surface Statistics Comparing MBE data to SBE data within overlapping areas (all units are in meters)

Appendix F

Electronic Deliverables (submitted electronically)

Gridded ASCII Dataset

APPENDIX B
JANUARY 8, 2014 GEOMORPHIC ANALYSIS TECHNICAL MEMORANDUM

Date: January 8, 2014

To: File

From: Dave Richardson, Brad Schrotenboer, and Mark Shupe

Subject: Anacostia River Sediment Project Geomorphic Analysis

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The purpose of this memorandum is to provide the results of a geomorphic analysis performed based on the results of the bathymetric survey of the tidal Anacostia River performed by Tetra Tech, Inc. (Tetra Tech) between September 20 and October 30, 2013. Bathymetric data provides a basis for understanding patterns of deposition and erosion in the river and was used to prepare a contour map of the top of the sediment surface in and around the study area for the Anacostia River Sediment Project. Results of the bathymetric survey are summarized in the Tetra Tech December 9, 2013 Anacostia River Bathymetric Survey 2013 Technical Memorandum (Technical Memorandum), which is provided as Appendix A of the Anacostia River Remedial Investigation Work Plan.

Bathymetric Survey Methodology and Results

The survey was performed using high-resolution multibeam echosounding (MBE), multi-channel sweep and single beam echosounding (SBE) equipment. It included the entire study area (Figure 1.1 of the Work Plan), except portions with insufficient water depth for the minimum-draft survey vessel (an 18-foot jet boat). Low to no water conditions prohibited surveying the upper portion of Kingman Lake and the main channel of the Anacostia River north of Bladensburg Marina.

Maps showing the variation of river bottom elevation throughout the study area are included in the Technical Memorandum. In summary, bottom elevations in the Washington Channel typically range from -3.5 to approximately -9 meters (MSL). Elevations of the river bottom below the 11th Street Bridge crossing are slightly greater (ranging from -0.5 to -7.0 meters) than in the Washington Channel. From the 11th Street Bridge up river to the Bladensburg Marina, the bottom elevation increases, ranging from +0.5 to -3.5 meters. North of the foot bridges that cross Kingman Lake between the Benning Road and East Capitol Street bridges, Kingman Lake is accessible by boat only during extreme high tide events. Overall, the elevations in the accessible portion of Kingman Lake ranged from less than +0.5 meters to approximately -3.5 meters and were typically between -0.5 and -1.5 meters.

Geomorphic Surface Mapping

Geomorphic surface mapping describes the depositional pattern in a water body using the sediment bed elevations provided by bathymetric mapping. The differences in elevation define the thalweg, point bars, scour holes, transverse bars, outfall deposits, and other features. The mapping can also provide insight into the effects of anthropogenic features on the sediment bed. The purpose of the geomorphic surface mapping is to understand the depositional pattern and provide sediment sampling locations selected to confirm or adjust the geomorphic surface boundaries. Contaminants of concern will be deposited with fine grained sediment or in the sand fraction based on their fate and transport characteristics. The geomorphic surface mapping allows a focused sampling strategy based on contaminant fate and transport.

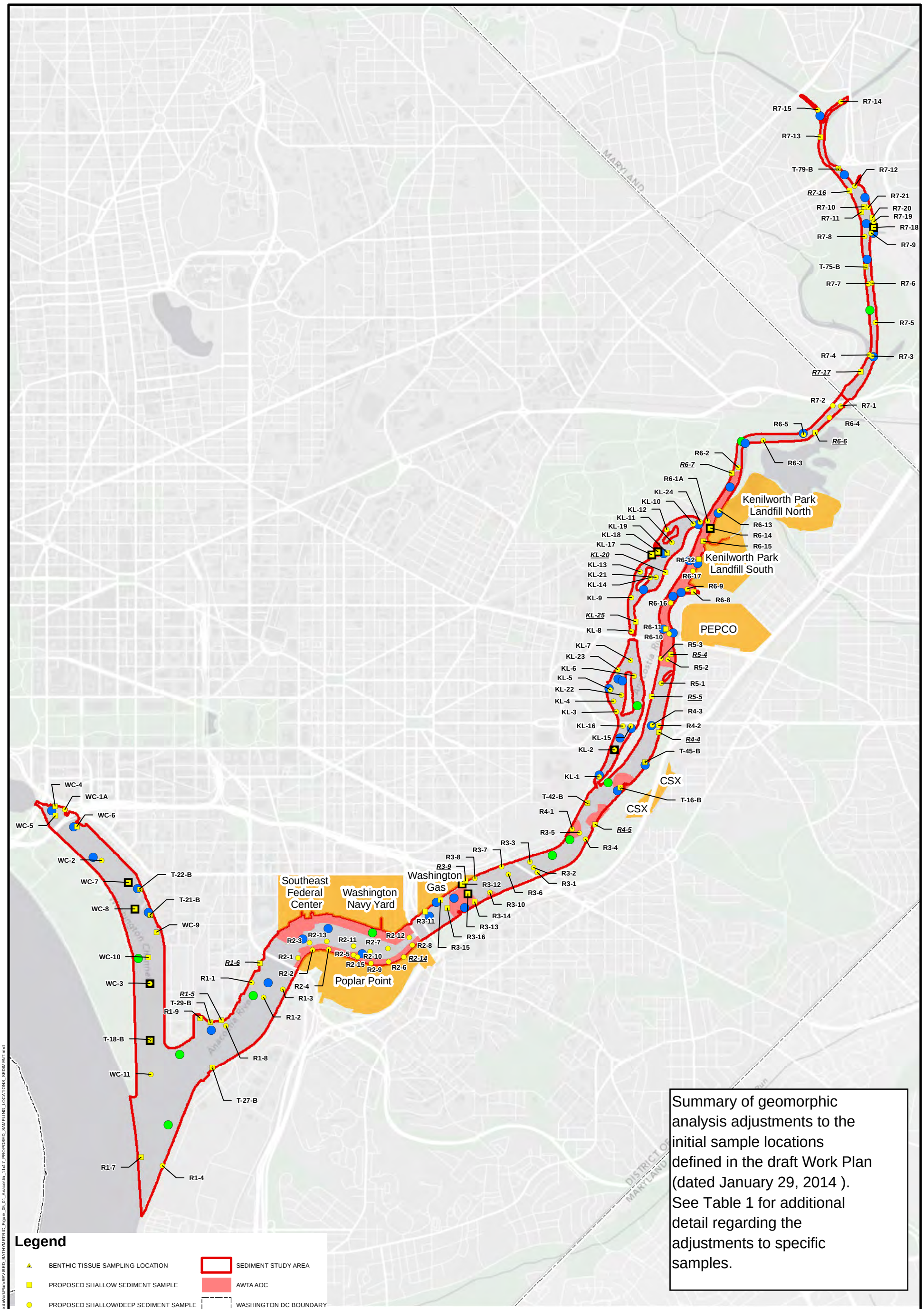
The geomorphic surface mapping was based on the September – October 2013 bathymetric field survey (noted above) as well as bathymetry derivatives (primarily contours, slope, and aspect). The river was mapped into distinct geomorphic surfaces. Boundaries were based on changes in aspect, slope, bed roughness/character, and other subtle differences that define the depositional and erosional pattern. The thalweg, the deepest part of the river, was also delineated to assist with the mapping process.

After the geomorphic surface mapping, a review of the historic sediment sample concentration data was completed to determine the broad patterns of deposition and erosion and the relationship to historic contaminant distribution. After comparing the geomorphic mapping and the thalweg location with the historic data, the pattern that emerged was one in which higher contaminant concentrations tended to be found near the thalweg of the channel, as opposed to along the edges of the channel. This deposition pattern appeared to be slightly stronger for poly-chlorinated biphenyl (PCB) data than for polycyclic aromatic hydrocarbon (PAH) data, suggesting that contaminant deposition in the tidal river is similar to an impounded body of water (lake or pond), as opposed to the deposition pattern typical for a higher-gradient meandering river. The deposition pattern appears to result from the low channel gradient, slow water velocity, and tidal effects.

Sample Location Selection

The initial (pre-bathymetric survey) sample locations defined in the draft Work Plan (dated January 29, 2014 and posted for public comment) were adjusted based on the geomorphic mapping and the broad patterns of contaminant deposition identified using historic sample concentration data. Sample locations were adjusted to provide sufficient characterization of the most important geomorphic zones of the river, the depositional areas. Proposed sample locations were removed if an area was sufficiently characterized by historic and/or other proposed sample locations. Proposed sample locations selected for human health characterization (pedestrian access to the river) were not adjusted. Verification locations were generally not adjusted, but the distance to the nearest historic sample (2000 or later) was noted. Outfall locations were generally not adjusted. The final sample layout maintains the original number of sample locations while adjusting a number of them to provide

characterization of the geomorphic environments in the river. For each proposed sample location that was moved, removed, or added a rationale has been provided. If necessary (for moved locations), the description of the location was updated. These changes are reflected on Table 1, Figure 1, and Figure 2 of this memorandum, and the changes were incorporated into the final versions of the Work Plan, Quality Assurance Project Plan (QAPP) and the Field Sampling Plan (FSP).



Summary of geomorphic analysis adjustments to the initial sample locations defined in the draft Work Plan (dated January 29, 2014). See Table 1 for additional detail regarding the adjustments to specific samples.

SOURCE: MODIFIED FROM CH2MHILL, 2011, AND DCGIS, 2012.

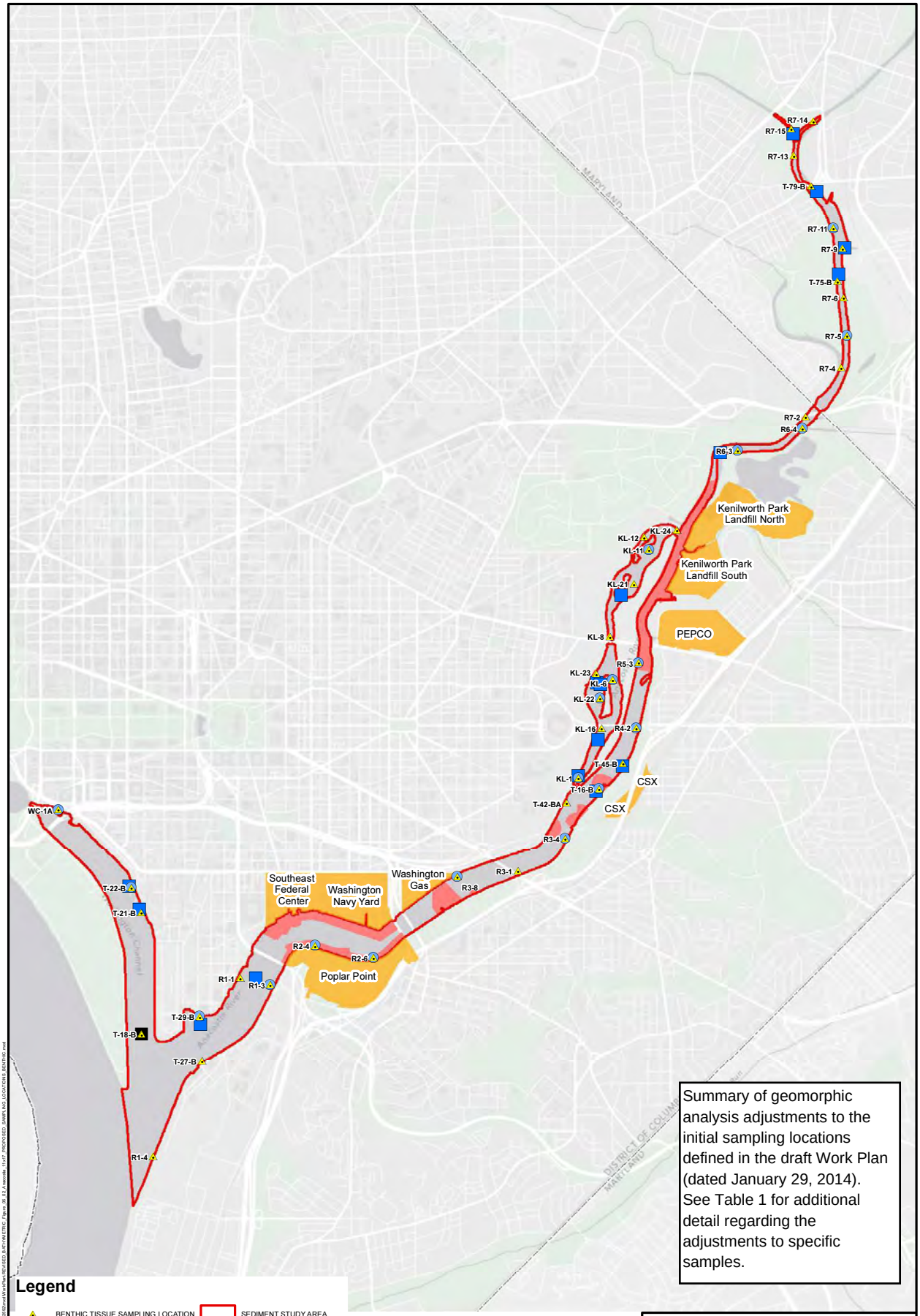
ANACOSTIA RIVER SEDIMENT REMEDIAL INVESTIGATION WORKPLAN

FIGURE 1
PROPOSED SEDIMENT SAMPLING LOCATIONS

TETRA TECH

Date Saved: 12/17/2013 4:53:13 PM User: peel.peters Path: S:\CAD\GIS\25\92\mxd\WorkPlan\REVISED_BATHYMETRIC_Figure_06_01_Anacostia_11x17_PROPOSED_SAMPLING_LOCATIONS_SEDIMENT.mxd

A-1764



Summary of geomorphic analysis adjustments to the initial sampling locations defined in the draft Work Plan (dated January 29, 2014). See Table 1 for additional detail regarding the adjustments to specific samples.

Legend

- BENTHIC TISSUE SAMPLING LOCATION
- PORE WATER SAMPLING LOCATION
- Moved Existing Location
- Remove Location
- PRP BOUNDARY
- SEDIMENT STUDY AREA
- AWTA AOC
- WASHINGTON DC BOUNDARY

DRAFT

0 1,500 3,000 Feet

SOURCE: MODIFIED FROM CH2MHILL, 2011, AND DCGIS, 2012.

ANACOSTIA RIVER SEDIMENTS
REMEDIAL INVESTIGATION WORKPLAN

FIGURE 2
PROPOSED BENTHIC INVERTEBRATE EVALUATION AND PORE WATER SAMPLING LOCATIONS IN SURFACE SEDIMENT

TETRA TECH

A-1766

New Name	Name	Reach	Pore Water	Deep Sediment	Rationale	Proximate to Existing Sample	Location	Notes, Including Rationale for Moving, Removing, or Adding Proposed Sample Locations: In main table red highlighting signifies removed locations, green highlight identifies added locations, yellow highlight means updated cell value, and blue text indicates the location was moved.
WC-09	WC-1A	Washington Channel	X	X	Outfall	N	Outfall F-477-703 North of I-395 Bridge	
WC-07	WC-2	Washington Channel		X	Spatial Coverage	N	Center of Washington Channel, midway between WC-1 and existing sample point	Moved northwest to characterize broad, shallow channel slope west of thalweg.
	~~WC-3~~	~~Washington Channel~~		~~X~~	~~Spatial Coverage~~	~~N~~	~~Center of Washington Channel, midway between two existing sample points~~	Already have good coverage from historic and proposed sample locations in the same geomorphic area.
WC-11	WC-4	Washington Channel			Outfall	N	Outfall F-290-057 North of I-395 Bridge	Type changed to outfall. Was originally listed as 'Spatial Coverage' but this did not match location description.
WC-10	WC-5	Washington Channel			Spatial Coverage	N	Mid-channel offshore from WC-4 and WC-1A	Moved northwest to be in center of thalweg depression.
WC-08	WC-6	Washington Channel			Spatial Coverage	N	Mid-channel offshore from Outfall F-518-460	Moved west to be in thalweg and center of geomorphic polygon.
	~~WC-7~~	~~Washington Channel~~			~~Spatial Coverage~~	~~N~~	~~Mid-channel offshore from marina and Outfall F-892-361~~	Historic and proposed locations already characterizing the same geomorphic area.
	~~WC-8~~	~~Washington Channel~~			~~Spatial Coverage~~	~~N~~	~~Mid-channel offshore from Outfalls F-969-934 & F-018-809~~	Historic and proposed locations already characterizing the same geomorphic area.
WC-04	WC-9	Washington Channel			Outfall	N	Outfall F-073-094	
WC-02	New Location	Washington Channel			Spatial Coverage		West side of Washington Channel, on slope between bank and thalweg	Added to characterize west channel slope in Washington Channel; in transect with WC-10
WC-03	WC-10	Washington Channel			Spatial Coverage	N	Center of Washington Channel, midway between two existing sample points	
R1-04	New Location	tol Street Bridge to Mouth of River			Spatial Coverage		Confluence of Washington Channel and Anacostia River	Added to characterize depositional area at confluence of Washington Channel and Anacostia River
WC-01	WC-11	Washington Channel		X	Spatial Coverage	N	Mouth of Washington Channel	
WC-06	T-22-B	Washington Channel	X		Spatial Coverage	N	Adjacent to marina dock	Moved slightly northwest. Previous location may be inaccessible when boats are docked.
WC-05	T-21-B	Washington Channel			Spatial Coverage	N	Adjacent to marina dock	Moved north to unsampled geomorphic polygon, away from geomorphic polygon boundary.
	~~T-18-B~~	~~Washington Channel~~			~~Spatial Coverage~~	~~N~~	~~Center channel upstream from mouth of Washington Channel~~	Already have good coverage from historic and proposed sample locations in the same geomorphic area.
R1-12	R1-1	South Capitol Street Bridge to Mouth of River		X	Outfall	N	West bank near F-093-544 coverage of unsampled portion of channel	
R1-11	R1-2	South Capitol Street Bridge to Mouth of River		X	Spatial Coverage	N	Center channel, coverage of unsampled portion of channel	
R1-10	New Location	tol Street Bridge to Mouth of River			Spatial Coverage		Slope northwest of thalweg between utility corridors	Added to characterize sloping northwest bank in unsampled area
R1-13	R1-3	South Capitol Street Bridge to Mouth of River	X	X	Spatial Coverage	N	Thalweg between utility corridors, coverage of unsampled portion of channel	Moved northwest to provide coverage in area between utility corridors (at thalweg).
R1-02	R1-4	South Capitol Street Bridge to Mouth of River		X	Outfall	N	Adjacent to Outfall F-128-495	
R1-03	New Location	tol Street Bridge to Mouth of River			Spatial Coverage		Offshore near confluence of Washington Channel and Anacostia River	Added to characterize broad, shallow depositional area along southeast bank, near confluence of Washington Channel and Anacostia River
R1-09	R1-5	South Capitol Street Bridge to Mouth of River			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)	
R1-14	R1-6	South Capitol Street Bridge to Mouth of River			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)	
R1-07	T-29-B	South Capitol Street Bridge to Mouth of River	X		Spatial Coverage	N	Near south bank, just upstream from confluence with Washington Channel	Moved south to characterize unsampled polygon and likely flow path between outfall and main channel.
R1-05	T-27-B	South Capitol Street Bridge to Mouth of River			Outfall	N	North band at Outfall F-937-544	There is no mapped outfall near this location. The outfall listed is on the opposite bank of the river.

New Name	Name	Reach	Pore Water	Deep Sediment	Rationale	Proximate to Existing Sample	Location	Notes, Including Rationale for Moving, Removing, or Adding Proposed Sample Locations: In main table red highlighting signifies removed locations, green highlight identifies added locations, yellow highlight means updated cell value, and blue text indicates the location was moved.
R1-01	R1-7	South Capitol Street Bridge to Mouth of River			Verification	Y	HPAH hotspot at mouth of Anacostia River	31 ft from 2000 ANS/USFWS Triad Study sample location
R1-08	R1-8	South Capitol Street Bridge to Mouth of River		X	Verification	Y	HPAH hotspot southeast of R1-5	34 ft from 2000 ANS/USFWS Triad Study sample location
R1-06	R1-9	South Capitol Street Bridge to Mouth of River			Spatial Coverage	N	Fort McNair Marina	
R2-01	R2-1	11th Street Bridge to South Capitol Street Bridge		X	Verification	Y	Overlap with year 2000 data point; east shoreline at Poplar Point	61 ft from 2000 ANS/USFWS Triad Study sample location
R2-02	R2-2	11th Street Bridge to South Capitol Street Bridge		X	Spatial Coverage	N	East shoreline at Poplar Point	
R2-03	R2-3	11th Street Bridge to South Capitol Street Bridge		X	Spatial Coverage	N	Center channel, offshore from R2-2	Moved northwest into main thalweg, midway between historic sample locations.
R2-04	R2-4	11th Street Bridge to South Capitol Street Bridge	X	X	Outfall	Y	East shoreline at Poplar Point, at Sewer Outfall F-897-104	
R2-07	R2-5	11th Street Bridge to South Capitol Street Bridge		X	Outfall, Verification	Y	East shoreline at Poplar Point, overlap with year 2000 point, adjacent to F-417-217	40 ft from 2000 ANS/USFWS Triad Study sample location
R2-13	R2-6	11th Street Bridge to South Capitol Street Bridge	X	X	Outfall	N	Adjacent to NPDES 005	
R2-12	R2-7	11th Street Bridge to South Capitol Street Bridge		X	Verification	Y	Center channel adjacent to year 2000 point	61 ft from 2000 ANS/USFWS Triad Study sample location
R2-15	R2-8	11th Street Bridge to South Capitol Street Bridge		X	Outfall	N	Adjacent to NPDES 006	
R2-11	R2-9	11th Street Bridge to South Capitol Street Bridge		X	Outfall	N	Adjacent to F-008-706	
R2-08	R2-10	11th Street Bridge to South Capitol Street Bridge		X	Spatial Coverage	N	Thalweg depression northwest of R2-9, northeast of R2-15	Moved southwest to depression where main thalweg and secondary thalweg meet.
R2-10	New Location	Bridge to South Capitol Street Bridge			Verification		Upstream of docks at Navy Yard, near north bank	Upstream of the docks at the Navy Yard, in area where channel widens, to verify historic data (2006, 2009 Washington Navy Yard Sed/Tiss)
R2-06	R2-11	11th Street Bridge to South Capitol Street Bridge		X	Verification	Y	Center channel from R2-05 and adjacent to year 2000 point	69 ft from 2000 ANS/USFWS Triad Study sample location
R2-16	R2-12	11th Street Bridge to South Capitol Street Bridge		X	Spatial Coverage	N	Center channel from R2-8	
R2-05	R2-13	11th Street Bridge to South Capitol Street Bridge		X	Spatial Coverage	N	Center channel from R2-4	Moved north of thalweg to characterize broad, flat channel bed.
R2-14	R2-14	11th Street Bridge to South Capitol Street Bridge		X	Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)	
R2-09	R2-15	11th Street Bridge to South Capitol Street Bridge		X	Outfall, Verification	Y	Outfall F-417-217; overlap with year 2000 sampling point	75 ft from 2000 ANS/USFWS Triad Study sample location
R3-12	R3-1	CSX Bridge to 11th Street Bridge		X	Verification	Y	Transect near Pennsylvania Ave. Bridge near year 2000 point	58 ft from 2000 ANS/USFWS Triad Study sample location
R3-11	R3-2	CSX Bridge to 11th Street Bridge		X	Verification	Y	Transect near Pennsylvania Ave. Bridge near year 2000 point	92 ft from 2000 ANS/USFWS Triad Study sample location

New Name	Name	Reach	Pore Water	Deep Sediment	Rationale	Proximate to Existing Sample	Location	Notes, Including Rationale for Moving, Removing, or Adding Proposed Sample Locations: In main table red highlighting signifies removed locations, green highlight identifies added locations, yellow highlight means updated cell value, and blue text indicates the location was moved.
R3-10	R3-3	CSX Bridge to 11th Street Bridge		X	Verification	Y	Transect near Pennsylvania Ave. Bridge near year 2000 point	89 ft from 2000 ANS/USFWS Triad Study sample location
R3-14	New Location	Bridge to 11th Street Bridge			Spatial Coverage		Upstream of Pennsylvania Ave. Bridge near secondary thalweg along northwest bank	Added to characterize broad depositional area that is currently unsampled.
R3-13	New Location	Bridge to 11th Street Bridge			Spatial Coverage		Downstream of CSX railroad bridge near northwest bank	Added location to characterize secondary thalweg and deposition area downstream of railroad bridge
R3-15	R3-4	CSX Bridge to 11th Street Bridge	X	X	Verification, Outfall	Y	Transect near CSX Bridge near year 2000 point; near Fort Davis tributary (F-238-290)	53 ft from 2000 ANS/USFWS Triad Study sample location
R3-16	R3-5	CSX Bridge to 11th Street Bridge		X	Verification	Y	Transect near CSX Bridge near year 2000 point	Closest 2000 ANS/USFWS Triad Study sample location is 338 ft away
R3-09	R3-6	CSX Bridge to 11th Street Bridge		X	Spatial Coverage	N	Center channel from R3-7	
R3-08	R3-7	CSX Bridge to 11th Street Bridge		X	Outfall	N	Adjacent to NPDES 018	
R3-06	R3-8	CSX Bridge to 11th Street Bridge	X	X	Outfall	N	Adjacent to F-405-220	
R3-05	R3-9	CSX Bridge to 11th Street Bridge			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)	
R3-07	R3-10	CSX Bridge to 11th Street Bridge		X	Verification, Outfall	Y	Outfall F-124-260 and a HPAH hotspot	46 ft from 2000 ANS/USFWS Triad Study sample location
R3-01	R3-11	CSX Bridge to 11th Street Bridge			Verification	N	Thalweg, near southwest corner of Washington Gas	Moved southeast from nearshore area to thalweg. Changed to 'Verification' from 'Spatial Coverage' because an existing sample is already in this location (2000 ANS/USFWS Triad Study).
	~~R3-12~~	~~Bridge to 11th Street Bridge~~			~~Spatial Coverage~~	~~N~~	~~Nearshore off of Washington Gas~~	Another spatial coverage location is already nearby.
	~~R3-13~~	~~Bridge to 11th Street Bridge~~			~~Spatial Coverage~~	~~N~~	~~Mid channel forming transect with R3-12~~	Adequate coverage already exists in this area.
R3-04	R3-14	CSX Bridge to 11th Street Bridge			Spatial Coverage	N	Near shoreline opposite from Washington Gas, forming transect with R3-16	Moved southwest along secondary thalweg. Better position between historic transects.
R3-02	R3-15	CSX Bridge to 11th Street Bridge			Spatial Coverage	N	Nearshore off of Washington Gas	Moved southwest to be in line with historic transect and to better represent geomorphic surface.
R3-03	R3-16	CSX Bridge to 11th Street Bridge			Spatial Coverage	N	Mid channel forming transect with R3-16	Moved northeast toward main thalweg and in line with new location of R3-14. Provides better coverage in unsampled area.
R4-01	R4-1	East Capitol Street Bridge to CSX Bridge		X	Verification	Y	Transect near CSX Bridge near year 2000 point	39 ft from 2000 ANS/USFWS Triad Study sample location
R4-09	R4-2	East Capitol Street Bridge to CSX Bridge	X	X	Verification, Outfall	Y	Transect near East Capitol St. Bridge; near Chaplin tributary (F-903-371) and 2000 point	Closest 2000 ANS/USFWS Triad Study sample location is 133 ft away
R4-08	R4-3	East Capitol Street Bridge to CSX Bridge		X	Spatial Coverage	N	Transect near East Capitol St. Bridge	Moved slightly southwest to be in center of geomorphic polygon, away from transitional edge areas.
R4-07	R4-4	East Capitol Street Bridge to CSX Bridge			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)	
R4-05	New Location	pitol Street Bridge to CSX Bridge			Spatial Coverage		Northwest bank upstream of mouth of Kingman Slough	Added to characterize widening channel and broad depositional area just upstream of confluence between Kingman Slough and Anacostia River
R4-02	R4-5	East Capitol Street Bridge to CSX Bridge			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)	
R4-03	T-42-BA	East Capitol Street Bridge to CSX Bridge			Verification	Y	HPAH hotspot downstream from Kingman Lake confluence	66 ft from 2000 ANS/USFWS Triad Study sample location
R4-04	T-16-B	East Capitol Street Bridge to CSX Bridge	X		Spatial Coverage	N	East bank between Fort Dupont Creek outfall and CSX railroad bridge	Moved southwest to provide better spatial coverage between existing historic locations.
R4-06	T-45-B	East Capitol Street Bridge to CSX Bridge			Spatial Coverage	N	East bank north of Fort Dupont Creek Outfall	Moved south to be closer to shore.
R5-02	R5-1	Benning Road Bridge to East Capitol Street Bridge		X	Outfall	N	Adjacent to F-090-064	
R5-03	R5-2	Benning Road Bridge to East Capitol Street Bridge		X	Verification	Y	Transect downstream from year 2000 transect	
R5-04	R5-3	Benning Road Bridge to East Capitol Street Bridge	X	X	Verification	Y	Transect downstream from year 2000 transect	Closest 2000 ANS/USFWS Triad Study sample location is 145 ft away
R5-05	R5-4	Benning Road Bridge to East Capitol Street Bridge			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)	70 ft from 2000 ANS/USFWS Triad Study sample location

New Name	Name	Reach	Pore Water	Deep Sediment	Rationale	Proximate to Existing Sample	Location	Notes, Including Rationale for Moving, Removing, or Adding Proposed Sample Locations: In main table red highlighting signifies removed locations, green highlight identifies added locations, yellow highlight means updated cell value, and blue text indicates the location was moved.
R5-01	R5-5	Benning Road Bridge to East Capitol Street Bridge			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)	
R6-09	R6-1A	Amtrak Bridge to Benning Road Bridge		X	Verification	Y	Mouth of Hickey Run near existing elevated year 2000 point	Changed status to verification only, because no named outfall nearby. 21 ft from 2000 ANS/USFWS Triad Study sample location.
R6-11	R6-2	Amtrak Bridge to Benning Road Bridge		X	Spatial Coverage	N	Center channel near Kenilworth Park North Landfill	Moved southwest to provide better longitudinal coverage between historic sample locations. In center of channel.
R6-14	New Location	Bridge to Benning Road Bridge			Spatial Coverage		Sharp meander upstream of Kenilworth Park North Landfill	Added to characterize thalweg at sharp meander bend
R6-13	R6-3	Amtrak Bridge to Benning Road Bridge	X	X	Spatial Coverage	N	Sharp meander upstream of Kenilworth Park North Landfill	Moved west to better characterize well-developed point bar at sharp meander.
R6-17	R6-4	Amtrak Bridge to Benning Road Bridge	X	X	Verification, Outfall	Y	Confluence with Lower Beaverdam Creek	96 ft from 2000 ANS/USFWS Triad Study sample location
R6-15	R6-5	Amtrak Bridge to Benning Road Bridge		X	Spatial Coverage	N	North bank between year 2000 transects	Moved slightly northwest to better characterize geomorphic surface (away from transitional area).
R6-16	R6-6	Amtrak Bridge to Benning Road Bridge			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)	
R6-12	R6-7	Amtrak Bridge to Benning Road Bridge			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)	
R6-05	R6-8	Amtrak Bridge to Benning Road Bridge			Spatial Coverage	N	Mouth of outfall at northwest boundary of the Pepco site	
R6-04	R6-9	Amtrak Bridge to Benning Road Bridge		X	Spatial Coverage	N	At south side of mouth of inlet for outfall at northwest boundary of the Pepco site	Moved southwest to be in a deposition area, where flow from outfall meets main channel.
R6-01	R6-10	Amtrak Bridge to Benning Road Bridge		X	Spatial Coverage	N	At mouth of inlet for outfall at southwest boundary of the Pepco site	Moved east to be closer to outfall
R6-02	R6-11	Amtrak Bridge to Benning Road Bridge			Spatial Coverage	Y	Center channel off of Pepco site; near ANS 2000 sample (concentration 1119 ug/kg)	Moved west to be in the thalweg.
R6-06	R6-12	Amtrak Bridge to Benning Road Bridge			Spatial Coverage	N	Nearshore sediment bar off of Kenilworth Park South Landfill, in transect with R6-17	Moved slightly south to be midway between existing transects.
R6-10	R6-13	Amtrak Bridge to Benning Road Bridge		X	Spatial Coverage	N	Nearshore off of Kenilworth Park North Landfill	Moved slightly southwest and closer to bank to better represent geomophic deposition area.
	~~R6-14~~	~~Bridge to Benning Road Bridge~~			~~Spatial Coverage~~	~~N~~	~~Nearshore off of Kenilworth Park North Landfill~~	Sufficient spatial/geomorphic coverage in area
R6-08	R6-15	Amtrak Bridge to Benning Road Bridge			Spatial Coverage	Y	Bar at mouth of Watts Branch; near ANS 2000 sample (concentration 599 ug/kg)	85 ft from 2000 ANS/USFWS Triad Study sample location
R6-03	R6-16	Amtrak Bridge to Benning Road Bridge		X	Spatial Coverage	N	Mid-channel off of Pepco site	Moved north to be in thalweg and midway between existing transects.
R6-07	R6-17	Amtrak Bridge to Benning Road Bridge		X	Spatial Coverage	N	West bank near Kenilworth Park South Landfill	Moved to opposite side of channel to be in uncharacterized geomorphic surface.
R7-01	R7-1	Upper tidal limit to Amtrak Bridge		X	Verification	Y	Transect at New York Ave. Bridge near existing year 2000 point	47 ft from 2000 ANS/USFWS Triad Study sample location
R7-02	R7-2	Upper tidal limit to Amtrak Bridge		X	Verification	Y	Transect at New York Ave. Bridge near existing year 2000 point	99 ft from 2000 ANS/USFWS Triad Study sample location
R7-04	R7-3	Upper tidal limit to Amtrak Bridge		X	Spatial Coverage	N	Transect near confluence with Dueling Creek	Moved southeast to be in thalweg
R7-05	R7-4	Upper tidal limit to Amtrak Bridge		X	Spatial Coverage	N	Transect near confluence with Dueling Creek	
R7-06	R7-5	Upper tidal limit to Amtrak Bridge	X	X	Spatial Coverage	N	Center channel downstream from unnamed wetland tributary	
R7-07	New Location	er tidal limit to Amtrak Bridge			Spatial Coverage		West bank near Colmar Manor Community Park	Added to characterize geomophic environment along west bank
R7-09	R7-6	Upper tidal limit to Amtrak Bridge		X	Verification	Y	Near year 2000 transect	
R7-08	R7-7	Upper tidal limit to Amtrak Bridge		X	Verification	Y	Near year 2000 transect	
R7-11	R7-8	Upper tidal limit to Amtrak Bridge		X	Verification	Y	Located near year 2000 point; transect with R7-9	Closest 2000 ANS/USFWS Triad Study sample location is 1,113 ft away
R7-12	R7-9	Upper tidal limit to Amtrak Bridge		X	Outfall	N	Confluence with unnamed tributary at outfall PG-TMP-13	Moved slightly east into uncharacterized geomorphic surface and closer to outfall
R7-16	R7-10	Upper tidal limit to Amtrak Bridge			Verification	Y	Center channel sediment bar; near year 2000 transect	65 ft from 2000 ANS/USFWS Triad Study sample location
R7-15	R7-11	Upper tidal limit to Amtrak Bridge	X		Verification	Y	Center channel sediment bar; near year 2000 transect	93 ft from 2000 ANS/USFWS Triad Study sample location

New Name	Name	Reach	Pore Water	Deep Sediment	Rationale	Proximate to Existing Sample	Location	Notes, Including Rationale for Moving, Removing, or Adding Proposed Sample Locations: In main table red highlighting signifies removed locations, green highlight identifies added locations, yellow highlight means updated cell value, and blue text indicates the location was moved.
R7-19	R7-12	Upper tidal limit to Amtrak Bridge		X	Outfall	N	Confluence with unnamed tributary at outfall PG-TMP-5	
R7-21	R7-13	Upper tidal limit to Amtrak Bridge			Spatial Coverage	N	Center channel sediment bar	
R7-23	R7-14	Upper tidal limit to Amtrak Bridge		X	Verification	Y	Upstream on Northeast Branch near year 2000 point	Closest 2000 ANS/USFWS Triad Study sample location is 1,086 ft away
R7-22	R7-15	Upper tidal limit to Amtrak Bridge		X	Spatial Coverage	N	Upstream on Northwest Branch	Moved toward confluence to avoid influences from upstream pedestrian bridge
R7-18	R7-16	Upper tidal limit to Amtrak Bridge			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)	
R7-03	R7-17	Upper tidal limit to Amtrak Bridge			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)	Does not appear to be in a typically accessible area.
R7-10	T-75-B	Upper tidal limit to Amtrak Bridge			Spatial Coverage	N	Center channel midway between R7-7 and R7-8	Moved northeast to center of channel.
R7-20	T-79-B	Upper tidal limit to Amtrak Bridge			Spatial Coverage	N	Southeast of Bladensburg Road Bridge along northeast bank	Moved downstream to edge of rip rap to avoid influence by upstream road bridge
	~~R7-18~~	~~r tidal limit to Amtrak Bridge~~			~~Spatial Coverage~~	~~N~~	~~Adjacent to pier structure at Bladensburg marina~~	Additional characterization in marina area unnecessary
R7-13	R7-19	Upper tidal limit to Amtrak Bridge		X	Spatial Coverage	N	Thalweg near Bladensburg marina	Moved to end of docks, near thalweg
R7-14	R7-20	Upper tidal limit to Amtrak Bridge			Spatial Coverage	N	Adjacent to shoreline at Bladensburg marina	
R7-17	R7-21	Upper tidal limit to Amtrak Bridge		X	Spatial Coverage	N	North of mid-channel bar to the north of Bladensburg marina	Moved north of mid-channel bar where channel widens and deposition is likely
KL-01	KL-1	Kingman Lake	X	X	Spatial Coverage	N	Downstream near mouth of Kingman Lake	Moved north to be in secondary thalweg.
	~~KL-2~~	~~Kingman Lake~~		~~X~~	~~Spatial Coverage~~	~~N~~	~~Broad channel between Kingman Lake mouth and East Capitol Street~~	Coverage of similar geomoprhic area already provided by KL-16
KL-04	KL-3	Kingman Lake		X	Outfall	N	Downstream from F-284-041	
KL-06	KL-4	Kingman Lake		X	Outfall	N	Downstream from unnamed outfall on west bank	
KL-07	KL-5	Kingman Lake		X	Outfall	N	Downstream from F-611-365	Moved slightly northwest to be closer to outfall and in distinct geomorphic area.
KL-05	New Location	Kingman Lake			Spatial Coverage		East channel north of East Capitol Street and south of Benning Road	Added to capture broad depositional area in Kingman Lake
KL-10	KL-6	Kingman Lake	X	X	Spatial Coverage	N	East channel north of East Capitol Street and south of Benning Road	
KL-11	KL-7	Kingman Lake		X	Spatial Coverage	N	Main channel south of Benning Road	
KL-12	KL-8	Kingman Lake		X	Outfall	N	Downstream from F-991-021	Changed 'Location' field to reflect correct outfall.
KL-14	KL-9	Kingman Lake		X	Outfall	N	Downstream from F-052-384	
KL-22	KL-10	Kingman Lake		X	Spatial Coverage	N	Upstream mouth of Kingman Lake	Moved east to be in main channel of mouth.
KL-20	KL-11	Kingman Lake	X	X	Spatial Coverage	N	Channel in northern silted-in portion of Kingman Lake	
KL-21	KL-12	Kingman Lake		X	Spatial Coverage	N	Channel in northern silted-in portion of Kingman Lake	
KL-17	KL-13	Kingman Lake		X	Spatial Coverage	N	Channel in northern silted-in portion of Kingman Lake	
KL-16	KL-14	Kingman Lake		X	Spatial Coverage	N	Channel in northern silted-in portion of Kingman Lake	
KL-03	KL-15	Kingman Lake		X	Spatial Coverage	N	Adjacent to East Capitol St. Bridge	Moved southeast to be in secondary thalweg.
KL-02	KL-16	Kingman Lake		X	Spatial Coverage	N	South of East Capitol St. Bridge	Moved south to be in center of large geomorphic surface, away from bridge.
	~~KL-17~~	~~Kingman Lake~~			~~Spatial Coverage~~	~~N~~	~~West bank near golf course~~	Removed due to sufficient geomorphic coverage in area.
	~~KL-18~~	~~Kingman Lake~~			~~Spatial Coverage~~	~~N~~	~~Island east of KL-17~~	Removed due to sufficient geomorphic coverage in area.
KL-19	KL-19	Kingman Lake			Spatial Coverage	N	Mud flat in northern silted-in portion of Kingman Lake	Moved west to be on mudflat adjacent to island.
KL-18	KL- 20	Kingman Lake			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)	
KL-15	KL-21	Kingman Lake		X	Spatial Coverage	N	Channel in northern silted-in portion of Kingman Lake	Moved south and west to be in wider part of main channel, and just upstream of slight channel constriction
KL-08	KL-22	Kingman Lake	X	X	Spatial Coverage	N	Mud flat north of East Capitol St. Bridge, near footbridge	Moved to north end of mudflat, where accessibility is easier and deposition is more likely
KL-09	KL-23	Kingman Lake		X	Spatial Coverage	N	Main channel of west arm between E. Capitol St and Benning Rd	Moved south to characterize main channel.
KL-23	KL-24	Kingman Lake		X	Spatial Coverage	N	Mudflat adjacent to upstream mouth of Kingman Lake	
KL-13	KL-25	Kingman Lake			Spatial Coverage	N	Characterization for human health (pedestrian access to riverbank)	

Sediment Studies in the Anacostia River Vicinity of the East Station Study Area

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Summary of Findings

Prepared for:

Washington Gas

By:

Hydro-Terra, Inc.

May 23, 2005

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INTRODUCTION

The purpose of this report is to summarize the findings from various sediment studies in the Anacostia River at and near the East Station study area. It is intended to help determine whether or not sufficient data exists to properly characterize sediment conditions opposite the East Station study area. Following a review of the findings by the DC Environmental Health Administration Water Quality Division, the Water Quality Division and Washington Gas will decide on an appropriate plan for conducting the required annual monitoring of sediment in the river opposite the study area.

From 1988 to present, the results from eight sediment-sampling events in the Anacostia River in the vicinity of the East Station study area have been obtained. The study area extends upriver from the abandoned 11th Street Sewer outfall to the upstream end of the pump house property used by Washington Gas (WG). During some of the investigations sampling was also performed upstream and downstream from the study area. Summarized below are the results of those investigations. Excerpts from the final reports of the investigations are attached as appendices labeled 1 through 8. The investigations are described herein in order of performance, beginning with the first sampling of sediment in 1988.

Should other relevant sediment studies be found following completion of this report, their findings will be summarized and submitted as an addendum to this report.

SEDIMENT INVESTIGATIONS

Hydro-Terra, Inc., *Contamination & Land Use Study, Phase II, Volumes I and II*, June 1989

The study was completed for WG and included sampling of river sediment at 12 locations during August and September 1988 and the completion of a benthic macroinvertebrate investigation. Extracts from the final report are found in Appendix 1 and include a map of the sediment sample locations (Figure 5-2) and a table showing the analytical results (Table F-3).

The sediment samples were collected from a depth of 1.5 feet using a core sampler and analyzed for Priority Pollutant base/neutrals and acids. Three of the samples were also analyzed for BTEX. The samples used in conducting the benthic macroinvertebrate study were collected at the same time and were analyzed for dissolved oxygen, pH, oxygen reduction potential, conductivity, and temperature.

Eight of the sediment samples were collected from locations between the abandoned 11th Street Sewer outfall and the upstream edge of the pump house property used by WG (Figure 5-2 in Appendix 1). Two other sediment samples (RS5 and RS4) were collected opposite the Navy Yard and another sample (RS6) was obtained upstream of the study

area, between the study area and the Sousa Bridge. PAHs were detected at all sample locations. The upstream sample (RS6) had a PAH concentration of 2.7 ug/g (mg/kg) (parts per million) (Table F-3 in Appendix 1). The two downstream samples RS4 and RS5 had concentrations of 4.2 and 4.45 mg/kg, respectively. The seven samples collected opposite the East Station study area had PAH concentrations ranging from a low of 31.25 mg/kg at RS9 between the COE dock and the 12th Street Sewer outfall to a high of 1,712 mg/kg at RS11 located opposite the upstream end of the pump house property. As is proper protocol, concentrations of PAHs not detected in some samples, but detected in others, were considered conservatively to be present at one half their detection limits.

River water samples were also collected at the sediment sampling locations. No VOCs or PAHs were detected in the water samples. Additionally, benthic samples were collected with a petite Ponar dredge at locations RS5, RS6, and RS7. Because of the limited scope of the benthic survey, conclusions regarding the effect of organic contaminants in sediment on the macroinvertebrate community could not be made. Analysis was further complicated by the overall low quality of the water in the investigated portion of the river due largely to inputs from urban runoff, combined sewer overflow, and sedimentation from soil erosion. Benthic macroinvertebrate species were found at all of the sampled locations and species diversity varied between samples. The composition of the benthic community appeared to reflect the poorly oxygenated water of the river and its high organic loading.

D. J. Velinsky, et al., *Sediment Contamination Studies of the Potomac and Anacostia Rivers around the District of Columbia, FINAL REPORT*, September 1992

The study was completed for the DCRA, Water Hygiene Branch. Excerpts from the report found in Appendix 2 include an executive summary of the study, a figure showing sampling locations (Page 66), and various tables showing sampling results from the Anacostia River and other locations. During the study, sediment samples were obtained at six locations in the river with a petite Ponar dredge and analyzed for various organic compounds, including PAHs and trace metals. None of the samples were collected in front of the East Station study area. Two samples (AR2 and AR3) were collected opposite the Navy Yard. AR-4 was sampled a short distance upstream from the Douglas Bridge; AR5 was collected opposite Buzzard's Point; and AR6 near Fort McNair. One sample, AR1, was collected upstream of the East Station study area, a short distance downstream of the Sousa Bridge. The sample locations are described in Table 2-4 on Page 22 in Appendix 2, and their locations are shown on Figure 3-10 found on Page 66 in the Appendix. PAH concentrations at AR1, AR2, and AR3 were 14.39, 15.07, and 13.18 mg/kg, respectively (Table 3-8, Page 74). The concentration increased to 28.27 ug/g at AR4. Downstream of AR4, the concentrations dropped to 9.56 (AR5) and 5.68 (AR6) mg/kg.

The results of the trace metal analyses are shown in Table 3-3, Page 46. Overall, metals concentrations were highest downstream of the East Station study area at AR6 located

approximately 7,500 feet downstream of the study area. For the most part, the concentrations at the upriver point (AR1) and the two downriver locations below AR-4 were similar.

The authors concluded that in terms of sediment contamination, sediment toxicity, and benthic community parameters, the lower Anacostia River is the area of greatest concern within the riverine system of Washington, D.C.

Versar, Inc., *An Assessment of Potential Residual Effects of the January 1992 Oil Spill in the Anacostia River*, January 1993

The investigation was performed for Steuart Petroleum Company which later became ST Services. The investigation resulted from a spill of No. 4 fuel oil a short distance upstream of the East Station study area and effected a large area of the river. Excerpts from the report, including tables and figures, are found in Appendix 3. Fifteen (15) shallow sediment samples were collected with a Ponar dredge and analyzed for TPH, PAHs, pesticides, PCBs, three metals (cadmium, lead, and mercury), and other parameters. Nine of the samples were collected from the spill area and two each from three reference areas. The reference areas included the channel or central area of the river, the west near-shore zone, and the east near-shore zone. Figure 1.2 in Appendix 3 is a map of the areas of investigation, and the TPH and PAH analytical results are shown in Table 2-5, also in the appendix.

The sample locations are not clearly defined in the report. It would appear that near-shore samples 1-East and 2-West are closest to the East Station study area. The PAH concentration at 1-East was 35.391 mg/kg and at 2-West, 77.274 mg/kg. Sample locations upriver and downriver from the East Station study area had lower concentrations of PAHs. The sample collected at 1-Central near the center of the river, opposite the East Station study area, also had a lower concentration of PAHs than near-shore samples 1-East and 2-West. However, statistically, no significant difference was found between the PAH concentrations in the spill area, including samples 1-East and 2-West located near the East Station study area. (Table 2-7 in Appendix 3). Also, no significant difference in cadmium, lead, and mercury concentrations in the shallow sediment within the three areas was determined (Table 2-9).

Ecology and Environment, Inc., *Site Inspection, National Capital Parks – East Station Site, S.E. Washington, DC*, December 1995

The inspection was completed for the National Park Service. Excerpts from the report are found in Appendix 4 and include tables and figures showing sediment sampling locations and results. Six sediment samples were collected, including one duplicate, in the general vicinity of five of Hydro-Terra's locations sampled in 1988 (Hydro-Terra, 1989). The samples were collected in April 1995 with an Echman dredge and analyzed for TOC, VOCs, SVOCs (acids & base/neutrals), pesticides, and metals. The sample

locations are shown on Figure 5-1. Three of the locations (SD-03, SD-04, and SD-05) are located near the shoreline and in front of the East Station study area, and SD-1 and SD-02 are located upstream of the study area. SD-1 was collected in the area of the Washington Yacht Club and SD-2, on the upstream side of the Steuart Petroleum pier which later was acquired by ST Services. SD-03 was collected upstream of the WG pump house pier, SD-04 between the Corp of Engineers (COE) dock and the 12th Street Sewer outfall, and SD-05 opposite the sewer outfall. Relatively low concentrations of BTEX compounds were found in sediment near the pump house pier, in front of the 12th Street Sewer outfall, and, to a lesser extent, in front of the yacht club. The highest concentration, 4.1 mg/kg, was found in the duplicate sample collected next to the pump house pier (Table 8-1).

A comparison of Ecology and Environment's (E&E's) detected concentrations of PAHs with those determined earlier by HT (Hydro-Terra, 1989) at similar locations is provided in the following table. Comparable locations are shown opposite each other in the table. For example, the location of SD-01 sampled by E&E is in the vicinity of RS6 sampled by Hydro-Terra (HT).

Location	E&E 1995 (mg/kg)	Location	HT 1988 (mg/kg)
SD-01	12.880	RS6	2.7
SD-02	7.950	RS11	1,712
SD-03	1.500	RS10	559
SD-03 (Dup.)	181.500		
SD-04	6.690	RS7	92
SD-05	6.402	RS3	202.5
		RS2	33.5

HT's concentrations conservatively include one half the detection limits for PAH compounds not detected in some samples but detected in one or more other samples; thus, results are somewhat overstated. E&E's method of totaling the PAHs is unknown. A comparison of the two sets of data suggests a possible improvement in sediment quality between 1988 and 1995.

Hydro-Terra, Inc., *Additional Remedial Investigation and Feasibility Study (Phase IV), East Station. Washington, D.C., Volumes 1 and 2,* March 1999

The Phase IV investigation was completed for WG. In Appendix 5 are excerpts from the report, including a figure showing sediment sampling locations, tables containing the analytical data, a table from the ecological risk assessment showing chemicals of potential concern in the river sediment, and tables and calculations from the assessment of human-health risk to anglers eating fish effected by chemicals in the sediment and to swimmers and waders from exposure to river sediment.

A total of seven shallow sediment samples, plus one duplicate sample, were collected in June 1996 during an outgoing tide. In collecting the sediment samples a core sampler was used, and the sampling depth was 18 inches. The sediment samples were analyzed for TAL metals, TCL VOCs and SVOCs, and cyanide.

Relatively low concentrations of volatile organic compounds (BTEX) were detected in three of the four sediment samples obtained opposite the East Station study area. None were found in the fourth sample collected near the COE dock. The concentrations ranged from 0.0027 mg/kg at 96SD-03S near the WG pump house pier to 0.0092 mg/kg at 96SD-05S near the 12th Street Sewer outfall. PAH concentrations in sediment opposite the study area ranged from 39.775 mg/kg (ppm) at 96SD-07S near the COE dock to 248.940 mg/kg at 96SD-04S collected between the 12th Street Sewer outfall and the COE dock. The average concentration opposite the study area was 137.880 mg/kg as compared to an average of 48.560 mg/kg in two sediment samples collected at distances of approximately 1,500 and 2,500 feet upriver from the ST Service (formerly Steuart Petroleum) pier. The concentration in a sample collected near that Steuart Petroleum pier was 184.100 mg/kg. The samples were analyzed by Phase Separation Sciences.

The average concentration of PAHs observed in sediment samples opposite the study area (137.880 mg/kg) is much lower than the average of 433.62 mg/kg obtained during the Phase II investigation in 1988 (Hydro-Terra, 1989), but higher than the average concentration of 36.15 mg/kg for the samples collected by E&E in 1995 (Ecology and Environment, 1995).

The detected organic compounds and metals were screened during the human-health risk assessment, and those found to be chemicals of potential concern in sediment are identified in Table D-2 (Data Groups 7 and 12). The human-health risk assessment identified three sediment-related exposure scenarios requiring evaluation. They were fish ingestion by anglers, sediment ingestion by a swimmer or wader, and dermal contact with sediment by swimmers or waders. In each case, the cancer risk was found to be less than the USEPA's threshold value of one additional cancer case in a population of 10,000. The non-cancer risk values (hazard index) were also less than the threshold value of 1.0 (Table 8-3). Calculations of the risk values are found on pages D-17 to D-22 in the appendix.

Sediment Capping Research Study by Louisiana State University, 2002

The study was conducted at a location just downstream of the Navy Yard and near the "O" Street pump house. Extensive sediment sampling was performed in an area of the river approximately 300 by 400 feet in size. In addition, an upstream sediment sample was collected near the COE dock and analyzed for TAL metals and TCL VOCs and SVOCs. The analytical results for that sample are found in Appendix 6. The metal concentrations were similar to results obtained during the Phase IV investigation (Hydro-Terra, 1999). The total concentration of PAHs was 19.010 mg/kg, a value lower than the

concentration measured near the COE dock during the Phase II and IV investigations (Hydro-Terra, 1989 and 1999). No BTEX was detected.

Sediment Sampling Results from the Removal of ST Services' Pier, December 2002 and January 2003

A total of seven sediment samples were collected by Gascoyne Laboratories and analyzed for VOCs and SVOCs. Four of the samples (Grab I through Grab 4) were collected in December 2002, presumably prior to pier removal, and three samples (Dolphin 2, 4, and 6) in January 2003, probably during pier removal. The Dolphin samples were obtained with a core sampler, but the sample depth is not reported. The method of sampling, the sampling depth, and the sample locations are not reported for the other samples. The laboratory reports are found in Appendix 7. Also found in the appendix is a table prepared by Hydro-Terra showing the PAH concentrations detected in each of the samples and drawings showing the locations of the Dolphin samples. It should be noted that sampling method described on the location forms refers only to the collection of the water samples.

PAH concentrations in the samples ranged from a low of 4.9 mg/kg to a high of 48.32 mg/kg. The average concentration was 17.748 mg/kg. No BTEX compounds were detected above the method detection limits.

Sediment Sampling Results from the Removal of WG's Two Piers, August and September 2003

During the removal of the two WG piers (pump house pier and petroleum offloading pier) in August and September 2003, 39 sediment samples were collected and analyzed by Gascoyne Laboratory. Appendix 8 contains a figure showing the approximate locations of the sampling points specified by the DC Water Quality Division and tables containing the analytical results. The sediment samples were collected to a depth of 18 inches using a core sampler. From each core, samples were taken from two depths (0 to 6 inches and 7 to 18 inches) and analyzed for TCL VOCs and SVOCs, TAL metals, gasoline-range organics, diesel-range organics, TPH, and percent moisture. The sample numbers for sediment samples obtained from 0 to 6 inches contain the letter "A" and those from 7 to 18 inches, the letter "B".

The metal analyses indicate that barium, copper, and lead concentrations in the sediment were lower overall than detected in the Phase IV sediment samples (Hydro-Terra, 1999). Other metals detected above their detection limits were similar in concentration to Phase IV findings. Of the BTEX family compounds, only ethylbenzene was detected above the detection limits. It was encountered in three of the samples (S1A, S12A, and S13A) at concentrations from 0.55 to 1.6 mg/kg.

PAH concentrations in 28 sediment samples from 0 to 6 inches in depth ranged from 7.820 mg/kg at S15A to 3,929.000 mg/kg at S13A, and averaged 226.794 mg/kg. Neglecting the highest detected concentration, the concentrations in the shallow sediment averaged 89.675 mg/kg. PAH concentrations in the 11 sediment samples collected at a depth of 7 to 18 inches ranged from 4.250 mg/kg at S2B to 63.670 mg/kg at S13B and averaged 18.231 mg/kg. The analytical results clearly show that PAH concentrations diminish considerably with depth.

For comparison, a sediment sample collected in 1996 to a depth of 18 inches next to the WG piers during the Phase IV investigation (Hydro-Terra, 1999) had a PAH concentration of 155.000 mg/kg, and another 18-inch core sample collected near the piers in 1988 (Hydro-Terra, 1989) had a concentration of 559 mg/kg. Two shallow samples collected in the area by E&E in 1995 had concentrations of 1.500 and 181.500 mg/kg.

SUMMARY OF FINDINGS

The investigations show that PAH concentrations in the sediment are higher in front of the East Station study area and the former Steuart Petroleum property than in areas upstream and downstream of those locations. However, this observation may be due, to some degree, to the fact that many more samples have been collected opposite these two areas than at upstream and downstream locations. In their study of the effect of the oil spill from the Steuart Petroleum facility, Versar concluded that there was, statistically, no significant difference in PAH and three metal concentrations between the spill area, including the East Station study area, and reference or background areas (Versar, 1993). A review of the results of all heavy-metal analyses from the study area and in upstream and downstream locations also suggests that there is no significant difference in their concentrations.

A comparison of the findings from the two HT investigations (Hydro-Terra, 1989 and 1999) and the E&E sediment sampling results (Ecology and Environment, 1995) indicates that PAH levels in the river sediment may be dropping over time. However, a comparison is difficult to make since PAH concentrations vary considerably from point to point opposite the study area; and the sample locations for the various investigations, although close to each other, were not the same.

It is evident from the results of the recent sediment analyses performed in conjunction with the removal of the two WG piers that, within the upper 18 inches of sediment, PAH concentration decreases with depth in the area of the WG piers. It is probable that the same condition exists opposite the entire study area.

The sediment-related exposure scenarios evaluated during the Phase IV investigation show that there is no significant cancer or non-cancer health risk to humans as a result of ingesting sediment, having skin contact with sediment, or eating fish effected by MGP-associated chemicals in sediment.

An unknown factor is the effect on sediment quality from the operation of the ground-water pump-and-treat system. The system was put into operation in 1994, at which time it was estimated that approximately 100 percent of the ground water in the sand/gravel unit and 60 percent in the fill unit were being captured and treated. In 2002, the system was modified, and effective capture and treatment of all ground water is believed to have been achieved.

APPENDIX 1

Hydro-Terra, Inc., *Contamination & Land Use Study, Phase II, Volumes I and II*, June 1989

CONTAMINATION and LAND USE STUDY

East Station Property

Prepared for:

Washington Gas Light Company
Washington, D.C.

Prepared by:

Hydro-Terra, Inc.
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April 1989

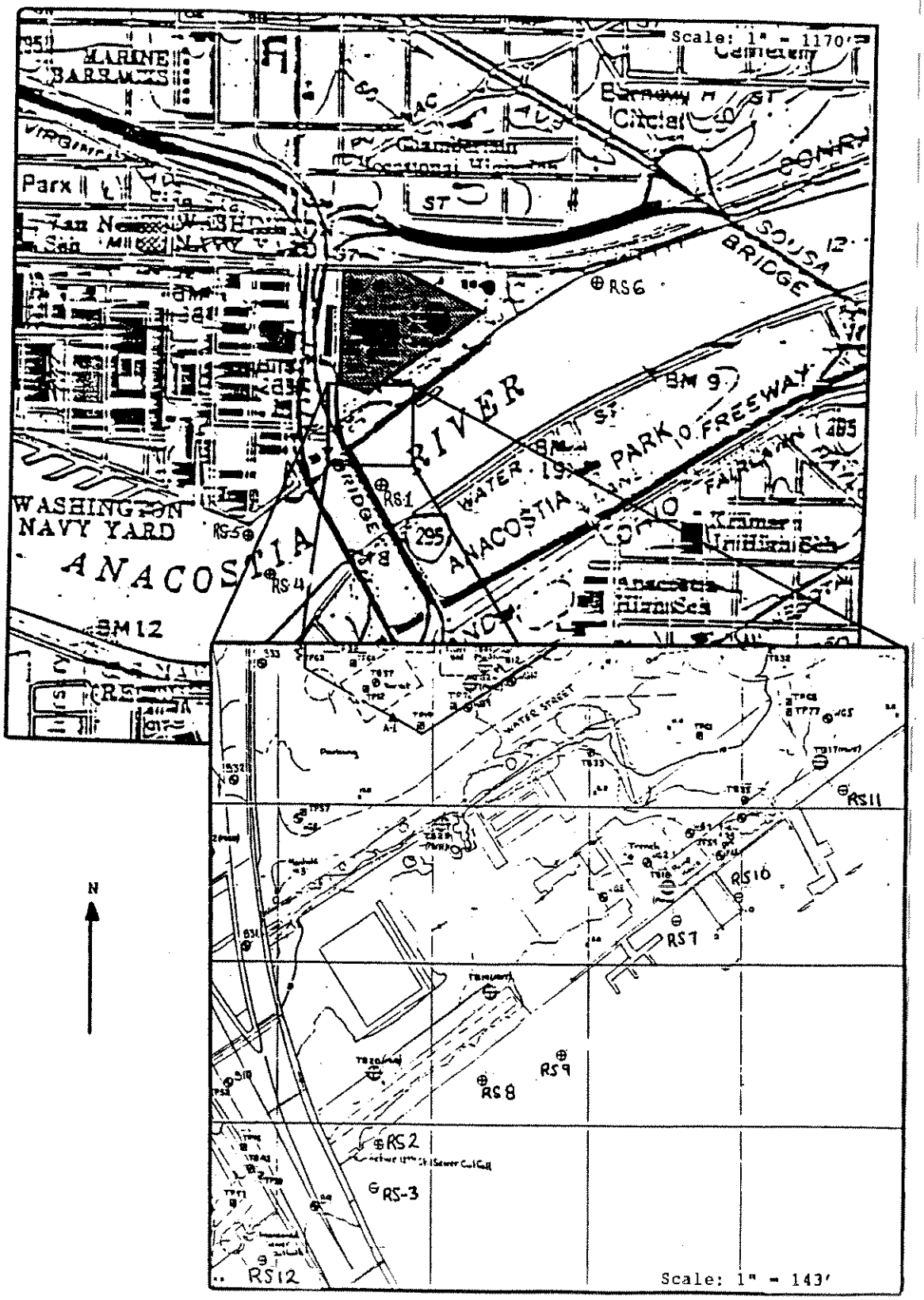

Figure 5-2. Sediment Sampling Location Map

APPENDIX 2

D. J. Velinsky, et al., *Sediment Contamination Studies of the Potomac and Anacostia Rivers around the District of Columbia, FINAL REPORT*, September 1992

Sediment Contamination Studies of the Potomac and Anacostia Rivers around the District of Columbia
FINAL REPORT

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ICPRB Report No. 92-2
September 10, 1992

Executive Summary

The objectives of this study are to define the extent of chemical contamination in the sediments around selected areas in the District of Columbia; to determine the extent and possible controlling factors of sediment toxicity to the amphipod Hyalella azteca; and to elucidate the possible source area(s) of organic and inorganic contaminants to the sediments around the District of Columbia.

A total of 54 sediment samples were collected from the Potomac (PR) and Anacostia Rivers (AR), Tidal Basin (TB), Washington Ship Channel (WSC) and Kingman Lake (KL) (Figure 2-1). In conjunction, sediment samples were collected directly in front of 14 major storm and combined sewer outfalls in three areas. Also, bottom sediment material was collected inside selected storm and combined sewers that directly discharge in the Tidal Basin, Ship Channel and Anacostia River. The outfall and sewer sediment samples were used to determine source areas for anthropogenic chemicals to river sediments around the District of Columbia. By combining sediment chemistry with the benthic macroinvertebrate abundance, diversity, and toxicity data it was possible to identify areas that were biologically impacted.

The geographic and spatial trends for both sedimentary trace metals and organics reveal specific areas of concern within the Washington, D.C. area. These locations are indicated by increased river sediment concentrations of both trace metals and hydrocarbons (chlorinated and non-chlorinated) relative to adjacent locations, and within the entire study area. In many cases, both trace metals and organics exhibit the same geographic trend. Substantial concentrations of lead (Pb), cadmium (Cd), and mercury (Hg), as well as organics such as polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and DDT (sum of DDT+DDE+DDD) were observed in many areas, such as near the Washington Navy Yard (AR-4), near Rock Creek in the Potomac River (PR-1), and upper Washington Ship Channel (WSC-1 to WSC-3).

Furthermore, concentration gradients between sewer, outfall, and sediment samples strongly suggest that urban runoff is a major source of these contaminants to the sediments. For certain constituents like total hydrocarbons (THC) and PAH, the outfall sediment distribution indicates a more diffuse input related to the ubiquitous nature of their sources (i.e., fossil fuel combustion, crankcase oils, etc.). Other contaminants have distributions that suggest more of a "point" source to the area. For example, the outfall and sewer sediment concentrations of PCB and to a lesser extent chlordane and total DDT are high only in specific locations. Similar trends are evident in the Tidal Basin, Washington Channel, and Anacostia River.

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In the Potomac River, station PR-1 has increased levels of most contaminants compared to other river locations. This station is located below the mouth of Rock Creek which flows through the northwest section of the District of Columbia. Rock Creek accepts numerous storm and combined sewers inputs that could be a major source of these contaminants.

The sediments at TB-1, contain slightly greater concentrations of most contaminants than in other Tidal Basin locations. Located near TB-1 is a large storm sewer that drains the Constitution Avenue area of the Mall, including the Smithsonian Institution. While the outfall sample taken at this location (OTB-1) does not exhibit higher concentrations, the concentrations of most contaminants at nearby outfalls, OTB-3, OTB-4, and OTB-5 are significantly higher than the basin sediments, suggesting a source from runoff through their respective drainage areas.

In the Washington Channel, the increased concentrations of many contaminants in the upper end of the channel (i.e., WSC-1, WSC-2, and WSC-3) suggests that increased loading and retention of sediment contaminants in this area is occurring. While a substantial proportion of the contamination is most likely due to street runoff (i.e., there are no combined sewers in this area), numerous boats and boat related activities also could contribute to the concentrations observed in the sediments.

The concentration differences between sewer, outfall, and river sediment samples in the Anacostia River, along with the spatial trends in trace metals and organics from station KL-5 to PR-4A, suggest that the numerous storm and combined sewers are a major source of contamination to the river. This is especially noted at station AR-4 located just downstream of the Washington Navy Yard, near the South Capital Street Bridge. While the extreme gradient between the sewer, outfall, and sediment at this location indicates urban runoff is a source, past and present activities at the Navy Yard and possibly the U.S. Botanical Gardens (located slightly downstream on the southern side of the river) also could contribute to contamination of the area. Although there is no heavy industry located in the area, there are other facilities that border the area (e.g., oil off-loading terminals, power plants, construction companies) that may have some impact. The net result of all these possible sources are substantially higher concentrations of all contaminants at AR-4, with a large concentration decrease downstream from this area, suggesting a possible greater source function at AR-4 and/or a greater retention of upstream sources (i.e., fine grain sediments) in this section of the river.

Trace metals and organics exhibit a wide range in concentrations throughout this study area. Concentrations were generally higher in either the outfall or sewer sediment samples compared to river sediments from the Tidal Basin, Washington Channel, and Anacostia River. In this study, station AR-4 in the Anacostia River exhibited the highest concentrations, while either one of two Potomac River

stations (e.g., PR-2, PR-3) or one station in the Washington Ship Channel (WSC-5) exhibited the lowest concentrations, dependent on the constituent. Sediment concentrations of Cd, copper (Cu), Hg, and Pb at station AR-4 are higher than those found in the mainstem Chesapeake Bay by a factor of two to four, dependent on the metal. Concentrations of all metals are well below those found in Baltimore Harbor and the Schuykill River (Philadelphia, PA). Compared to the estuarine portion of the Potomac River (i.e., Maryland Department of the Environment stations MLE2.2, XDA11, and XEA659), sediment concentrations of all metals are higher in the Washington, D.C., area. For all groups of organics, concentrations measured in this study are higher than those from the mainstem Chesapeake Bay, but lower than those found in Baltimore Harbor. Comparison was based on in-place sediments only. The concentrations of trace metals and organics were substantially higher in most outfalls and sewers, and this material will eventually mix with the sediments in respective areas. These data reflect the effect of an urban environment to the tidal freshwater portion of the Potomac Estuary. On a chemical basis alone, it appears that specific areas within the Washington, D.C., area are moderately contaminated with trace metals and organics and the most severely impacted area is that of the Anacostia River near station AR-4.

Results of sediment toxicity testing and macroinvertebrate community analysis agree that the lower Anacostia River stations (i.e., from AR-1 to AR-4) exhibited the most severe degree of biological impairment. Sediments from these stations generally elicited the highest toxicity and harbored the least diverse benthic macroinvertebrate communities. Sediment contaminant concentrations are highest at these four stations, indicating a strong relationship between sediment contamination and biological impairment. This investigation also identified Kingman Lake sediment as a potential environmental concern. Even though only one station within Kingman Lake exhibited toxicity (i.e., growth impairment at KL-1), amphipod survival was overall quite low, and chemical contaminant levels of Kingman Lake sediments are high. The two other areas, the Washington Ship Channel and the Tidal Basin, showed low sediment toxicity, moderate benthic community parameters, and levels of sediment contamination below those occurring in the Anacostia River. The sole Potomac River site is the most perplexing situation. Sediment toxicity testing and benthic community analysis indicate biological impairment at this station. However, sediment contaminant levels here are the lowest of any station, and sediment toxicity test results may have been the result of high concentrations of ammonia ($NH_4^+ + NH_3$) in the porewaters. Therefore, biological impairment, suggested by benthic community analysis, may instead be a result of temporal variation of the macrofaunal community and impacts related to seasonal dynamics in ammonia, or physical disruption.

This study has succeeded in demonstrating the importance of employing a "burden of evidence approach," such as the sediment quality triad, in sediment contamination assessments. Had the

assessment been based entirely on comparing contaminant concentrations in field collected sediment to effects-related criteria (i.e., Long and Morgan's (1990) ER-L and ER-M), it would be concluded that sediment from all stations possessed the potential for biological impairment. Similarly, sediment toxicity tests alone would have included the Potomac River station with those within the stretch of the lower Anacostia River as the most severely biologically impaired. By utilizing synoptic measures of sediment contamination, sediment toxicity, and benthic community parameters, it was possible to firmly justify labeling the lower Anacostia River as the area of greatest concern within the riverine system of Washington, D.C.

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Note: Tables showing PAH concentration are at back of section

Table 1-1. Sedimentary concentrations of selected organics and trace metals from ICPRB (1991)*.

General Locations	TPCB[1] ng/g	TPAH[2] µg/g	DDT[3] ng/g	DDE[3] ng/g	CHL[4] ng/g	Cu[5] µg/g	Pb µg/g	Zn µg/g
ANACOSTIA RIVER								
Bladensburg Marina	82	7	5	10	32	35	29	159
NY Ave. Bridge	130	9	1	10	33	44	29	180
Hickey Hill	220	12	10	<1	6	50	50	241
Benning Rd.	320	11	3	15	50	50	79	265
Kingman Lake	480	16	2	35	65	95	168	479
NE Boundary Sewer	430	17	3	27	96	80	136	415
11th Street Bridge	380	16	3	35	48	103	179	452
South Capitol St. Bridge	1800	45	6	<1	105	207	351	587
Buzzard Point Marina	360	11	1	29	22	92	107	396
POTOMAC RIVER								
Fletchers Boat House	124	6	16	19	4	40	29	181
Key Bridge	190	3	2	7	4	49	10	231
Rock Creek	120	5	9	12	17	31	68	138
Pentagon Lagoon	550	7	1	21	6	48	40	289
Above Nat'l Airport	580	7	<1	4	<1	38	10	148
Along Nat'l Airport	17	<1	<1	<1	<1	34	10	109
Below Nat'l Airport	96	24	<1	3	2	37	10	143
Naval Research Lab	96	3	<1	10	6	47	10	222
PEPCO; Alexandria, VA	220	3	<1	6	4	103	10	253
BP Loading Dock	20	4	<1	<1	<1	44	10	143
Woodrow Wilson Bridge	160	5	<1	8	6	55	69	293
Rosier Bluff, East Side	180	3	<1	6	4	45	20	230
Tidal Basin	1200	11	20	78	15	121	346	529
Washington Ship Channel	650	7	<1	27	15	148	178	475
Watts Branch Tidal	342	7	3	<1	16	29	68	182
Hickey Run Tidal	7	1	<1	<1	<1	30	10	61
Lower Beaverdam	480	7	<1	<1	62	48	96	415
Upper Rock Creek	26	2	<1	<1	<1	19	10	79
Lower Rock Creek	98	4	10	5	9	46	10	63

*[1]TPCB is the sum of 209 individual congeners. [2]TPAH is the sum of 15 individual aromatic hydrocarbons. [3]DDT and DDE are the sum of both o+p and p+p forms. [4]CHL is the sum of α and Γ chlordane. [5]Cu, Pb, Zn are the strong (HCl) acid digestible fraction of the sediment.

Table 2-4. Station Locations: General Descriptions

Sta. Loc./#	General Description of Area
Tidal Basin	
TB-1	Northside of Kutz Bridge.
TB-1.5	Southside of Kutz Bridge.
TB-2	Approximately 500 yds south of TB-1.
TB-3	Approximately 500 yds south of TB-2, near Jefferson Memorial.
TB-4	Westside of basin, in small cove.
TB-5	Middle of basin, sampled in triplicate.
TB-6	Near paddleboat area, east end of basin.
OTB-1-1	Pipe on northside of Kutz Bridge, directly in front of outfall.
OTB-1-2	Same as OTB-1-1 except on right side of outfall facing northward.
OTB-2	Outfall on east wall down from Jefferson Memorial.
OTB-3	Round outfall on south wall of paddleboat area.
OTB-4	Outfall closer to paddleboat area on south wall.
OTB-5	Behind paddleboat docks on south wall, near ramp.
Potomac River	
PR-1	Approx. 300' south of Rock Creek (station PMS-13).
PR-2	Southeast of Roosevelt Island, north of Memorial Bridge.
PR-3	Near northend of National Airport, south of VORTAC (station 8).
PR-4	Due south of Haines Pt. (ca. 900 yds), east of buoy C" 1" and north of lighted blk/red buoy, sampled in triplicate.
Washington Ship Channel	
WSC-1	In cove at northend of channel, upstream from Washington Marina, above bridges, directly off of Park Service buildings.
WSC-2	Eastside of channel, off of Flagship Restaurant.
WSC-3	Upstream of Police dock, on eastside of channel, just off of Spirit of Washington dock.
WSC-4	Not Sampled
WSC-5	Eastside of channel, near seawall in Ft. McNair by golf course, within seagrass bed.
WSC-6	Mouth of WSC and AR, northside of Anacostia River channel, near red/green buoy.
OWSC-1	Large outfall, downstream of Police docks, near Titanic statue.
OWSC-2	In boat slip area, down upstream of Phillips Seafood.
OWSC-3	Under Bridge, just downstream from Washington Marina, ca. 50ft from seawall.
Anacostia River	
AR-1	Downstream of Sousa Bridge, northside of river, downstream from large outfall.
AR-2	Downstream of 11 St. Bridge, near bend in river (station ANA-17) on northside.
AR-3	Within Navy Yard, downstream from USS Barry, northside of river.
AR-4	Downstream of Navy Yard, before Douglas Bridge, northside of river, near gravel plant.
AR-5	Downstream from Douglas Bridge, northside of river near bend, Buzzards Point (V St, SW).
AR-6	Northside of river, just off marina piers, upstream from Greenleaf Point.

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Table 2-4 (continue)

Sta. Loc./#	General Description of Area
OAR-1	Large outfall, downstream of Sousa Bridge, northside of river, near wreck.
OAR-2	Upstream of Navy Yard, on northside of river, at bend in river.
OAR-3	Near DPW yard (Ost and Half st, SW), about 50ft downstream from outfall.
OAR-4	Large outfall, southside of river across from Navy Yard and USS Barry.
OAR-5	Not Sampled
OAR-6	Northside of river, at end of 2nd St., SW, near brown boathouse, right at large outfall.
Kingman Lake	
KL-1	Northend of lake, downstream from 2nd island, on shallow (1.5ft) mudflat.
KL-2	Downstream from Benning Road bridge, in north side of cove.
KL-3	Midway between footbridge and E. Capitol Street Bridge, mid-channel.
KL-4	Midway between E. Capitol Street Bridge and entrance to Kingman Lake.
KL-5	Mid-Channel Anacostia River, south of entrance to Kingman Lake.

Boldface indicates stations for sediment toxicity, benthic community, AVS and porewater ammonium analysis. Station IDs. starting with the prefix (O) indicate samples that were taken directly in front of an outfall, while stations with the prefix (S) indicate samples that were taken in a sewer.

Table 2-5 (continue)

Sta. Loc./#	Characteristics of surficial sediments:
Anacostia River	
AR-1	Brown mud; oil sheen present; plant material; amphipod present on 3rd grab.
AR-2	No description taken, heavy rain.
AR-3	Brown mud; gas bubbles present; oil sheen and leaf material present.
AR-4	Consolidated brown mud with black streaks present; oil sheen on 3rd grab.
AR-5	Brown mud with some black streaks; gas bubbles present; grab 5C had more brown-colored sediment present.
AR-6	Brown-colored fluid mud with black streaks below surface; gas bubbles in sediment; plant material and a live clam was present.
OAR-1	Brown-colored fine grain material.
OAR-2	Fine grain material present; brown-colored, man-made debris present.
OAR-3	Dark coarse grain material; definite oil sheen on sample, no life.
OAR-4	Brown fine grain mud; black streaks below surface; trace of oil sheen.
OAR-5	Not Sampled
OAR-6	Brown-colored coarse grain material with some fines; plenty of debris; oil sheen; coal and slag chips present.
Kingman Lake	
KL-1	Semi-consolidated mud with rust color on surface; some plant material present.
KL-2	Grey/brown mud; gas bubbles and plant material present.
KL-3	Semi-consolidated brown mud; black streaks below surface; gas bubbles present; 3rd grab had oligiochaete present.
KL-4	More consolidated than KL-5, all brown sediment with some gas bubbles.
KL-5	Brown fine grain mud with some lighter brown material; some plant type material; oil sheen on mud.

River were taken on the northern side of the river outside the main center channel. In both the Potomac and Anacostia Rivers, one station (PR-4 and AR-5, respectively) was sampled in triplicate (i.e., 3 separate samples of 3 grabs each within 5 m of each other). Outfall samples were obtained in both the Anacostia River (ID: OAR) and Washington Ship Channel (ID: OWSC; Tables 2-4 and 1-4).

More than 10 storm sewers empty into the Washington Ship Channel (Table 2-1). These storm sewers drain an area from approximately Independence Avenue (Smithsonian Institution), 13th Street, and 4th Street in southwest Washington, D.C.. As part of this study, three outfalls, just off the end of three sewers, were sampled plus one sample from within a storm sewer (Table 2-5). Additionally, one sample (ID: OWSC-R1) was obtained on 16 September 1991 in the northern section of the channel, within the Washington Marina area. This sample was taken from the dock, just in front of a storm sewer outfall that drains along Maine Avenue and 14th Street, S.W.. Although this sample was taken four months after the other samples, it is presented along with the other outfall samples of the Washington Ship Channel.

As in the Tidal Basin, storm or combined sewer lines were sampled in the Washington Ship Channel and Anacostia River. In the Washington Ship Channel, one sample (ID: SWSC) was obtained (21 May 1991) from a storm sewer that drains along Maine Ave., S.W. (Table 2-6). In the Anacostia River, 4 (1 combined, 3 storm) sewer samples (ID: SAR) were obtained from various locations along the river. Samples were obtained on either 21 May or 17 July 1991 (Table 2-6). Sample descriptions are provided in Table 2-7. No samples were obtained from sewers that drain into the Potomac River. All stations in the Potomac and Anacostia rivers, Tidal Basin and Washington Ship Channel are influenced by semi-diurnal tides of up to 3 ft in amplitude. Weather conditions in the week preceding storm and combined sewer sampling are presented in Table 2-8.

Kingman Lake

Sediment samples from the Kingman Lake area (ID: KL) were sampled on 19 June 1991. A total of 5 sediment samples were obtained, 4 in the lake proper and 1 in the Anacostia River, south of the entrance to Kingman Lake (Tables 2-3 and 2-4; Figure 2-1). Sample descriptions are provided in Table 2-5. No storm or combined sewer samples or outfall samples were obtained in Kingman Lake and all stations are influenced by tides.

Field Sampling Procedures

The procedures for sediment sampling were similar for all stations (see QA/QC documentation for a full description). A Hydrolab Surveyor II was used to collect dissolved oxygen,

temperature, conductivity, pH, and water depth just above the sediment surface (Table 2-9). The meter was calibrated before and after each day of the sampling program. Sediments were obtained with a stainless steel petite-Ponar grab sampler (0.06 m^2) that was acetone rinsed at the beginning of each day. The sampler was inspected for possible cross-contamination (i.e., sediment from previous station) and rinsed with ambient water at each station. Next, the sampler was carefully lowered to the sediment bottom and then lifted about 0.5 m above the bottom. At this point the sampler was released to free-fall to the sediment surface, triggered and raised to the boat. Sample acceptance procedures followed U.S. EPA guidelines (US EPA, 1987; EAD, 1990; ASTM, 1990). A visual description (i.e., color of the sediment, presence or absence of living or dead organisms, bicycle helmets, bicyclist, and other unusual artifacts) was made for all accepted samples. The top 2 to 3 cm of sediment not in contact with the sides of the sampler were removed and placed into a pre-cleaned pyrex-glass bowl. This process was repeated until sufficient sediment was obtained.

Sediments were mixed until homogeneous in both texture and color with a pre-cleaned stainless steel spoon. Aliquots of sediment were placed into separate containers for chemical and toxicity testing. Samples for organic analysis were placed in pre-baked (450°C for 12 hours) glass mason jars and capped with pre-baked aluminum foil lined caps. Grain size and trace metals samples were placed into Zip-loc plastic bags. Samples for acid-volatile sulfur (AVS) and porewater ammonium were placed into separate 50 ml plastic centrifuge tubes. Sediment samples for toxicity testing were placed into pre-cleaned glass jars and sealed with Teflon-lined caps. AVS samples were quick frozen on board using dry ice (-78°C), whereas porewater ammonium samples were kept at 4°C until processing within the same day (see below). All other samples were placed in coolers at approximately 4°C while in the field. Once on shore, sediment samples for organic and metal analyses were placed in a freezer at -20°C, while samples for toxicity testing and grain size analysis were kept at 4°C.

Organic and trace metal clean-techniques met or exceeded the criteria of both U.S. EPA (U.S. EPA, 1987) and NOAA (Status and Trends Studies). All materials coming in contact with the samples were either glass or metal that were cleaned of any contaminants prior to use. All glass bowls were soaked in 0.5M HCl overnight, rinsed with distilled deionized water (DDW) and solvent rinsed with methanol, hexane, then dichloromethane (Burrick and Jackson, Inc.) and allowed to air dry in a hood. All metal utensils were washed similarly but without using the dilute acid rinse. During the sampling program, caution was used to avoid contamination from engine fuel or exhausts. Exhaust samples were taken to help asses sample contamination from this source.

Table 2-9. Bottom water characteristics of the various study areas.

Sta. ID.	Depth (ft)	DO (mg O_2/L)	Temperature (°C)	pH
Tidal Basin				
TB-1	5.0	9.2	27.5	8.5
TB-1.5	3.0	7.9	27.4	8.2
TB-2	6.0	9.2	27.5	8.4
TB-3	5.0	9.8	27.4	8.4
TB-4	8.0	9.0	27.4	8.3
TB-5A	7.0	11.2	27.9	8.5
TB-6	8.0	8.8	27.5	8.3
Potomac River				
PR-1	16.0	3.7	26.6	7.3
PR-2	7.0	7.0	27.7	8.0
PR-3	9.0	9.0	27.2	8.1
PR-4A	11.0	7.9	27.0	7.7
Washington Ship Channel				
WSC-1	26.0	6.9	26.7	7.9
WSC-2	29.0	4.0	25.9	7.5
WSC-3	27.0	2.3	25.3	7.2
WSC-5	4.6	8.5	27.1	7.9
WSC-6	12.1	7.7	26.9	7.7
Anacostia River				
AR-1	11.8	6.0	27.0	7.2
AR-2	18.7	6.3	26.5	7.2
AR-3	24.2	6.7	26.9	7.4
AR-4	22.3	7.2	26.7	7.5
AR-5A	24.2	7.5	26.8	7.6
AR-6	26.9	7.5	26.7	7.6
Kingman Lake				
KL-1	2.0	1.3	22.8	6.4
KL-2	7.0	0.5	22.4	6.5
KL-3	3.0	0.7	23.4	6.6
KL-4	3.0	0.6	23.1	6.7
KL-5	9.0	2.6	22.1	6.9

Triplicate grab samples, not pooled, were taken for benthic macro-invertebrate community analysis. Each grab was washed through a U.S. #35 (500 μm) plastic sieve, preserved with 95% (v/v) denatured ethanol. Samples were returned to the laboratory for counting and identification.

Analytical Methods

Biological Analyses

Sediment Toxicity. Fifteen sites were sampled (Table 2-4) for toxicity testing. Reference sediment, chosen to match experimental sediments in physico-chemical properties (i.e., grain size and organic matter), was collected from Corsica River (MD). This sediment is free of chemical contamination (Schlekat et al., 1992). Reference sediment provides a site-specific basis of comparison to individual test sediments (ASTM, 1990; EAD, 1990; Ingersoll and Nelson, 1990). Corsica River sediment also fulfilled criteria for a control sediment that had no significant toxic effect (i.e., sediment known to be non-toxic to and within the geochemical requirements of the test species), and is used to provide a measure of test acceptability. Because the ambient salinity at the Corsica River collection site was 6 ppt, interstitial salinity was adjusted by wet sieving (500 μm sieve) in spring water prior to test initiation (ASTM, 1990; Ingersoll and Nelson, 1990).

Amphipod sediment toxicity tests were conducted according to protocols developed under the guidance of the American Society for Testing and Materials (ASTM, 1990; Ingersoll and Nelson, 1990). The test organism selected for this study was the freshwater amphipod Hyalella azteca. This organism is sensitive to sediment-borne contaminants, and is easily cultured and maintained under laboratory conditions. Additionally, H. azteca is used extensively to assess effects of sediment contaminants on survival, growth, and reproduction (Nebeker et al., 1984; Ingersoll and Nelson, 1990). A 28-day, partial life cycle test with two test endpoints, amphipod survival and growth (as measured by carapace length), was employed.

Experimental chambers consisted of a quart glass jar containing water and sediment in a ratio of 4:1 (v:v). Aeration at a rate of approximately two bubbles per second was provided by a 1-ml pipette. Test water was spring water from Chattolanee Spring, Baltimore County, MD (ave. pH=7.7; hardness=110 ppm as $CaCO_3$; alkalinity=100 ppm as $CaCO_3$). Sediments and water were allowed to equilibrate for 24-h before the random addition of 20 laboratory cultured juvenile H. azteca per replicate. There were 4 replicates per treatment. A discrete size class of H. azteca was obtained by selecting amphipods that were retained on a 250 μm sieve after passing through a 500 μm sieve. Water temperature was maintained at 20°C (± 2°C), and the photoperiod was 16:8 light:dark.

Table 3-1. Bottom sediment and porewater characteristics for the various study areas*.

Sta. ID.	TOC (%)	SAND (%)	SILT (%)	Clay (%)	AVS (μmole S/g-dw)	PW NH_3 (mg N/L)
KL-1	4.05	12.84	50.29	36.87	12.9	11.1
KL-2	4.02	3.00	68.83	28.31	11.8	13.4
KL-3	4.06	0.20	67.10	32.69	12.7	18.3
KL-4	4.95	12.89	54.32	32.79	9.2	26.5
KL-5	6.08	11.10	54.64	34.26	4.8	5.6
AR-1	3.89	13.93	53.41	32.66	10.8	25.1
AR-2	3.99	0.54	63.23	36.23	7.5	30.6
AR-3	2.98	0.53	70.91	28.56	7.5	26.5
AR-4	4.30	13.99	59.16	26.85	26.4	34.2
AR-5A	3.75	0.69	71.41	27.90	17.0	18.8
AR-6	3.57	0.86	67.73	31.41	ND	ND
OAR-1	4.89	9.70	61.57	28.72	ND	ND
OAR-2	3.44	9.04	68.15	22.81	ND	ND
OAR-3	2.62	77.68	20.16	2.17	ND	ND
OAR-4	4.68	10.71	61.34	27.95	ND	ND
OAR-6	6.08	16.84	52.85	30.31	ND	ND
OAR-R1	0.66	44.90	33.86	21.24	ND	ND
SAR-2	1.02	78.16	21.36	0.48	ND	ND
SAR-3	0.28	85.63	14.22	0.15	ND	ND
SAR-5	2.50	78.55	19.91	1.54	ND	ND
SAR-6	0.84	77.35	20.92	1.73	ND	ND
WSC-1	3.21	1.47	72.20	26.34	83.0	6.4
WSC-2	2.89	0.42	80.17	19.41	ND	ND
WSC-3	3.37	0.33	84.24	15.43	47.6	5.5
WSC-5	2.54	31.45	50.72	17.83	ND	ND
WSC-6	3.74	0.71	69.80	29.49	ND	ND
OWSC-1	3.30	15.06	72.98	11.96	ND	ND
OWSC-2	11.07	38.53	51.45	10.02	ND	ND
OWSC-3	2.87	78.60	20.35	1.05	ND	ND
OWSC-R1	8.76	39.33	23.30	37.37	ND	ND
SWSC-2	0.37	75.46	23.99	0.55	ND	ND
PR-1	3.86	21.87	45.82	32.31	ND	ND
PR-2	2.41	13.17	51.77	35.06	ND	ND
PR-3	3.92	9.59	54.99	35.41	ND	ND
PR-4A	4.14	5.77	59.97	34.26	4.2	27.4
TB-1	6.37	2.90	69.94	27.16	1.0	12.9
TB-1.5	4.13	1.34	73.60	25.06	ND	ND
TB-2	3.02	0.68	35.09	35.09	ND	ND
TB-3	4.70	21.33	46.55	32.12	20.4	5.5
TB-4	3.30	0.45	76.46	23.09	ND	ND
TB-5A	3.10	1.20	67.66	31.14	ND	ND
TB-6	3.37	0.63	73.47	25.90	ND	ND
OTB-1-1	NA	NA	NA	NA	NA	NA
OTB-1-2	3.00	19.42	71.44	9.14	ND	ND
OTB-2	1.98	80.07	18.57	1.36	ND	ND
OTB-3	1.89	86.56	12.50	0.94	ND	ND
OTB-4	1.88	81.29	16.51	2.20	ND	ND
OTB-5	2.34	77.44	21.00	1.56	ND	ND
STB-2-1	9.69	60.71	33.52	5.77	ND	ND
STB-2-2	10.98	48.62	47.80	3.58	ND	ND

*Station IDs. starting with (O) indicate samples that were taken directly in front of an outfall, while (S) indicates samples that were taken in a sewer. Stations AR-5, PR-4 and TB-5 were sampled and analyzed in triplicate and the average value is reported. AVS is acid-volatile sulfur and PW NH_3 is the concentration of porewater ammonia ($NH_3 + NH_4^+$).
ND - No Data.

Table 3-2. Trace metal comparison between Phase I (ICPRB, 1990) and present study*.

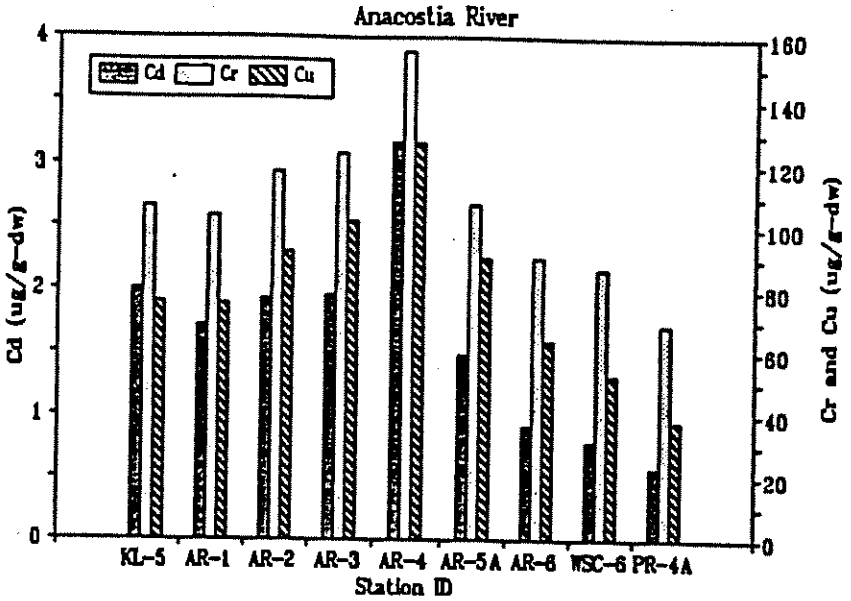
Sta. ID.	Cd	Cr	Cu	Fe	Hg	Pb	Zn
Anacostia River							
No.22	4.00	140.00	95.00	ND	0.40	168.00	479.00
KL-4	1.92	106.30	96.60	4.19	0.46	199.30	462.00
ANA-12	8.00	130.00	80.00	ND	0.37	136.00	415.00
KL-5	2.01	106.50	76.10	4.38	0.35	143.70	418.00
ANA-17	8.00	150.00	103.00	ND	0.27	179.00	452.00
AR-2	1.93	117.60	91.90	4.56	0.29	147.50	401.00
ANA-21	6.00	120.00	207.00	ND	1.20	351.00	587.00
AR-4	3.18	155.50	126.90	4.19	1.04	408.90	512.00
ANA-24	4.00	140.00	92.00	ND	0.33	107.00	396.00
AR-6	0.92	90.30	63.80	4.82	0.54	83.20	279.00
Tidal Basin							
No.15	6.00	190.00	121.00	ND	0.34	346.00	529.00
TB-6	0.93	92.30	59.10	4.88	0.27	91.40	285.00
Potomac River							
PMS-13	<2	68.00	31.00	ND	0.08	68.00	138.00
PR-1	0.99	96.20	59.70	4.45	0.56	127.70	365.00
Washington Ship Channel							
PWC-06	4.00	140.00	148.00	ND	0.61	178.00	475.00
WSC-2	1.03	95.50	99.90	4.99	0.58	146.60	332.00

* Concentrations in μg metal per gram dry weight, except for Fe which is in %. Station locations for the Phase I study may not exactly match the present study.

Table 3-3. Sedimentary concentrations of trace metals in the various study areas*.

Sta. ID.	Cd	Cr	Cu	Fe	Hg	Pb	Zn
KL-1	1.53	105.9	63.8	4.07	0.28	133.8	348.0
KL-2	2.21	134.0	92.3	5.04	0.43	184.3	466.0
KL-3	2.19	118.0	100.1	4.73	0.39	176.5	450.0
KL-4	1.92	106.3	96.6	4.19	0.46	199.3	462.0
KL-5	2.01	106.5	76.1	4.38	0.35	143.7	418.0
AR-1	1.72	103.4	75.6	3.91	0.34	138.9	355.0
AR-2	1.93	117.6	91.9	4.56	0.29	147.5	401.0
AR-3	1.96	123.5	102.0	4.82	0.37	156.9	406.0
AR-4	3.18	155.5	126.9	4.19	1.04	408.9	512.0
AR-5A	1.48	107.5	90.2	5.23	0.36	130.5	367.3
AR-6	0.92	90.3	63.8	4.82	0.54	83.2	279.0
OAR-1	1.72	111.0	73.4	4.01	0.30	164.0	420.0
OAR-2	1.75	116.0	145.0	4.25	1.21	185.0	450.0
OAR-3	0.90	58.0	69.9	1.54	0.72	175.0	215.0
OAR-4	1.43	109.0	86.9	4.08	0.30	151.0	382.0
OAR-6	0.50	74.0	94.7	3.73	1.16	111.0	208.0
OAR-R1	0.29	31.0	19.9	1.79	0.17	40.0	80.0
SAR-2	0.79	634.0	327.8	3.63	0.18	8137.0	512.0
SAR-3	0.37	163.0	20.5	2.38	0.01	102.0	224.0
SAR-5	1.68	133.0	97.4	1.64	2.02	207.0	271.0
SAR-6	0.45	122.0	47.9	1.43	0.22	96.0	164.0
WSC-1	1.19	94.3	103.0	5.06	0.74	183.0	356.0
WSC-2	1.03	95.5	99.9	4.99	0.58	146.6	332.0
WSC-3	1.09	90.7	92.6	5.24	0.52	125.8	339.0
WSC-5	0.45	51.1	33.4	2.92	0.23	48.3	137.0
WSC-6	0.79	86.8	52.6	4.76	0.25	61.9	247.0
OWSC-1	1.25	83.0	102.2	3.33	0.64	163.0	400.0
OWSC-2	3.31	105.0	251.3	3.56	0.63	425.0	1094.0
OWSC-3	0.95	63.0	112.3	1.51	0.20	515.0	406.0
OWSC-R1	3.05	167.0	348.0	4.11	0.87	2101.0	750.0
SWSC-2	4.07	44.0	27.6	1.16	0.05	72.0	200.0
PR-1	0.99	96.2	59.7	4.45	0.56	127.7	365.0
PR-2	0.55	66.6	34.2	3.89	0.15	32.0	168.0
PR-3	0.52	63.4	35.6	3.76	0.13	33.9	171.0
PR-4A	0.58	69.0	37.8	4.06	0.15	39.0	188.3
TB-1	1.67	97.4	120.1	4.89	0.45	204.0	385.0
TB-1.5	NA	NA	NA	NA	NA	NA	NA
TB-2	0.84	91.1	55.1	4.55	0.25	84.5	255.0
TB-3	0.74	75.9	44.5	3.89	0.24	109.5	216.0
TB-4	0.97	96.9	66.7	5.09	0.29	104.3	292.0
TB-5A	0.83	87.0	55.3	4.67	0.27	79.3	259.7
TB-6	0.93	92.3	59.1	4.88	0.27	91.4	285.0
OTB-1-1	0.24	41.0	19.7	0.89	0.07	36.0	62.0
OTB-1-2	0.83	30.0	47.9	1.67	0.15	120.0	235.0
OTB-2	0.43	28.0	13.7	1.91	0.06	320.0	112.0
OTB-3	0.89	167.0	25.9	2.50	0.09	1015.0	180.0
OTB-4	0.94	176.0	102.6	2.89	9.22	3627.0	527.0
OTB-5	0.73	149.0	39.4	2.32	0.13	465.0	197.0
STB-2-1	9.46	3063.0	1784.9	7.07	7.03	31296.0	1236.0
STB-2-2	2.81	518.0	510.8	1.89	4.96	5022.0	684.0

*Station IDs. starting with (O) indicate samples that were taken directly in front of an outfall, while (S) indicates samples that were taken in a sewer. All concentrations are in µg per gram dry weight, except for Fe which is %. Stations AR-5, PR-4 and TB-5 were sampled and analyzed in triplicate, these data are the average (See Table 3-4). NA - Not Analyzed.



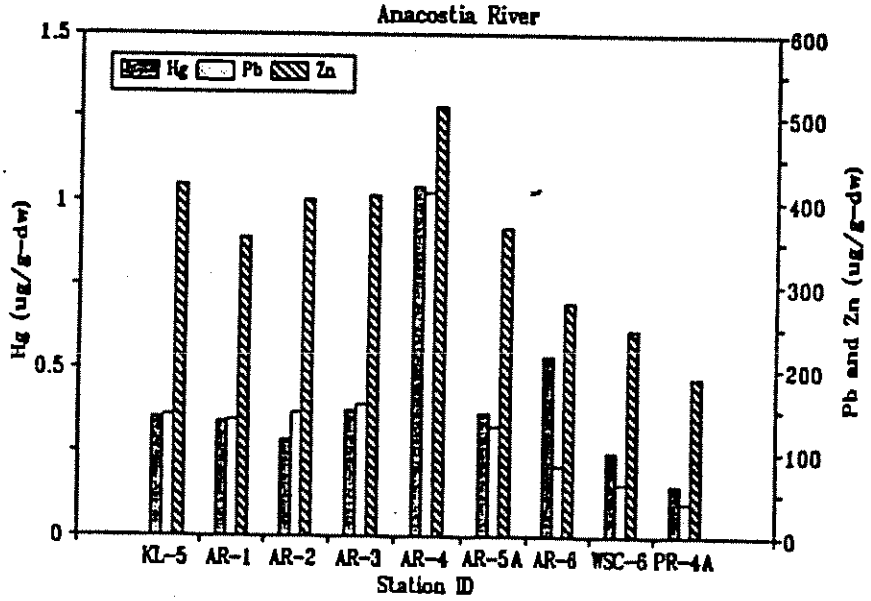


Figure 3-5. Sedimentary trace metal distribution: Anacostia River.

Table 3-4. Results from triplicate analysis of 3 separate samples from the Anacostia and Potomac Rivers and Tidal Basin*.

Sta. ID.	TOC	Silt+Clay	Cd	Cr	Cu	Fe	Hg	Pb	Zn
Anacostia River									
AR-5a	3.72	0.99	1.48	107.4	89.2	5.21	0.36	131.7	371.0
AR-5b	3.89	0.99	1.52	106.5	93.3	5.23	0.39	130.0	366.0
AR-5c	3.64	0.99	1.45	108.5	88.1	5.26	0.34	129.7	365.0
Average	3.75	0.99	1.48	107.5	90.2	5.23	0.36	130.5	367.3
± SD	0.13	0.001	0.035	1.0	2.7	0.03	0.025	1.1	3.2
Potomac River									
PR-4a	4.25	0.95	0.65	70.5	39.9	4.27	0.15	42.0	198.0
PR-4b	4.11	0.94	0.56	67.7	38.1	4.06	0.16	39.0	186.0
PR-4c	4.07	0.94	0.52	68.7	35.4	3.84	0.14	36.0	181.0
Average	4.14	0.94	0.58	69.0	37.8	4.06	0.15	39.0	188.3
± SD	0.09	0.01	0.067	1.4	2.3	0.22	0.008	3.0	8.7
Tidal Basin									
TB-5a	3.05	0.99	0.85	91.6	55.3	4.71	0.26	82.8	264.0
TB-5b	3.02	0.99	0.83	85.1	54.8	4.63	0.29	81.2	257.0
TB-5c	3.23	0.99	0.82	84.2	55.9	4.68	0.25	73.9	258.0
Average	3.10	0.99	0.83	87.0	55.3	4.67	0.27	79.3	259.7
± SD	0.11	0.002	0.015	4.0	0.6	0.04	0.017	4.7	3.8

*All concentrations are in μg per gram dry weight, except for Fe and TOC which are %. Silt+Clay is the fraction of silt and clay in the sample. At each station, three samples, of three grabs each, were taken within approximately 5 m of each other. ± SD is the standard deviation (1σ).

Table 3-5. Concentrations of trace metals normalized to the fraction of fine grain sediment from the various study areas*.

Sta. ID.	Cd	Cr	Cu	Fe	Hg	Pb	Zn
KL-1	1.76	121.5	73.2	4.67	0.32	153.5	399.3
KL-2	2.28	137.9	95.0	5.19	0.44	189.7	479.7
KL-3	2.19	118.2	100.3	4.74	0.39	176.9	450.9
KL-4	2.20	122.0	110.9	4.81	0.52	228.8	530.4
KL-5	2.26	119.8	85.6	4.93	0.39	161.6	470.2
AR-1	2.00	120.1	87.8	4.54	0.40	161.4	412.5
AR-2	1.94	118.2	92.4	4.58	0.29	148.3	403.2
AR-3	1.97	124.2	102.5	4.85	0.37	157.7	408.2
AR-4	3.70	180.8	147.5	4.87	1.21	475.4	595.3
AR-5A	1.49	108.2	90.8	5.27	0.37	131.4	369.9
AR-6	0.93	91.1	64.4	4.86	0.54	83.9	281.4
OAR-1	1.90	122.9	81.3	4.44	0.33	181.6	465.2
OAR-2	1.92	127.5	159.4	4.67	1.33	203.4	494.7
OAR-3	4.03	259.7	313.0	6.90	3.24	783.7	962.8
OAR-4	1.60	122.1	97.3	4.57	0.34	169.1	427.8
OAR-6	0.60	89.0	113.9	4.49	1.39	133.5	250.1
OAR-R1	0.53	56.3	36.1	3.25	0.31	72.6	145.2
SAR-2	3.62	2902.9	1500.9	16.62	0.81	37257.3	2344.3
SAR-3	2.57	1134.3	142.7	16.56	0.07	709.8	1558.8
SAR-5	7.83	620.0	454.1	7.65	9.43	965.0	1263.4
SAR-6	1.99	538.6	211.5	6.31	0.97	423.8	724.1
WSC-1	1.21	95.7	104.5	5.13	0.75	185.7	361.3
WSC-2	1.03	95.9	100.3	5.01	0.58	147.2	333.4
WSC-3	1.09	91.0	92.9	5.26	0.52	126.2	340.1
WSC-5	0.66	74.5	48.7	4.26	0.33	70.5	199.9
WSC-6	0.80	87.4	53.0	4.79	0.25	62.3	248.8
OWSC-1	1.47	97.7	120.3	3.92	0.75	191.9	470.9
OWSC-2	5.38	170.8	408.8	5.79	1.02	691.4	1779.7
OWSC-3	4.44	294.4	524.8	7.06	0.92	2406.5	1897.2
OWSC-R1	5.03	275.3	573.4	6.77	1.43	3463.3	1236.4
SWSC-2	16.59	179.3	112.5	4.73	0.20	293.4	815.0
PR-1	1.27	123.1	76.4	5.70	0.72	163.4	467.2
PR-2	0.63	76.7	39.4	4.48	0.17	36.9	193.5
PR-3	0.58	70.1	39.4	4.16	0.15	37.5	189.2
PR-4A	0.61	73.2	40.1	4.31	0.16	41.4	199.9
TB-1	1.72	100.3	123.7	5.04	0.47	210.1	396.5
TB-1.5	NA	NA	NA	NA	NA	NA	NA
TB-2	1.20	129.8	78.5	6.48	0.35	120.4	363.4
TB-3	0.94	96.5	56.6	4.94	0.31	139.2	274.6
TB-4	0.97	97.3	67.0	5.11	0.29	104.8	293.3
TB-5a	0.84	88.0	56.0	4.73	0.27	80.3	262.8
TB-6	0.94	92.9	59.5	4.91	0.27	92.0	286.8
OTB-1-1							
OTB-1-2	1.03	37.2	59.4	2.07	0.18	148.9	291.6
OTB-2	2.16	140.5	68.7	9.58	0.32	1605.6	562.0
OTB-3	6.62	1242.6	192.7	18.60	0.68	7552.1	1339.3
OTB-4	5.02	940.7	548.4	15.45	49.26	19385.4	2816.7
OTB-5	3.24	660.5	174.6	10.28	0.56	2061.2	873.2
STB-2-1	24.08	7795.9	4542.9	17.99	17.89	79653.9	3145.8
STB-2-2	5.47	1008.2	994.2	3.68	9.65	9774.2	1331.3

*Concentrations in μg metal per gram fine grain sediment (silt+clay), except for Fe which is in %.. Stations AR-5, PR-4 and TB-5 were sampled and analyzed in triplicate, these data are the average (See Table 3-3 for raw data). \
NA - Not Analyzed.

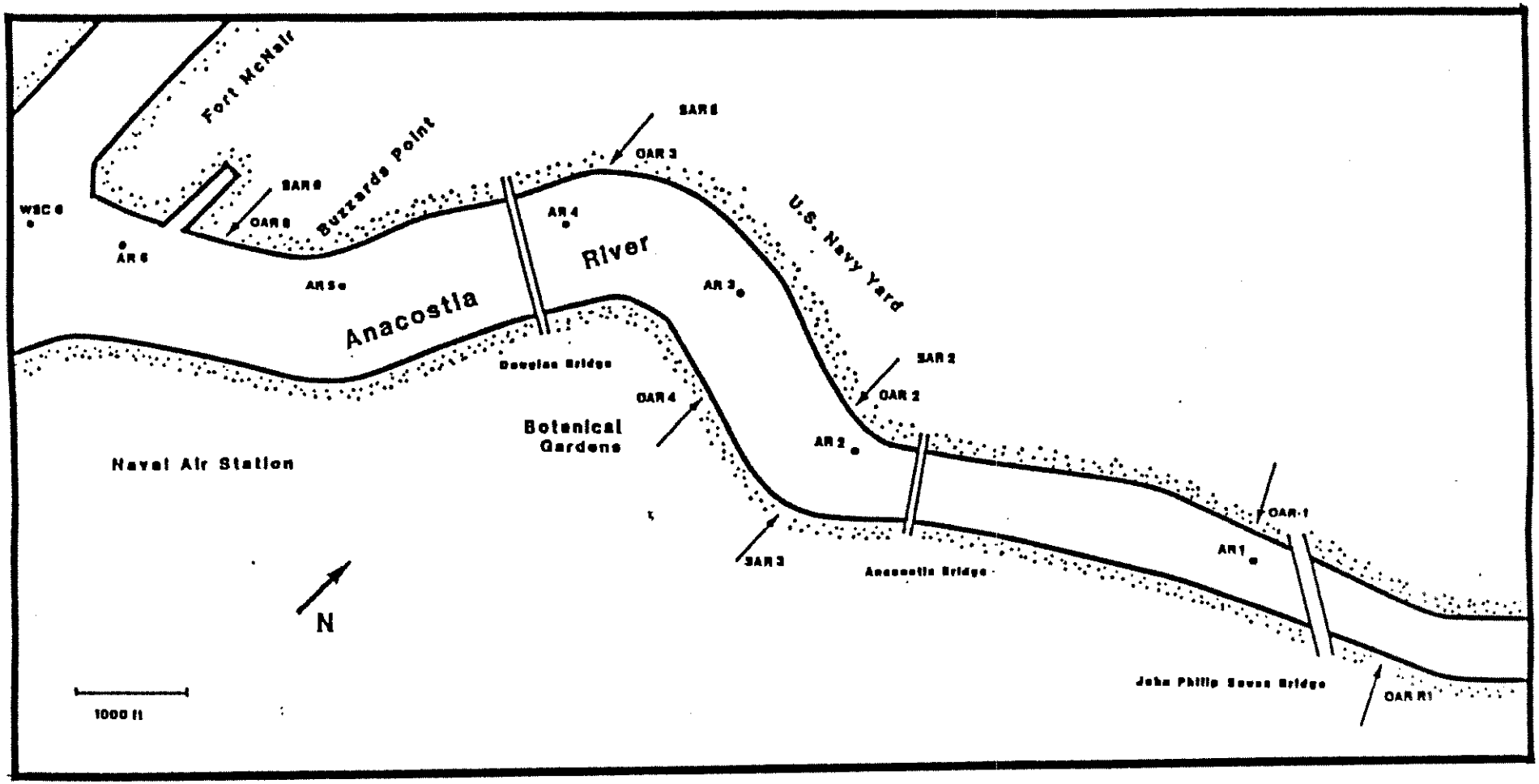


Figure 3-10. Sewer, outfall and sediment sampling locations in the Anacostia River.

A-1817

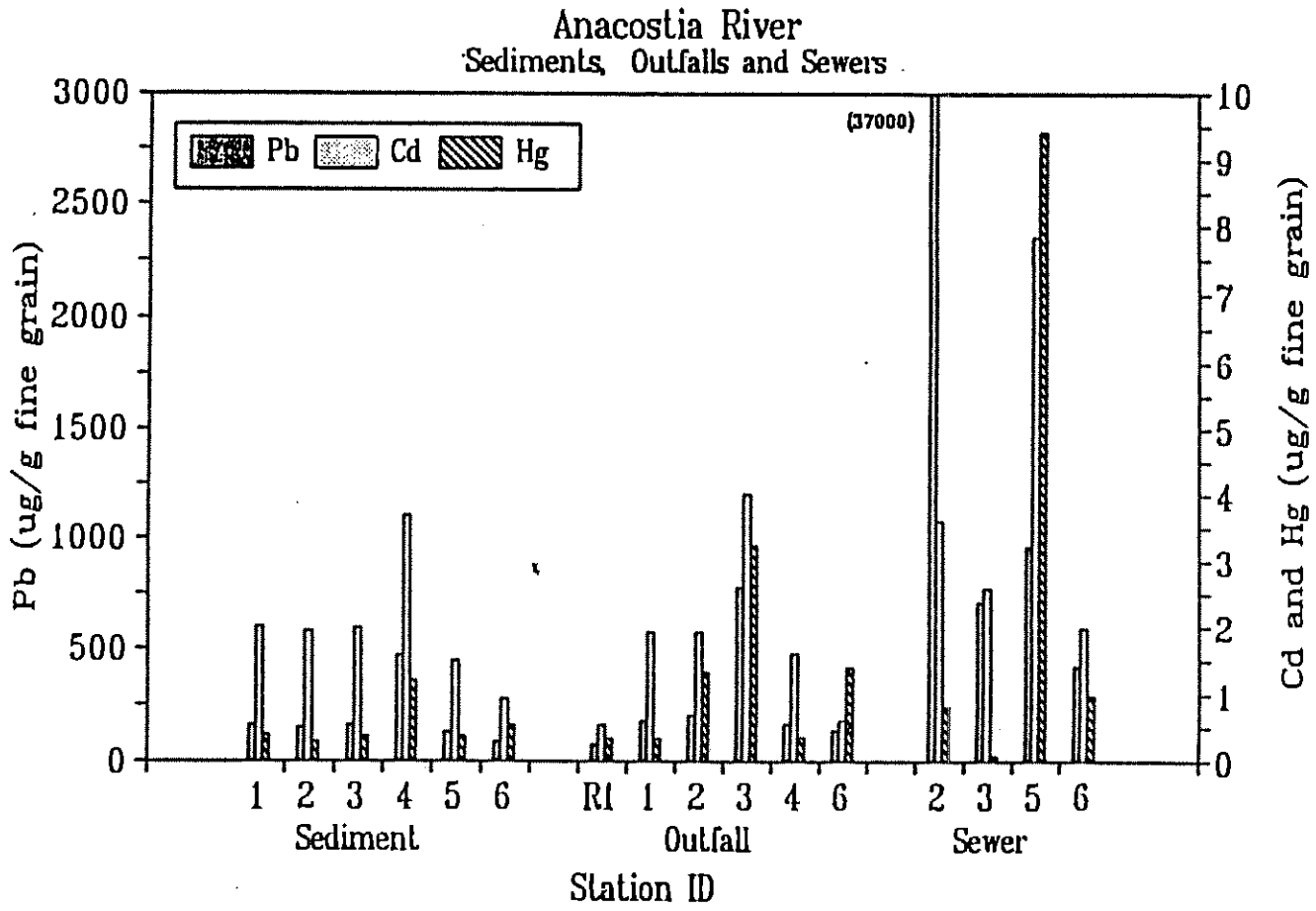


Figure 3-11a. Outfall, sewer and sediments of the Anacostia River: Trace Metals.

A-1818

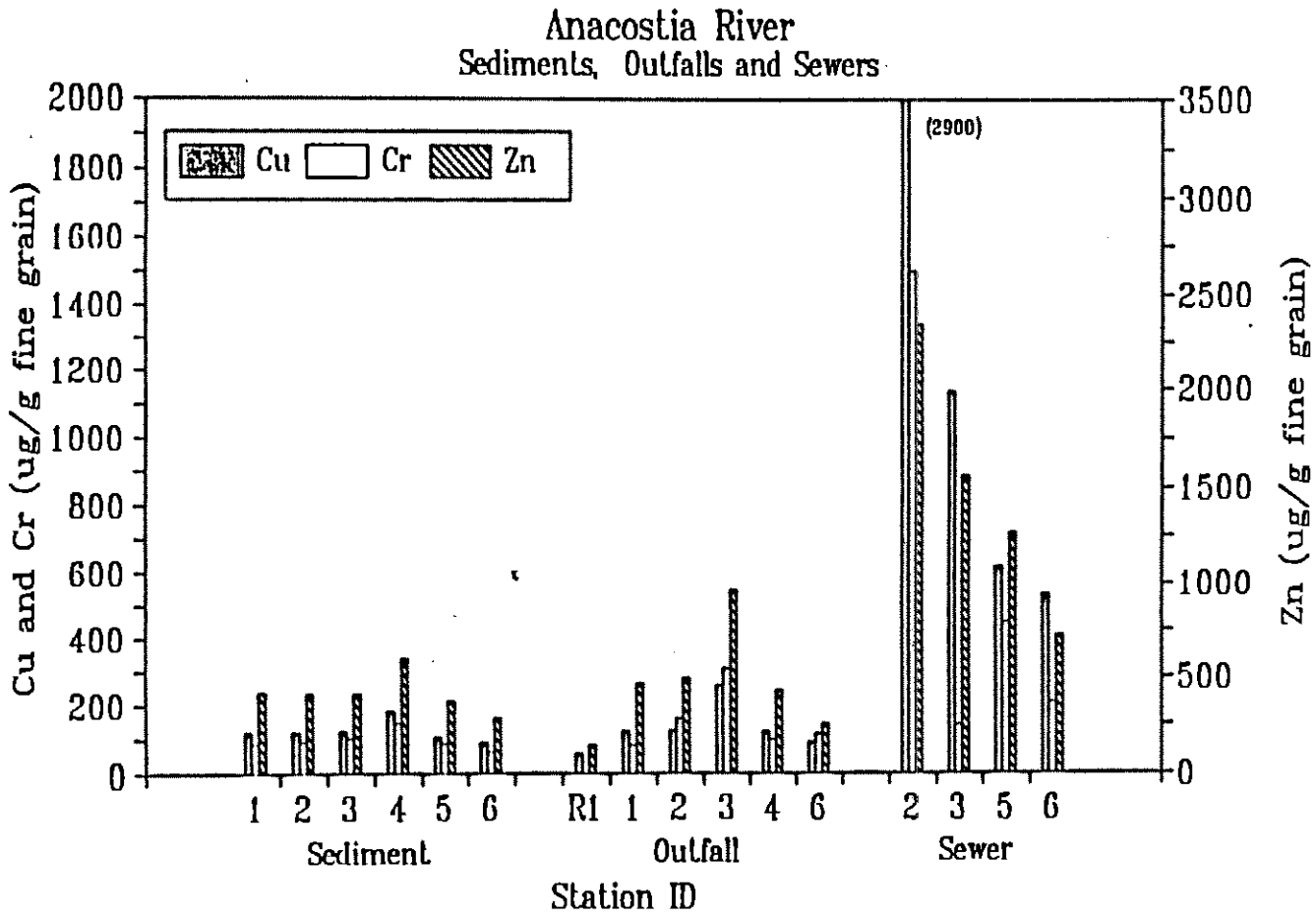


Figure 3-11b. Outfall, sewer and sediments of the Anacostia River: Trace Metals.

A-1819

Table 3-8. Sedimentary concentrations of hydrocarbons from the various study areas*.

Sta. ID.	Total PAH	Total SHC	UCM	THC
KL-1	16.08	17.67	910.57	944.32
KL-2	15.26	14.92	1000.60	1030.78
KL-3	14.19	15.21	2089.70	2119.10
KL-4	10.31	15.85	1267.79	1293.95
KL-5	9.76	27.94	852.24	889.94
AR-1	14.39	12.74	902.10	929.24
AR-2	15.07	22.13	1367.61	1404.80
AR-3	13.18	12.07	855.53	880.78
AR-4	28.27	31.04	1539.30	1598.61
AR-5A	9.56	10.69	783.70	803.95
AR-6	5.68	6.25	350.40	362.33
OAR-1	23.71	26.20	1457.84	1507.75
OAR-2	28.58	21.55	876.11	926.24
OAR-3	23.61	14.85	393.54	432.00
OAR-4	19.06	15.54	1191.57	1226.17
OAR-6	36.95	6.11	116.83	159.89
OAR-R1	11.52	7.50	580.50	599.52
SAR-2	32.07	9.66	468.80	510.53
SAR-3	5.76	2.24	393.10	401.10
SAR-5	39.57	25.36	901.20	966.14
SAR-6	8.74	7.52	499.90	516.16
WSC-1	7.16	8.41	384.63	400.21
WSC-2	7.18	8.83	451.20	467.21
WSC-3	6.34	6.23	430.30	442.87
WSC-5	8.73	6.12	105.80	120.65
WSC-6	5.59	17.31	280.80	303.70
OWSC-1	9.91	66.17	603.60	679.68
OWSC-2	44.16	36.06	951.89	1032.12
OWSC-3	129.95	6.59	293.00	429.54
OWSC-R1	78.27	54.46	4075.00	4207.74
SWSC-2	4.37	3.71	555.30	563.38
PR-1	29.15	5.87	132.05	167.07
PR-2	3.58	13.48	109.60	126.65
PR-3	3.74	13.36	92.68	109.78
PR-4A	3.61	12.99	109.33	125.94
TB-1	11.60	3.71	379.60	394.90
TB-1.5	9.75	14.79	595.13	619.67
TB-2	3.80	3.46	161.90	169.16
TB-3	8.69	18.27	299.70	326.66
TB-4	4.93	12.21	438.54	455.69
TB-5A	4.79	12.32	331.55	348.66
TB-6	3.82	3.82	171.20	178.84
OTB-1-1	6.88	1.19	86.10	94.17
OTB-1-2	8.01	10.66	285.10	303.77
OTB-2	10.58	2.96	143.00	156.54
OTB-3	4.96	5.92	448.83	459.71
OTB-4	11.61	22.06	629.18	662.85
OTB-5	10.65	21.98	738.76	771.39
STB-2-1	9.04	12.11	1474.64	1495.79
STB-2-2	8.60	11.25	965.28	985.13

*Concentrations in μg per gram dry weight. PAH-polycyclic aromatic hydrocarbons; SHC-saturated hydrocarbons; UCM-unresolved complex mixture; THC-total hydrocarbons. Station IDs. starting with (O) indicate samples that were taken directly in front of an outfall, while (S) indicates samples that were taken in a sewer. Stations AR-5, PR-4 and TB-5 were sampled and analyzed in triplicate and the average value is reported.

Table 3-9. General Characteristics of Biogenic and Petroleum Hydrocarbons*.

Natural Biogenic Hydrocarbons

Narrow range of molecular weight distribution of SHC and PAH (if present), UCM is either low or absent.

Odd- to even-numbered alkane ratio is > 1.

Terrestrial plant material indicated by an alkane distribution from nC_{23} to nC_{34}, centered around nC_{29} or nC_{31}.

Aquatic organisms have a predominance of nC_{15} to nC_{21} alkanes with an greater amounts of odd-numbered compounds.

Fossil Fuel or Petroleum Hydrocarbons

Wider range in molecular weight distribution of both SHC and PAH, UCM is present in large amounts compared to alkanes and PAHs.

Odd- to even-numbered alkane ratio = 1.

Several homologous series with adjacent members in approximately the same concentrations.

Natural source sources of PAH indicated by less complex distribution with compounds related to structure of precursors (i.e., perylene and retene).

Direct discharge of oil is indicated by PAHs (e.g., naphthalene, phenanthrene-anthracene, and chrysene series) contains many alkyl-substituted species (i.e., C_1, C_2 and C_3).

Combustion products have a greater abundance of un-substituted parent compounds, with homologs which decrease in abundance as the degree of alkyl substitution increases.

UCM present in greater proportion than resolved peaks.

* Taken from Youngblood and Blumer, 1975; Farrington, 1980; Hites et al., 1980; Wakeham et al., 1980; Boehm and Farrington, 1984; Boehm, 1984; Pruell and Quinn, 1985; Pierce et al., 1986.

Table 3-10. Comparison between Phase I (ICPRB, 1990) and present study for selected organics in the different study areas*.

Sta.ID.	PAH[1]	PCB[2]	DDT[3]	Chlordane[4]
Anacostia River				
No.22	16.12	0.48	37.30	86.00
KL-4	6.07	0.51	76.40	153.00
ANA-12	17.22	0.43	30.40	96.00
KL-5	6.27	0.66	78.00	139.00
ANA-17	15.54	0.38	40.40	48.00
AR-2	8.71	0.50	56.00	91.10
ANA-21	44.97	1.80	8.10	105.00
AR-4	10.10	2.20	123.80	88.50
ANA-24	11.35	0.36	30.60	22.00
AR-6	29.30	0.22	28.70	27.60
Tidal Basin				
No.15	11.27	1.20	99.00	15.30
TB-6	1.91	0.15	28.80	7.47
Potomac River				
PMS-13	4.78	0.12	22.90	16.60
PR-1	16.30	0.26	103.00	41.60
Washington Ship Channel				
PWC-06	6.66	0.65	28.10	15.40
WSC-2	3.66	0.33	35.90	18.61

*Concentrations for PAH and PCB in μg per gram dry weight, and for DDT and total chlordane in ng per gram dry weight. [1]Sum of 15 individual PAH; [2]Sum of 209 congeners; [3]Total DDT = DDD+DDE+DDT; [4]Sum of Γ+α-chlordane and cis+trans + nonachlordane.

Table 3-11. Results from triplicate analysis of 3 separate samples from the Anacostia and Potomac Rivers and Tidal Basin*.

Sta. ID.	Total PAH	Total SHC	UCM	THC
Anacostia River				
AR-5a	9.83	11.11	905.40	926.34
AR-5b	8.76	8.27	616.80	633.83
AR-5c	10.09	12.70	828.80	851.59
Average	9.56	10.69	783.67	803.92
± SD	0.57	1.83	122.07	124.08
Potomac River				
PR-4a	4.23	16.67	109.30	130.20
PR-4b	3.48	11.68	125.30	140.46
PR-4c	3.13	10.63	92.90	106.66
Average	3.61	12.99	109.17	125.77
± SD	0.46	2.63	13.23	14.15
Tidal Basin				
TB-5a	4.57	12.75	316.90	334.22
TB-5b	5.10	33.75[1]	2197.80[1]	2236.65[1]
TB-5c	4.71	11.88	346.20	362.79
Average	4.79	12.32	331.55	348.66
± SD	0.22	NC	NC	NC

* All concentrations are in μg per gram dry weight. At each station, three samples of three grabs each were taken within approximately 5 m of each other. ± SD is the standard deviation (1σ). [1] Data not included in average. NC - Not calculated.

Table 3-12. Concentrations of hydrocarbons normalized to the fraction of fine grain sediment*.

Sta. ID.	Total PAH	Total SHC	UCM	THC
KL-1	18.45	20.27	1044.71	1083.43
KL-2	15.71	15.36	1030.06	1061.13
KL-3	14.22	15.24	2094.10	2123.56
KL-4	11.84	18.20	1455.39	1485.42
KL-5	10.97	31.42	958.65	1001.05
AR-1	16.72	14.81	1048.10	1079.63
AR-2	15.15	22.25	1375.03	1412.43
AR-3	13.25	12.13	860.09	885.47
AR-4	32.86	36.09	1789.68	1858.63
AR-5A	9.62	10.77	789.14	809.53
AR-6	5.73	6.30	353.44	365.47
OAR-1	26.26	29.02	1614.62	1669.90
OAR-2	31.43	23.69	963.18	1018.30
OAR-3	105.73	66.50	1762.37	1934.60
OAR-4	21.35	17.40	1334.49	1373.24
OAR-6	44.52	7.37	140.75	192.64
OAR-R1	20.95	13.64	1055.45	1090.04
SAR-2	146.86	44.22	2146.52	2337.59
SAR-3	40.07	15.62	2735.56	2791.25
SAR-5	184.50	118.24	4201.40	4504.13
SAR-6	38.58	33.20	2207.06	2278.84
WSC-1	7.27	8.53	390.33	406.13
WSC-2	7.21	8.87	453.10	469.18
WSC-3	6.36	6.25	431.72	444.33
WSC-5	12.65	8.87	153.33	174.85
WSC-6	5.65	17.49	283.64	306.77
OWSC-1	11.66	77.85	710.12	799.62
OWSC-2	72.40	59.12	1560.48	1692.00
OWSC-3	618.81	31.40	1395.24	2045.45
OWSC-R1	128.31	89.28	6680.32	6897.93
SWSC-2	17.48	14.84	2221.20	2253.52
PR-1	37.31	7.51	169.01	213.83
PR-2	4.12	15.52	126.22	145.86
PR-3	4.14	14.77	102.52	121.44
PR-4A	3.84	13.79	116.03	133.65
TB-1	11.94	3.82	390.94	406.70
TB-1.5	9.88	14.99	603.22	628.09
TB-2	5.41	4.93	230.69	241.04
TB-3	11.05	23.22	380.96	415.23
TB-4	4.96	12.27	440.53	457.75
TB-5A	4.85	19.69	965.20	989.75
TB-6	3.84	3.85	172.29	179.97
OTB-1-1	NC	NC	NC	NC
OTB-1-2	9.89	13.16	351.98	375.03
OTB-2	52.90	14.80	715.00	782.70
OTB-3	38.16	45.54	3452.56	3536.26
OTB-4	61.08	116.09	3311.50	3488.67
OTB-5	46.30	95.56	3212.00	3353.86
STB-2-1	23.18	31.05	3781.13	3835.36
STB-2-2	16.86	22.06	1892.70	1931.63

* Concentrations in μg per gram fine grain sediment (silt+clay). Station IDs. starting with (O) indicate samples that were taken directly in front of an outfall, while (S) indicates samples that were taken in a sewer. Stations AR-5, PR-4 and TB-5 were sampled and analyzed in triplicate and this is the average value. NC - Not Calculated (no grain size data).

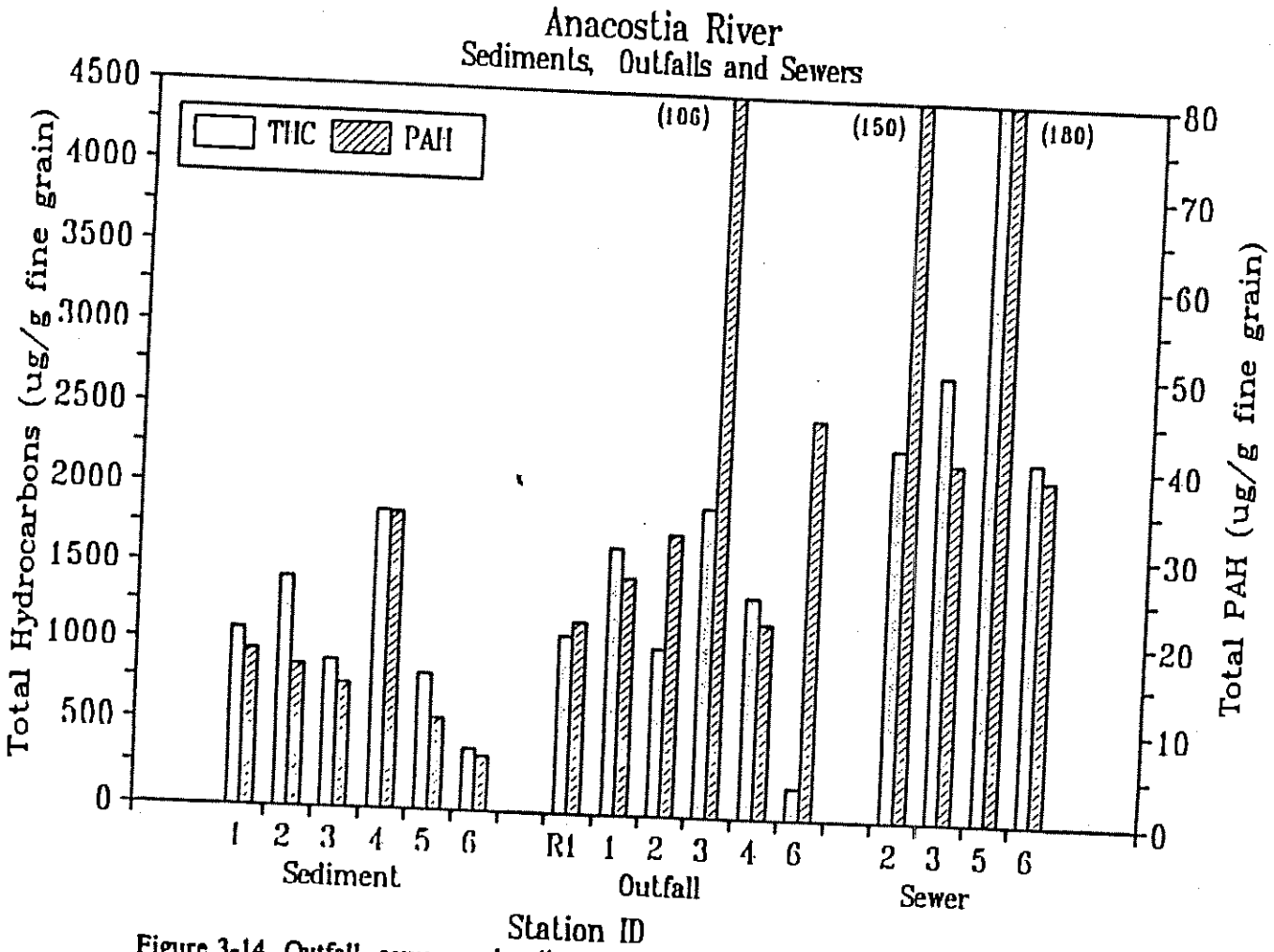


Figure 3-14. Outfall, sewers and sediments of the Anacostia River: Hydrocarbons.

A-1824

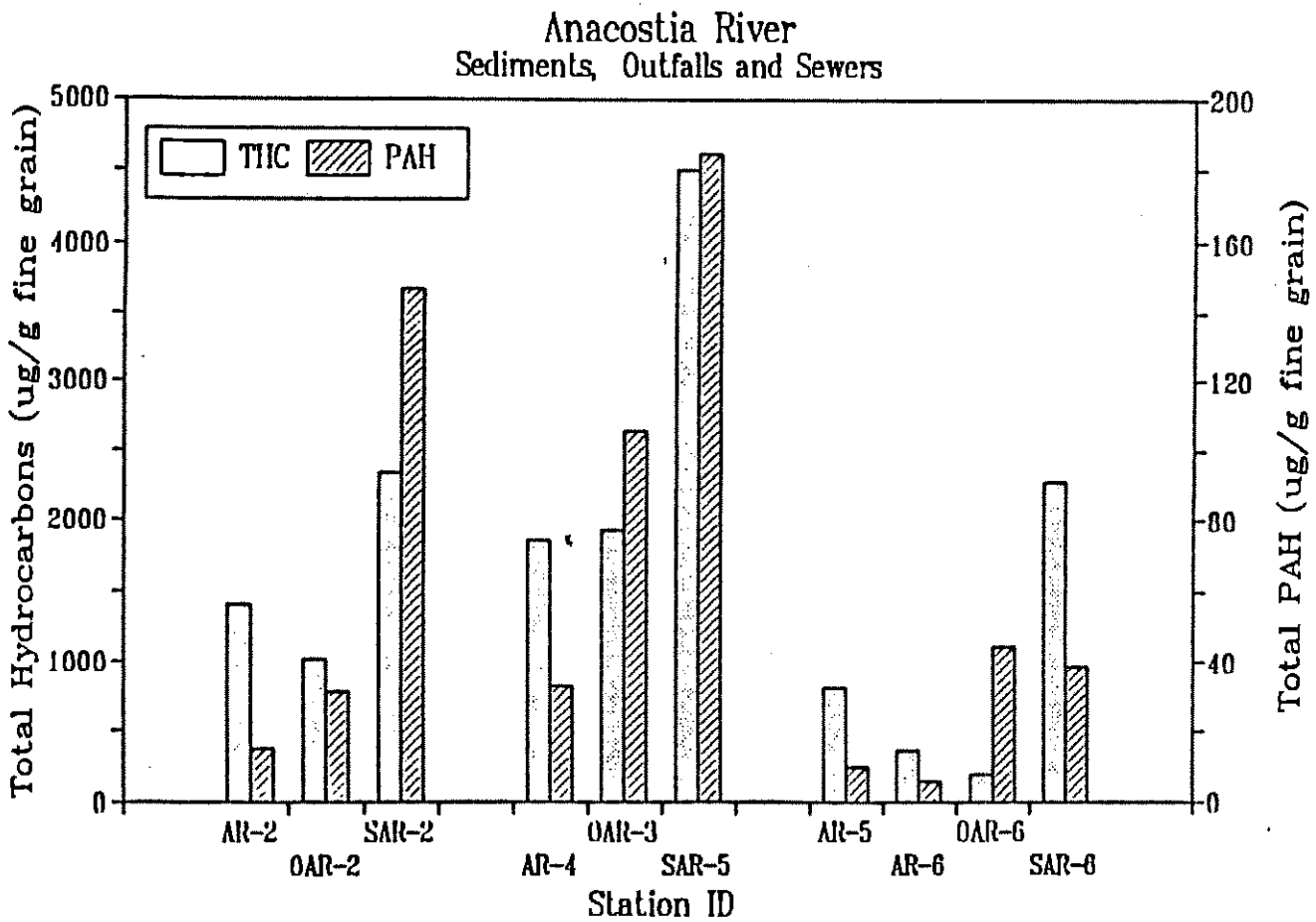


Figure 3-15. Outfall, sewer and sediment series in the Anacostia River: Hydrocarbons.

A-1825

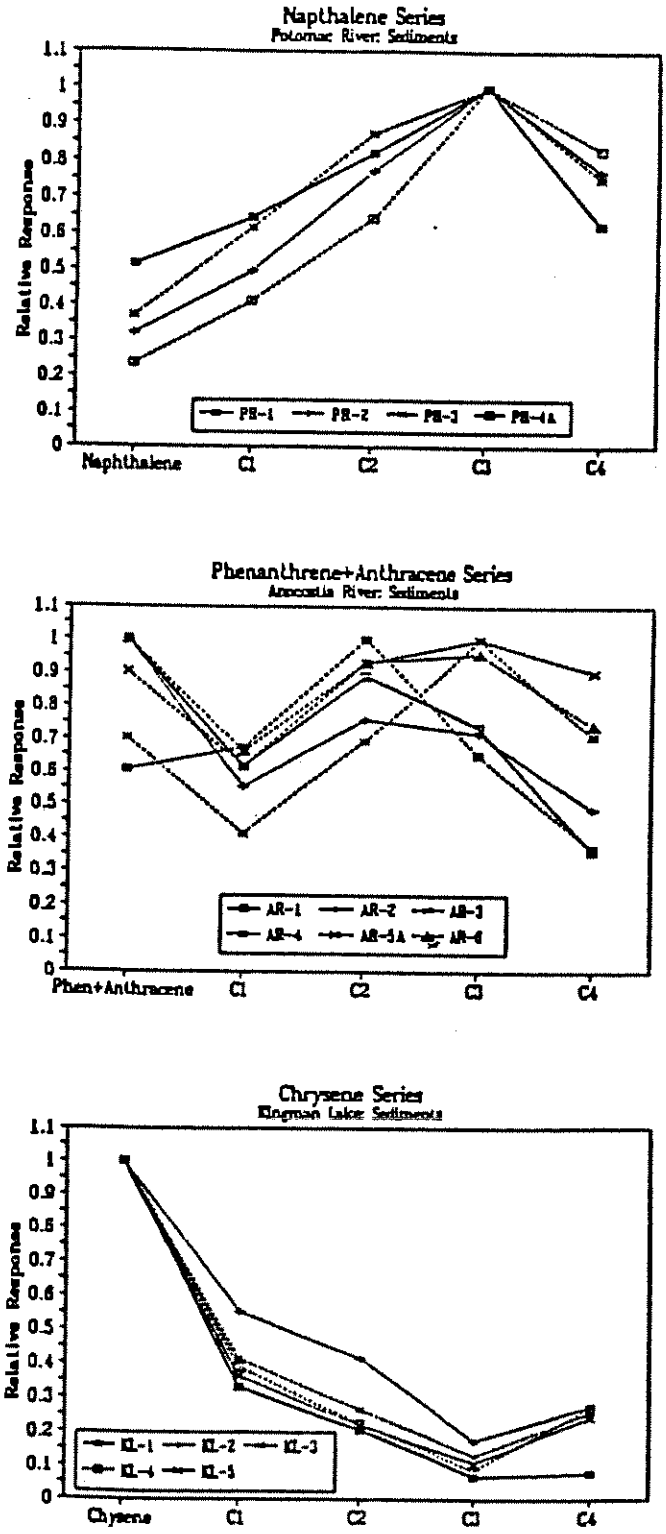


Figure 3-16. Relative abundances of naphthalenes, phenanthrene+anthracenes, and chrysenes in various locations.

POTOMAC RIVER BASIN STUDY - AROMATIC HYDROCARBON DATA - 1991

INVEST#:					
ID:	OWSC-3	AR-1	AR-2	AR-3	AR-4
LABSAMNO:	>Q1620	>Q1612	>Q1658	>Q1613	>Q1655
UNIT:	ng/g	ng/g	ng/g	ng/g	ng/g
PNA Analyte	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL
NAPHTHALENE	367.20	29.86	68.41	45.85	130.40
C1-NAPHTHALENES	432.38	48.94	102.31	81.25	291.36
C2-NAPHTHALENES	548.34	132.89	153.49	129.22	1127.27
C3-NAPHTHALENES	614.74	570.06	259.89	219.90	2374.27
C4-NAPHTHALENES	495.50	329.59	359.92	393.71	2195.01
BIPHENYL	105.79	12.61	17.79	13.27	46.94
ACENAPHTHYLENE	191.74	14.96	54.65	38.13	65.29
ACENAPHTHENE	1104.37	19.86	36.99	31.74	76.60
FLUORENE	1661.11	34.34	54.79	49.97	144.83
C1-FLUORENES	478.67	49.36	75.36	74.52	369.94
C2-FLUORENES	557.18	134.75	212.93	219.74	889.71
C3-FLUORENES	1172.65	259.16	511.63	561.96	1209.30
PHENANTHRENE	16638.63	591.95	636.40	474.98	1040.27
ANTHRACENE	2336.08	76.26	91.57	75.29	137.87
C1-PHEN_ANTHR	3764.85	410.26	403.11	321.91	1309.84
C2-PHEN_ANTHR	1997.52	594.20	552.43	542.98	1945.55
C3-PHEN_ANTHR	854.57	492.28	521.97	783.91	1267.76
C4-PHEN_ANTHR	329.87	242.11	354.84	557.27	719.87
DIBENZOTHIO	674.15	36.09	38.01	28.15	103.55
C1-DIBEN	290.09	63.29	67.19	50.79	250.50
C2-DIBEN	328.80	172.52	177.45	163.78	550.63
C3-DIBEN	286.22	239.50	273.39	327.83	611.23
FLUORANTHENE	19713.87	1492.93	1618.16	1230.91	1867.04
PYRENE	14614.72	1327.70	1489.94	996.60	1810.53
C1-FLUORAN_PYR	4763.41	707.20	801.71	816.30	1092.86
BENaANTHRACENE	8976.68	607.11	410.07	375.03	580.88
CHRYSENE	8840.65	817.34	704.84	589.20	799.39
C1-CHRYSENES	2651.68	334.25	300.09	316.53	458.89
C2-CHRYSENES	956.89	190.82	202.99	229.25	365.24
C3-CHRYSENES	271.66	80.00	87.01	109.05	163.31
C4-CHRYSENES	976.07	178.47	151.96	149.96	123.74
BENbFLUORAN	6890.77	919.31	819.83	772.54	646.58
BENkFLUORAN	5514.33	613.60	572.41	263.39	665.42
BENePYRENE	4391.30	610.08	556.46	496.67	570.52
BENaPYRENE	6482.92	586.26	502.43	425.28	557.58
PERYLENE	2139.70	220.52	172.99	160.54	171.87
I123cdPYRENE	3554.92	543.94	819.86	493.57	729.64
DBahANTHRA	815.76	132.08	166.05	103.38	186.07
BghiPERYLENE	3164.17	476.04	664.74	467.48	618.26

LABNAME: GERG/TAMU DATE: 06-Mar-92 LAB APPROVAL: Thomas J. Jackson

POTOMAC RIVER BASIN STUDY - AROMATIC HYDROCARBON DATA (CONT)- 1991

INVEST#:					
ID:	OWSC-3	AR-1	AR-2	AR-3	AR-4
LABSAMNO:	>Q1620	>Q1612	>Q1658	>Q1613	>Q1655
UNIT:	ng/g	ng/g	ng/g	ng/g	ng/g
Analyte (Cont)	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL
2-METHYLNAPH	222.50	31.19	67.71	54.16	193.41
1-METHYLNAPH	209.88	17.75	34.60	27.09	97.95
2,6-DIMETHNAPH	142.06	36.33	61.31	55.09	483.16
2,3,5-TRIMETHNAPH	112.69	36.69	43.81	39.54	465.69
1-METHYLPHEN	791.98	88.87	79.01	67.87	269.81
Surrogate Recoveries					
NAPHD8:	87.1	36.1	84.4	91.8	85.0
ACEND10:	76.1	40.0	81.7	91.4	77.8
PHEND10:	80.8	23.9	83.8	113.5	81.8
CHRYD12:	51.5	26.6	128.7	200.6	115.2
PERYD12:	105.6	15.2	92.6	102.6	114.3

LABNAME: GERG/TAMU DATE: 06-Mar-92 LAB APPROVAL: Thomas F. Jackson

POTOMAC RIVER BASIN STUDY - AROMATIC HYDROCARBON DATA - 1991

INVEST#:					
ID:	AR-5A	AR-5B	AR-5C	AR-6 CLAM	AR-6
LABSAMNO:	>Q1614	>Q1615	>Q1656	>Q1672	>Q1616
UNIT:	ng/g	ng/g	ng/g	ng/g	ng/g
PNA Analyte	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL
NAPHTHALENE	38.81	37.75	78.11	38.97	31.71
C1-NAPHTHALENES	74.09	65.63	114.75	42.21	57.31
C2-NAPHTHALENES	123.88	116.19	181.42	68.75	86.76
C3-NAPHTHALENES	188.89	155.12	265.11	168.85	115.57
C4-NAPHTHALENES	207.67	178.33	272.73	312.16	130.98
BIPHENYL	13.96	9.04	21.44	7.90	12.05
ACENAPHTHYLENE	27.65	19.96	45.63	19.58	21.08
ACENAPHTHENE	20.16	13.20	26.74	10.72	14.91
FLUORENE	37.89	24.66	47.35	5.77	30.99
C1-FLUORENES	58.55	37.81	76.09	60.47	43.48
C2-FLUORENES	149.61	111.19	196.80	197.45	119.14
C3-FLUORENES	330.35	222.43	372.81	670.80	247.96
PHENANTHRENE	339.83	295.40	357.73	36.75	189.03
ANTHRACENE	65.01	61.73	60.29	34.67	34.66
C1-PHEN_ANTHR	266.75	236.11	300.87	108.77	147.65
C2-PHEN_ANTHR	421.13	368.46	424.30	373.45	207.99
C3-PHEN_ANTHR	493.01	411.61	399.93	541.72	214.79
C4-PHEN_ANTHR	466.06	415.41	297.26	515.71	166.03
DIBENZOTHIO	19.88	17.79	23.58	7.69	11.96
C1-DIBEN	42.93	39.48	46.77	28.88	23.42
C2-DIBEN	127.52	108.44	113.96	151.18	55.04
C3-DIBEN	216.09	184.29	167.85	229.25	95.39
FLUORANTHENE	896.10	830.76	852.91	252.49	482.26
PYRENE	895.78	809.09	853.88	423.77	478.27
C1-FLUORAN_PYR	606.37	539.69	485.70	449.14	302.19
BENaANTHRACENE	237.50	223.36	251.62	109.60	169.28
CHRYSENE	408.63	378.68	416.14	372.97	252.53
C1-CHRYSENES	218.67	196.29	210.13	173.45	155.51
C2-CHRYSENES	169.53	156.91	160.70	138.63	104.94
C3-CHRYSENES	95.94	85.08	64.45	62.66	49.17
C4-CHRYSENES	106.25	92.61	96.88	79.39	56.34
BENbFLUORAN	539.50	542.12	642.45	165.61	303.83
BENkFLUORAN	283.78	245.67	204.30	48.51	227.80
BENePYRENE	332.19	317.10	359.71	247.52	213.27
BENaPYRENE	304.73	278.71	301.84	43.80	212.37
PERYLENE	237.26	230.94	196.57	41.70	138.56
I123cdPYRENE	353.90	325.49	523.25	36.65	219.70
DBahANTHRA	82.75	67.37	124.92	21.32	42.27
BghiPERYLENE	328.68	310.64	448.28	59.46	214.64

LABNAME: GERG/TAMU DATE: 06-Mar-92 LAB APPROVAL: Thomas P. Jackson

POTOMAC RIVER BASIN STUDY - AROMATIC HYDROCARBON DATA (CONT)- 1991

INVEST#:					
ID:	AR-5A	AR-5B	AR-5C	AR-6 CLAM	AR-6
LABSAMNO:	>Q1614	>Q1615	>Q1656	>Q1672	>Q1616
UNIT:	ng/g	ng/g	ng/g	ng/g	ng/g
Analyte (Cont)	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL	Conc DB QUAL
2-METHYLNAPH	49.88	43.89	76.37	25.15	38.24
1-METHYLNAPH	24.21	21.74	38.38	17.06	19.07
2,6-DIMETHNAPH	53.07	31.46	71.39	17.21	35.47
2,3,5-TRIMETHNAPH	29.92	19.79	48.49	13.12	22.00
1-METHYLPHEN	48.30	39.83	34.67	23.58	29.26
Surrogate Recoveries					
NAPHD8:	74.3	80.4	70.7	57.4	71.8
ACEND10:	77.2	116.4	70.3	58.8	67.4
PHEND10:	80.0	91.0	81.2	56.5	94.7
CHRYD12:	148.0	167.4	120.0	54.7	141.6
PERYD12:	54.5	53.7	64.3	45.1	69.9

LABNAME: GERG/TAMU DATE: 06-Mar-92 LAB APPROVAL: Thomas J. Jackson

APPENDIX 3

Versar, Inc., *An Assessment of Potential Residual Effects of the January 1992 Oil Spill in the Anacostia River*, January 1993

AN ASSESSMENT OF POTENTIAL RESIDUAL EFFECTS OF THE JANUARY 1992 OIL SPILL IN THE ANACOSTIA RIVER

A Study Completed for

Steuart Petroleum Company
4646 Fortieth St., NW
Washington, DC 20007

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6 January 1993

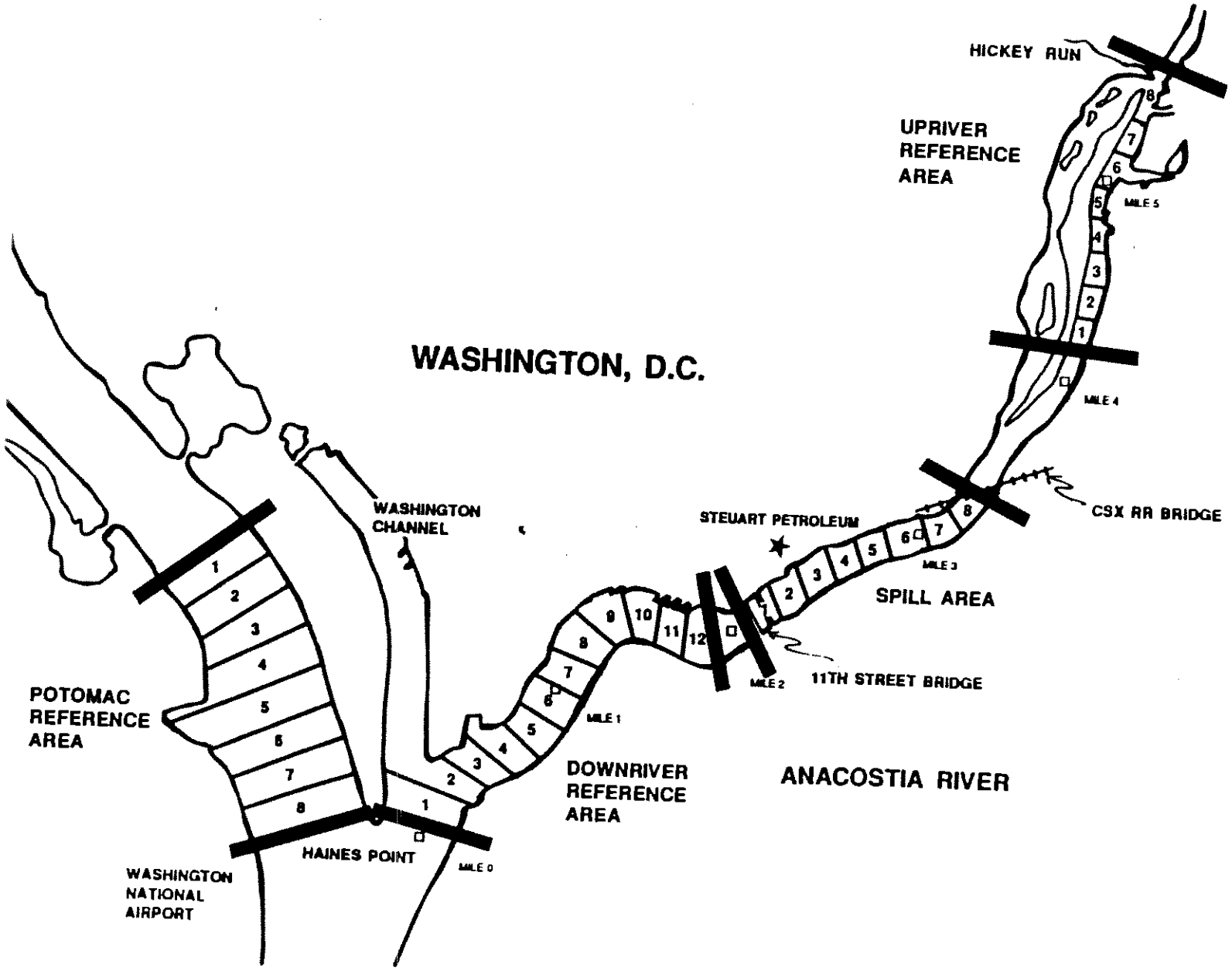

Figure 1-2. Map of the spill and reference areas of the Anacostia and Potomac Rivers

PAHs are acutely toxic at concentrations between 50 and 1000 μg/l and that sublethaltoxic effects can occur at concentrations in the 0.1 to 5.0 μg/l range. No EPA criteria or aquatic toxicity data were available for TPH.

Since the Anacostia River is not used as a source of drinking water, the EPA (1986) criteria for human health apply only to consumption of aquatic biota. Risks associated with PAH concentrations in fish and shellfish from the river are discussed in Section 2.3.

2.1.3.5 Interpretation

- The oil spill was not the dominant source of hydrocarbons detected in the river. Continuing inputs from urban runoff through stormwater, combined sewage, and a contaminated tributary are probably the major sources of the hydrocarbons detected in the river water.

2.2 CONCENTRATIONS IN RIVER SEDIMENTS

2.2.1 Introduction

Oil and hazardous chemicals released to aquatic systems frequently settle out of the water column and accumulate in sediments due to adsorption to particles (EPA 1992b). Bottom dwelling organisms, fish, wildlife, and humans can be exposed to contaminants from sediments either directly or through the food chain. Storms can cause sediments to be resuspended in the water column, increasing potential exposure. As part of the impact assessment, it was necessary to determine the location and extent of residual oil in the river sediments. Sediment samples were collected and analyzed from the spill, downriver, and upriver areas. Data from the post-spill study were compared with data collected by Velinsky et al. (1992) at fixed stations in June 1991. The two studies could be compared because both used the same laboratory and methods (GERG) for chemical analyses.

Several parameters in addition to TPH and PAHs were measured to evaluate sediment contamination. Since sediment-bound contaminants are associated with particle surfaces, sand-sized particles, which have smaller surface areas, generally are less contaminated per unit weight than silt or clay-sized particles under identical conditions (O'Connor and Ehler 1991); therefore, the particle size distribution of the sediment samples was measured and contaminant concentrations were normalized for grain size if grain size was different in different river areas.

In addition to hydrocarbons, sediments of the Anacostia River are contaminated with organochlorine pesticides, PCBs, and toxic metals (Velinsky et al. 1992). Concentrations of these chemicals were measured to document the contaminant status of the river with respect to toxic chemicals that are not related to the spill. Concentrations were compared before and after the oil spill and with guidance values for sediment contamination.

2.2.2 Methods

2.2.2.1 Sample Collection

Surface sediment samples were collected with a stainless steel ponar grab on August 11, 1992. Fifteen samples were collected: 9 from the spill area and 3 from each reference area. Within each area, a third of the samples were collected from the channel, a third from the west near-shore zone, and a third from the east near-shore zone. Following ASTM (1991) guidelines, an acid-washed watch glass was used to collect the top 2 cm of sediment from each grab. Only sediments at least 2.5 cm from the sides of the grab were taken to avoid contamination by the grab. Samples from several grabs were placed in a Teflon stirring bowl, homogenized with an acid-washed glass stirring rod, and placed in pre-cleaned 500-ml bottles. Betwaen stations, all sampling gear and utensils were washed with detergent and water and rinsed with deionized water. The sample bottles were placed in an iced cooler, stored at - 20 °C, and shipped on ice to GERG for chemical analysis.

2.2.2.2 Sample Analysis

Samples were prepared and analyzed for TPH, PAHs, organochlorine pesticides, PCBs, cadmium, lead, and mercury according to GERG Standard Operating Procedures. TPH and PAH methods and GC/FID analyses were the same as those used for the water samples. Organochlorine pesticides and PCBs were measured by gas chromatography with electron capture detection using GERG SOP 9017, which corresponds to EPA methods 8080, 608, and 8081. Cadmium and lead were measured by graphite furnace atomic absorption spectrophotometry according to GERG SOP ST10, which corresponds to EPA methods 213.2 (cadmium) and 239.2 (lead). Mercury was analyzed by cold vapor atomic absorption spectrophometry according to ST11, which corresponds to EPA method 245.1.

2.2.2.3 Data Analysis

The need to normalize the sediment data for particle size was analyzed by comparing the mean percent silt-clay ($< 63\ \mu m$) in the spill and combined reference areas. There was no statistically significant difference between the mean silt-clay percentage in the spill area (74.0%) and the combined reference areas (56.5%; *t* test, $p = 0.28$). A linear regression of total PAH concentrations with silt-clay particle size fraction was not significant, indicating that there was no consistent relationship between the two parameters; therefore, contaminant data were not normalized for particle size.

Data were evaluated to determine the need for transformation to improve the normality of the distribution of values. In this case, the data were normally distributed without transformation for all parameters except total PAH, and parametric statistics were performed on the untransformed data. For total PAH, the normality of the data was improved by the log transformation; analyses were performed with both the transformed and untransformed data, and the results were compared.

As for the water samples, *t* tests were conducted to identify differences in mean total PAH, TPH, PCBs, DDT, chlordane, cadmium, lead, and mercury concentrations between the spill area and the combined reference areas. ANOVA was then performed to compare mean concentrations among the three river areas. If ANOVA indicated significant differences between the means for the areas, Tukey's multiple comparison test was used to determine the groupings.

Risks resulting from the presence of multiple contaminants in the river sediments were characterized in two ways. First, studies that tested the toxicity of river sediments to representative test organisms were reviewed. Second, sediment chemistry data were interpreted by comparing concentrations with guidance values. The values developed by Long and Morgan (1990) were used in the absence of EPA-sanctioned sediment quality criteria for the chemicals of concern. Long and Morgan (1990) summarized available field and laboratory studies demonstrating biological effects of chemicals in sedimants. By listing the measured sediment concentrations in ascending order with the observed adverse biological effects, they calculated effects range-low (ER-L) and effects range-median (ER-M) concentrations. The ER-L was the 10th percentile concentration and was interpreted as the concentration above which adverse effects may begin. The ER-M was the 50th percentile and was interpreted to approximate the concentration at which adverse effects were frequently observed. In the present study, the more conservative ER-M was used as a guidance value for assessing the potential for biological effects. The ER-M values have no regulatory standing and were used solely as a means of interpreting chemical concentrations.

2.2.3 Results and Discussion

2.2.3.1 Spatial Comparisons of TPH and PAHs

Mean TPH concentration in the spill area (1911 mg/kg) was significantly higher than the mean concentration in the reference area combined (1270 mg/kg). Mean concentration of total PAHs was about twice as great (~32 mg/kg) in the spill area than in the other areas (~15 mg/kg; Table 2-5). A *t*-test comparison of the spill area with the combined reference areas indicated that the differences were statistically significant (Table 2-6). These results were significant regardless of whether the data had been log-transformed.

Table 2-5. TPH and total PAH concentrations in Anacostia River sediment samples (mg/kg dry weight).

Area	Location	TPH	Total PAH
Upriver	6-East	460	12.158
	4-Central	1010	14.608
	5-West	1330	18.108
	Mean ± one SD	933 ± 440	14.958 ± 2.990
Spill	1-East	2890	35.391
	6-East	1760	21.485
	8-East	980	51.814
	1-Central	2120	17.648
	3-Central	1900	19.492
	7-Central	1420	21.109
	2-West	1995	77.274
	3-West	2160	18.628
	8-West	1970	32.218
	Mean ± one SD	1911 ± 525	32.784 ± 20.059
Downriver	11-East	2320	25.623
	7-Central	1320	10.636
	5-West	1180	8.706
	Mean ± one SD	1607 ± 622	14.988 ± 9.260

Table 2-6. Comparisons (*t* test) of spill area and combined reference areas TPH and total PAH concentrations (mg/kg dry weight) in sediment samples.

Chemical	Spill Area	Reference Areas	Results
TPH	1911 ± 525	1270 ± 606	spill > reference ($p=0.05$)
PAHs	32.784 ± 20.059	14.973 ± 606	spill > reference ($p=0.03$)

ANOVA tests of the three areas did not indicate significant differences in total PAH or TPH concentrations (Table 2-7). The outcome of the analysis was the same regardless of whether the PAH data had been log-transformed. These results indicate that, with combined reference areas, the *t* test was more sensitive for detecting differences than the ANOVA. This is a result of the greater number of reference-area samples in the *t* test (n=6) than in the ANOVA (n=3). The results do not indicate a river gradient; they indicate that sediments in the spill area are more contaminated with total PAHs than either of the reference areas.

Table 2-7. ANOVA comparisons of TPH and total PAH concentrations (mg/kg dry weight) in sediment samples. Groups with the same capital letter are not significantly different (Tukey's test; $p>0.05$)

Chemical	Upriver	Spill	Downriver
TPH	933 (A)	1911 (A)	1607 (A)
PAHs	14.958*	32.784*	14.988*

* ANOVA indicated no significant differences between groups ($p=0.18$).

The relative distribution of low molecular weight (2 and 3 ring) and high molecular weight (4 to 6 ring) PAH compounds in Anacostia River sediments was analyzed to provide information on sources of these compounds. Combustion from forest fires and fossil fuels produces mostly high molecular weight, unsubstituted compounds such as fluoranthene, pyrene, chrysene, and benzanthracenes (Kennicutt et al. 1991). High molecular weight compounds are the dominant PAHs in urban runoff (Hoffman et al. 1984) and constitute most PAHs in estuarine and coastal sediments. High molecular weight PAHs are a minor fraction of petroleum; sediment

residues of degraded fuel oil tend to contain lower molecular weight aromatics such as phenanthrenes and fluorenes (M.C. Kennicutt, GERG, pers. comm.).

The Anacostia sediments were dominated by high molecular weight PAHs. For all samples, high molecular weight compounds represented an average of 72% of the total PAHs. The percentage of high molecular weight PAHs was similar in samples from the upriver (74%), spill (68%), and downriver (70%) areas. This indicates that the Anacostia sediments have received inputs of combustion-derived PAHs, either directly or through urban runoff.

2.2.3.2 Fingerprinting Studies

GC/FID analyses were performed on all 15 Anacostia sediment samples, and chromatograms were compared with the chromatogram from the #4 fuel oil.

As shown in Figure 2-3, the chromatograms for the sediment sample from spill segment 2 and the #4 fuel oil sample are quite different. The high molecular weight UCM (largely in the C-17 to greater than C-31 range) in the sediment chromatogram is typical of crankcase oil and urban runoff (M.C. Kennicutt, GERG, personal communication). No similar UCM was observed in the chromatogram from the #4 fuel oil, which had most peaks in the C-11 through C-21 range. If oil with this chromatogram were to be altered by microbial degradation and weathering, it would yield a UCM of much lower molecular weight. Chromatograms of the other sediment samples were similar to the one shown in Figure 2-3 and are reproduced in Appendix A.

It is apparent from analysis of the GC/FID data that the spilled #4 fuel oil was probably not the dominant source of the hydrocarbons found in the river sediments.

2.2.3.3 Spatial Comparisons of Other Contaminants

The spill area appears to be more polluted than the combined reference areas with respect to several contaminants that are not related to the spill. Mean concentrations of chlordane, DDT, cadmium, and lead were about twice as high in the spill area than in the reference areas, and these differences were statistically significant (*t* tests; Table 2-8). Concentrations of PCBs and mercury were about 1.5 times higher in the spill area, but these differences were not statistically significant.

Table 2-8. Comparisons (*t* test) of contaminant concentrations (mg/kg dry weight) in sediments from spill and combined reference areas.

Chemical	Spill Area	Reference Areas	Results
Chlordane	0.118 ± 0.034	0.060 ± 0.024	spill > reference ($p=0.003$)
DDT	0.101 ± 0.033	0.042 ± 0.022	spill > reference ($p=0.002$)
PCBs	0.561 ± 0.191	0.390 ± 0.125	n.s. ($p=0.08$)
Cadmium	1.664 ± 0.508	1.175 ± 0.298	spill > reference ($p=0.05$)
Lead	278.8 ± 160.6	111.4 ± 31.0	spill > reference ($p=0.01$)
Mercury	0.338 ± 0.114	0.225 ± 0.121	n.s. ($p=0.09$)

ANOVA comparisons (Table 2-9) indicated that concentrations of chlordane and DDT were significantly higher in the spill area than in one (but not both) of the reference areas. For the other chemicals, there were no statistically significant differences between areas. The ANOVA results do not indicate a river gradient; they show the spill area to be more contaminated in general than either of the reference areas.

Table 2-9. ANOVA comparisons of total PAH and TPH concentrations (mg/kg dry weight) in sediment samples. Groups with the same capital letter are not significantly different (Tukey's test; $p>0.05$)

Chemical	Upriver	Spill	Downriver
Chlordane	0.069 (A,B)	0.118 (A)	0.051 (B)
DDT	0.031 (B)	0.100 (A)	0.053 (A,B)
PCBs	0.351*	0.561*	0.430*
Cadmium	1.143*	1.664*	1.207*
Lead	90.0*	278.8*	132.7*
Mercury	0.156*	0.338*	0.294*

* ANOVA indicated no significant differences between groups ($p>0.05$).

2.2.3.4 Historical Comparisons

Concentrations of total PAHs were compared with pre-spill data collected in June 1991 by Velinsky et al. (1992). This study's pre-spill data was compared readily with the present study because analyses for both studies were conducted using the same methods and the same laboratory (GERG). PAH concentrations measured by Velinsky et al. (1992) are given in Table 2-10, along with the corresponding 1992 sample location. Velinsky et al. (1992) sampled four stations in the present study's downriver area, one between the spill and downriver area, and one in the spill area. No comparisons were available for the upriver area because the 1991 samples were collected in Kingman Lake rather than in the main river.

Table 2-10. Total PAH concentrations (mg/kg dry weight) measured in 1991 in Anacostia River sediments by Velinsky et al. (1992).

1991 Site Designation	Corresponding 1992 Area and Segment	Total PAH Concentration
AR-1	Spill-5	14.390
AR-2	Downriver-11	15.070
AR-3	Between Spill and Downriver	13.180
AR-4	Downriver-9	28.270
AR-5	Downriver-6	9.560
AR-6	Downriver-3	5.680
	Downriver: Mean ± one SD	14.645 ± 8.545

Three types of statistical comparisons were made between the pre- and post-spill data using *t* tests. First, the mean concentrations in the two downriver areas were compared. Next, the 1991 single sample from what would become the spill area was compared with the mean from the spill area in 1992. Finally, the 1991 spill and downriver combined mean value was compared with the spill and downriver value for 1992. Comparisons were made for the four chemicals (PAHs, PCBs, chlordane, and lead) that exceeded ER-M values in 1992 (see Section 2.2.3.5)

The mean concentration of total PAHs of the four downriver sediment samples measured before the spill was nearly equal to that measured after the spill. The pre-spill total PAH concentration in the single sample measured in the spill area was about

4.0 CONCLUSIONS

A monitoring study was conducted to evaluate potential residual effects of the January 1992 spill of #4 fuel oil in the Anacostia River. The investigation included both chemical and biological studies. Chemical studies were conducted to determine if remnants of the spilled oil remained in the water, sediment, and biota of the river. Biological studies were conducted to assess adverse effects on key biological resources in the river, specifically, benthic (bottom dwelling) fauna and the early life stages of anadromous fish.

4.1 PRESENCE OF SPILLED OIL

Chemical monitoring of the river water revealed that trace amounts of petroleum hydrocarbons were present in the river. These petroleum hydrocarbons included polynuclear aromatic hydrocarbons (PAH), which are generally the most toxic constituents of spilled petroleum and refined products. Petroleum concentrations were not statistically different in the spill area compared to two reference areas located upriver and downriver from the spill area. No historical data that could be used to compare hydrocarbon concentrations in the river water before and after the spill were identified.

The concentrations of total petroleum hydrocarbons (TPH) and polynuclear aromatic hydrocarbons (PAH) in water from the upriver reference area were generally higher than concentrations downriver suggesting a concentration gradient in the river. Analysis of the composition of petroleum and the types of PAHs in the river water indicated that the spilled fuel oil was unlikely to be the source of petroleum hydrocarbons. The high molecular weight unresolved complex mixture in the Anacostia water samples was different from the lower molecular weight gas chromatographic peaks produced by a sample of the #4 fuel oil and is more typical of urban runoff. Analyses of samples collected from an upstream tributary and two stormwater lines that empty into the spill area suggested that urban runoff was probably the dominant source of petroleum hydrocarbons in the river water.

The concentration of TPH in the sediments of the spill area was 1.5 times as high as the concentration in the sediments of reference areas, and the concentration of PAHs was twice as high. There was, however, no statistically significant difference in mean total PAH concentrations measured in river sediments before and after the spill. Analysis of the composition of petroleum and the types of PAHs indicated that the spilled fuel oil was not a significant source of petroleum hydrocarbons in river sediments. River sediments contained predominately high molecular weight PAH compounds which are typical of combustion products and urban runoff but are largely absent from petroleum. Additionally, the unresolved complex mixture of hydrocarbons

in the sediments was of a higher molecular weight than the chromatographic peaks produced by a sample of the #4 fuel oil.

PAH concentrations in three fish species (channel catfish, brown bullhead, and carp) and a bottom dwelling freshwater clam (Asiatic clam) were determined to be similar in the spill and reference areas. No historical PAH data for fish tissues were identified to compare with post-spill concentrations and clam data were inadequate to perform a statistical comparison. The total PAH concentration in a single clam sample collected in the downriver area after the spill was similar to the concentration in a clam collected from the same area before the spill by Velinsky et al. (1992).

The human and ecological health implications of the PAH concentrations in fish and clam tissues are unknown; however, significant risks are associated with consuming these fish from the Anacostia due to the presence of other contaminants. A health advisory limiting consumption of catfish, carp, and eels from the Anacostia due to high concentrations of polychlorinated biphenyls (PCBs) and the chlorinated pesticide chlordane has been in effect since 1989. These and other contaminants present in the sediments and biota of the Anacostia are not related to the January 1992 oil spill.

4.2 BIOLOGICAL EFFECTS

Benthic macroinvertebrate communities in the spill and reference areas were similar, and there was no evidence that the oil spill has adversely affected the benthic community. Total abundance and diversity in the spill area were similar to those in the same area in 1991 (Velinsky et al. 1992). Benthic fauna were dominated by pollution-tolerant organisms, particularly oligochaete worms and chironomid dipteran larvae. Macroinvertebrates collected in the present study were similar to those collected from the Anacostia River in previous studies (Edmondson 1988; Velinsky et al. 1992) and in the Potomac River just below its confluence with the Anacostia River (Ranasinghe 1992).

The abundance of ichthyoplankton (fish eggs and larvae) was not significantly different between spill and reference areas during the one month monitored. The dominant species in the river were blueback herring and alewife which represented 99% of the ichthyoplankton collected. Densities of these species (collectively called river herring) were substantially greater in the Anacostia River than in a reference area in the Potomac River. Densities were low at all three Anacostia areas and the Potomac area during the first week of collection. In subsequent weeks, maximum river herring abundances progressed downriver from the upriver reference area in week 2, to the spill area in week 3, ending with maximum concentrations in the downriver reference area in week 4. These data suggest that the river herring spawned in the upriver area, and the population progressively moved or was transported downriver. There were no

statistical differences in 1992 river herring abundances when compared with 1989 and 1990 data collected during a similar three-week period (American Fisheries Society 1990, 1991).

APPENDIX 4

Ecology & Environment, Inc., *Site Inspection, National Capital Parks – East Station Site, Washington, DC*, December 1995

UY2050/RC1457

SITE INSPECTION
FOR
NATIONAL CAPITAL PARKS - EAST STATION SITE

Southeast Washington, DC

Prepared Under:

Contract No. 1443CX0001-95-003

and

Purchase Order No. 1443PX0001-95-C47

December 1995

Prepared for:

National Park Service - National Capital Area

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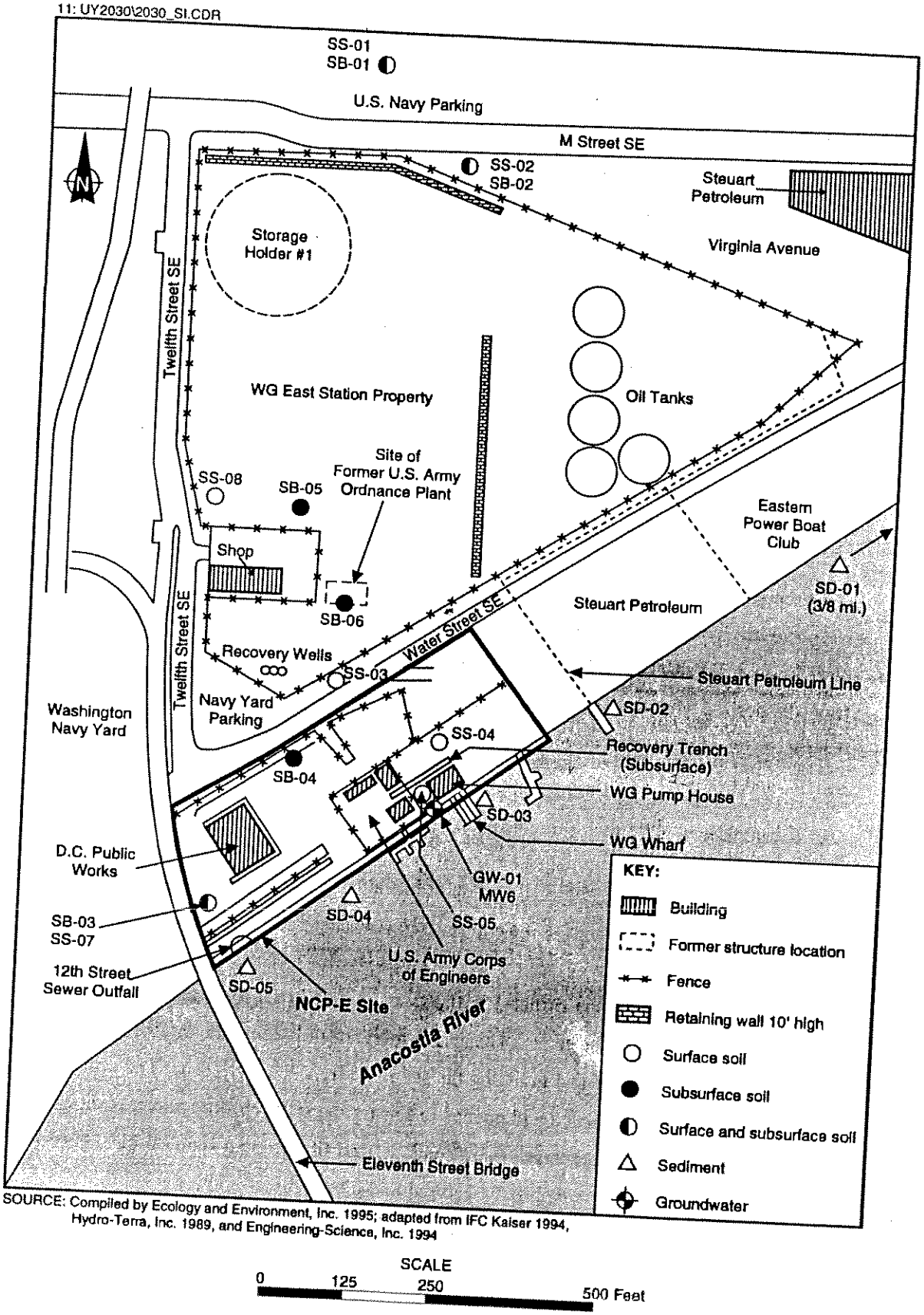

SOURCE: Compiled by Ecology and Environment, Inc. 1995; adapted from IFC Kaiser 1994, Hydro-Terra, Inc. 1989, and Engineering-Science, Inc. 1994

Figure 5-1 **SI SAMPLING LOCATIONS, NATIONAL CAPITAL PARKS-EAST STATION SITE, WASHINGTON, D.C.**

5.1 SI SAMPLE COLLECTION METHODS

5.1.1 Surface Soil

Surface soil samples were collected from a depth interval of 0 to 6 inches. In general soil was collected with a stainless steel spoon, placed into an aluminum pie pan, homogenized, and then placed into the proper sample container. Samples analyzed for volatile organic compounds (VOCs) were placed directly into the sample containers prior to mixing soil in the pans. All surface soil samples were analyzed for the Target Compound List (TCL) (which includes VOCs, base/neutral and acid extractable organic compounds (BNA), and pesticide/polychlorinated biphenyls (PEST/PCBs)), Target Analyte List (TAL) metals (aluminum, arsenic, barium, beryllium, calcium, total chromium, cobalt, copper, iron, lead, magnesium, mercury, nickel, potassium, sodium, vanadium, and zinc), and cyanide.

5.1.2 Subsurface Soil

Subsurface soil samples were collected from areas of known contamination and from two proposed background locations. Discrete samples from depths ranging from 6 to 10 feet were reached by excavating a pit to the desired depth. The excavated soil not sampled was placed on plastic sheeting. Soil samples were collected directly from the last backhoe scoop from the desired sampling depth. Samples were collected and containerized in the same manner as the surface soil samples. All subsurface soil samples were analyzed for TCL, TAL metals, and cyanide.

5.1.3 Sediment

Sediment samples were collected at points along the Anacostia River both upstream and downstream from the site. All samples were collected from floating docks or piers approximately 20 feet from the shore. An Eckman Dredge was used to obtain sediment from the river bed in the following manner: a rope was used to lower the dredge in its open position to the bottom of the river. The spring mechanism holding the dredge open was released closing the dredge and grabbing the sediment from the river bed. The sediment-filled dredge was then retrieved and opened to release the sediment into an aluminum pie pan. Sediment samples for VOC analysis were containerized first using a stainless steel spoon. The remaining sediment was then homogenized and placed directly into the appropriate containers.

Hydro-Terra, Inc., June 1989. Benthic macroinvertebrate samples were collected at 6 points in the Anacostia and tested; and 12 river sediment samples, air samples, and 3 water samples from the 12th Street storm sewer were collected and tested.

The benthic macroinvertebrate survey showed a community that reflects the poorly-oxygenated water of the Anacostia River and high organic loading of the lower Anacostia.

Sediment samples collected along the Anacostia River showed phenolic concentrations ranging from 75.5 μg/kg to 2,068 μg/kg (at RS7, located between the active 12th Street sewer outfall and the WG pump house). Samples showed PAHs ranging from 4.7 to 1,705 μg/kg (at RS11, located upstream of the Washington Gas Pier). Sample RS10 and RS11 indicated PAH at significantly higher concentrations than the remaining samples. No BTEX compounds were detected in the sediment.

Air sampling was performed by two methods: field testing using an HNu meter and sampling with an MSA Model C-210 sampling pump. The highest HNu readings were detected inside trenches (test pits) during sampling actions. The highest concentration of benzene, 182.3 $\mu g/m^3$, was detected in sample A-1. This sample was collected at the southwest corner of the WG property.

Samples collected from the 12th Street sewer showed that groundwater contaminated by coal tar related PAHs is not entering the sewer.

8.4 SEDIMENT SAMPLING

8.4.1 Sample Locations

Five sediment samples and one duplicate were collected to confirm previous results and to provide QA/QC data to support this investigation. The samples were collected in approximately the same locations as were selected in 1988 by Hydro-Terra. Sample locations are presented in Figure 5-1.

- Sediment sample SD-01, located 1,980 feet (northeast) and upstream of the site, was designated as a background sample. The sample was collected off of a pier within the Washington Yacht Club property.

- Sediment sample SD-02 was collected from the loading pier operated by Steuart Petroleum. An oily sheen was noted on the sediment during sampling, and a tar stain remained in the aluminum pan after the sediment was containerized.

- Sample SD-03 and its duplicate SD-03D were collected off of a pier behind the WG pumphouse located on the NPS property.

- Sediment sample SD-04, collected off of the pier used by the U. S. Army Corps of Engineers, also contained an oily sheen and dark streaks of oil.

- Finally, Sediment sample SD-05 was collected off of a boat dock that was approximately 20 feet off shore from the end of the 12th Street sewer outfall. This sample had a sheen and streaks of tar or oil.

8.4.2 Analytical Results

Table 8-1 present results of analyses conducted on the sediment samples collected for this SI. Several PAHs including benzo(b)fluoranthene with an estimated value of 1,100 μg/kg and benzo(a)pyrene with an estimated value of 730 μg/kg were detected above the method detection limit in sample SD-01 which was designated a site background. These detections are likely due to other upriver sources along the Anacostia. Other than duplicate sample, SD-03D, no sample contained above-background levels of PAHs. Two pesticides, 4,4-DDD and 4,4-DDE (degradation products of DDT) were detected at 0.017 mg/kg and 0.029 mg/kg respectively in sample SD-05. The total metals in samples SD-02 through SD-05 did not exceed the total metals in the background sample.

8.5 CONCLUSIONS

No contamination of the Anacostia River could be attributed to the NCP-E site based on two factors: 1) PAHs were detected in the background sample indicating contamination in the Anacostia River resulting from other sources and 2) the river is subject to strong tidal influences which make it impossible to predict contaminant migration pathways in the river with any degree of confidence. Other factors worth noting are:

- The Anacostia River receives urban run-off and contamination from industries and boating activities from both upstream and downstream sources.

Table 8-1

SEDIMENT ANALYTICAL RESULTS
NATIONAL CAPITAL PARKS - EAST STATION SITE

Sample ID	SD-01	SD-02	SD-03	SD-03D	SD-04	SD-05
Location	Washington Yacht Club	Steuart Petroleum Pier	WG Pump House Pier	Duplicate of SD-03	U.S. Army Corps of Engineers Pier	12th Street Sewer Outfall
Percent Solids	34	35	37	36	34	73
PARAMETER						
TOC (mg/kg)	160000	160000	190000	180000	180000	9900
VOC (µg/kg)						
acetone	94	***97***	80	53	87 J	7.8 J
chlorobenzene	<15	<14	<14	<14	<15	9.3 J
chloromethane	<29	<29	<27	<28	<29	***7.4 J***
ethylbenzene	<15	<14	***220***	11 J	<15	<6.8
toluene	9.8 J	<14	2.7 J	<14	<15	***10 J***
xylene	<15	<14	***140***	62	<15	3.0 J
TOTAL VOC	103.8	97	443	126	87	37.5
BNA (µg/kg)						
acenaphthene	<5800	<4700	<4400	15000	<4800	***240 J***
anthracene	<5800	<4700	<4400	5800 J	<4800	***150 J***
benzo(a)anthracene	<5800	<4700	<4400	4800 J	430 J	300 J
benzo(b)fluoranthene	***1100 J***	990 J	<4400	3200 J	880 J	280 J
benzo(k)fluoranthene	***540 J***	<4700	<4400	2100 J	<4800	160 J
benzo(a)pyrene	***730 J***	490 J	<4400	4100 J	<4800	230 J

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Table 8-1

SEDIMENT ANALYTICAL RESULTS
NATIONAL CAPITAL PARKS - EAST STATION SITE

Sample ID Location Percent Solids	SD-01 Washington Yacht Club 34	SD-02 Steuart Petroleum Pier 35	SD-03 WG Pump House Pier 37	SD-03D Duplicate of SD-03 36	SD-04 U.S. Army Corps of Engineers Pier 34	SD-05 12th Street Sewer Outfall 73
benzo(ghi)perylene	***870 J***	<4700	<4400	2500 J	<4800	180 J
bis(2-ethylhexyl)phthalate	***4400 J***	2300 J	1500 J	2100 J	1900 J	1400
butylbenzylphthalate	***1300 J***	<4700	<4400	65000	<4800	520
chrysene	***910 J***	690 J	<4400	5400 J	640 J	350 J
dibenzofuran	<5800	<4700	<4400	1000 J	<4800	<450
dibenzo(a,h)anthracene	<5800	<4700	<4400	<9200	<4800	***82 J***
di-n-octylphthalate	<5800	<4700	<4400	<9200	<4800	***180 J***
fluoranthene	1000 J	***1100 J***	<4400	9400	900 J	640
fluorene	<5800	<4700	<4400	8700 J	<4800	***140 J***
indeno(1,2,3-cd)pyrene	***830 J***	<4700	<4400	2000 J	<4800	190 J
naphthalene	<5800	<4700	<4400	6900 J	<4800	***250 J***
phenanthrene	<5800	***780 J***	<4400	21000	740 J	660
pyrene	1200 J	***1600 J***	<4400	14000	1200 J	620
2-methylnaphthalene	<5800	<4700	<4400	8500 J	<4800	***130 J***
TOTAL PAHs	12880	7950	1500	181500	6690	6402

Key at end of table.

11:UY2050/RC1457-12/02/95-F1

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Table 8-1

SEDIMENT ANALYTICAL RESULTS
NATIONAL CAPITAL PARKS - EAST STATION SITE

Sample ID Location Percent Solids	SD-01 Washington Yacht Club 34	SD-02 Steuart Petroleum Pier 35	SD-03 WG Pump House Pier 37	SD-03D Duplicate of SD-03 36	SD-04 U.S. Army Corps of Engineers Pier 34	SD-05 12th Street Sewer Outfall 73
PESTICIDE/PCB (mg/kg)						
4,4'-DDD	<0.059	<0.057	<0.054	<0.11	<0.059	***0.017 J***
4,4'DDE	<0.059	<0.057	<0.054	<0.11	<0.059	***0.029***
METALS (mg/kg)						
aluminum	3300	3700	***4600***	4500	3800	550
arsenic	5.6	6.9	***7.6***	7.6	6.3	1.0
barium	91	94	***100***	110	***100***	19
beryllium	<1.5	<1.5	***1.4***	<1.4	<1.5	<0.68
calcium	***24000***	5900	4100	5800	4600	7900
chromium total	27	30	36	34	***34***	12
cobalt	16	19	***22***	19	19	<2.7
copper	***97***	82	96	96	94	26
iron	14000	17000	***22000***	23000	18000	9200
lead	160	160	***170***	160	160	67
magnesium	1500	1600	***1800***	1600	1700	1600
manganese	410	420	400	380	***510***	78
nickel	27	31	***34***	31	30	9.4

Key at end of table.

11:UY2050/RC1457-12/02/95-P1

A-1858

Table 8-1

SEDIMENT ANALYTICAL RESULTS
NATIONAL CAPITAL PARKS - EAST STATION SITE

Sample ID	SD-01	SD-02	SD-03	SD-03D	SD-04	SD-05
Location	Washington Yacht Club	Steuart Petroleum Pier	WG Pump House Pier	Duplicate of SD-03	U.S. Army Corps of Engineers Pier	12th Street Sewer Outfall
Percent Solids	34	35	37	36	34	73
potassium	***360***	330	350	360	340	74
sodium	***200***	<140	<140	<140	<150	<68
vanadium	28	30	***38***	37	30	4.0
zinc	340	350	***390***	400	350	110
TOTAL METALS	44561	29752	34145	36534	29773	34050

Notes: Table only includes analytes that were detected in at least one sample.
Bolded values = highest analyte concentration in sample pool.

Key:

BNA = Base/neutral and acid extractable organic compound.
J = Estimated value.
mg/kg = Milligrams per kilogram.
PAH = Polynuclear aromatic hydrocarbon.
PCB = Polychlorinated biphenyl.
TOC = Total organic carbon.
VOC = Volatile organic compound.
µg/kg = Micrograms per kilogram.
< = Result below sample detection limit.

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- Hickey Run and Watts Branch, two streams that join the Anacostia approximately 3 miles upstream of the NCP-E site are known to be significant sources of contamination (Ref. 30). Hickey Run has caught on fire on several occasions (Ref. 30).

- Only one of the sediment samples, a duplicate, contained above background PAH levels indicative of coal tar contamination. Most remaining BNAs were below the method detection limits. Upon consultation with the EPA it was concluded that site related contamination could not be attributed to the surface water on the basis of a duplicate sample (Ref. 47).

It is also important to note that previous investigations have documented PAH contaminants in the surface water pathway. The methodology used in interpreting these results and/or lack of QA/QC data precludes their use in attributing contamination to the NCP-E site. The data should, however, be taken into consideration and is summarized below. A statistical comparison of mean total PAH and TPH concentrations in sediment from different portions of the Anacostia River was conducted by Versar. The investigation concluded that PAH and TPH concentrations in the sediment collected near the NCP-E site are statistically higher than concentrations in sediment sampled upriver and downriver from the site (Ref. 30). In the same study, results of biological sampling of fish and clams in the Anacostia River near the NCP-E site and upriver from it suggested that contaminant concentrations in the fish and clam tissue were not statistically different in the two areas compared. Fish are mobile and are not the best indicators of sources of contamination.

Similarly, results of 1989 sediment sampling conducted by Hydro-Terra also showed contamination with PAHs and phenolic compounds. Concentration of PAHs in samples RS10 (adjacent to the pier in front of WG pump house) and RS11 (located upriver from WG pier) were particularly elevated compared to other samples. QA/QC data for these results were not identified.

Recreational fishing is known to occur on the Anacostia River and along the surface water pathway. Commercial fishing takes place 8 miles southwest and downstream past the confluence of the Anacostia with the Potomac River and starting from Woodrow Wilson Bridge downriver to Moss Point.

APPENDIX 5

Hydro-Terra, Inc., *Additional Remedial Investigation and Feasibility Study (Phase IV), East Station, Washington, D.C., Volumes 1 and 2*, March 1999

HYDROLOGY GEOLOGY ENGINEERING

Additional Remedial Investigation and Feasibility Study (Phase IV)

East Station
Washington, D.C.

Prepared for:
WASHINGTON GAS
Washington, D.C.

Prepared by:
HYDRO-TERRA, INC.
Columbia, Maryland

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March 25, 1999

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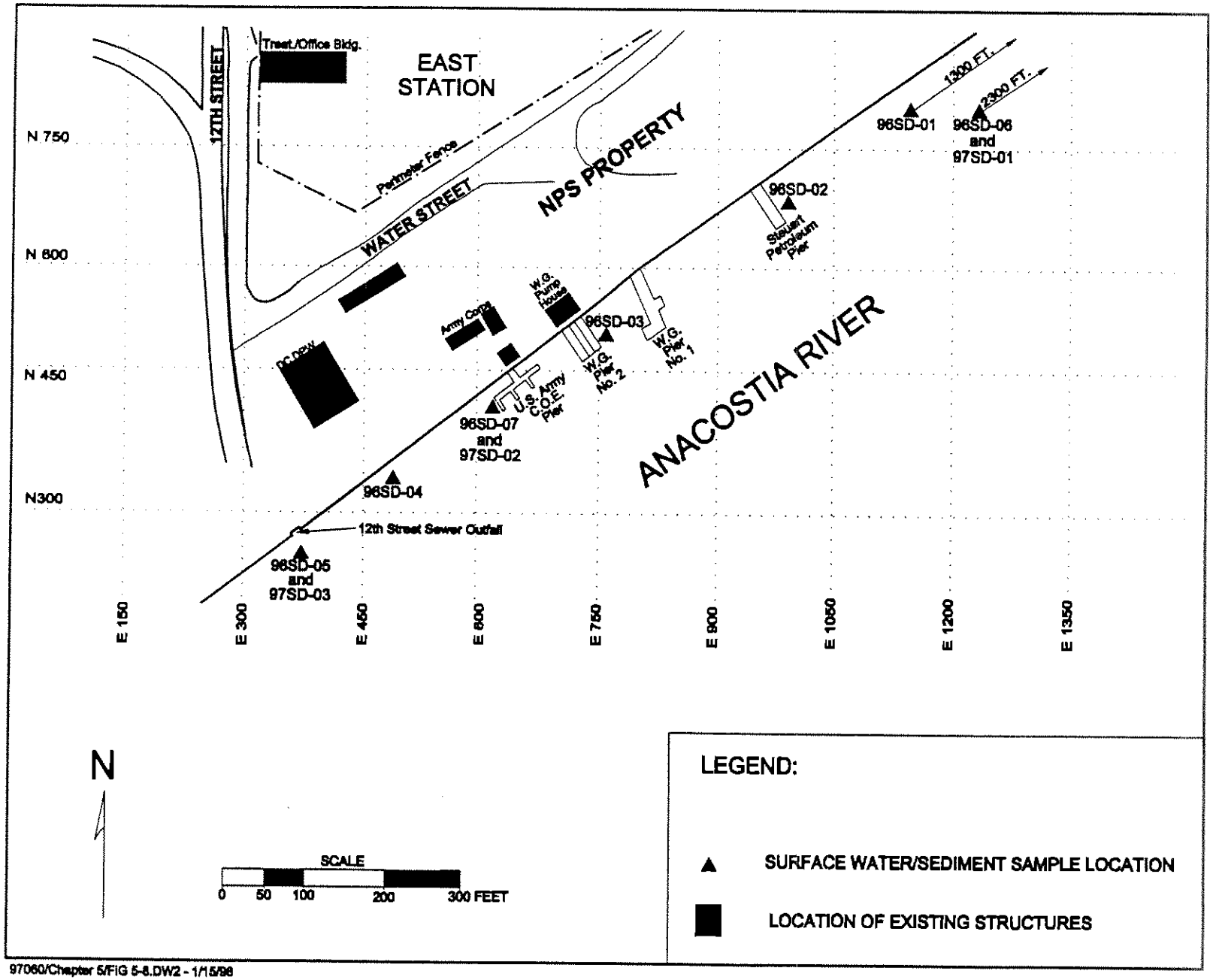


97060/Chapter 5/FIG 5-8.DW2 - 1/15/98

FIGURE 5-8
Location of Surface Water/Sediment Samples
(June 1996 and February 1997)

A-1864

TABLE A-17

Anacostia River Sediment Sampling Results
(June 1996)

VOLATILES Method: 8240	96SD-01S			96SD-02S			96SD-03S			96SD-04S		
	DC (µg/Kg)	MDL (µg/Kg)	Flags	DC (µg/Kg)	MDL (µg/Kg)	Flags	DC (µg/Kg)	MDL (µg/Kg)	Flags	DC (µg/Kg)	MDL (µg/Kg)	Flags
Chloromethane	ND	1.2	U	ND	1.2	U	ND	1.1	U	ND	1.1	U
Bromomethane	ND	0.6	U	ND	0.7	U	ND	0.6	U	ND	0.6	U
Vinyl Chloride	ND	0.8	U	ND	0.9	U	ND	0.8	U	ND	0.8	U
Chloroethane	ND	0.9	U	ND	0.9	U	ND	0.8	U	ND	0.8	U
Methylene chloride	84	2.4		ND	2.3	U	ND	2.1	U	ND	2.1	U
Acetone	240	2		210	2		77	2	B	170	2	
Carbon Disulfide	ND	0.8	U	ND	0.8	U	ND	0.8	U	ND	0.8	U
1,1-Dichloroethene	ND	1	U	ND	1.1	U	ND	1	U	ND	1	U
1,1-Dichloroethane	ND	0.5	U	ND	0.6	U	ND	0.5	U	ND	0.5	U
cis-1,2-Dichloroethene	ND	0.4	U	ND	0.5	U	ND	0.4	U	ND	0.4	U
trans-1,2-Dichloroethene	ND	0.8	U	ND	0.9	U	ND	0.8	U	ND	0.8	U
Chloroform	ND	0.6	U	ND	0.6	U	ND	0.5	U	ND	0.5	U
1,2-Dichloroethane	ND	0.4	U	ND	0.4	U	ND	0.4	U	ND	0.3	U
2-Butanone	72	1.8		42	1.8		ND	1.6	U	32	1.8	
1,1,1-Trichloroethane	ND	0.5	U	ND	0.6	U	ND	0.5	U	ND	0.5	U
Carbon Tetrachloride	ND	0.5	U	ND	0.5	U	ND	0.5	U	ND	0.5	U
Vinyl Acetate	ND	1.5	U	ND	1.6	U	ND	1.5	U	ND	1.4	U
Bromodichloromethane	ND	0.5	U	ND	0.5	U	ND	0.5	U	ND	0.4	U
1,2-Dichloropropane	ND	0.6	U	ND	0.6	U	ND	0.6	U	ND	0.5	U
cis-1,3-Dichloropropene	ND	0.4	U	ND	0.4	U	ND	0.4	U	ND	0.4	U
Trichloroethene	ND	1.3	U	ND	1.4	U	ND	1.3	U	ND	1.2	U
Benzene	ND	0.6	U	5	0.6		ND	0.6	U	ND	0.6	U
Dibromochloromethane	ND	0.3	U	ND	0.3	U	ND	0.2	U	ND	0.2	U
trans-1,3-Dichloropropene	ND	0.4	U	ND	0.4	U	ND	0.4	U	ND	0.4	U
1,1,2-Trichloroethane	ND	0.4	U	ND	0.4	U	ND	0.4	U	ND	0.4	U
2-Chloroethylvinylether	ND	0.6	U	ND	0.7	U	ND	0.6	U	ND	0.6	U
Bromoform	ND	0.1	U	ND	0.1	U	ND	0.1	U	ND	0.1	U
4-Methyl-2-Pentanone	ND	0.5	U	ND	0.6	U	ND	0.5	U	ND	0.5	U
2-Hexanone	ND	0.8	U	ND	0.8	U	ND	0.8	U	ND	0.8	U
Tetrachloroethene	ND	0.6	U	ND	0.6	U	ND	0.6	U	ND	0.6	U
1,1,2,2-Tetrachloroethane	ND	0.4	U	ND	0.4	U	ND	0.4	U	ND	0.3	U
Toluene	11	0.6		ND	0.6	U	ND	0.5	U	2.4	0.6	
Chlorobenzene	20	0.4		ND	0.4	U	2	0.4		ND	0.3	U
Ethylbenzene	ND	1	U	ND	1	U	2.7	1		ND	0.9	U
m + p Xylene	ND	1	U	ND	1.1	U	ND	1	U	ND	1	U
o-Xylene	ND	0.6	U	14	0.6		ND	0.5	U	ND	0.5	U
Styrene	ND	0.5	U	ND	0.5	U	ND	0.4	U	4.8	0.4	

Key at end of table.

TABLE A-17 (Continued)

VOLATILES Method: 8240	96SD-05S			96SD-05S (DUP.)			96SD-06S			96SD-07S		
	DC (µg/Kg)	MDL (µg/Kg)	Flags	DC (µg/Kg)	MDL (µg/Kg)	Flags	DC (µg/Kg)	MDL (µg/Kg)	Flags	DC (µg/Kg)	MDL (µg/Kg)	Flags
Chloromethane	ND	1.1	U	ND	1.1	U	ND	1.6	U	ND	1.5	U
Bromomethane	ND	0.6	U	ND	0.6	U	ND	0.9	U	ND	0.8	U
Vinyl Chloride	ND	0.8	U	ND	0.8	U	ND	1.1	U	ND	1	U
Chloroethane	ND	0.8	U	ND	0.8	U	ND	1.2	U	ND	1.1	U
Methylene chloride	ND	2.1	U	20	2.1	B	ND	3	U	ND	2.8	U
Acetone	58	2	B	110	2		150	2		290	2	
Carbon Disulfide	ND	0.8	U	ND	0.8	U	ND	1.1	U	ND	1	U
1,1-Dichloroethene	ND	1	U	ND	1	U	ND	1.4	U	ND	1.3	U
1,1-Dichloroethane	ND	0.5	U	ND	0.5	U	ND	0.7	U	ND	0.7	U
cis-1,2-Dichloroethene	ND	0.4	U	ND	0.4	U	ND	0.6	U	ND	0.6	U
trans-1,2-Dichloroethene	ND	0.8	U	ND	0.8	U	ND	1.2	U	ND	1.1	U
Chloroform	ND	0.5	U	ND	0.5	U	ND	0.8	U	ND	0.7	U
1,2-Dichloroethane	ND	0.4	U	ND	0.4	U	ND	0.5	U	ND	0.5	U
2-Butanone	ND	1.6	U	26	1.6		ND	2.3	U	53	1.8	
1,1,1-Trichloroethane	ND	0.5	U	ND	0.5	U	ND	0.7	U	ND	0.7	U
Carbon Tetrachloride	ND	0.5	U	ND	0.5	U	ND	0.7	U	ND	0.7	U
Vinyl Acetate	ND	1.5	U	ND	1.5	U	ND	2.1	U	ND	2	U
Bromodichloromethane	ND	0.5	U	ND	0.5	U	ND	0.7	U	ND	0.6	U
1,2-Dichloropropane	ND	0.6	U	ND	0.6	U	ND	0.8	U	ND	0.7	U
cis-1,3-Dichloropropene	ND	0.4	U	ND	0.4	U	ND	0.6	U	ND	0.5	U
Trichloroethene	ND	1.2	U	ND	1.3	U	ND	1.8	U	ND	1.7	U
Benzene	ND	0.6	U	ND	0.6	U	ND	0.8	U	ND	0.8	U
Dibromochloromethane	ND	0.2	U	ND	0.2	U	ND	0.3	U	ND	0.3	U
trans-1,3-Dichloropropene	ND	0.4	U	ND	0.4	U	ND	0.5	U	ND	0.5	U
1,1,2-Trichloroethane	ND	0.4	U	ND	0.4	U	ND	0.6	U	ND	0.5	U
2-Chloroethylvinylether	ND	0.6	U	ND	0.6	U	ND	0.9	U	ND	0.8	U
Bromoform	ND	0.1	U	ND	0.1	U	ND	0.2	U	ND	0.2	U
4-Methyl-2-Pentanone	18	0.5	J	ND	0.5	U	ND	0.7	U	ND	0.7	U
2-Hexanone	2.8	0.8	J	ND	0.8	U	ND	1.1	U	ND	1	U
Tetrachloroethene	ND	0.6	U	ND	0.6	U	ND	0.8	U	ND	0.8	U
1,1,2,2-Tetrachloroethane	ND	0.3	U	ND	0.4	U	ND	0.5	U	ND	0.5	U
Toluene	ND	0.5	U	3.3	0.6		ND	0.7	U	ND	0.7	U
Chlorobenzene	2.2	0.4		ND	0.4	U	ND	0.5	U	ND	0.5	U
Ethylbenzene	9.2	1		ND	0.9	U	ND	1.3	U	ND	1.2	U
m + p Xylene	ND	1	U	ND	1	U	ND	1.4	U	ND	1.3	U
o-Xylene	ND	0.5	U	3.2	0.6		ND	0.8	U	ND	0.7	U
Styrene	ND	0.4	U	ND	0.4	U	ND	0.6	U	ND	0.6	U

NOTES: DC - Detected Concentration MDL - Method Detection Limit ND - The result is below the MDL NA - Not Applicable

FLAGS:
U - Indicates that the compound was analyzed for but not detected at or above the Contract Required Quantitation Limit (CRQL).
B - Designates that the reported result was found to be below the respective method or field blank limit.
J - The associated numerical value is an estimated quantity.
UJ - The compound was analyzed for but not detected. The sample quanitation limit is an estimated quantity due to variance from quality control limits.
D - Reported result taken from diluted sample analysis.

TABLE A-17

Anacostia River Sediment Sample Results

SEMIVOLATILES Method: 8270	96SD-01S			96SD-02S			96SD-03S			96SD-04S		
	DC (µg/Kg)	MDL (µg/Kg)	Flags	DC (µg/Kg)	MDL (µg/Kg)	Flags	DC (µg/Kg)	MDL (µg/Kg)	Flags	DC (µg/Kg)	MDL (µg/Kg)	Flags
bis(2-chloroethyl) ether	ND	530	UD	ND	540	UD	ND	520	UD	ND	500	UD
Phenol	ND	530	UD	ND	540	UD	ND	520	UD	ND	500	UD
2-Chlorophenol	ND	1,300	UD	ND	1,300	UD	ND	1,200	UD	ND	1,200	UD
1,3-Dichlorobenzene	ND	1,300	UD	ND	1,400	UD	ND	1,300	UD	ND	1,300	UD
1,4-Dichlorobenzene	ND	1,300	UD	ND	1,400	UD	ND	1,300	UD	ND	1,200	UD
1,2-Dichlorobenzene	ND	1,700	UD	ND	1,800	UD	ND	1,700	UD	ND	1,600	UD
Benzyl Alcohol	ND	3,200	UD	ND	3,200	UD	ND	3,100	UD	ND	3,000	UD
bis(2-chloroisopropyl) ether	ND	480	UD	ND	490	UD	ND	470	UD	ND	450	UD
2-Methylphenol	ND	3,200	UD	ND	3,200	UD	ND	3,100	UD	ND	3,000	UD
Hexachloroethane	ND	1,200	UD	ND	1,200	UD	ND	1,100	UD	ND	1,100	UD
N-Nitroso-di-n-propylamine	ND	590	UD	ND	600	UD	ND	580	UD	ND	560	UD
4-Methylphenol	ND	3,200	UD	ND	3,200	UD	ND	3,100	UD	ND	3,000	UD
Nitrobenzene	ND	890	UD	ND	910	UD	ND	870	UD	ND	840	UD
Isophorone	ND	440	UD	ND	450	UD	ND	440	UD	ND	420	UD
2-Nitrophenol	ND	1,400	UD	ND	1,400	UD	ND	1,400	UD	ND	1,300	UD
2,4-Dimethylphenol	ND	2,000	UD	ND	2,100	UD	ND	2,000	UD	ND	1,900	UD
Benzoic Acid	ND	16,000	UD	ND	16,000	UD	ND	16,000	UD	ND	15,000	UD
bis(2-chloroethoxy) methane	ND	460	UD	ND	470	UD	ND	450	UD	ND	440	UD
2,4-Dichlorophenol	ND	960	UD	ND	980	UD	ND	940	UD	ND	900	UD
1,2,4-Trichlorobenzene	ND	850	UD	ND	860	UD	ND	830	UD	ND	790	UD
Naphthalene	410	710	JD	3,900	730	D	4,800	700	D	6,900	700	D
4-Chloroaniline	ND	3,200	UD	ND	3,200	UD	ND	3,100	UD	ND	3,000	UD
Hexachlorobutadiene	ND	1,100	UD	ND	1,100	UD	ND	1,100	UD	ND	1,000	UD
4-Chloro-3methylphenol	ND	710	UD	ND	730	UD	ND	700	UD	ND	670	UD
2-Methylnaphthalene	ND	3,200	UD	1,700	3,200	JD	18,000	1,650	D	3,600	1,650	D
Hexachlorocyclopentadiene	ND	1,100	UD	ND	1,100	UD	ND	1,100	UD	ND	1,000	UD
2,4,6-Trichlorophenol	ND	1,000	UD	ND	1,100	UD	ND	1,000	UD	ND	970	UD
2,4,5-Trichorophenol	ND	1,000	UD	ND	1,100	UD	ND	1,000	UD	ND	970	UD
2-Chloronaphthalene	ND	830	UD	ND	850	UD	ND	810	UD	ND	780	UD
2-Nitroaniline	ND	16,000	UD	ND	16,000	UD	ND	16,000	UD	ND	15,000	UD
Acenaphthylene	ND	1,500	UD	1,600	800	D	2,400	800	D	2,900	800	D
Dimethyl phthalate	ND	380	UD	ND	390	UD	ND	370	UD	ND	360	UD
2,6-Dinitrotoluene	ND	320	UD	ND	330	UD	ND	310	UD	ND	300	UD
Acenaphthene	930	285	D	7,400	285	D	22,000	285	D	20,000	285	D
3-Nitroaniline	ND	16,000	UD	ND	16,000	UD	ND	16,000	UD	ND	15,000	UD
2,4-Dinitrophenol	ND	1,500	UD	ND	1,500	UD	ND	1,500	UD	ND	1,400	UD
Dibenzofuran	530	1,650	JD	1,200	1,650	JD	1,600	1,650	JD	ND	3,000	UD
2,4-Dinitrotoluene	ND	360	UD	ND	360	UD	ND	350	UD	ND	330	UD
4-Nitrophenol	ND	16,000	UD	ND	16,000	UD	ND	16,000	UD	ND	15,000	UD
Fluorene	860	335	D	7,000	335	D	14,000	335	D	12,000	335	D
4-Chlorophenyl-phenylether	ND	360	UD	ND	370	UD	ND	350	UD	ND	340	UD
Diethylphthalate	ND	510	UD	ND	520	UD	ND	500	UD	ND	480	UD
4-Nitroaniline	ND	16,000	UD	ND	16,000	UD	ND	16,000	UD	ND	15,000	UD
4,6-Dinitro-2-methylphenol	ND	2,600	UD	ND	2,600	UD	ND	2,500	UD	ND	2,400	UD
n-Nitrosodiphenylamine	ND	1,000	UD	ND	1,000	UD	ND	1,000	UD	ND	960	UD
4-Bromophenyl-phenylether	ND	1,200	UD	ND	1,300	UD	ND	1,200	UD	ND	1,200	UD
Hexachlorobenzene	ND	630	UD	ND	640	UD	ND	610	UD	ND	590	UD
Pentachlorophenol	ND	2,000	UD	ND	2,000	UD	ND	1,900	UD	ND	1,800	UD
Phenanthrene	11,000	210	D	22,000	210	D	40,000	210	D	42,000	210	D
Anthracene	2,400	270	D	ND	530	UD	ND	500	UD	ND	480	UD
Di-n-butylphthalate	850	600	JD	ND	1,200	UD	ND	1,100	UD	ND	1,100	UD
Fluoranthene	14,000	185	D	32,000	185	D	17,000	185	D	25,000	185	D
Pyrene	9,200	270	D	36,000	270	D	20,000	270	D	36,000	270	D
Butylbenzylphthalate	ND	760	UD	ND	770	UD	ND	740	UD	ND	710	UD
3,3-Dichlorobenzidine	ND	6,400	UD	ND	6,500	UD	ND	6,200	UD	ND	6,000	UD
Benzo[a]anthracene	5,800	385	D	11,000	385	D	9,100	385	D	16,000	385	D
Chrysene	6,200	270	D	13,000	270	D	9,500	270	D	16,000	270	D
Bis (2-ethylhexyl)phthalate	3,700	550	D	1,600	550	D	640	550	JD	780	550	JD
Di-n-octylphthalate	ND	1,300	UD	ND	1,300	UD	ND	1,300	UD	ND	1,200	UD
Benzo[b]fluoranthene	5,100	235	D	8,800	235	D	4,200	235	D	9,200	235	D
Benzo(k)fluoranthene	3,700	240	D	7,600	240	D	3,700	240	D	9,500	240	D
Benzo[a]pyrene	9,000	185	D	18,000	185	D	12,000	185	D	27,000	185	D
Indeno(1,2,3-dc)pyrene	2,800	275	D	5,300	275	D	2,700	275	D	6,300	275	D
Dibenzo[a,h]anthracene	3,300	295	D	3,000	295	D	1,300	295	D	6,900	295	D
Benzo[g,h,i]perylene	3,400	195	D	7,300	195	D	5,300	195	D	13,000	195	D

Key at end of table.

SEMIVOLATILES Method: 8270	96SD-05S			96SD-05S (DUP.)			96SD-06S			96SD-07S		
	DC (µg/Kg)	MDL (µg/Kg)	Flags	DC (µg/Kg)	MDL (µg/Kg)	Flags	DC (µg/Kg)	MDL (µg/Kg)	Flags	DC (µg/Kg)	MDL (µg/Kg)	Flags
bis(2-chloroethyl) ether	ND	500	UD	ND	510	UD	ND	720	UD	ND	670	UD
Phenol	ND	500	UD	ND	510	UD	ND	720	UD	ND	670	UD
2-Chlorophenol	ND	1,200	UD	ND	1,200	UD	ND	1,700	UD	ND	1,600	UD
1,3-Dichlorobenzene	ND	1,300	UD	ND	1,300	UD	ND	1,800	UD	ND	1,700	UD
1,4-Dichlorobenzene	ND	1,200	UD	ND	1,300	UD	ND	1,800	UD	ND	1,700	UD
1,2-Dichlorobenzene	ND	1,600	UD	ND	1,700	UD	ND	2,400	UD	ND	2,200	UD
Benzyl Alcohol	ND	3,000	UD	ND	3,000	UD	ND	4,300	UD	ND	4,000	UD
bis(2-chloroisopropyl) ether	ND	450	UD	ND	460	UD	ND	660	UD	ND	610	UD
2-Methylphenol	ND	3,000	UD	ND	3,000	UD	ND	4,300	UD	ND	4,000	UD
Hexachloroethane	ND	1,100	UD	ND	1,100	UD	ND	1,600	UD	ND	1,500	UD
N-Nitroso-di-n-propylamine	ND	550	UD	ND	570	UD	ND	810	UD	ND	750	UD
4-Methylphenol	ND	3,000	UD	ND	3,000	UD	ND	4,300	UD	ND	4,000	UD
Nitrobenzene	ND	840	UD	ND	860	UD	ND	1,200	UD	ND	1,100	UD
Isophorone	ND	420	UD	ND	430	UD	ND	610	UD	ND	560	UD
2-Nitrophenol	ND	1,300	UD	ND	1,300	UD	ND	1,900	UD	ND	1,800	UD
2,4-Dimethylphenol	ND	1,900	UD	ND	2,000	UD	ND	2,800	UD	ND	2,600	UD
Benzoic Acid	ND	15,000	UD	ND	15,000	UD	ND	22,000	UD	ND	20,000	UD
bis(2-chloroethoxy) methane	ND	430	UD	ND	450	UD	ND	630	UD	ND	590	UD
2,4-Dichlorophenol	ND	890	UD	ND	920	UD	ND	1,300	UD	ND	1,200	UD
1,2,4-Trichlorobenzene	ND	790	UD	ND	810	UD	ND	1,200	UD	ND	1,100	UD
Naphthalene	1,500	670	D	1,600	680	D	ND	980	UD	ND	900	UD
4-Chloroaniline	ND	3,000	UD	ND	3,000	UD	ND	4,300	UD	ND	4,000	UD
Hexachlorobutadiene	ND	1,000	UD	ND	1,000	UD	ND	1,500	UD	ND	1,400	UD
4-Chloro-3methylphenol	ND	670	UD	ND	680	UD	ND	970	UD	ND	900	UD
2-Methylnaphthalene	5,100	1,650	D	5,800	1,650	D	ND	4,300	UD	440	1,650	JD
Hexachlorocyclopentadiene	ND	1,000	UD	ND	1,000	UD	ND	1,500	UD	ND	1,400	UD
2,4,6-Trichlorophenol	ND	970	UD	ND	990	UD	ND	1,400	UD	ND	1,300	UD
2,4,5-Trichorophenol	ND	970	UD	ND	990	UD	ND	1,400	UD	ND	1,300	UD
2-Chloronaphthalene	ND	780	UD	ND	800	UD	ND	1,100	UD	ND	1,000	UD
2-Nitroaniline	ND	15,000	UD	ND	15,000	UD	ND	22,000	UD	ND	20,000	UD
Acenaphthylene	1,000	800	JD	860	800	JD	ND	2,100	UD	470	800	JD
Dimethyl phthalate	ND	360	UD	ND	370	UD	ND	520	UD	ND	480	UD
2,6-Dinitrotoluene	ND	300	UD	ND	310	UD	ND	440	UD	ND	400	UD
Acenaphthene	10,000	285	D	7,900	285	D	470	285	JD	3,200	285	D
3-Nitroaniline	ND	15,000	UD	ND	15,000	UD	ND	22,000	UD	ND	20,000	UD
2,4-Dinitrophenol	ND	1,400	UD	ND	1,500	UD	ND	2,100	UD	ND	1,900	UD
Dibenzofuran	1,200	1,650	JD	1,600		JD	ND	4,300	UD	ND	4,000	UD
2,4-Dinitrotoluene	ND	330	UD	ND	340	UD	ND	490	UD	ND	450	UD
4-Nitrophenol	ND	15,000	UD	ND	15,000	UD	ND	22,000	UD	ND	20,000	UD
Fluorene	5,600	335	D	5,000	335	D	430	335	JD	2,100	2,100	D
4-Chlorophenyl-phenylether	ND	340	UD	ND	340	UD	ND	490	UD	ND	450	UD
Diethylphthalate	ND	480	UD	ND	490	UD	ND	690	UD	ND	640	UD
4-Nitroaniline	ND	15,000	UD	ND	15,000	UD	ND	22,000	UD	ND	20,000	UD
4,6-Dinitro-2-methylphenol	ND	2,400	UD	ND	2,500	UD	ND	3,500	UD	ND	3,200	UD
n-Nitrosodiphenylamine	ND	950	UD	ND	980	UD	ND	1,400	UD	ND	1,300	UD
4-Bromophenyl-phenylether	ND	1,100	UD	ND	1,200	UD	ND	1,700	UD	ND	1,500	UD
Hexachlorobenzene	ND	590	UD	ND	600	UD	ND	850	UD	ND	790	UD
Pentachlorophenol	ND	1,800	UD	ND	1,900	UD	ND	2,700	UD	ND	2,500	UD
Phenanthrene	17,000	210	D	17,000	210	D	2,000	210	D	7,100	210	D
Anthracene	4,700	270	D	4,500	270	D	ND	700	UD	1,500	270	JD
Di-n-butylphthalate	ND	1,100	UD	ND	1,100	UD	ND	1,600	UD	ND	1,500	UD
Fluoranthene	9,400	185	D	8,100	185	D	2,700	185	D	4,400	185	D
Pyrene	13,000	270	D	15,000	270	D	2,100	270	D	6,300	270	D
Butylbenzylphthalate	ND	710	UD	ND	730	UD	ND	1,000	UD	ND	950	UD
3,3-Dichlorobenzidine	ND	5,900	UD	ND	6,100	UD	ND	8,700	UD	ND	8,000	UD
Benzo[a]anthracene	4,700	385	D	4,500	385	D	930	385	JD	2,100	385	D
Chrysene	6,800	270	D	6,500	270	D	1,400	270	D	2,600	270	D
Bis (2-ethylhexyl)phthalate	7,200	550	D	6,800	550	JD	4,400	550	D	4,600	550	D
Di-n-octylphthalate	ND	1,200	UD	ND	1,300	UD	ND	1,800	UD	ND	1,600	UD
Benzo[b]fluoranthene	2,500	235	D	4,700	235	JD	1,200	235	D	1,400	235	D
Benzo(k)fluoranthene	2,400	240	D	6,200	240	D	970	240	D	1,500	240	D
Benzo[a]pyrene	8,000	185	D	8,100	185	D	2,100	185	D	4,000	185	D
Indeno(1,2,3-dc)pyrene	1,900	275	D	2,300	275	D	740	275	D	1,200	275	D
Dibenzo[a,h]anthracene	2,300	295	D	1,200	295	D	ND	760	UD	ND	710	UD
Benzo[g,h,i]perylene	3,500	195	D	4,500	195	D	830	195	D	2,200	195	D

NOTES: DC - Detected Concentration MDL - Method Detection Limit ND - The result is below the MDL NA - Not Applicable

FLAGS: U - Indicates that the compound was analyzed for but not detected at or above the Contract Required Quantitation Limit (CRQL).
B - Designates that the reported result was found to be below the respective method or field blank limit.
J - The associated numerical value is an estimated quantity.
UJ - The compound was analyzed for but not detected. The sample quanitation limit is an estimated quantity due to variance from quality control limits.
D - Reported result taken from diluted sample analysis.

TABLE A-17
Anacostia River Sediment Sampling Results

INORGANICS Methods: 6010A, 200.7 and 9010	96SD-01S			96SD-02S			96SD-03S			96SD-04S		
	DC (mg/kg)	MDL (mg/kg)	Flags	DC (mg/kg)	MDL (mg/kg)	Flags	DC (mg/kg)	MDL (mg/kg)	Flags	DC (mg/kg)	MDL (mg/kg)	Flags
Aluminum	4,960	4.87		14,000	5.17		22,200	4.71		11,300	4.67	
Antimony	ND	0.50	UL	0.77	0.53	L	ND	0.49	UL	ND	0.48	UL
Arsenic	4.7	0.86		12.2	0.91		8.5	0.83		8.7	0.82	
Barium	127	0.74	J	168	0.79	J	170	0.72	J	121	0.71	J
Beryllium	0.35	0.09	J	1.2	0.10		1.3	0.09		0.94	0.09	
Cadmium	1.1	0.04		2.7	0.04		1.3	0.04		1.8	0.04	
Calcium	8630	7.63		2,690	8.09		2,150	7.37		2,090	7.30	
Chromium	30.4	0.17		54.9	0.18		43.5	0.16		55.9	0.16	
Cobalt	11.6	0.93		14.8	0.99		18.0	0.90		11.1	0.89	
Copper	631	0.39	J	112	0.41	J	324	0.38	J	91.8	0.37	J
Iron	13,300	5.11		31,600	5.42		39,400	4.94		23,000	4.90	
Lead	598	1.19		280	1.26		75.2	1.15		289	1.14	
Magnesium	2,660	11.79		2,140	12.50		3,180	11.39		1,240	11.29	
Manganese	166	0.24	J	237	0.26	J	678	0.23	J	230	0.23	J
Mercury	0.96	0.19	J	0.87	0.20	J	0.55	0.18	J	0.62	0.16	J
Nickel	38.1	0.45		31.4	0.47		31.4	0.43	N	20.2	0.43	
Potassium	592	4.45	J	1,460	4.71	J	2,240	4.30	J	1,000	4.26	J
Selenium	ND	1.26	U	ND	1.34	U	ND	1.22	U	ND	1.21	U
Silver	0.51	0.30	J	2.3	0.32		0.7	0.29	J	3.1	0.28	
Sodium	323	48.92		272	51.87		183	47.27	B	215	46.83	
Thallium	ND	1.45	U	ND	1.54	U	ND	1.40	U	ND	1.39	U
Vanadium	25.6	0.22		47.1	0.24		55.8	0.22		38.9	0.21	
Zinc	316	1.25	J	400	1.32	J	152	1.20	J	179	1.19	J
Total Cyanides	ND	1.90	U	48.8			33			18.1		

NOTES: DC - Detected Concentration MDL - Method Detection Limit ND - The result is below the MDL NA - Not Applicable

FLAGS:
U - Indicates analyte was not detected at or above the Contract Required Detection Limit (CRDL)
B - Designates that the reported result was found to be below the respective method or field blank limit.
J - Designates that the associated numerical value is an estimated quantity.
L - The reported value may be biased low, due to variance from quality control limits.

TABLE A-17 (Continued)

INORGANICS Methods: 6010A, 200.7 and 9010	96SD-05S			96SD-05S (DUP.)			96SD-06S			96SD-07S		
	DC (mg/kg)	MDL (mg/kg)	Flags	DC (mg/kg)	MDL (mg/kg)	Flags	DC (mg/kg)	MDL (mg/kg)	Flags	DC (mg/kg)	ND (mg/kg)	Flags
Aluminum	10,900	4.42		10,300	4.78		18,500	6.66		22,900	6.31	
Antimony	0.76	0.46	L	ND	0.49	UL	ND	0.69	UL	ND	0.65	UL
Arsenic	5.8	0.78		5.7	0.84		6.3	1.17		6.6	1.11	
Barium	109	0.67	J	110	0.73	J	142	1.02	J	152	0.96	J
Beryllium	0.85	0.08		0.84	0.09		1.5	0.13		1.6	0.12	
Cadmium	1.7	0.03		1.9	0.04		2.4	0.05		2.3	0.05	
Calcium	4260	6.92		3660	7.49		3750	10.43		2940	9.88	
Chromium	48.8	0.15		48.6	0.16		67	0.23		66.0	0.22	
Cobalt	14.3	0.84		14.0	0.91		18.3	1.27		21.8	1.20	
Copper	58.5	0.35	J	60.2	0.38	J	72.1	0.53	J	82.5	0.51	J
Iron	18,700	4.64		21,500	5.02		29,500	7.00		33,900	6.62	
Lead	533	1.08		502	1.17		164	1.63		161	1.54	
Magnesium	3,360	10.70		3,380	11.57		4,400	16.13		4,660	15.27	
Manganese	181	0.22	J	200	0.24	J	331	0.33	J	323	0.31	J
Mercury	0.38	0.16	J	0.33	0.18	J	0.54	0.26	J	0.3	0.23	J
Nickel	38.7	0.40		40.4	0.44		46.2	0.61		53.0	0.58	
Potassium	1,170	4.03	J	1,100	4.36	J	2,050	6.08	J	2,400	5.76	J
Selenium	ND	1.15	U	ND	1.24	U	ND	1.73	U	ND	1.64	U
Silver	2.1	0.27		1.4	0.29	J	1.4	0.41	J	2	0.39	
Sodium	266	44.37		264	48.02		313	66.90		337	63.36	
Thallium	ND	1.32	U	ND	1.42	U	ND	1.98	U	ND	1.88	U
Vanadium	45.5	0.20		47.2	0.22		60.6	0.31		68.1	0.29	
Zinc	339	1.13	J	342	1.22	J	354	1.70	J	340	1.61	J
Total Cyanides	ND	1.8	U	ND	1.9	U	ND	2.6	U	ND	2.4	U

NOTES: DC - Detected Concentration MDL - Method Detection Limit ND - The result is below the MDL NA - Not Applicable

FLAGS:
U - Indicates analyte was not detected at or above the Contract Required Detection Limit (CRDL)
B - Designates that the reported result was found to be below the respective method or field blank limit.
J - Designates that the associated numerical value is an estimated quantity.
L - The reported value may be biased low, due to variance from quality control limits.

Table A-17 (Cont.)
Anacostia River Sediment Sampling Results
(June 1996)

Total Organic Carbon Methods: 415.1 & 160.3	96SD-01S	96SD-02S	96SD-03S	96SD-04S
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Carbon TOC	6,000	86,000	17,000	37,000
Percent Water	61.3	49.7	43.6	38.8

Total Organic Carbon Methods: 415.1 & 160.3	96SD-05S	96SD-05S (DUP.)	96SD-06S	96SD-07S
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Carbon TOC	22,000	16,000	24,000	16,000
Percent Water	45.5	67.8	59.4	45.6

Report #_____

Gascoyne Laboratories, Inc.
Grab Sampling Report

Client: MELKA MARINE
Site: WATER ST WASH D.C.
Sample I.D.: DOLPHIN 2
Sample Code: SW
Date: 1/24/03 Time: 0910

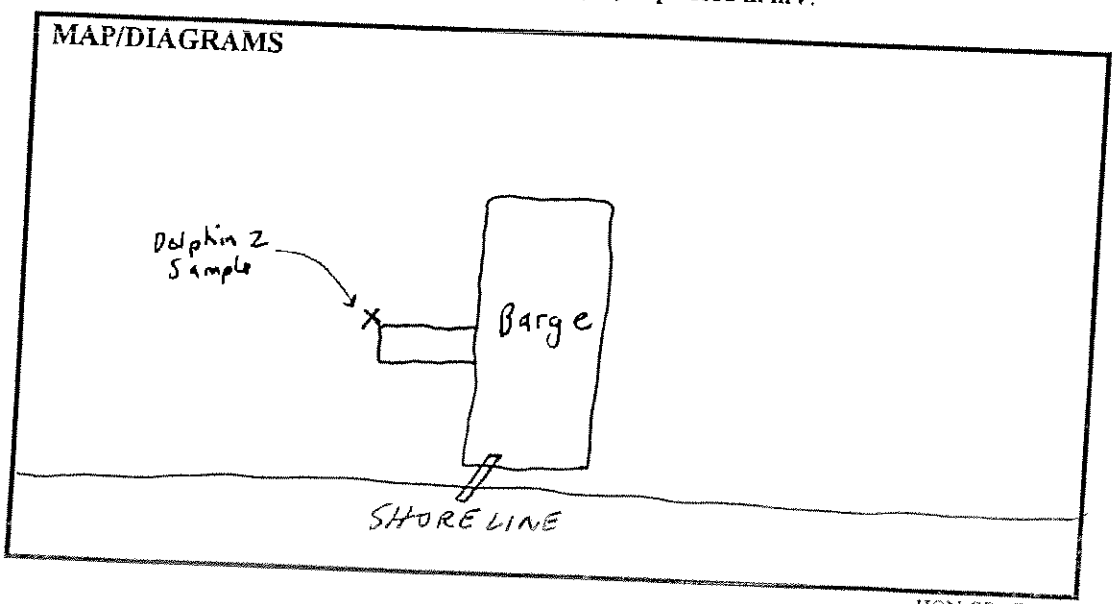
Sampling Method: Vertical Kemmerer used to collect sample @ 1/2 way DOWN (Approx 6 ft)
Comments:

Reference the latest version of SOP Field – 014

Analysis	Results	Detection Limits	Method	Analyst	Date
pH	N/A	NA	EPA 150.1		
Temperature		NA	EPA 150.1		
Spec. Conductance		NA	EPA 120.1		
Res. Chlorine(1)		0.03	SM 4500-CLG		
Dis. Oxygen(1)		0.1	EPA 360.1		
Free CO_2(1)		1	SM 4500-CO_2-C		
Flow =		NA	GLI		
EH		NA	ASTM 1498		

Notes:
(1) Results expressed as mg/liter (ppm).
(2) Specific Conductance reported as micromhos/cm.
(3) Flow rate expressed as _____.
(4) Oxidation-Reduction Potential (eH) expressed in mV.

MAP/DIAGRAMS



HQN:GRABSAMP:white

Report #_____

Gascoyne Laboratories, Inc.
Grab Sampling Report

Client: MELKA MARINE Site: WATER ST WASH DC.
Sample I.D.: Dolphin 4
Sample Code: WS Date: 1/24/03 Time: 0930

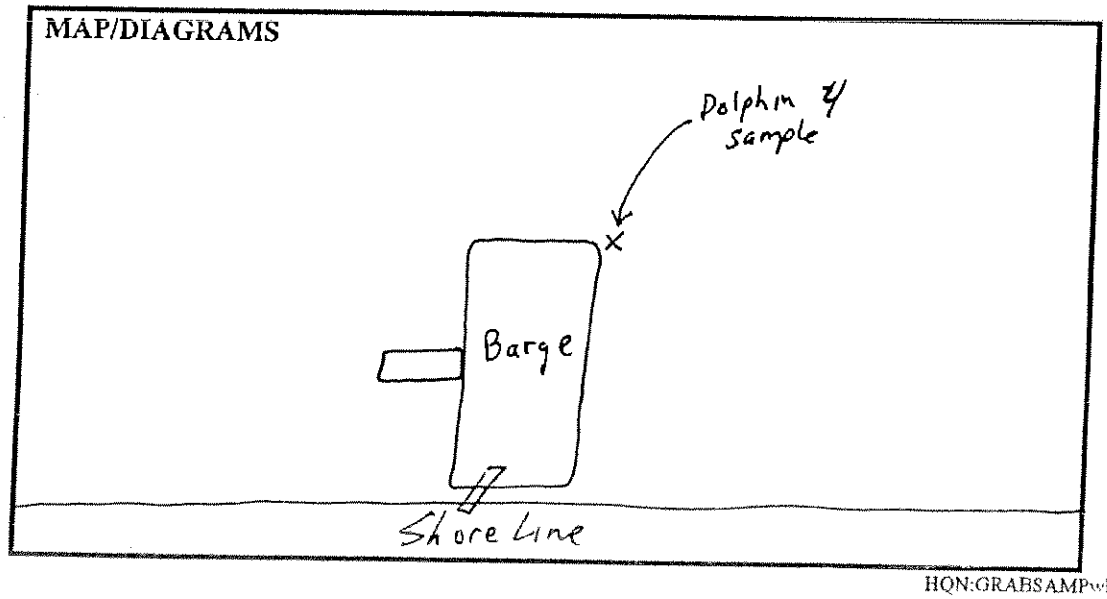
Sampling Method: Vertical Kemmerer used to collect sample 1/2 way down (Approx 7-8 ft)
Comments:

Reference the latest version of SOP Field – 014

Analysis	Results	Detection Limits	Method	Analyst	Date
pH	N/A	NA	EPA 150.1		
Temperature		NA	EPA 150.1		
Spec. Conductance		NA	EPA 120.1		
Res. Chlorine(1)		0.03	SM 4500-CLG		
Dis. Oxygen(1)		0.1	EPA 360.1		
Free CO_2(1)		1	SM 4500-CO_2-C		
Flow =		NA	GLI		
EH		NA	ASTM 1498		

Notes:
(1) Results expressed as mg/liter (ppm).
(2) Specific Conductance reported as micromhos/cm.
(3) Flow rate expressed as _____.
(4) Oxidation-Reduction Potential (eH) expressed in mV.

MAP/DIAGRAMS



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Report #_____

Gascoyne Laboratories, Inc.
Grab Sampling Report

Client: MELKA MARINE Site: WATER ST / WASH D.C.
Sample I.D.: Dolphin 6
Sample Code: WS Date: 1/24/03 Time: 0945

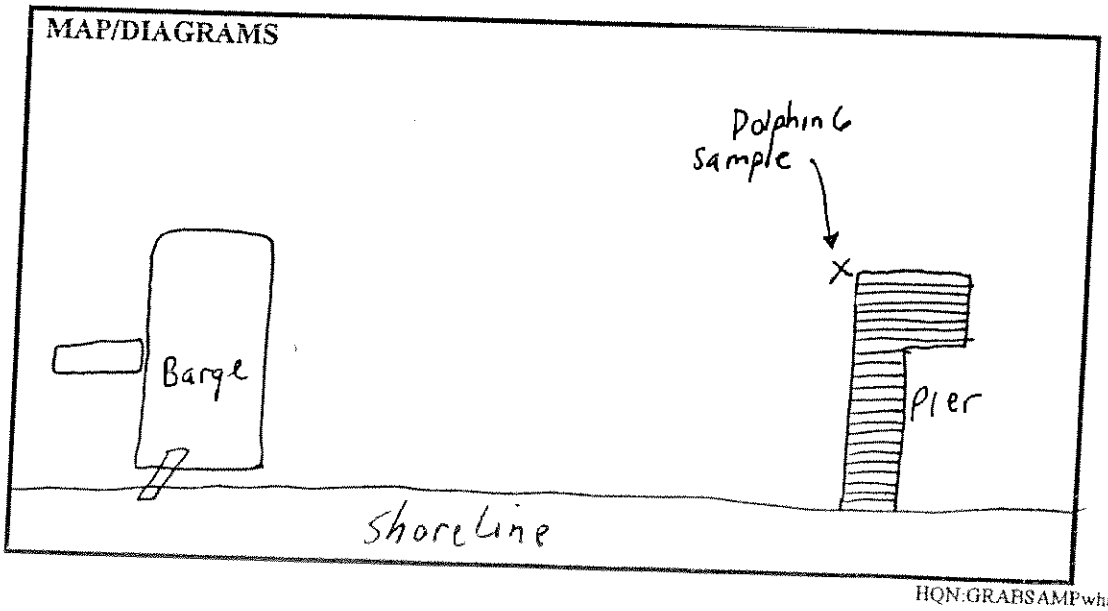
Sampling Method: Vertical Kemmer used to collect sample 1/2 way down (Approx 7-8 ft)
Comments:

Reference the latest version of SOP Field – 014

Analysis	Results	Detection Limits	Method	Analyst	Date
pH	N/A	NA	EPA 150.1		
Temperature		NA	EPA 150.1		
Spec. Conductance		NA	EPA 120.1		
Res. Chlorine(1)		0.03	SM 4500-CLG		
Dis. Oxygen(1)		0.1	EPA 360.1		
Free CO_2(1)		1	SM 4500-CO_2-C		
Flow =		NA	GLI		
EH		NA	ASTM 1498		

Notes:
(1) Results expressed as mg/liter (ppm).
(2) Specific Conductance reported as micromhos/cm.
(3) Flow rate expressed as _____.
(4) Oxidation-Reduction Potential (eH) expressed in mV.

MAP/DIAGRAMS



HQN:GRABSAMPwhite

Gascoyne Laboratories, Inc.

2101 Van Deman Street
Baltimore, MD 21224

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(410) 633-6553

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: Dolphin 2 grab

Report No: 0301603

Lab ID: 0301603-001

Project:

Collection Date: 01/31/2003 8:35

Matrix: SLUDGE

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
MOISTURE CONTENT (DRIED AT 105°C)				Analyst: CLF
Prep. Method: NA	Prep. Date: NA		Prep Analyst	NA
PMOIST	51	0.050	wt%	01/31/2003 13:40
TCL SEMI VOLATILE ORGANIC COMPOUNDS (EPA 8270C)				Analyst: MLS
Prep. Method: EPA 3550B	Prep. Date: 02/05/2003 7:00:00 AM		Prep Analyst	WAR
note: Reported results are estimated due to internal standards, Chrysene-d12 & Perylene-d12 out of acceptance limits.				
Bis(2-chloroethyl)ether	< 670	670	µg/Kg-dry	02/10/2003 22:47
Phenol	1,100	670	µg/Kg-dry	02/1D/2003 22:47
2-Chlorophenol	< 670	670	µg/Kg-dry	02/10/2003 22:47
1,3-Dichlorobenzene	< 670	670	µg/Kg-dry	02/1D/2003 22:47
1,4-Dichlorobenzene	< 670	670	µg/Kg-dry	02/10/2003 22:47
1,2-Dichlorobenzene	< 670	670	µg/Kg-dry	02/10/2003 22:47
Bis(2-chloroisopropyl)ether	< 670	670	µg/Kg-dry	02/10/2003 22:47
2-Methylphenol	< 670	670	µg/Kg-dry	02/10/2003 22:47
Hexachloroethane	< 670	670	µg/Kg-dry	02/10/2003 22:47
N-Nitrosodi-n-propylamine	< 670	670	µg/Kg-dry	02/10/2003 22:47
4-Methylphenol,3-Methylphenol	< 670	670	µg/Kg-dry	02/10/2003 22:47
Nitrobenzene	< 670	670	µg/Kg-dry	02/10/2003 22:47
Isophorone	< 670	670	µg/Kg-dry	02/10/2003 22:47
2-Nitrophenol	< 670	670	µg/Kg-dry	02/10/2003 22:47
2,4-Dimethylphenol	< 670	670	µg/Kg-dry	02/10/2003 22:47
Bis(2-chloroethoxy)methane	< 670	670	µg/Kg-dry	02/10/2003 22:47
2,4-Dichlorophenol	< 670	670	µg/Kg-dry	02/10/2003 22:47
1,2,4-Trichlorobenzene	< 670	670	µg/Kg-dry	02/10/2003 22:47
Naphthalene	< 670	670	µg/Kg-dry	02/10/2003 22:47
4-Chloroaniline	< 1,400	1,400	µg/Kg-dry	02/10/2003 22:47
Hexachlorobutadiene	< 670	670	µg/Kg-dry	02/10/2003 22:47
4-Chloro-3-methylphenol	< 1,400	1,400	µg/Kg-dry	02/10/2003 22:47
2-Methylnaphthalene	< 670	670	µg/Kg-dry	02/10/2003 22:47

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: Dolphin 2 grab

Report No: 0301603

Project:

Lab ID: 0301603-001

Matrix: SLUDGE

Collection Date: 01/31/2003 8:35

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
Hexachlorocyclopentadiene	< 670	670	µg/Kg-dry	02/10/2003 22:47
2,4,6-Trichlorophenol	< 670	670	µg/Kg-dry	02/10/2003 22:47
2,4,5-Trichlorophenol	< 670	670	µg/Kg-dry	02/10/2003 22:47
2-Chloronaphthalene	< 670	670	µg/Kg-dry	02/10/2003 22:47
2-Nitroaniline	< 3,500	3,500	µg/Kg-dry	02/10/2003 22:47
Acenaphthylene	< 670	670	µg/Kg-dry	02/10/2003 22:47
Dimethyl phthalate	< 670	670	µg/Kg-dry	02/10/2003 22:47
2,6-Dinitrotoluene	< 670	670	µg/Kg-dry	02/10/2003 22:47
Acenaphthene	930	670	µg/Kg-dry	02/10/2003 22:47
3-Nitroaniline	< 3,500	3,500	µg/Kg-dry	02/10/2003 22:47
2,4-Dinitrophenol	< 3,500	3,500	µg/Kg-dry	02/10/2003 22:47
Dibenzofuran	< 670	670	µg/Kg-dry	02/10/2003 22:47
2,4-Dinitrotoluene	< 670	670	µg/Kg-dry	02/10/2003 22:47
4-Nitrophenol	< 3,500	3,500	µg/Kg-dry	02/10/2003 22:47
Fluorene	1,300	670	µg/Kg-dry	02/10/2003 22:47
4-Chlorophenyl phenyl ether	< 670	670	µg/Kg-dry	02/10/2003 22:47
Diethyl phthalate	< 670	670	µg/Kg-dry	02/10/2003 22:47
4-Nitroaniline	< 3,500	3,500	µg/Kg-dry	02/10/2003 22:47
4,6-Dinitro-2-methylphenol	< 3,500	3,500	µg/Kg-dry	02/10/2003 22:47
N-Nitrosodiphenylamine	< 670	670	µg/Kg-dry	02/10/2003 22:47
4-Bromophenyl phenyl ether	< 670	670	µg/Kg-dry	02/10/2003 22:47
Hexachlorobenzene	< 670	670	µg/Kg-dry	02/10/2003 22:47
Pentachlorophenol	< 3,500	3,500	µg/Kg-dry	02/10/2003 22:47
Phenanthrene	6,400	670	µg/Kg-dry	02/10/2003 22:47
Anthracene	700	670	µg/Kg-dry	02/10/2003 22:47
Carbazole	< 670	670	µg/Kg-dry	02/10/2003 22:47
Di-n-butyl phthalate	< 670	670	µg/Kg-dry	02/10/2003 22:47
Fluoranthene	7,000	670	µg/Kg-dry	02/10/2003 22:47
Pyrene	16,000	1,300	µg/Kg-dry	02/11/2003 19:28
Butyl benzyl phthalate	< 670	670	µg/Kg-dry	02/10/2003 22:47
3,3'-Dichlorobenzidine	< 1,400	1,400	µg/Kg-dry	02/10/2003 22:47
Benz(a)anthracene	3,100	670	µg/Kg-dry	02/10/2003 22:47

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: Dolphin 2 grab

Report No: 0301603

Lab ID: 0301603-001

Project:

Collection Date: 01/31/2003 8:35

Matrix: SLUDGE

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
Chrysene	4,700	670	µg/Kg-dry	02/10/2003 22:47
Bis(2-ethylhexyl)phthalate	4,200	670	µg/Kg-dry	02/10/2003 22:47
Di-n-octyl phthalate	< 670	670	µg/Kg-dry	02/10/2003 22:47
Benzo(b)fluoranthene	2,600	670	µg/Kg-dry	02/10/2003 22:47
Benzo(k)fluoranthene	1,800	670	µg/Kg-dry	02/10/2003 22:47
Benzo(a)pyrene	1,600	670	µg/Kg-dry	02/10/2003 22:47
Indeno(1,2,3-cd)pyrene	990	670	µg/Kg-dry	02/10/2003 22:47
Dibenz(a,h)anthracene	< 670	670	µg/Kg-dry	02/10/2003 22:47
Benzo(g,h,i)perylene	1,200	670	µg/Kg-dry	02/10/2003 22:47

VOLATILE ORGANIC COMPOUNDS, TCL LIST (EPA 5030A/8260B) Analyst: THP

Prep. Method: NA Prep. Date: NA Prep Analyst NA

Chloromethane	< 980	980	µg/Kg-dry	02/04/2003 7:36
Vinyl chloride	< 980	980	µg/Kg-dry	02/04/2003 7:36
Bromomethane	< 980	980	µg/Kg-dry	02/04/2003 7:36
Chloroethane	< 980	980	µg/Kg-dry	02/04/2003 7:36
Acetone	< 9,800	9,800	µg/Kg-dry	02/04/2003 7:36
1,1-Dichloroethene	< 490	490	µg/Kg-dry	02/04/2003 7:36
Carbon disulfide	< 490	490	µg/Kg-dry	02/04/2003 7:36
Methylene chloride	< 490	490	µg/Kg-dry	02/04/2003 7:36
trans-1,2-Dichloroethene	< 490	490	µg/Kg-dry	02/04/2003 7:36
1,1-Dichloroethane	< 490	490	µg/Kg-dry	02/04/2003 7:36
2-Butanone	< 9,800	9,800	µg/Kg-dry	02/04/2003 7:36
cis-1,2-Dichloroethene	< 490	490	µg/Kg-dry	02/04/2003 7:36
Chloroform	< 490	490	µg/Kg-dry	02/04/2003 7:36
1,1,1-Trichloroethane	< 490	490	µg/Kg-dry	02/04/2003 7:36
Carbon tetrachloride	< 490	490	µg/Kg-dry	02/04/2003 7:36
Benzene	< 490	490	µg/Kg-dry	02/04/2003 7:36
1,2-Dichloroethane	< 490	490	µg/Kg-dry	02/04/2003 7:36
Trichloroethene	< 490	490	µg/Kg-dry	02/04/2003 7:36
1,2-Dichloropropane	< 490	490	µg/Kg-dry	02/04/2003 7:36

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: Dolphin 2 grab

Report No: 0301603

Project:

Lab ID: 0301603-001

Matrix: SLUDGE

Collection Date: 01/31/2003 8:35

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
Bromodichloromethane	< 490	490	µg/Kg-dry	02/04/2003 7:36
4-Methyl-2-pentanone	< 4,900	4,900	µg/Kg-dry	02/04/2003 7:36
cis-1,3-Dichloropropene	< 490	490	µg/Kg-dry	02/04/2003 7:36
Toluene	< 490	490	µg/Kg-dry	02/04/2003 7:36
trans-1,3-Dichloropropene	< 490	490	µg/Kg-dry	02/04/2003 7:36
1,1,2-Trichloroethane	< 490	490	µg/Kg-dry	02/04/2003 7:36
2-Hexanone	< 4,900	4,900	µg/Kg-dry	02/04/2003 7:36
Tetrachloroethene	< 490	490	µg/Kg-dry	02/04/2003 7:36
Dibromochloromethane	< 490	490	µg/Kg-dry	02/04/2003 7:36
Chlorobenzene	< 490	490	µg/Kg-dry	02/04/2003 7:36
Ethylbenzene	< 490	490	µg/Kg-dry	02/04/2003 7:36
m,p-Xylene	< 490	490	µg/Kg-dry	02/04/2003 7:36
o-Xylene	< 490	490	µg/Kg-dry	02/04/2003 7:36
Styrene	< 490	490	µg/Kg-dry	02/04/2003 7:36
Bromoform	< 490	490	µg/Kg-dry	02/04/2003 7:36
1,1,2,2-Tetrachloroethane	< 490	490	µg/Kg-dry	02/04/2003 7:36
Xylenes, Total	< 980	980	µg/Kg-dry	02/04/2003 7:36

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: Dolphin 4 grab

Report No: 0301603

Lab ID: 0301603-002

Project:

Collection Date: 01/31/2003 8:55

Matrix: SLUDGE

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
MOISTURE CONTENT (DRIED AT 105°C)				Analyst: CLF
Prep. Method: NA	Prep. Date: NA		Prep Analyst	NA
PMOIST	60	0.050	wt%	01/31/2003 13:40
TCL SEMI VOLATILE ORGANIC COMPOUNDS (EPA 8270C)				Analyst: MLS
Prep. Method: EPA 3550B	Prep. Date: 02/05/2003 7:00:00 AM		Prep Analyst	WAR
note: Reported results are estimated due to internal standards, Chrysene-d12 & Perylene-d12 out of acceptance limits.				
Bis(2-chloroethyl)ether	< 820	820	µg/Kg-dry	02/10/2003 23:26
Phenol	1,600	820	µg/Kg-dry	02/10/2003 23:26
2-Chlorophenol	< 820	820	µg/Kg-dry	02/10/2003 23:26
1,3-Dichlorobenzene	< 820	820	µg/Kg-dry	02/10/2003 23:26
1,4-Dichlorobenzene	< 820	820	µg/Kg-dry	02/10/2003 23:26
1,2-Dichlorobenzene	< 820	820	µg/Kg-dry	02/10/2003 23:26
Bis(2-chloroisopropyl)ether	< 820	820	µg/Kg-dry	02/10/2003 23:26
2-Methylphenol	< 820	820	µg/Kg-dry	02/10/2003 23:26
Hexachloroethane	< 820	820	µg/Kg-dry	02/10/2003 23:26
N-Nitrosodi-n-propylamine	< 820	820	µg/Kg-dry	02/10/2003 23:26
4-Methylphenol,3-Methylphenol	< 820	820	µg/Kg-dry	02/10/2003 23:26
Nitrobenzene	< 820	820	µg/Kg-dry	02/10/2003 23:26
Isophorone	< 820	820	µg/Kg-dry	02/10/2003 23:26
2-Nitrophenol	< 820	820	µg/Kg-dry	02/10/2003 23:26
2,4-Dimethylphenol	< 820	820	µg/Kg-dry	02/10/2003 23:26
Bis(2-chloroethoxy)methane	< 820	820	µg/Kg-dry	02/10/2003 23:26
2,4-Dichlorophenol	< 820	820	µg/Kg-dry	02/10/2003 23:26
1,2,4-Trichlorobenzene	< 820	820	µg/Kg-dry	02/10/2003 23:26
Naphthalene	< 820	820	µg/Kg-dry	02/10/2003 23:26
4-Chloroaniline	< 1,700	1,700	µg/Kg-dry	02/10/2003 23:26
Hexachlorobutadiene	< 820	820	µg/Kg-dry	02/10/2003 23:26
4-Chloro-3-methylphenol	< 1,700	1,700	µg/Kg-dry	02/10/2003 23:26
2-Methylnaphthalene	< 820	820	µg/Kg-dry	02/10/2003 23:26

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: Dolphin 4 grab

Report No: 0301603

Project:

Lab ID: 0301603-002

Collection Date: 01/31/2003 8:55

Matrix: SLUDGE

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
Hexachlorocyclopentadiene	< 820	820	µg/Kg-dry	02/10/2003 23:26
2,4,6-Trichlorophenol	< 820	820	µg/Kg-dry	02/10/2003 23:26
2,4,5-Trichlorophenol	< 820	820	µg/Kg-dry	02/10/2003 23:26
2-Chloronaphthalene	< 820	820	µg/Kg-dry	02/10/2003 23:26
2-Nitroaniline	< 4,200	4,200	µg/Kg-dry	02/10/2003 23:26
Acenaphthylene	< 820	820	µg/Kg-dry	02/10/2003 23:26
Dimethyl phthalate	< 820	820	µg/Kg-dry	02/10/2003 23:26
2,6-Dinitrotoluene	< 820	820	µg/Kg-dry	02/10/2003 23:26
Acenaphthene	< 820	820	µg/Kg-dry	02/10/2003 23:26
3-Nitroaniline	< 4,200	4,200	µg/Kg-dry	02/10/2003 23:26
2,4-Dinitrophenol	< 4,200	4,200	µg/Kg-dry	02/10/2003 23:26
Dibenzofuran	< 820	820	µg/Kg-dry	02/10/2003 23:26
2,4-Dinitrotoluene	< 820	820	µg/Kg-dry	02/10/2003 23:26
4-Nitrophenol	< 4,200	4,200	µg/Kg-dry	02/10/2003 23:26
Fluorene	< 820	820	µg/Kg-dry	02/10/2003 23:26
4-Chlorophenyl phenyl ether	< 820	820	µg/Kg-dry	02/10/2003 23:26
Diethyl phthalate	< 820	820	µg/Kg-dry	02/10/2003 23:26
4-Nitroaniline	< 4,200	4,200	µg/Kg-dry	02/10/2003 23:26
4,6-Dinitro-2-methylphenol	< 4,200	4,200	µg/Kg-dry	02/10/2003 23:26
N-Nitrosodiphenylamine	< 820	820	µg/Kg-dry	02/10/2003 23:26
4-Bromophenyl phenyl ether	< 820	820	µg/Kg-dry	02/10/2003 23:26
Hexachlorobenzene	< 820	820	µg/Kg-dry	02/10/2003 23:26
Pentachlorophenol	< 4,200	4,200	µg/Kg-dry	02/10/2003 23:26
Phenanthrene	< 820	820	µg/Kg-dry	02/10/2003 23:26
Anthracene	< 820	820	µg/Kg-dry	02/10/2003 23:26
Carbazole	< 820	820	µg/Kg-dry	02/10/2003 23:26
Di-n-butyl phthalate	< 820	820	µg/Kg-dry	02/10/2003 23:26
Fluoranthene	1,400	820	µg/Kg-dry	02/10/2003 23:26
Pyrene	2,900	820	µg/Kg-dry	02/10/2003 23:26
Butyl benzyl phthalate	< 820	820	µg/Kg-dry	02/10/2003 23:26
3,3'-Dichlorobenzidine	< 1,700	1,700	µg/Kg-dry	02/10/2003 23:26
Benz(a)anthracene	860	820	µg/Kg-dry	02/10/2003 23:26

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: Dolphin 4 grab

Report No: 0301603

Lab ID: 0301603-002

Project:

Collection Date: 01/31/2003 8:55

Matrix: SLUDGE

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
Chrysene	1,500	820	µg/Kg-dry	02/10/2003 23:26
Bis(2-ethylhexyl)phthalate	6,300	820	µg/Kg-dry	02/10/2003 23:26
Di-n-octyl phthalate	< 820	820	µg/Kg-dry	02/10/2003 23:26
Benzo(b)fluoranthene	1,300	820	µg/Kg-dry	02/10/2003 23:26
Benzo(k)fluoranthene	860	820	µg/Kg-dry	02/10/2003 23:26
Benzo(a)pyrene	900	820	µg/Kg-dry	02/10/2003 23:26
Indeno(1,2,3-cd)pyrene	860	820	µg/Kg-dry	02/10/2003 23:26
Dibenz(a,h)anthracene	< 820	820	µg/Kg-dry	02/10/2003 23:26
Benzo(g,h,i)perylene	1,000	820	µg/Kg-dry	02/10/2003 23:26

VOLATILE ORGANIC COMPOUNDS, TCL LIST (EPA 5030A/8260B) Analyst: THP

Prep. Method: NA Prep. Date: NA Prep Analyst NA

Chloromethane	< 1,200	1,200	µg/Kg-dry	02/04/2003 8:08
Vinyl chloride	< 1,200	1,200	µg/Kg-dry	02/04/2003 8:08
Bromomethane	< 1,200	1,200	µg/Kg-dry	02/04/2003 8:08
Chloroethane	< 1,200	1,200	µg/Kg-dry	02/04/2003 8:08
Acetone	< 12,000	12,000	µg/Kg-dry	02/04/2003 8:08
1,1-Dichloroethene	< 610	610	µg/Kg-dry	02/04/2003 8:08
Carbon disulfide	< 610	610	µg/Kg-dry	02/04/2003 8:08
Methylene chloride	< 610	610	µg/Kg-dry	02/04/2003 8:08
trans-1,2-Dichloroethene	< 610	610	µg/Kg-dry	02/04/2003 8:08
1,1-Dichloroethane	< 610	610	µg/Kg-dry	02/04/2003 8:08
2-Butanone	< 12,000	12,000	µg/Kg-dry	02/04/2003 8:08
cis-1,2-Dichloroethene	< 610	610	µg/Kg-dry	02/04/2003 8:08
Chloroform	< 610	610	µg/Kg-dry	02/04/2003 8:08
1,1,1-Trichloroethane	< 610	610	µg/Kg-dry	02/04/2003 8:08
Carbon tetrachloride	< 610	610	µg/Kg-dry	02/04/2003 8:08
Benzene	< 610	610	µg/Kg-dry	02/04/2003 8:08
1,2-Dichloroethane	< 610	610	µg/Kg-dry	02/04/2003 8:08
Trichloroethene	< 610	610	µg/Kg-dry	02/04/2003 8:08
1,2-Dichloropropane	< 610	610	µg/Kg-dry	02/04/2003 8:08

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: Dolphin 4 grab

Report No: 0301603

Lab ID: 0301603-002

Project:

Collection Date: 01/31/2003 8:55

Matrix: SLUDGE

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
Bromodichloromethane	< 610	610	µg/Kg-dry	02/04/2003 8:08
4-Methyl-2-pentanone	< 6,100	6,100	µg/Kg-dry	02/04/2003 8:08
cis-1,3-Dichloropropene	< 610	610	µg/Kg-dry	02/04/2003 8:08
Toluene	< 610	610	µg/Kg-dry	02/04/2003 8:08
trans-1,3-Dichloropropene	< 610	610	µg/Kg-dry	02/04/2003 8:08
1,1,2-Trichloroethane	< 610	610	µg/Kg-dry	02/04/2003 8:08
2-Hexanone	< 6,100	6,100	µg/Kg-dry	02/04/2003 8:08
Tetrachloroethene	< 610	610	µg/Kg-dry	02/04/2003 8:08
Dibromochloromethane	< 610	610	µg/Kg-dry	02/04/2003 8:08
Chlorobenzene	< 610	610	µg/Kg-dry	02/04/2003 8:08
Ethylbenzene	< 610	610	µg/Kg-dry	02/04/2003 8:08
m,p-Xylene	< 610	610	µg/Kg-dry	02/04/2003 8:08
o-Xylene	< 610	610	µg/Kg-dry	02/04/2003 8:08
Styrene	< 610	610	µg/Kg-dry	02/04/2003 8:08
Bromoform	< 610	610	µg/Kg-dry	02/04/2003 8:08
1,1,2,2-Tetrachloroethane	< 610	610	µg/Kg-dry	02/04/2003 8:08
Xylenes, Total	< 1,200	1,200	µg/Kg-dry	02/04/2003 8:08

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: Dolphin 6 grab

Report No: 0301603

Lab ID: 0301603-003

Project:

Collection Date: 01/31/2003 9:05

Matrix: SLUDGE

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
MOISTURE CONTENT (DRIED AT 105°C)				Analyst: CLF
Prep. Method: NA	Prep. Date: NA		Prep Analyst	NA
PMOIST	58	0.050	wt%	01/31/2003 13:40
TCL SEMI VOLATILE ORGANIC COMPOUNDS (EPA 8270C)				Analyst: MLS
Prep. Method: EPA 3550B	Prep. Date: 02/05/2003 7:00:00 AM		Prep Analyst	WAR
note: Reported results are estimated due to internal standards, Chrysene-d12 & Perylene-d12 out of acceptance limits.				
Bis(2-chloroethyl)ether	< 790	790	µg/Kg-dry	02/10/2003 20:08
Phenol	1,100	790	µg/Kg-dry	02/10/2003 20:08
2-Chlorophenol	< 790	790	µg/Kg-dry	02/10/2003 20:08
1,3-Dichlorobenzene	< 790	790	µg/Kg-dry	02/10/2003 20:08
1,4-Dichlorobenzene	< 790	790	µg/Kg-dry	02/10/2003 20:08
1,2-Dichlorobenzene	< 790	790	µg/Kg-dry	02/10/2003 20:08
Bis(2-chloroisopropyl)ether	< 790	790	µg/Kg-dry	02/10/2003 20:08
2-Methylphenol	< 790	790	µg/Kg-dry	02/10/2003 20:08
Hexachloroethane	< 790	790	µg/Kg-dry	02/10/2003 20:08
N-Nitrosodi-n-propylamine	< 790	790	µg/Kg-dry	02/10/2003 20:08
4-Methylphenol,3-Methylphenol	< 790	790	µg/Kg-dry	02/10/2003 20:08
Nitrobenzene	< 790	790	µg/Kg-dry	02/10/2003 20:08
Isophorone	< 790	790	µg/Kg-dry	02/10/2003 20:08
2-Nitrophenol	< 790	790	µg/Kg-dry	02/10/2003 20:08
2,4-Dimethylphenol	< 790	790	µg/Kg-dry	02/10/2003 20:08
Bis(2-chloroethoxy)methane	< 790	790	µg/Kg-dry	02/10/2003 20:08
2,4-Dichlorophenol	< 790	790	µg/Kg-dry	02/10/2003 20:08
1,2,4-Trichlorobenzene	< 790	790	µg/Kg-dry	02/10/2003 20:08
Naphthalene	< 790	790	µg/Kg-dry	02/10/2003 20:08
4-Chloroaniline	< 1,600	1,600	µg/Kg-dry	02/10/2003 20:08
Hexachlorobutadiene	< 790	790	µg/Kg-dry	02/10/2003 20:08
4-Chloro-3-methylphenol	< 1,600	1,600	µg/Kg-dry	02/10/2003 20:08
2-Methylnaphthalene	< 790	790	µg/Kg-dry	02/10/2003 20:08

Gascoyne Laboratories, Inc.

2101 Van Deman Street
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(410) 633-1800

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: Dolphin 6 grab

Report No: 0301603

Lab ID: 0301603-003

Project:

Collection Date: 01/31/2003 9:05

Matrix: SLUDGE

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
Hexachlorocyclopentadiene	< 790	790	µg/Kg-dry	02/10/2003 20:08
2,4,6-Trichlorophenol	< 790	790	µg/Kg-dry	02/10/2003 20:08
2,4,5-Trichlorophenol	< 790	790	µg/Kg-dry	02/10/2003 20:08
2-Chloronaphthalene	< 790	790	µg/Kg-dry	02/10/2003 20:08
2-Nitroaniline	< 4,000	4,000	µg/Kg-dry	02/10/2003 20:08
Acenaphthylene	< 790	790	µg/Kg-dry	02/10/2003 20:08
Dimethyl phthalate	< 790	790	µg/Kg-dry	02/10/2003 20:08
2,6-Dinitrotoluene	< 790	790	µg/Kg-dry	02/10/2003 20:08
Acenaphthene	1,000	790	µg/Kg-dry	02/10/2003 20:08
3-Nitroaniline	< 4,000	4,000	µg/Kg-dry	02/10/2003 20:08
2,4-Dinitrophenol	< 4,000	4,000	µg/Kg-dry	02/10/2003 20:08
Dibenzofuran	< 790	790	µg/Kg-dry	02/10/2003 20:08
2,4-Dinitrotoluene	< 790	790	µg/Kg-dry	02/10/2003 20:08
4-Nitrophenol	< 4,000	4,000	µg/Kg-dry	02/10/2003 20:08
Fluorene	950	790	µg/Kg-dry	02/10/2003 20:08
4-Chlorophenyl phenyl ether	< 790	790	µg/Kg-dry	02/10/2003 20:08
Diethyl phthalate	< 790	790	µg/Kg-dry	02/10/2003 20:08
4-Nitroaniline	< 4,000	4,000	µg/Kg-dry	02/10/2003 20:08
4,6-Dinitro-2-methylphenol	< 4,000	4,000	µg/Kg-dry	02/10/2003 20:08
N-Nitrosodiphenylamine	< 790	790	µg/Kg-dry	02/10/2003 20:08
4-Bromophenyl phenyl ether	< 790	790	µg/Kg-dry	02/10/2003 20:08
Hexachlorobenzene	< 790	790	µg/Kg-dry	02/10/2003 20:08
Pentachlorophenol	< 4,000	4,000	µg/Kg-dry	02/10/2003 20:08
Phenanthrene	3,100	790	µg/Kg-dry	02/10/2003 20:08
Anthracene	< 790	790	µg/Kg-dry	02/10/2003 20:08
Carbazole	< 790	790	µg/Kg-dry	02/10/2003 20:08
Di-n-butyl phthalate	< 790	790	µg/Kg-dry	02/10/2003 20:08
Fluoranthene	1,800	790	µg/Kg-dry	02/10/2003 20:08
Pyrene	4,200	790	µg/Kg-dry	02/10/2003 20:08
Butyl benzyl phthalate	< 790	790	µg/Kg-dry	02/10/2003 20:08
3,3'-Dichlorobenzidine	< 1,600	1,600	µg/Kg-dry	02/10/2003 20:08
Benz(a)anthracene	1,100	790	µg/Kg-dry	02/10/2003 20:08

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: Dolphin 6 grab

Report No: 0301603

Project:

Lab ID: 0301603-003

Collection Date: 01/31/2003 9:05

Matrix: SLUDGE

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
Chrysene	1,600	790	µg/Kg-dry	02/10/2003 20:08
Bis(2-ethylhexyl)phthalate	5,500	790	µg/Kg-dry	02/10/2003 20:08
Di-n-octyl phthalate	< 790	790	µg/Kg-dry	02/10/2003 20:08
Benzo(b)fluoranthene	1,300	790	µg/Kg-dry	02/10/2003 20:08
Benzo(k)fluoranthene	< 790	790	µg/Kg-dry	02/10/2003 20:08
Benzo(a)pyrene	920	790	µg/Kg-dry	02/10/2003 20:08
Indeno(1,2,3-cd)pyrene	< 790	790	µg/Kg-dry	02/10/2003 20:08
Dibenz(a,h)anthracene	< 790	790	µg/Kg-dry	02/10/2003 20:08
Benzo(g,h,i)perylene	940	790	µg/Kg-dry	02/10/2003 20:08

VOLATILE ORGANIC COMPOUNDS, TCL LIST (EPA 5030A/8260B) Analyst: THP

Prep. Method: NA Prep. Date: NA Prep Analyst NA

Chloromethane	< 1,100	1,100	µg/Kg-dry	02/04/2003 8:40
Vinyl chloride	< 1,100	1,100	µg/Kg-dry	02/04/2003 8:40
Bromomethane	< 1,100	1,100	µg/Kg-dry	02/04/2003 8:40
Chloroethane	< 1,100	1,100	µg/Kg-dry	02/04/2003 8:40
Acetone	< 11,000	11,000	µg/Kg-dry	02/04/2003 8:40
1,1-Dichloroethene	< 560	560	µg/Kg-dry	02/04/2003 8:40
Carbon disulfide	< 560	560	µg/Kg-dry	02/04/2003 8:40
Methylene chloride	< 560	560	µg/Kg-dry	02/04/2003 8:40
trans-1,2-Dichloroethene	< 560	560	µg/Kg-dry	02/04/2003 8:40
1,1-Dichloroethane	< 560	560	µg/Kg-dry	02/04/2003 8:40
2-Butanone	< 11,000	11,000	µg/Kg-dry	02/04/2003 8:40
cis-1,2-Dichloroethene	< 560	560	µg/Kg-dry	02/04/2003 8:40
Chloroform	< 560	560	µg/Kg-dry	02/04/2003 8:40
1,1,1-Trichloroethane	< 560	560	µg/Kg-dry	02/04/2003 8:40
Carbon tetrachloride	< 560	560	µg/Kg-dry	02/04/2003 8:40
Benzene	< 560	560	µg/Kg-dry	02/04/2003 8:40
1,2-Dichloroethane	< 560	560	µg/Kg-dry	02/04/2003 8:40
Trichloroethene	< 560	560	µg/Kg-dry	02/04/2003 8:40
1,2-Dichloropropane	< 560	560	µg/Kg-dry	02/04/2003 8:40

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: Dolphin 6 grab

Report No: 0301603

Lab ID: 0301603-003

Project:

Collection Date: 01/31/2003 9:05

Matrix: SLUDGE

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
Bromodichloromethane	< 560	560	µg/Kg-dry	02/04/2003 8:40
4-Methyl-2-pentanone	< 5,600	5,600	µg/Kg-dry	02/04/2003 8:40
cis-1,3-Dichloropropene	< 560	560	µg/Kg-dry	02/04/2003 8:40
Toluene	< 560	560	µg/Kg-dry	02/04/2003 8:40
trans-1,3-Dichloropropene	< 560	560	µg/Kg-dry	02/04/2003 8:40
1,1,2-Trichloroethane	< 560	560	µg/Kg-dry	02/04/2003 8:40
2-Hexanone	< 5,600	5,600	µg/Kg-dry	02/04/2003 8:40
Tetrachloroethene	< 560	560	µg/Kg-dry	02/04/2003 8:40
Dibromochloromethane	< 560	560	µg/Kg-dry	02/04/2003 8:40
Chlorobenzene	< 560	560	µg/Kg-dry	02/04/2003 8:40
Ethylbenzene	< 560	560	µg/Kg-dry	02/04/2003 8:40
m,p-Xylene	< 560	560	µg/Kg-dry	02/04/2003 8:40
o-Xylene	< 560	560	µg/Kg-dry	02/04/2003 8:40
Styrene	< 560	560	µg/Kg-dry	02/04/2003 8:40
Bromoform	< 560	560	µg/Kg-dry	02/04/2003 8:40
1,1,2,2-Tetrachloroethane	< 560	560	µg/Kg-dry	02/04/2003 8:40
Xylenes, Total	< 1,100	1,100	µg/Kg-dry	02/04/2003 8:40

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: #1 grab

Report No: 0212558

Project: Washington D.C.

Lab ID: 0212558-001

Matrix: SLUDGE

Collection Date: 12/27/2002 10:58

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
MOISTURE CONTENT (DRIED AT 105°C)				
Prep. Method: NA	Prep. Date: NA		Prep Analyst NA	Analyst: CLF
PMOIST	61	0.050	wt%	12/30/2002 14:35
TCL SEMI VOLATILE ORGANIC COMPOUNDS (EPA 8270C)				
Prep. Method: EPA 3550B	Prep. Date: 01/02/2003 10:00:00 AM		Prep Analyst WAR	Analyst: MLS
Bis(2-chloroethyl)ether	< 850	850	µg/Kg-dry	01/10/2003 16:13
Phenol	1,100	850	µg/Kg-dry	01/10/2003 16:13
2-Chlorophenol	< 850	850	µg/Kg-dry	01/10/2003 16:13
1,3-Dichlorobenzene	< 850	850	µg/Kg-dry	01/10/2003 16:13
1,4-Dichlorobenzene	< 850	850	µg/Kg-dry	01/10/2003 16:13
1,2-Dichlorobenzene	< 850	850	µg/Kg-dry	01/10/2003 16:13
Bis(2-chloroisopropyl)ether	< 850	850	µg/Kg-dry	01/10/2003 16:13
2-Methylphenol	< 850	850	µg/Kg-dry	01/10/2003 16:13
Hexachloroethane	< 850	850	µg/Kg-dry	01/10/2003 16:13
N-Nitrosodi-n-propylamine	< 850	850	µg/Kg-dry	01/10/2003 16:13
4-Methylphenol,3-Methylphenol	< 850	850	µg/Kg-dry	01/10/2003 16:13
Nitrobenzene	< 850	850	µg/Kg-dry	01/10/2003 16:13
Isophorone	< 850	850	µg/Kg-dry	01/10/2003 16:13
2-Nitrophenol	< 850	850	µg/Kg-dry	01/10/2003 16:13
2,4-Dimethylphenol	< 850	850	µg/Kg-dry	01/10/2003 16:13
Bis(2-chloroethoxy)methane	< 850	850	µg/Kg-dry	01/10/2003 16:13
2,4-Dichlorophenol	< 850	850	µg/Kg-dry	01/10/2003 16:13
1,2,4-Trichlorobenzene	< 850	850	µg/Kg-dry	01/10/2003 16:13
Naphthalene	< 850	850	µg/Kg-dry	01/10/2003 16:13
4-Chloroaniline	< 850	850	µg/Kg-dry	01/10/2003 16:13
Hexachlorobutadiene	< 1,700	1,700	µg/Kg-dry	01/10/2003 16:13
4-Chloro-3-methylphenol	< 850	850	µg/Kg-dry	01/10/2003 16:13
2-Methylnaphthalene	< 1,700	1,700	µg/Kg-dry	01/10/2003 16:13
	< 850	850	µg/Kg-dry	01/10/2003 16:13

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: #1 grab

Report No: 0212558

Project: Washington D.C.

Lab ID: 0212558-001

Matrix: SLUDGE

Collection Date: 12/27/2002 10:58

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
Hexachlorocyclopentadiene	< 850	850	µg/Kg-dry	01/10/2003 16:13
2,4,6-Trichlorophenol	< 850	850	µg/Kg-dry	01/10/2003 16:13
2,4,5-Trichlorophenol	< 850	850	µg/Kg-dry	01/10/2003 16:13
2-Chloronaphthalene	< 850	850	µg/Kg-dry	01/10/2003 16:13
2-Nitroaniline	< 4,400	4,400	µg/Kg-dry	01/10/2003 16:13
Acenaphthylene	< 850	850	µg/Kg-dry	01/10/2003 16:13
Dimethyl phthalate	< 850	850	µg/Kg-dry	01/10/2003 16:13
2,6-Dinitrotoluene	< 850	850	µg/Kg-dry	01/10/2003 16:13
Acenaphthene	< 850	850	µg/Kg-dry	01/10/2003 16:13
3-Nitroaniline	< 4,400	4,400	µg/Kg-dry	01/10/2003 16:13
2,4-Dinitrophenol	< 4,400	4,400	µg/Kg-dry	01/10/2003 16:13
Dibenzofuran	< 850	850	µg/Kg-dry	01/10/2003 16:13
2,4-Dinitrotoluene	< 850	850	µg/Kg-dry	01/10/2003 16:13
4-Nitrophenol	< 4,400	4,400	µg/Kg-dry	01/10/2003 16:13
Fluorene	< 850	850	µg/Kg-dry	01/10/2003 16:13
4-Chlorophenyl phenyl ether	< 850	850	µg/Kg-dry	01/10/2003 16:13
Diethyl phthalate	< 850	850	µg/Kg-dry	01/10/2003 16:13
4-Nitroaniline	< 4,400	4,400	µg/Kg-dry	01/10/2003 16:13
4,6-Dinitro-2-methylphenol	< 4,400	4,400	µg/Kg-dry	01/10/2003 16:13
N-Nitrosodiphenylamine	< 850	850	µg/Kg-dry	01/10/2003 16:13
4-Bromophenyl phenyl ether	< 850	850	µg/Kg-dry	01/10/2003 16:13
Hexachlorobenzene	< 850	850	µg/Kg-dry	01/10/2003 16:13
Pentachlorophenol	< 4,400	4,400	µg/Kg-dry	01/10/2003 16:13
Phenanthrene	< 850	850	µg/Kg-dry	01/10/2003 16:13
Anthracene	< 850	850	µg/Kg-dry	01/10/2003 16:13
Carbazole	< 850	850	µg/Kg-dry	01/10/2003 16:13
Di-n-butyl phthalate	< 850	850	µg/Kg-dry	01/10/2003 16:13
Fluoranthene	1,500	850	µg/Kg-dry	01/10/2003 16:13
Pyrene	2,200	850	µg/Kg-dry	01/10/2003 16:13
Butyl benzyl phthalate	< 850	850	µg/Kg-dry	01/10/2003 16:13
3,3'-Dichlorobenzidine	< 1,700	1,700	µg/Kg-dry	01/10/2003 16:13
Benz(a)anthracene	< 850	850	µg/Kg-dry	01/10/2003 16:13

Another Mitchell Company

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Report No: 0212558

Project: Washington D.C.

Matrix: SLUDGE

Client Sample ID: #1 grab

Lab ID: 0212558-001

Collection Date: 12/27/2002 10:58

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
Bromodichloromethane	< 620	620	µg/Kg-dry	01/08/2003 20:59
4-Methyl-2-pentanone	< 6,200	6,200	µg/Kg-dry	01/08/2003 20:59
cis-1,3-Dichloropropene	< 620	620	µg/Kg-dry	01/08/2003 20:59
Toluene	< 620	620	µg/Kg-dry	01/08/2003 20:59
trans-1,3-Dichloropropene	< 620	620	µg/Kg-dry	01/08/2003 20:59
1,1,2-Trichloroethane	< 620	620	µg/Kg-dry	01/08/2003 20:59
2-Hexanone	< 6,200	6,200	µg/Kg-dry	01/08/2003 20:59
Tetrachloroethene	< 620	620	µg/Kg-dry	01/08/2003 20:59
Dibromochloromethane	< 620	620	µg/Kg-dry	01/08/2003 20:59
Chlorobenzene	< 620	620	µg/Kg-dry	01/08/2003 20:59
Ethylbenzene	< 620	620	µg/Kg-dry	01/08/2003 20:59
m,p-Xylene	< 620	620	µg/Kg-dry	01/08/2003 20:59
o-Xylene	< 620	620	µg/Kg-dry	01/08/2003 20:59
Styrene	< 620	620	µg/Kg-dry	01/08/2003 20:59
Bromoform	< 620	620	µg/Kg-dry	01/08/2003 20:59
1,1,2,2-Tetrachloroethane	< 620	620	µg/Kg-dry	01/08/2003 20:59
Xylenes, Total	< 1,200	1,200	µg/Kg-dry	01/08/2003 20:59

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: #2 grab

Report No: 0212558

Project: Washington D.C.

Lab ID: 0212558-002

Matrix: SLUDGE

Collection Date: 12/27/2002 11:05

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
MOISTURE CONTENT (DRIED AT 105°C)				Analyst: CLF
Prep. Method: NA	Prep. Date: NA		Prep Analyst	NA
PMOIST	61	0.050	wt%	12/30/2002 14:35
TCL SEMI VOLATILE ORGANIC COMPOUNDS (EPA 8270C)				Analyst: MLS
Prep. Method: EPA 3550B	Prep. Date: 01/02/2003 10:00:00 AM		Prep Analyst	WAR
Bis(2-chloroethyl)ether	< 850	850	µg/Kg-dry	01/10/2003 16:54
Phenol	1,300	850	µg/Kg-dry	01/10/2003 16:54
2-Chlorophenol	< 850	850	µg/Kg-dry	01/10/2003 16:54
1,3-Dichlorobenzene	< 850	850	µg/Kg-dry	01/10/2003 16:54
1,4-Dichlorobenzene	< 850	850	µg/Kg-dry	01/10/2003 16:54
1,2-Dichlorobenzene	< 850	850	µg/Kg-dry	01/10/2003 16:54
Bis(2-chloroisopropyl)ether	< 850	850	µg/Kg-dry	01/10/2003 16:54
2-Methylphenol	< 850	850	µg/Kg-dry	01/10/2003 16:54
Hexachloroethane	< 850	850	µg/Kg-dry	01/10/2003 16:54
N-Nitrosodi-n-propylamine	< 850	850	µg/Kg-dry	01/10/2003 16:54
4-Methylphenol,3-Methylphenol	< 850	850	µg/Kg-dry	01/10/2003 16:54
Nitrobenzene	< 850	850	µg/Kg-dry	01/10/2003 16:54
Isophorone	< 850	850	µg/Kg-dry	01/10/2003 16:54
2-Nitrophenol	< 850	850	µg/Kg-dry	01/10/2003 16:54
2,4-Dimethylphenol	< 850	850	µg/Kg-dry	01/10/2003 16:54
Bis(2-chloroethoxy)methane	< 850	850	µg/Kg-dry	01/10/2003 16:54
2,4-Dichlorophenol	< 850	850	µg/Kg-dry	01/10/2003 16:54
1,2,4-Trichlorobenzene	< 850	850	µg/Kg-dry	01/10/2003 16:54
Naphthalene	< 850	850	µg/Kg-dry	01/10/2003 16:54
4-Chloroaniline	< 1,700	1,700	µg/Kg-dry	01/10/2003 16:54
Hexachlorobutadiene	< 850	850	µg/Kg-dry	01/10/2003 16:54
4-Chloro-3-methylphenol	< 1,700	1,700	µg/Kg-dry	01/10/2003 16:54
2-Methylnaphthalene	< 850	850	µg/Kg-dry	01/10/2003 16:54

Another Microbac Company

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: #2 grab

Report No: 0212558

Project: Washington D.C.

Lab ID: 0212558-002

Matrix: SLUDGE

Collection Date: 12/27/2002 11:05

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
Hexachlorocyclopentadiene	< 850	850	µg/Kg-dry	01/10/2003 16:54
2,4,6-Trichlorophenol	< 850	850	µg/Kg-dry	01/10/2003 16:54
2,4,5-Trichlorophenol	< 850	850	µg/Kg-dry	01/10/2003 16:54
2-Chloronaphthalene	< 850	850	µg/Kg-dry	01/10/2003 16:54
2-Nitroaniline	< 4,400	4,400	µg/Kg-dry	01/10/2003 16:54
Acenaphthylene	< 850	850	µg/Kg-dry	01/10/2003 16:54
Dimethyl phthalate	< 850	850	µg/Kg-dry	01/10/2003 16:54
2,6-Dinitrotoluene	< 850	850	µg/Kg-dry	01/10/2003 16:54
Acenaphthene	1,500	850	µg/Kg-dry	01/10/2003 16:54
3-Nitroaniline	< 4,400	4,400	µg/Kg-dry	01/10/2003 16:54
2,4-Dinitrophenol	< 4,400	4,400	µg/Kg-dry	01/10/2003 16:54
Dibenzofuran	< 850	850	µg/Kg-dry	01/10/2003 16:54
2,4-Dinitrotoluene	< 850	850	µg/Kg-dry	01/10/2003 16:54
4-Nitrophenol	< 4,400	4,400	µg/Kg-dry	01/10/2003 16:54
Fluorene	1,600	850	µg/Kg-dry	01/10/2003 16:54
4-Chlorophenyl phenyl ether	< 850	850	µg/Kg-dry	01/10/2003 16:54
Diethyl phthalate	< 850	850	µg/Kg-dry	01/10/2003 16:54
4-Nitroaniline	< 4,400	4,400	µg/Kg-dry	01/10/2003 16:54
4,6-Dinitro-2-methylphenol	< 4,400	4,400	µg/Kg-dry	01/10/2003 16:54
N-Nitrosodiphenylamine	< 850	850	µg/Kg-dry	01/10/2003 16:54
4-Bromophenyl phenyl ether	< 850	850	µg/Kg-dry	01/10/2003 16:54
Hexachlorobenzene	< 850	850	µg/Kg-dry	01/10/2003 16:54
Pentachlorophenol	< 4,400	4,400	µg/Kg-dry	01/10/2003 16:54
Phenanthrene	5,800	850	µg/Kg-dry	01/10/2003 16:54
Anthracene	970	850	µg/Kg-dry	01/10/2003 16:54
Carbazole	< 850	850	µg/Kg-dry	01/10/2003 16:54
Di-n-butyl phthalate	< 850	850	µg/Kg-dry	01/10/2003 16:54
Fluoranthene	4,800	850	µg/Kg-dry	01/10/2003 16:54
Pyrene	8,600	850	µg/Kg-dry	01/10/2003 16:54
Butyl benzyl phthalate	< 850	850	µg/Kg-dry	01/10/2003 16:54
3,3'-Dichlorobenzidine	< 1,700	1,700	µg/Kg-dry	01/10/2003 16:54
Benz(a)anthracene	2,600	850	µg/Kg-dry	01/10/2003 16:54

Another Microbiologics Company

Gascoyne Laboratories, Inc.

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: #2 grab

Report No: 0212558

Project: Washington D.C.

Lab ID: 0212558-002

Matrix: SLUDGE

Collection Date: 12/27/2002 11:05

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
Chrysene	3,300	850	µg/Kg-dry	01/10/2003 16:54
Bis(2-ethylhexyl)phthalate	3,200	850	µg/Kg-dry	01/10/2003 16:54
Di-n-octyl phthalate	< 850	850	µg/Kg-dry	01/10/2003 16:54
Benzo(b)fluoranthene	1,000	850	µg/Kg-dry	01/10/2003 16:54
Benzo(k)fluoranthene	1,100	850	µg/Kg-dry	01/10/2003 16:54
Benzo(a)pyrene	< 850	850	µg/Kg-dry	01/10/2003 16:54
Indeno(1,2,3-cd)pyrene	< 850	850	µg/Kg-dry	01/10/2003 16:54
Dibenz(a,h)anthracene	< 850	850	µg/Kg-dry	01/10/2003 16:54
Benzo(g,h,i)perylene	< 850	850	µg/Kg-dry	01/10/2003 16:54

VOLATILE ORGANIC COMPOUNDS, TCL LIST (EPA 5030A/8260B)

Prep. Method: NA Prep. Date: NA Prep Analyst NA Analyst: THP

note: Sample received with headspace.

Chloromethane	< 1,300	1,300	µg/Kg-dry	01/08/2003 21:31
Vinyl chloride	< 1,300	1,300	µg/Kg-dry	01/08/2003 21:31
Bromomethane	< 1,300	1,300	µg/Kg-dry	01/08/2003 21:31
Chloroethane	< 1,300	1,300	µg/Kg-dry	01/08/2003 21:31
Acetone	< 13,000	13,000	µg/Kg-dry	01/08/2003 21:31
1,1-Dichloroethene	< 630	630	µg/Kg-dry	01/08/2003 21:31
Carbon disulfide	< 630	630	µg/Kg-dry	01/08/2003 21:31
Methylene chloride	< 630	630	µg/Kg-dry	01/08/2003 21:31
trans-1,2-Dichloroethene	< 630	630	µg/Kg-dry	01/08/2003 21:31
1,1-Dichloroethane	< 630	630	µg/Kg-dry	01/08/2003 21:31
2-Butanone	< 13,000	13,000	µg/Kg-dry	01/08/2003 21:31
cis-1,2-Dichloroethene	< 630	630	µg/Kg-dry	01/08/2003 21:31
Chloroform	< 630	630	µg/Kg-dry	01/08/2003 21:31
1,1,1-Trichloroethane	< 630	630	µg/Kg-dry	01/08/2003 21:31
Carbon tetrachloride	< 630	630	µg/Kg-dry	01/08/2003 21:31
Benzene	< 630	630	µg/Kg-dry	01/08/2003 21:31
1,2-Dichloroethane	< 630	630	µg/Kg-dry	01/08/2003 21:31
Trichloroethene	< 630	630	µg/Kg-dry	01/08/2003 21:31
1,2-Dichloropropane	< 630	630	µg/Kg-dry	01/08/2003 21:31

Another [redacted]

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: #2 grab

Report No: 0212558

Project: Washington D.C.

Lab ID: 0212558-002

Matrix: SLUDGE

Collection Date: 12/27/2002 11:05

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
Bromodichloromethane	< 630	630	µg/Kg-dry	01/08/2003 21:31
4-Methyl-2-pentanone	< 6,300	6,300	µg/Kg-dry	01/08/2003 21:31
cis-1,3-Dichloropropene	< 630	630	µg/Kg-dry	01/08/2003 21:31
Toluene	< 630	630	µg/Kg-dry	01/08/2003 21:31
trans-1,3-Dichloropropene	< 630	630	µg/Kg-dry	01/08/2003 21:31
1,1,2-Trichloroethane	< 630	630	µg/Kg-dry	01/08/2003 21:31
2-Hexanone	< 6,300	6,300	µg/Kg-dry	01/08/2003 21:31
Tetrachloroethene	< 630	630	µg/Kg-dry	01/08/2003 21:31
Dibromochloromethane	< 630	630	µg/Kg-dry	01/08/2003 21:31
Chlorobenzene	< 630	630	µg/Kg-dry	01/08/2003 21:31
Ethylbenzene	< 630	630	µg/Kg-dry	01/08/2003 21:31
m,p-Xylene	< 630	630	µg/Kg-dry	01/08/2003 21:31
o-Xylene	< 630	630	µg/Kg-dry	01/08/2003 21:31
Styrene	< 630	630	µg/Kg-dry	01/08/2003 21:31
Bromoform	< 630	630	µg/Kg-dry	01/08/2003 21:31
1,1,2,2-Tetrachloroethane	< 630	630	µg/Kg-dry	01/08/2003 21:31
Xylenes, Total	< 1,300	1,300	µg/Kg-dry	01/08/2003 21:31

Another Mitchell Company

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: #3 grab

Report No: 0212558

Project: Washington D.C.

Lab ID: 0212558-003

Matrix: SLUDGE

Collection Date: 12/27/2002 11:20

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
MOISTURE CONTENT (DRIED AT 105°C)				
Prep. Method: NA	Prep. Date: NA		Prep Analyst NA	Analyst: CLF
PMOIST	61	0.050	wt%	12/30/2002 14:35
TCL SEMI VOLATILE ORGANIC COMPOUNDS (EPA 8270C)				
Prep. Method: EPA 3550B	Prep. Date: 01/02/2003 10:00:00 AM		Prep Analyst WAR	Analyst: MLS
Bis(2-chloroethyl)ether	< 850	850	µg/Kg-dry	01/10/2003 17:35
Phenol	1,200	850	µg/Kg-dry	01/10/2003 17:35
2-Chlorophenol	< 850	850	µg/Kg-dry	01/10/2003 17:35
1,3-Dichlorobenzene	< 850	850	µg/Kg-dry	01/10/2003 17:35
1,4-Dichlorobenzene	< 850	850	µg/Kg-dry	01/10/2003 17:35
1,2-Dichlorobenzene	< 850	850	µg/Kg-dry	01/10/2003 17:35
Bis(2-chloroisopropyl)ether	< 850	850	µg/Kg-dry	01/10/2003 17:35
2-Methylphenol	< 850	850	µg/Kg-dry	01/10/2003 17:35
Hexachloroethane	< 850	850	µg/Kg-dry	01/10/2003 17:35
N-Nitrosodi-n-propylamine	< 850	850	µg/Kg-dry	01/10/2003 17:35
4-Methylphenol,3-Methylphenol	< 850	850	µg/Kg-dry	01/10/2003 17:35
Nitrobenzene	< 850	850	µg/Kg-dry	01/10/2003 17:35
Isophorone	< 850	850	µg/Kg-dry	01/10/2003 17:35
2-Nitrophenol	< 850	850	µg/Kg-dry	01/10/2003 17:35
2,4-Dimethylphenol	< 850	850	µg/Kg-dry	01/10/2003 17:35
Bis(2-chloroethoxy)methane	< 850	850	µg/Kg-dry	01/10/2003 17:35
2,4-Dichlorophenol	< 850	850	µg/Kg-dry	01/10/2003 17:35
1,2,4-Trichlorobenzene	< 850	850	µg/Kg-dry	01/10/2003 17:35
Naphthalene	< 850	850	µg/Kg-dry	01/10/2003 17:35
4-Chloroaniline	< 1,700	1,700	µg/Kg-dry	01/10/2003 17:35
Hexachlorobutadiene	< 850	850	µg/Kg-dry	01/10/2003 17:35
4-Chloro-3-methylphenol	< 1,700	1,700	µg/Kg-dry	01/10/2003 17:35
2-Methylnaphthalene	< 850	850	µg/Kg-dry	01/10/2003 17:35

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: #3 grab

Report No: 0212558

Project: Washington D.C.

Lab ID: 0212558-003

Matrix: SLUDGE

Collection Date: 12/27/2002 11:20

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
Hexachlorocyclopentadiene	< 850	850	µg/Kg-dry	01/10/2003 17:35
2,4,6-Trichlorophenol	< 850	850	µg/Kg-dry	01/10/2003 17:35
2,4,5-Trichlorophenol	< 850	850	µg/Kg-dry	01/10/2003 17:35
2-Chloronaphthalene	< 850	850	µg/Kg-dry	01/10/2003 17:35
2-Nitroaniline	< 4,400	4,400	µg/Kg-dry	01/10/2003 17:35
Acenaphthylene	< 850	850	µg/Kg-dry	01/10/2003 17:35
Dimethyl phthalate	< 850	850	µg/Kg-dry	01/10/2003 17:35
2,6-Dinitrotoluene	< 850	850	µg/Kg-dry	01/10/2003 17:35
Acenaphthene	< 850	850	µg/Kg-dry	01/10/2003 17:35
3-Nitroaniline	< 4,400	4,400	µg/Kg-dry	01/10/2003 17:35
2,4-Dinitrophenol	< 4,400	4,400	µg/Kg-dry	01/10/2003 17:35
Dibenzofuran	< 850	850	µg/Kg-dry	01/10/2003 17:35
2,4-Dinitrotoluene	< 850	850	µg/Kg-dry	01/10/2003 17:35
4-Nitrophenol	< 4,400	4,400	µg/Kg-dry	01/10/2003 17:35
Fluorene	< 850	850	µg/Kg-dry	01/10/2003 17:35
4-Chlorophenyl phenyl ether	< 850	850	µg/Kg-dry	01/10/2003 17:35
Diethyl phthalate	< 850	850	µg/Kg-dry	01/10/2003 17:35
4-Nitroaniline	< 4,400	4,400	µg/Kg-dry	01/10/2003 17:35
4,6-Dinitro-2-methylphenol	< 4,400	4,400	µg/Kg-dry	01/10/2003 17:35
N-Nitrosodiphenylamine	< 850	850	µg/Kg-dry	01/10/2003 17:35
4-Bromophenyl phenyl ether	< 850	850	µg/Kg-dry	01/10/2003 17:35
Hexachlorobenzene	< 850	850	µg/Kg-dry	01/10/2003 17:35
Pentachlorophenol	< 4,400	4,400	µg/Kg-dry	01/10/2003 17:35
Phenanthrene	1,100	850	µg/Kg-dry	01/10/2003 17:35
Anthracene	< 850	850	µg/Kg-dry	01/10/2003 17:35
Carbazole	< 850	850	µg/Kg-dry	01/10/2003 17:35
Di-n-butyl phthalate	< 850	850	µg/Kg-dry	01/10/2003 17:35
Fluoranthene	1,300	850	µg/Kg-dry	01/10/2003 17:35
Pyrene	2,700	850	µg/Kg-dry	01/10/2003 17:35
Butyl benzyl phthalate	< 850	850	µg/Kg-dry	01/10/2003 17:35
3,3'-Dichlorobenzidine	< 1,700	1,700	µg/Kg-dry	01/10/2003 17:35
Benz(a)anthracene	< 850	850	µg/Kg-dry	01/10/2003 17:35

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: #3 grab

Report No: 0212558

Project: Washington D.C.

Lab ID: 0212558-003

Matrix: SLUDGE

Collection Date: 12/27/2002 11:20

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
Chrysene	1,100	850	µg/Kg-dry	01/10/2003 17:35
Bis(2-ethylhexyl)phthalate	2,500	850	µg/Kg-dry	01/10/2003 17:35
Di-n-octyl phthalate	< 850	850	µg/Kg-dry	01/10/2003 17:35
Benzo(b)fluoranthene	< 850	850	µg/Kg-dry	01/10/2003 17:35
Benzo(k)fluoranthene	< 850	850	µg/Kg-dry	01/10/2003 17:35
Benzo(a)pyrene	< 850	850	µg/Kg-dry	01/10/2003 17:35
Indeno(1,2,3-cd)pyrene	< 850	850	µg/Kg-dry	01/10/2003 17:35
Dibenz(a,h)anthracene	< 850	850	µg/Kg-dry	01/10/2003 17:35
Benzo(g,h,i)perylene	< 850	850	µg/Kg-dry	01/10/2003 17:35

VOLATILE ORGANIC COMPOUNDS, TCL LIST (EPA 5030A/8260B)

Prep. Method: NA Prep. Date: NA Prep Analyst NA Analyst: THP

note: Sample received with headspace.

Chloromethane	< 1,200	1,200	µg/Kg-dry	01/08/2003 22:02
Vinyl chloride	< 1,200	1,200	µg/Kg-dry	01/08/2003 22:02
Bromomethane	< 1,200	1,200	µg/Kg-dry	01/08/2003 22:02
Chloroethane	< 1,200	1,200	µg/Kg-dry	01/08/2003 22:02
Acetone	< 12,000	12,000	µg/Kg-dry	01/08/2003 22:02
1,1-Dichloroethene	< 620	620	µg/Kg-dry	01/08/2003 22:02
Carbon disulfide	< 620	620	µg/Kg-dry	01/08/2003 22:02
Methylene chloride	< 620	620	µg/Kg-dry	01/08/2003 22:02
trans-1,2-Dichloroethene	< 620	620	µg/Kg-dry	01/08/2003 22:02
1,1-Dichloroethane	< 620	620	µg/Kg-dry	01/08/2003 22:02
2-Butanone	< 12,000	12,000	µg/Kg-dry	01/08/2003 22:02
cis-1,2-Dichloroethene	< 620	620	µg/Kg-dry	01/08/2003 22:02
Chloroform	< 620	620	µg/Kg-dry	01/08/2003 22:02
1,1,1-Trichloroethane	< 620	620	µg/Kg-dry	01/08/2003 22:02
Carbon tetrachloride	< 620	620	µg/Kg-dry	01/08/2003 22:02
Benzene	< 620	620	µg/Kg-dry	01/08/2003 22:02
1,2-Dichloroethane	< 620	620	µg/Kg-dry	01/08/2003 22:02
Trichloroethene	< 620	620	µg/Kg-dry	01/08/2003 22:02
1,2-Dichloropropane	< 620	620	µg/Kg-dry	01/08/2003 22:02

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: #3 grab

Report No: 0212558

Project: Washington D.C.

Lab ID: 0212558-003

Matrix: SLUDGE

Collection Date: 12/27/2002 11:20

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
Bromodichloromethane	< 620	620	µg/Kg-dry	01/08/2003 22:02
4-Methyl-2-pentanone	< 6,200	6,200	µg/Kg-dry	01/08/2003 22:02
cis-1,3-Dichloropropene	< 620	620	µg/Kg-dry	01/08/2003 22:02
Toluene	< 620	620	µg/Kg-dry	01/08/2003 22:02
trans-1,3-Dichloropropene	< 620	620	µg/Kg-dry	01/08/2003 22:02
1,1,2-Trichloroethane	< 620	620	µg/Kg-dry	01/08/2003 22:02
2-Hexanone	< 6,200	6,200	µg/Kg-dry	01/08/2003 22:02
Tetrachloroethene	< 620	620	µg/Kg-dry	01/08/2003 22:02
Dibromochloromethane	< 620	620	µg/Kg-dry	01/08/2003 22:02
Chlorobenzene	< 620	620	µg/Kg-dry	01/08/2003 22:02
Ethylbenzene	< 620	620	µg/Kg-dry	01/08/2003 22:02
m,p-Xylene	< 620	620	µg/Kg-dry	01/08/2003 22:02
o-Xylene	< 620	620	µg/Kg-dry	01/08/2003 22:02
Styrene	< 620	620	µg/Kg-dry	01/08/2003 22:02
Bromoform	< 620	620	µg/Kg-dry	01/08/2003 22:02
1,1,2,2-Tetrachloroethane	< 620	620	µg/Kg-dry	01/08/2003 22:02
Xylenes, Total	< 1,200	1,200	µg/Kg-dry	01/08/2003 22:02

Another Microbiics Company

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: #4 grab

Report No: 0212558

Project: Washington D.C.

Lab ID: 0212558-004

Matrix: SLUDGE

Collection Date: 12/27/2002 11:45

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
MOISTURE CONTENT (DRIED AT 105°C)				
Prep. Method: NA	Prep. Date: NA		Prep Analyst NA	Analyst: CLF
PMOIST	62	0.050	wt%	12/30/2002 14:35
TCL SEMI VOLATILE ORGANIC COMPOUNDS (EPA 8270C)				
Prep. Method: EPA 3550B	Prep. Date: 01/02/2003 10:00:00 AM		Prep Analyst WAR	Analyst: MLS
Bis(2-chloroethyl)ether	< 870	870	µg/Kg-dry	01/10/2003 18:16
Phenol	1,200	870	µg/Kg-dry	01/10/2003 18:16
2-Chlorophenol	< 870	870	µg/Kg-dry	01/10/2003 18:16
1,3-Dichlorobenzene	< 870	870	µg/Kg-dry	01/10/2003 18:16
1,4-Dichlorobenzene	< 870	870	µg/Kg-dry	01/10/2003 18:16
1,2-Dichlorobenzene	< 870	870	µg/Kg-dry	01/10/2003 18:16
Bis(2-chloroisopropyl)ether	< 870	870	µg/Kg-dry	01/10/2003 18:16
2-Methylphenol	< 870	870	µg/Kg-dry	01/10/2003 18:16
Hexachloroethane	< 870	870	µg/Kg-dry	01/10/2003 18:16
N-Nitrosodi-n-propylamine	< 870	870	µg/Kg-dry	01/10/2003 18:16
4-Methylphenol,3-Methylphenol	< 870	870	µg/Kg-dry	01/10/2003 18:16
Nitrobenzene	< 870	870	µg/Kg-dry	01/10/2003 18:16
Isophorone	< 870	870	µg/Kg-dry	01/10/2003 18:16
2-Nitrophenol	< 870	870	µg/Kg-dry	01/10/2003 18:16
2,4-Dimethylphenol	< 870	870	µg/Kg-dry	01/10/2003 18:16
Bis(2-chloroethoxy)methane	< 870	870	µg/Kg-dry	01/10/2003 18:16
2,4-Dichlorophenol	< 870	870	µg/Kg-dry	01/10/2003 18:16
1,2,4-Trichlorobenzene	< 870	870	µg/Kg-dry	01/10/2003 18:16
Naphthalene	< 870	870	µg/Kg-dry	01/10/2003 18:16
4-Chloroaniline	< 1,800	1,800	µg/Kg-dry	01/10/2003 18:16
Hexachlorobutadiene	< 870	870	µg/Kg-dry	01/10/2003 18:16
4-Chloro-3-methylphenol	< 1,800	1,800	µg/Kg-dry	01/10/2003 18:16
2-Methylnaphthalene	< 870	870	µg/Kg-dry	01/10/2003 18:16

Another [redacted]

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: #4 grab

Report No: 0212558

Project: Washington D.C.

Lab ID: 0212558-004

Matrix: SLUDGE

Collection Date: 12/27/2002 11:45

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
Hexachlorocyclopentadiene	< 870	870	µg/Kg-dry	01/10/2003 18:16
2,4,6-Trichlorophenol	< 870	870	µg/Kg-dry	01/10/2003 18:16
2,4,5-Trichlorophenol	< 870	870	µg/Kg-dry	01/10/2003 18:16
2-Chloronaphthalene	< 870	870	µg/Kg-dry	01/10/2003 18:16
2-Nitroaniline	< 4,500	4,500	µg/Kg-dry	01/10/2003 18:16
Acenaphthylene	< 870	870	µg/Kg-dry	01/10/2003 18:16
Dimethyl phthalate	< 870	870	µg/Kg-dry	01/10/2003 18:16
2,6-Dinitrotoluene	< 870	870	µg/Kg-dry	01/10/2003 18:16
Acenaphthene	< 870	870	µg/Kg-dry	01/10/2003 18:16
3-Nitroaniline	< 4,500	4,500	µg/Kg-dry	01/10/2003 18:16
2,4-Dinitrophenol	< 4,500	4,500	µg/Kg-dry	01/10/2003 18:16
Dibenzofuran	< 870	870	µg/Kg-dry	01/10/2003 18:16
2,4-Dinitrotoluene	< 870	870	µg/Kg-dry	01/10/2003 18:16
4-Nitrophenol	< 4,500	4,500	µg/Kg-dry	01/10/2003 18:16
Fluorene	< 870	870	µg/Kg-dry	01/10/2003 18:16
4-Chlorophenyl phenyl ether	< 870	870	µg/Kg-dry	01/10/2003 18:16
Diethyl phthalate	< 870	870	µg/Kg-dry	01/10/2003 18:16
4-Nitroaniline	< 4,500	4,500	µg/Kg-dry	01/10/2003 18:16
4,6-Dinitro-2-methylphenol	< 4,500	4,500	µg/Kg-dry	01/10/2003 18:16
N-Nitrosodiphenylamine	< 870	870	µg/Kg-dry	01/10/2003 18:16
4-Bromophenyl phenyl ether	< 870	870	µg/Kg-dry	01/10/2003 18:16
Hexachlorobenzene	< 870	870	µg/Kg-dry	01/10/2003 18:16
Pentachlorophenol	< 4,500	4,500	µg/Kg-dry	01/10/2003 18:16
Phenanthrene	900	870	µg/Kg-dry	01/10/2003 18:16
Anthracene	< 870	870	µg/Kg-dry	01/10/2003 18:16
Carbazole	< 870	870	µg/Kg-dry	01/10/2003 18:16
Di-n-butyl phthalate	< 870	870	µg/Kg-dry	01/10/2003 18:16
Fluoranthene	960	870	µg/Kg-dry	01/10/2003 18:16
Pyrene	2,200	870	µg/Kg-dry	01/10/2003 18:16
Butyl benzyl phthalate	< 870	870	µg/Kg-dry	01/10/2003 18:16
3,3'-Dichlorobenzidine	< 1,800	1,800	µg/Kg-dry	01/10/2003 18:16
Benz(a)anthracene	< 870	870	µg/Kg-dry	01/10/2003 18:16

Another Microbiologics Company

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: #4 grab

Report No: 0212558

Project: Washington D.C.

Lab ID: 0212558-004

Matrix: SLUDGE

Collection Date: 12/27/2002 11:45

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
Chrysene	1,000	870	µg/Kg-dry	01/10/2003 18:16
Bis(2-ethylhexyl)phthalate	2,700	870	µg/Kg-dry	01/10/2003 18:16
Di-n-octyl phthalate	< 870	870	µg/Kg-dry	01/10/2003 18:16
Benzo(b)fluoranthene	< 870	870	µg/Kg-dry	01/10/2003 18:16
Benzo(k)fluoranthene	< 870	870	µg/Kg-dry	01/10/2003 18:16
Benzo(a)pyrene	< 870	870	µg/Kg-dry	01/10/2003 18:16
Indeno(1,2,3-cd)pyrene	< 870	870	µg/Kg-dry	01/10/2003 18:16
Dibenz(a,h)anthracene	< 870	870	µg/Kg-dry	01/10/2003 18:16
Benzo(g,h,i)perylene	< 870	870	µg/Kg-dry	01/10/2003 18:16

VOLATILE ORGANIC COMPOUNDS, TCL LIST (EPA 5030A/8260B)

Prep. Method: NA Prep. Date: NA Prep Analyst NA Analyst: THP

note: Sample received with headspace.

Chloromethane	< 1,300	1,300	µg/Kg-dry	01/08/2003 22:34
Vinyl chloride	< 1,300	1,300	µg/Kg-dry	01/08/2003 22:34
Bromomethane	< 1,300	1,300	µg/Kg-dry	01/08/2003 22:34
Chloroethane	< 1,300	1,300	µg/Kg-dry	01/08/2003 22:34
Acetone	< 13,000	13,000	µg/Kg-dry	01/08/2003 22:34
1,1-Dichloroethene	< 650	650	µg/Kg-dry	01/08/2003 22:34
Carbon disulfide	< 650	650	µg/Kg-dry	01/08/2003 22:34
Methylene chloride	< 650	650	µg/Kg-dry	01/08/2003 22:34
trans-1,2-Dichloroethene	< 650	650	µg/Kg-dry	01/08/2003 22:34
1,1-Dichloroethane	< 650	650	µg/Kg-dry	01/08/2003 22:34
2-Butanone	< 13,000	13,000	µg/Kg-dry	01/08/2003 22:34
cis-1,2-Dichloroethene	< 650	650	µg/Kg-dry	01/08/2003 22:34
Chloroform	< 650	650	µg/Kg-dry	01/08/2003 22:34
1,1,1-Trichloroethane	< 650	650	µg/Kg-dry	01/08/2003 22:34
Carbon tetrachloride	< 650	650	µg/Kg-dry	01/08/2003 22:34
Benzene	< 650	650	µg/Kg-dry	01/08/2003 22:34
1,2-Dichloroethane	< 650	650	µg/Kg-dry	01/08/2003 22:34
Trichloroethene	< 650	650	µg/Kg-dry	01/08/2003 22:34
1,2-Dichloropropane	< 650	650	µg/Kg-dry	01/08/2003 22:34

Another [redacted]

Gascoyne Laboratories, Inc.

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REPORT OF ANALYSIS

Test Results

Client: Melka Marine, Inc.

Client Sample ID: #4 grab

Report No: 0212558

Project: Washington D.C.

Lab ID: 0212558-004

Matrix: SLUDGE

Collection Date: 12/27/2002 11:45

Analyses	Test Results	Reporting Limit	Units	Date/Time Analyzed
Bromodichloromethane	< 650	650	µg/Kg-dry	01/08/2003 22:34
4-Methyl-2-pentanone	< 6,500	6,500	µg/Kg-dry	01/08/2003 22:34
cis-1,3-Dichloropropene	< 650	650	µg/Kg-dry	01/08/2003 22:34
Toluene	< 650	650	µg/Kg-dry	01/08/2003 22:34
trans-1,3-Dichloropropene	< 650	650	µg/Kg-dry	01/08/2003 22:34
1,1,2-Trichloroethane	< 650	650	µg/Kg-dry	01/08/2003 22:34
2-Hexanone	< 6,500	6,500	µg/Kg-dry	01/08/2003 22:34
Tetrachloroethene	< 650	650	µg/Kg-dry	01/08/2003 22:34
Dibromochloromethane	< 650	650	µg/Kg-dry	01/08/2003 22:34
Chlorobenzene	< 650	650	µg/Kg-dry	01/08/2003 22:34
Ethylbenzene	< 650	650	µg/Kg-dry	01/08/2003 22:34
m,p-Xylene	< 650	650	µg/Kg-dry	01/08/2003 22:34
o-Xylene	< 650	650	µg/Kg-dry	01/08/2003 22:34
Styrene	< 650	650	µg/Kg-dry	01/08/2003 22:34
Bromoform	< 650	650	µg/Kg-dry	01/08/2003 22:34
1,1,2,2-Tetrachloroethane	< 650	650	µg/Kg-dry	01/08/2003 22:34
Xylenes, Total	< 1,300	1,300	µg/Kg-dry	01/08/2003 22:34

Another Microbac Company

APPENDIX 8

Sediment Sampling Results from the Removal of WG's Two Piers, August and September 2003

Summary of Constituents in Samples

Washington Gas East Station, Dock/Pump House, Water Street, SE, Washington, DC 20003

Sampling Designation		S1A		S2A		S2B	S3A		S3B
Matrix		Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
Sampling Date		22-Aug-03	17-Sep-03	22-Aug-03	17-Sep-03	22-Aug-03	22-Aug-03	17-Sep-03	22-Aug-03
Constituents	Detection Limits								
INORGANICS / Units	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Mercury	0.084	< 0.026	0.047	0.38	0.34	0.86	0.30	0.32	0.36
Aluminum	5.0	2,000	2,200	16,000	15,000	17,000	14,000	17,000	14,000
Antimony	25	< 25	< 25	< 25	< 25	< 24	< 25	< 25	< 25
Arsenic	250	< 250	< 25	< 250	< 25	< 240	< 250	< 25	< 250
Barium	5.0	56	40	140	150	160	140	140	140
Beryllium	0.25	0.28	< 0.25	1.6	1.5	1.3	1.6	1.6	1.5
Cadmium	0.50	< 0.49	< 0.50	1.2	1.1	< 0.49	1.3	1.3	1.8
Calcium	25	17,000	11,000	3,800	3,800	1,700	3,800	3,600	3,100
Chromium	1.0	15	16	56	52	27	56	61	59
Cobalt	0.50	< 0.49	< 2.5	9.5	5.9	2.4	7.8	7.0	6.0
Copper	5.0	40	29	92	85	26	83	87	79
Iron	50	16,000	19,000	37,000	35,000	34,000	35,000	35,000	35,000
Lead	50	260	160	110	1,400	25	120	110	240
Magnesium	5.0	8,300	7,700	3,800	3,700	2,800	3,700	4,100	3,400
Manganese	5.0	130	110	470	440	680	440	430	390
Nickel	1.0	27	22	43	40	20	42	44	45
Potassium	5.0	210	210	1,400	1,400	1,400	1,300	1,500	1,300
Selenium	25	< 25	< 25	< 25	< 25	< 24	< 25	< 25	< 25
Silver	1.0	< 0.98	< 0.99	1.4	1.4	< 0.98	1.3	1.3	1.9
Sodium	25	55	63	130	120	53	120	130	82
Thallium	25	< 25	< 25	< 25	< 25	< 24	< 25	< 25	< 25
Vanadium	5.0	12	15	57	53	49	55	59	66
Zinc	10	130	41	390	300	79	370	350	390
PMOIST - % WT.	0.05	34	23	62	59	36	64	62	49
ORGANICS / Units	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Gasoline Range Organics	13	< 9.5	< 10	< 10	< 10	< 10	< 9.9	< 11	< 8.3
Diesel Range Organics	10	1,900	500	660	610	23	680	530	2,000
TotalPetroleumHydrocarbons	10	2,000	1,000	2,300	1,500	140	2,300	1,100	4,100
VOC TCL S / Units	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry
1,1,1-Trichloroethane	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
1,1,2,2-Tetrachloroethane	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
1,1,2-Trichloroethane	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
1,1-Dichloroethane	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
1,1-Dichloroethene	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
1,2-Dichloroethane	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
1,2-Dichloropropane	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
2-Butanone	8,200	< 7,200	< 6,700	< 14,000	< 12,000	< 7,900	< 14,000	< 14,000	< 8,200
2-Hexanone	4,100	< 3,600	< 3,300	< 6,800	< 6,200	< 4,000	< 6,900	< 7,100	< 4,100
4-Methyl-2-pentanone	4,100	< 3,600	< 3,300	< 6,800	< 6,200	< 4,000	< 6,900	< 7,100	< 4,100
Acetone	8,200	< 7,200	< 6,700	< 14,000	< 12,000	< 7,900	< 14,000	< 14,000	< 8,200
Benzene	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
Bromodichloromethane	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
Bromoform	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
Bromomethane	820	< 720	< 670	< 1,400	< 1,200	< 790	< 1,400	< 1,400	< 820
Carbon disulfide	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
Carbon tetrachloride	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
Chlorobenzene	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
Chloroethane	820	< 720	< 670	< 1,400	< 1,200	< 790	< 1,400	< 1,400	< 820
Chloroform	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
Chloromethane	820	< 720	< 670	< 1,400	< 1,200	< 790	< 1,400	< 1,400	< 820
cis-1,2-Dichloroethene	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
cis-1,3-Dichloropropene	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
Dibromochloromethane	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
Ethylbenzene	410	550	< 330	< 680	< 620	< 400	< 690	< 710	< 410
m,p-Xylene	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
Methylene chloride	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
o-Xylene	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
Styrene	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
Tetrachloroethene	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
Toluene	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
trans-1,2-Dichloroethene	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
trans-1,3-Dichloropropene	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
Trichloroethene	410	< 360	< 330	< 680	< 620	< 400	< 690	< 710	< 410
Vinyl chloride	820	< 720	< 670	< 1,400	< 1,200	< 790	< 1,400	< 1,400	< 820
Xylenes, Total	820	< 720	< 670	< 1,400	< 1,200	< 790	< 1,400	< 1,400	< 820

"A" samples are composites taken from 0-6 inches depth; "B" samples are composites taken from 7-18 inches depth at the same location.

* Designates estimated values

Summary of Constituents in Samples

Washington Gas East Station, Dock/Pump House, Water Street, SE, Washington, DC 20003

Sampling Designation		S1A		S2A		S2B	S3A		S3B
Matrix		Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
Sampling Date		22-Aug-03	17-Sep-03	22-Aug-03	17-Sep-03	22-Aug-03	22-Aug-03	17-Sep-03	22-Aug-03
TCL SV S / Units	µg/Kg-dry	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-dry
1,2,4-Trichlorobenzene	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
1,2-Dichlorobenzene	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
1,3-Dichlorobenzene	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
1,4-Dichlorobenzene	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
2,4,5-Trichlorophenol	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
2,4,6-Trichlorophenol	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
2,4-Dichlorophenol	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
2,4-Dimethylphenol	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
2,4-Dinitrophenol	2,700	< 2,600	< 4,400	< 4,500	< 8,300	< 2,700	< 4,700	< 4,500	< 3,300
2,4-Dinitrotoluene	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
2,6-Dinitrotoluene	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
2-Chloronaphthalene	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
2-Chlorophenol	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
2-Methylnaphthalene	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
2-Methylphenol	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
2-Nitroaniline	2,700	< 2,600	< 4,400	< 4,500	< 8,300	< 2,700	< 4,700	< 4,500	< 3,300
2-Nitrophenol	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
3,3'-Dichlorobenzidine	1,100	< 1,000	< 1,700	< 1,800	< 3,300	< 1,000	< 1,900	< 1,800	< 1,300
3-Nitroaniline	2,700	< 2,600	< 4,400	< 4,500	< 8,300	< 2,700	< 4,700	< 4,500	< 3,300
4,6-Dinitro-2-methylphenol	2,700	< 2,600	< 4,400	< 4,500	< 8,300	< 2,700	< 4,700	< 4,500	< 3,300
4-Bromophenyl phenyl ether	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
4-Chloro-3-methylphenol	1,100	< 1,000	< 1,700	< 1,800	< 3,300	< 1,000	< 1,900	< 1,800	< 1,300
4-Chloroaniline	1,100	< 1,000	< 1,700	< 1,800	< 3,300	< 1,000	< 1,900	< 1,800	< 1,300
4-Chlorophenyl phenyl ether	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
4-Methylphenol,3-	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
4-Nitroaniline	2,700	< 2,600	< 4,400	< 4,500	< 8,300	< 2,700	< 4,700	< 4,500	< 3,300
4-Nitrophenol	2,700	< 2,600	< 4,400	< 4,500	< 8,300	< 2,700	< 4,700	< 4,500	< 3,300
Acenaphthene	520	9,000	2,500	< 870	7,000	< 520	< 920	< 870	< 650
Acenaphthylene	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
Anthracene	520	3,700	1,500	< 870	2,100	< 520	< 920	< 870	< 650
Benz(a)anthracene	1,100	6,700	6,100	1600 *	8,100	< 520	< 920	870*	790 *
Benzo(a)pyrene	2,700	4700 *	7900*	1500 *	8000*	< 520	< 920	1600*	800 *
Benzo(b)fluoranthene	520	3300 *	4900*	2600 *	6200*	< 520	< 920	1600*	1100 *
Benzo(g,h,i)perylene	520	4700 *	11000*	1300 *	5600*	< 520	< 920	2100*	910 *
Benzo(k)fluoranthene	520	3700 *	5100*	1300 *	6800*	< 520	< 920	2100*	< 650
Bis(2-chloroethoxy)methane	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
Bis(2-chloroethyl)ether	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
Bis(2-chloroisopropyl)ether	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
Bis(2-ethylhexyl)phthalate	520	< 500	< 860	3600 *	6,000	< 520	3,000	7,500	4,200
Butyl benzyl phthalate	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
Carbazole	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
Chrysene	1,100	7,100	6,400	4200 *	8,800	< 520	< 920	1400*	840 *
Di-n-butyl phthalate	520	< 500	< 860	< 870	< 4,000	< 520	< 920	< 870	< 650
Di-n-octyl phthalate	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
Dibenz(a,h)anthracene	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
Dibenzofuran	520	< 500	< 860	1,700	< 1,600	< 520	< 920	< 870	< 650
Diethyl phthalate	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
Dimethyl phthalate	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
Fluoranthene	520	6,900	8,900	9,100	8,700	< 520	< 920	1,300	870
Fluorene	520	4,700	1,400	2,000	5,100	< 520	< 920	< 870	< 650
Hexachlorobenzene	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
Hexachlorobutadiene	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
Hexachlorocyclopentadiene	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
Hexachloroethane	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
Indeno(1,2,3-cd)pyrene	520	3000 *	5600*	1100 *	3300*	< 520	< 920	1500*	< 650
Isophorone	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
N-Nitrosodi-n-propylamine	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
N-Nitrosodiphenylamine	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
Naphthalene	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
Nitrobenzene	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
Pentachlorophenol	2,700	< 2,600	< 4,400	< 4,500	< 8,300	< 2,700	< 4,700	< 4,500	< 3,300
Phenanthrene	1,100	16,000	3,500	21,000	23,000	< 520	< 920	< 870	1,400
Phenol	520	< 500	< 860	< 870	< 1,600	< 520	< 920	< 870	< 650
Pyrene	1,100	26,000	32,000	13,000	32,000	< 520	2200 *	3200*	3900 *

"A" samples are composites taken from 0-6 inches depth; "B" samples are composites taken from 7-18 inches depth at the same location.
* Designates estimated values

Summary of Constituents in Samples

Washington Gas East Station, Dock/Pump House, Water Street, SE, Washington, DC 20003

Sampling Designation		S4A		S4B	S5A		S5B	S6A	
Matrix		Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
Sampling Date		22-Aug-03	17-Sep-03	22-Aug-03	22-Aug-03	17-Sep-03	22-Aug-03	22-Aug-03	17-Sep-03
Constituents	Detection Limits								
INORGANICS / Units	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Mercury	0.084	0.31	0.34	0.42	1.9	0.48	1.5	0.18	0.046
Aluminum	5.0	14,000	16,000	14,000	13,000	13,000	17,000	7,800	3,400
Antimony	25	< 25	< 25	< 25	< 25	< 25	< 25	< 24	< 25
Arsenic	250	< 250	< 25	< 250	< 250	< 25	< 250	< 240	< 25
Barium	5.0	140	140	150	130	130	170	83	58
Beryllium	0.25	1.6	1.6	1.5	1.4	1.1	1.3	0.77	0.36
Cadmium	0.50	1.4	1.3	1.7	1.1	0.66	< 0.50	< 0.49	< 0.50
Calcium	25	3,600	4,200	3,300	5,800	2,600	1,800	9,100	9,800
Chromium	1.0	55	57	55	48	34	24	19	20
Cobalt	0.50	9.0	6.8	7.1	11	5.4	3.0	< 0.49	< 2.5
Copper	5.0	92	91	92	89	50	27	64	52
Iron	50	35,000	40,000	35,000	36,000	29,000	33,000	28,000	23,000
Lead	50	120	120	220	110	99	22	130	120
Magnesium	5.0	3,800	3,800	3,600	3,400	2,700	2,900	1,900	7,300
Manganese	5.0	420	470	370	500	530	680	200	150
Nickel	1.0	45	46	48	42	28	21	17	43
Potassium	5.0	1,400	1,400	1,300	1,300	1,200	1,500	670	500
Selenium	25	< 25	< 25	< 25	< 25	< 25	< 25	< 24	< 25
Silver	1.0	1.5	1.5	2.4	1.4	< 0.99	< 0.99	< 0.97	< 1.0
Sodium	25	120	130	98	140	91	59	82	76
Thallium	25	< 25	< 25	< 25	< 25	< 25	< 25	< 24	< 25
Vanadium	5.0	57	58	65	53	46	47	28	16
Zinc	10	390	350	400	370	170	81	110	60
PMOIST - % WT.	0.05	60	65	53	46	43	36	32	22
ORGANICS / Units	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Gasoline Range Organics	13	< 10	< 10	< 11	< 9.6	< 10	< 9.4	< 9.8	< 10
Diesel Range Organics	10	660	570	1,100	580	260	17	1,300	500
TotalPetroleumHydrocarbons	10	4,200	1,700	3,400	2,200	1,500	210	2,400	1,400
VOC TCL S / Units	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry
1,1,1-Trichloroethane	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
1,1,2,2-Tetrachloroethane	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
1,1,2-Trichloroethane	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
1,1-Dichloroethane	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
1,1-Dichloroethene	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
1,2-Dichloroethane	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
1,2-Dichloropropane	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
2-Butanone	8,200	< 13,000	< 14,000	< 11,000	< 8,900	< 8,700	< 7,400	< 7,200	< 6,400
2-Hexanone	4,100	< 6,500	< 7,100	< 5,700	< 4,400	< 4,400	< 3,700	< 3,600	< 3,200
4-Methyl-2-pentanone	4,100	< 6,500	< 7,100	< 5,700	< 4,400	< 4,400	< 3,700	< 3,600	< 3,200
Acetone	8,200	< 13,000	< 14,000	< 11,000	< 8,900	< 8,700	< 7,400	< 7,200	< 6,400
Benzene	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
Bromodichloromethane	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
Bromoform	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
Bromomethane	820	< 1,300	< 1,400	< 1,100	< 890	< 870	< 740	< 720	< 640
Carbon disulfide	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
Carbon tetrachloride	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
Chlorobenzene	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
Chloroethane	820	< 1,300	< 1,400	< 1,100	< 890	< 870	< 740	< 720	< 640
Chloroform	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
Chloromethane	820	< 1,300	< 1,400	< 1,100	< 890	< 870	< 740	< 720	< 640
cis-1,2-Dichloroethene	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
cis-1,3-Dichloropropene	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
Dibromochloromethane	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
Ethylbenzene	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
m,p-Xylene	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
Methylene chloride	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
o-Xylene	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
Styrene	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
Tetrachloroethene	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
Toluene	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
trans-1,2-Dichloroethene	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
trans-1,3-Dichloropropene	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
Trichloroethene	410	< 650	< 710	< 570	< 440	< 440	< 370	< 360	< 320
Vinyl chloride	820	< 1,300	< 1,400	< 1,100	< 890	< 870	< 740	< 720	< 640
Xylenes, Total	820	< 1,300	< 1,400	< 1,100	< 890	< 870	< 740	< 720	< 640

"A" samples are composites taken from 0-6 inches depth; "B" samples are composites taken from 7-18 inches depth at the same location.

* Designates estimated values

Summary of Constituents in Samples

Washington Gas East Station, Dock/Pump House, Water Street, SE, Washington, DC 20003

Sampling Designation		S4A		S4B	S5A		S5B	S6A	
Matrix		Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
Sampling Date		22-Aug-03	17-Sep-03	22-Aug-03	22-Aug-03	17-Sep-03	22-Aug-03	22-Aug-03	17-Sep-03
TCL SV S / Units	µg/Kg-dry	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-
1,2,4-Trichlorobenzene	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
1,2-Dichlorobenzene	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
1,3-Dichlorobenzene	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
1,4-Dichlorobenzene	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
2,4,5-Trichlorophenol	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
2,4,6-Trichlorophenol	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
2,4-Dichlorophenol	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
2,4-Dimethylphenol	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
2,4-Dinitrophenol	2,700	< 4,200	< 4,900	< 3,600	< 3,100	< 3,000	< 2,700	< 2,500	< 4,400
2,4-Dinitrotoluene	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
2,6-Dinitrotoluene	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
2-Chloronaphthalene	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
2-Chlorophenol	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
2-Methylnaphthalene	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
2-Methylphenol	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
2-Nitroaniline	2,700	< 4,200	< 4,900	< 3,600	< 3,100	< 3,000	< 2,700	< 2,500	< 4,400
2-Nitrophenol	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
3,3'-Dichlorobenzidine	1,100	< 1,700	< 1,900	< 1,400	< 1,200	< 1,200	< 1,000	< 990	< 1,700
3-Nitroaniline	2,700	< 4,200	< 4,900	< 3,600	< 3,100	< 3,000	< 2,700	< 2,500	< 4,400
4,6-Dinitro-2-methylphenol	2,700	< 4,200	< 4,900	< 3,600	< 3,100	< 3,000	< 2,700	< 2,500	< 4,400
4-Bromophenyl phenyl ether	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
4-Chloro-3-methylphenol	1,100	< 1,700	< 1,900	< 1,400	< 1,200	< 1,200	< 1,000	< 990	< 1,700
4-Chloroaniline	1,100	< 1,700	< 1,900	< 1,400	< 1,200	< 1,200	< 1,000	< 990	< 1,700
4-Chlorophenyl phenyl ether	520	< 820	< 940	< 700	< 610	<580	< 520	< 490	< 850
4-Methylphenol,3-	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
4-Nitroaniline	2,700	< 4,200	< 4,900	< 3,600	< 3,100	< 3,000	< 2,700	< 2,500	< 4,400
4-Nitrophenol	2,700	< 4,200	< 4,900	< 3,600	< 3,100	< 3,000	< 2,700	< 2,500	< 4,400
Acenaphthene	520	1,700	< 940	< 700	990	610	< 520	15,000	2,300
Acenaphthylene	520	< 820	< 940	< 700	< 610	< 580	< 520	690	< 850
Anthracene	520	880	< 940	< 700	1,000	< 580	< 520	13,000	1,100
Benz(a)anthracene	1,100	870	1300*	920 *	3,200	1300*	< 520	15,000	2300*
Benzo(a)pyrene	2,700	1,000	2100*	900 *	2800 *	1900*	< 520	10000 *	3300*
Benzo(b)fluoranthene	520	1,200	2100*	< 700	1700 *	1300*	< 520	5600 *	1500*
Benzo(g,h,i)perylene	520	2,000	1700*	< 700	1600 *	2500*	< 520	6100 *	2600*
Benzo(k)fluoranthene	520	< 820	2400*	< 700	2300 *	1100*	< 520	8400 *	2500*
Bis(2-chloroethoxy)methane	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
Bis(2-chloroethyl)ether	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
Bis(2-chloroisopropyl)ether	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
Bis(2-ethylhexyl)phthalate	520	3,500	6500*	9,800	1900 *	2500*	< 520	< 490	< 850
Butyl benzyl phthalate	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
Carbazole	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
Chrysene	1,100	< 820	2000*	870 *	3900 *	1500*	< 520	15,000	2800*
Di-n-butyl phthalate	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
Di-n-octyl phthalate	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
Dibenz(a,h)anthracene	520	< 820	< 940	< 700	< 610	< 580	< 520	1800 *	< 850
Dibenzofuran	520	< 820	< 940	< 700	< 610	< 580	< 520	830	< 850
Diethyl phthalate	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
Dimethyl phthalate	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
Fluoranthene	520	2,500	1,700	1,300	4,100	2,000	< 520	28,000	4,900
Fluorene	520	5,500	< 940	< 700	1,100	670	< 520	10,000	1,500
Hexachlorobenzene	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
Hexachlorobutadiene	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
Hexachlorocyclopentadiene	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
Hexachloroethane	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
Indeno(1,2,3-cd)pyrene	520	840	1800*	< 700	1400 *	1600*	< 520	4200 *	1500*
Isophorone	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
N-Nitrosodi-n-propylamine	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
N-Nitrosodiphenylamine	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
Naphthalene	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
Nitrobenzene	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
Pentachlorophenol	2,700	< 4,200	< 4,900	< 3,600	< 3,100	< 3,000	< 2,700	< 2,500	< 4,400
Phenanthrene	1,100	14,000	1,800	1,500	5,600	2,400	< 520	50,000	2,700
Phenol	520	< 820	< 940	< 700	< 610	< 580	< 520	< 490	< 850
Pyrene	1,100	6,800	4900*	4500 *	9,300	6500*	< 520	46,000	11,000

"A" samples are composites taken from 0-6 inches depth; "B" samples are composites taken from 7-18 inches depth at the same location.

* Designates estimated values

Summary of Constituents in Samples

Washington Gas East Station, Dock/Pump House, Water Street, SE, Washington, DC 20003

Sampling Designation		S7A		S7B	S8A		S8B	S9A		S9B	S10A	
Matrix		Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
Sampling Date		21-Aug-03	17-Sep-03	21-Aug-03	21-Aug-03	21-Aug-03	17-Sep-03	21-Aug-03	17-Sep-03	21-Aug-03	22-Aug-03	17-Sep-03
Constituents	Detection Limits											
INORGANICS / Units	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Mercury	0.084	0.39	0.34	0.41	0.34	0.40	0.28	0.32	0.43	0.31	0.54	0.19
Aluminum	5.0	16,000	11,000	15,000	14,000	15,000	14,000	13,000	17,000	13,000	13,000	16,000
Antimony	25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25
Arsenic	250	< 250	< 25	< 250	< 250	< 250	< 25	< 250	< 25	< 250	< 250	< 25
Barium	5.0	140	110	140	130	150	130	120	130	120	160	140
Beryllium	0.25	1.6	1.0	1.5	1.5	1.7	1.4	1.4	1.6	1.3	1.3	1.4
Cadmium	0.50	1.4	1.1	1.6	1.5	1.7	1.5	1.3	1.4	1.3	1.6	0.88
Calcium	25	3,300	3,500	3,700	2,800	3,200	2,900	2,800	3,200	2,500	2,700	2,800
Chromium	1.0	56	40	57	54	60	53	50	58	48	46	44
Cobalt	0.50	10	6.7	8.4	6.9	8.4	8.9	8.5	6.2	6.9	< 0.49	9.2
Copper	5.0	92	63	100	85	99	83	80	78	73	130	69
Iron	50	34,000	26,000	3,500	33,000	36,000	33,000	31,000	35,000	30,000	61,000	34,000
Lead	50	130	230	180	130	160	140	130	110	120	200	80
Magnesium	5.0	4,000	2,700	4,000	3,800	4,100	3,800	3,500	3,900	3,300	2,600	3,400
Manganese	5.0	380	270	400	400	420	350	320	430	320	480	460
Nickel	1.0	48	37	51	45	49	46	43	44	41	40	36
Potassium	5.0	1,500	1,000	1,400	1,300	1,400	1,400	1,300	1,500	1,200	1,100	1,500
Selenium	25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25
Silver	1.0	1.9	1.6	2.5	2.0	2.2	1.9	1.7	1.6	1.6	2.4	1.2
Sodium	25	120	87	110	120	110	110	110	120	92	98	99
Thallium	25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25
Vanadium	5.0	60	46	63	55	61	56	53	59	50	53	54
Zinc	10	400	260	430	380	440	340	360	320	330	600	230
PMOIST - % WT.	0.05	66	57	52	60	57	57	62	58	52	57	65
ORGANICS / Units	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Gasoline Range Organics	13	< 11	< 9.8	< 10	< 11	< 12	< 10	< 13	< 10	< 12	< 9.4	< 9.8
Diesel Range Organics	10	710	950	1,300	700	1,000	970	670	250	950	6,300	500
TotalPetroleumHydrocarbons	10	4,200	2,900	4,900	2,800	3,200	2,000	3,400	1,400	4,000	1,800	1,100
VOC TCL S / Units	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry
1,1,1-Trichloroethane	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
1,1,2,2-Tetrachloroethane	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
1,1,2-Trichloroethane	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
1,1-Dichloroethane	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
1,1-Dichloroethene	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
1,2-Dichloroethane	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
1,2-Dichloropropane	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
2-Butanone	8,200	< 16,000	< 11,000	< 11,000	< 14,000	< 14,000	< 12,000	< 16,000	< 12,000	< 13,000	< 11,000	< 14,000
2-Hexanone	4,100	< 8,000	< 5,700	< 5,400	< 7,000	< 7,200	< 5,800	< 8,200	< 5,900	< 6,400	< 5,400	< 7,000
4-Methyl-2-pentanone	4,100	< 8,000	< 5,700	< 5,400	< 7,000	< 7,200	< 5,800	< 8,200	< 5,900	< 6,400	< 5,400	< 7,000
Acetone	8,200	< 16,000	< 11,000	< 11,000	< 14,000	< 14,000	< 12,000	< 16,000	< 12,000	< 13,000	< 11,000	< 14,000
Benzene	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
Bromodichloromethane	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
Bromoform	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
Bromomethane	820	< 1,600	< 1,100	< 1,100	< 1,400	< 1,400	< 1,200	< 1,600	< 1,200	< 1,300	< 1,100	< 1,400
Carbon disulfide	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
Carbon tetrachloride	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
Chlorobenzene	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
Chloroethane	820	< 1,600	< 1,100	< 1,100	< 1,400	< 1,400	< 1,200	< 1,600	< 1,200	< 1,300	< 1,100	< 1,400
Chloroform	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
Chloromethane	820	< 1,600	< 1,100	< 1,100	< 1,400	< 1,400	< 1,200	< 1,600	< 1,200	< 1,300	< 1,100	< 1,400
cis-1,2-Dichloroethene	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
cis-1,3-Dichloropropene	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
Dibromochloromethane	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
Ethylbenzene	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
m,p-Xylene	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
Methylene chloride	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
o-Xylene	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
Styrene	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
Tetrachloroethene	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
Toluene	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
trans-1,2-Dichloroethene	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
trans-1,3-Dichloropropene	410	< 800	< 570	< 540	< 700	< 720	< 580	< 820	< 590	< 640	< 540	< 700
Trichloroethene	820	< 1,600	< 1,100	< 1,100	< 1,400	< 1,400	< 1,200	< 1,600	< 1,200	< 1,300	< 1,100	< 1,400
Vinyl chloride	820	< 1,600	< 1,100	< 1,100	< 1,400	< 1,400	< 1,200	< 1,600	< 1,200	< 1,300	< 1,100	< 1,400
Xylenes, Total												

"A" samples are composites taken from 0-6 inches depth; "B" samples are composites taken from 7-18 inches depth at the same location.

* Designates estimated values

Summary of Constituents in Samples

Washington Gas East Station, Dock/Pump House, Water Street, SE, Washington, DC 20003

Sampling Designation		S7A		S7B	S8A		S8B	S9A		S9B	S10A	
Matrix		Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
Sampling Date		21-Aug-03	17-Sep-03	21-Aug-03	21-Aug-03	21-Aug-03	17-Sep-03	21-Aug-03	17-Sep-03	21-Aug-03	22-Aug-03	17-Sep-03
TCL SV S / Units	µg/Kg-dry	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-dry
1,2,4-Trichlorobenzene	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
1,2-Dichlorobenzene	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
1,3-Dichlorobenzene	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
1,4-Dichlorobenzene	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
2,4,5-Trichlorophenol	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
2,4,6-Trichlorophenol	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
2,4-Dichlorophenol	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
2,4-Dimethylphenol	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
2,4-Dinitrophenol	2,700	< 5,000	< 7,900	< 3,500	< 4,200	< 4,000	< 7,900	< 4,500	< 4,000	< 3,500	< 4,000	< 24,000
2,4-Dinitrotoluene	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
2,6-Dinitrotoluene	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
2-Chloronaphthalene	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
2-Chlorophenol	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
2-Methylnaphthalene	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	27,000	< 4,700
2-Methylphenol	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
2-Nitroaniline	2,700	< 5,000	< 7,900	< 3,500	< 4,200	< 4,000	< 7,900	< 4,500	< 4,000	< 3,500	< 4,000	< 24,000
2-Nitrophenol	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
3,3'-Dichlorobenzidine	1,100	< 2,000	< 3,100	< 1,400	< 1,700	< 1,600	< 3,100	< 1,800	< 1,600	< 1,400	< 1,600	< 9,600
3-Nitroaniline	2,700	< 5,000	< 7,900	< 3,500	< 4,200	< 4,000	< 7,900	< 4,500	< 4,000	< 3,500	< 4,000	< 24,000
4,6-Dinitro-2-methylphenol	2,700	< 5,000	< 7,900	< 3,500	< 4,200	< 4,000	< 7,900	< 4,500	< 4,000	< 3,500	< 4,000	< 24,000
4-Bromophenyl phenyl ether	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
4-Chloro-3-methylphenol	1,100	< 2,000	< 3,100	< 1,400	< 1,700	< 1,600	< 3,100	< 1,800	< 1,600	< 1,400	< 1,600	< 9,600
4-Chloroaniline	1,100	< 2,000	< 3,100	< 1,400	< 1,700	< 1,600	< 3,100	< 1,800	< 1,600	< 1,400	< 1,600	< 9,600
4-Chlorophenyl phenyl ether	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
4-Methylphenol,3-	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
4-Nitroaniline	2,700	< 5,000	< 7,900	< 3,500	< 4,200	< 4,000	< 7,900	< 4,500	< 4,000	< 3,500	< 4,000	< 24,000
4-Nitrophenol	2,700	< 5,000	< 7,900	< 3,500	< 4,200	< 4,000	< 7,900	< 4,500	< 4,000	< 3,500	< 4,000	< 24,000
Acenaphthene	520	< 970	< 1,500	2,400	< 820	< 770	< 1,500	< 870	< 790	1,300	54,000	7,800
Acenaphthylene	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	2,100	< 4,700
Anthracene	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	36,000	5,700
Benz(a)anthracene	1,100	1300 *	< 1,500	1300 *	< 820	1100 *	< 1,500	1000 *	870*	1500 *	26,000	5000*
Benzo(a)pyrene	2,700	< 970	1,800	< 690	< 820	1100 *	1700*	1100 *	1500*	1300 *	20000 *	6500*
Benzo(b)fluoranthene	520	2200 *	< 1,500	1200 *	< 820	1400 *	< 1,500	1000 *	1900*	1200 *	11000 *	5000*
Benzo(g,h,i)perylene	520	1800 *	1,800	1300 *	< 820	1200 *	1800*	1200 *	1800*	1400 *	9000 *	< 4,700
Benzo(k)fluoranthene	520	1100 *	< 1,500	880 *	< 820	< 770	1700*	< 870	1500*	750 *	16000 *	5000*
Bis(2-chloroethoxy)methane	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
Bis(2-chloroethyl)ether	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
Bis(2-chloroisopropyl)ether	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
Bis(2-ethylhexyl)phthalate	520	7,900	5,100	6,000	2400 *	6,800	5600*	4,700	3800*	4,000	< 770	5100*
Butyl benzyl phthalate	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
Carbazole	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
Chrysene	1,100	2200 *	< 1,500	1500 *	< 820	1300 *	< 1,500	1300 *	1400*	2100 *	30,000	6700*
Di-n-butyl phthalate	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
Di-n-octyl phthalate	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
Dibenz(a,h)anthracene	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
Dibenzofuran	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	2,600	< 4,700
Diethyl phthalate	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
Dimethyl phthalate	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
Fluoranthene	520	2,900	1,800	1,400	< 820	1,100	1,700	1,400	1,600	2,100	39,000	10,000
Fluorene	520	< 970	< 1,500	1,300	< 820	< 770	< 1,500	< 870	< 790	800	31,000	5,200
Hexachlorobenzene	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
Hexachlorobutadiene	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
Hexachlorocyclopentadiene	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
Hexachloroethane	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
Indeno(1,2,3-cd)pyrene	520	1400 *	< 1,500	1000 *	< 820	940 *	< 1,500	900 *	1600*	960 *	6700 *	< 4,700
Isophorone	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
N-Nitrosodi-n-propylamine	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
N-Nitrosodiphenylamine	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
Naphthalene	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	1,300	< 4,700
Nitrobenzene	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
Pentachlorophenol	2,700	< 5,000	< 7,900	< 3,500	< 4,200	< 4,000	< 7,900	< 4,500	< 4,000	< 3,500	< 4,000	< 24,000
Phenanthrene	1,100	4,700	2,900	3,700	< 820	2,100	< 1,500	2,400	1,200	3,400	110,000	22,000
Phenol	520	< 970	< 1,500	< 690	< 820	< 770	< 1,500	< 870	< 790	< 690	< 770	< 4,700
Pyrene	1,100	7,200	5,900	5,000	1400 *	4700 *	3700*	6,100	3300*	6,500	99,000	25,000

"A" samples are composites taken from 0-6 inches depth; "B" samples are composites taken from 7-18 inches depth at the same location.

* Designates estimated values

Summary of Constituents in Samples

Washington Gas East Station, Dock/Pump House, Water Street, SE, Washington, DC 20003

Sampling Designation		S10B	S11A		S12A		S12B
Matrix		Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
Sampling Date		21-Aug-03	21-Aug-03	17-Sep-03	21-Aug-03	17-Sep-03	21-Aug-03
Constituents	Detection Limits						
INORGANICS / Units	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Mercury	0.084	0.18	0.91	0.19	0.27	0.50	0.33
Aluminum	5.0	17,000	17,000	7,700	15,000	16,000	16,000
Antimony	25	< 25	< 25	< 25	< 25	< 25	< 25
Arsenic	250	< 250	< 250	< 25	< 250	< 25	< 250
Barium	5.0	180	170	200	140	130	150
Beryllium	0.25	1.4	1.3	0.62	1.6	1.6	1.6
Cadmium	0.50	< 0.50	< 0.50	0.68	1.3	1.3	1.6
Calcium	25	2,400	2,700	22,000	3,200	3,100	3,200
Chromium	1.0	26	29	46	55	56	59
Cobalt	0.50	1.3	2.1	< 2.5	8.3	6.7	7.1
Copper	5.0	31	39	93	83	75	96
Iron	50	42,000	36,000	58,000	35,000	34,000	37,000
Lead	50	30	48	210	130	100	170
Magnesium	5.0	2,800	3,100	14,000	3,700	3,800	4,100
Manganese	5.0	1,800	1,000	240	420	370	480
Nickel	1.0	22	22	62	43	42	48
Potassium	5.0	1,400	1,500	590	1,400	1,500	1,400
Selenium	25	< 25	< 25	< 25	< 25	< 25	< 25
Silver	1.0	< 1.0	< 1.0	1.0	1.3	1.4	2.2
Sodium	25	62	75	78	110	120	96
Thallium	25	< 25	< 25	< 25	< 25	< 25	< 25
Vanadium	5.0	49	52	38	55	56	61
Zinc	10	86	120	170	370	310	420
PMOIST - % WT.	0.05	38	40	35	56	58	52
ORGANICS / Units	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Gasoline Range Organics	13	< 10	< 11	< 9.9	< 12	< 10	< 12
Diesel Range Organics	10	150	1,600	2,000	560	490	1,100
TotalPetroleumHydrocarbons	10	360	3,900	2,900	3,800	1,800	4,200
VOC_TCL_S / Units	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry
1,1,1-Trichloroethane	410	< 400	< 470	< 380	< 700	< 590	< 630
1,1,2,2-Tetrachloroethane	410	< 400	< 470	< 380	< 700	< 590	< 630
1,1,2-Trichloroethane	410	< 400	< 470	< 380	< 700	< 590	< 630
1,1-Dichloroethane	410	< 400	< 470	< 380	< 700	< 590	< 630
1,1-Dichloroethene	410	< 400	< 470	< 380	< 700	< 590	< 630
1,2-Dichloroethane	410	< 400	< 470	< 380	< 700	< 590	< 630
1,2-Dichloropropane	410	< 400	< 470	< 380	< 700	< 590	< 630
2-Butanone	8,200	< 8,000	< 9,500	< 7,600	< 14,000	< 12,000	< 13,000
2-Hexanone	4,100	< 4,000	< 4,700	< 3,800	< 7,000	< 5,900	< 6,300
4-Methyl-2-pentanone	4,100	< 4,000	< 4,700	< 3,800	< 7,000	< 5,900	< 6,300
Acetone	8,200	< 8,000	< 9,500	< 7,600	< 14,000	< 12,000	< 13,000
Benzene	410	< 400	< 470	< 380	< 700	< 590	< 630
Bromodichloromethane	410	< 400	< 470	< 380	< 700	< 590	< 630
Bromoform	410	< 400	< 470	< 380	< 700	< 590	< 630
Bromomethane	820	< 800	< 950	< 760	< 1,400	< 1,200	< 1,300
Carbon disulfide	410	< 400	< 470	< 380	< 700	< 590	< 630
Carbon tetrachloride	410	< 400	< 470	< 380	< 700	< 590	< 630
Chlorobenzene	410	< 400	< 470	< 380	< 700	< 590	< 630
Chloroethane	820	< 800	< 950	< 760	< 1,400	< 1,200	< 1,300
Chloroform	410	< 400	< 470	< 380	< 700	< 590	< 630
Chloromethane	820	< 800	< 950	< 760	< 1,400	< 1,200	< 1,300
cis-1,2-Dichloroethene	410	< 400	< 470	< 380	< 700	< 590	< 630
cis-1,3-Dichloropropene	410	< 400	< 470	< 380	< 700	< 590	< 630
Dibromochloromethane	410	< 400	< 470	< 380	< 700	< 590	< 630
Ethylbenzene	410	< 400	< 470	840	< 700	< 590	< 630
m,p-Xylene	410	< 400	< 470	< 380	< 700	< 590	< 630
Methylene chloride	410	< 400	< 470	< 380	< 700	< 590	< 630
o-Xylene	410	< 400	< 470	< 380	< 700	< 590	< 630
Styrene	410	< 400	< 470	< 380	< 700	< 590	< 630
Tetrachloroethene	410	< 400	< 470	< 380	< 700	< 590	< 630
Toluene	410	< 400	< 470	< 380	< 700	< 590	< 630
trans-1,2-Dichloroethene	410	< 400	< 470	< 380	< 700	< 590	< 630
trans-1,3-Dichloropropene	410	< 400	< 470	< 380	< 700	< 590	< 630
Trichloroethene	410	< 400	< 470	< 380	< 700	< 590	< 630
Vinyl chloride	820	< 800	< 950	< 760	< 1,400	< 1,200	< 1,300
Xylenes, Total	820	< 800	< 950	< 760	< 1,400	< 1,200	< 1,300

"A" samples are composites taken from 0-6 inches depth; "B" samples are composites taken from 7-18 inches depth at the same location.
* Designates estimated values

Summary of Constituents in Samples

Washington Gas East Station, Dock/Pump House, Water Street, SE, Washington, DC 20003

Sampling Designation		S10B	S11A		S12A		S12B
Matrix		Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
Sampling Date		21-Aug-03	21-Aug-03	17-Sep-03	21-Aug-03	17-Sep-03	21-Aug-03
TCL SV S / Units	µg/Kg-dry	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-
1,2,4-Trichlorobenzene	520	< 530	< 550	< 2,500	< 750	< 790	< 690
1,2-Dichlorobenzene	520	< 530	< 550	< 2,500	< 750	< 790	< 690
1,3-Dichlorobenzene	520	< 530	< 550	< 2,500	< 750	< 790	< 690
1,4-Dichlorobenzene	520	< 530	< 550	< 2,500	< 750	< 790	< 690
2,4,5-Trichlorophenol	520	< 530	< 550	< 2,500	< 750	< 790	< 690
2,4,6-Trichlorophenol	520	< 530	< 550	< 2,500	< 750	< 790	< 690
2,4-Dichlorophenol	520	< 530	< 550	< 2,500	< 750	< 790	< 690
2,4-Dimethylphenol	520	< 530	< 550	< 2,500	< 750	< 790	< 690
2,4-Dinitrophenol	2,700	< 2,700	< 2,800	< 13,000	< 3,900	< 4,000	< 3,500
2,4-Dinitrotoluene	520	< 530	< 550	< 2,500	< 750	< 790	< 690
2,6-Dinitrotoluene	520	< 530	< 550	< 2,500	< 750	< 790	< 690
2-Chloronaphthalene	520	< 530	< 550	< 2,500	< 750	< 790	< 690
2-Chlorophenol	520	< 530	< 550	< 2,500	< 750	< 790	< 690
2-Methylnaphthalene	520	720	28,000	< 2,500	< 750	< 790	< 690
2-Methylphenol	520	< 530	< 550	< 2,500	< 750	< 790	< 690
2-Nitroaniline	2,700	< 2,700	< 2,800	< 13,000	< 3,900	< 4,000	< 3,500
2-Nitrophenol	520	< 530	< 550	< 2,500	< 750	< 790	< 690
3,3'-Dichlorobenzidine	1,100	< 1,100	< 1,100	< 5,200	< 1,500	< 1,600	< 1,400
3-Nitroaniline	2,700	< 2,700	< 2,800	< 13,000	< 3,900	< 4,000	< 3,500
4,6-Dinitro-2-methylphenol	2,700	< 2,700	< 2,800	< 13,000	< 3,900	< 4,000	< 3,500
4-Bromophenyl phenyl ether	520	< 530	< 550	< 2,500	< 750	< 790	< 690
4-Chloro-3-methylphenol	1,100	< 1,100	< 1,100	< 5,200	< 1,500	< 1,600	< 1,400
4-Chloroaniline	1,100	< 1,100	< 1,100	< 5,200	< 1,500	< 1,600	< 1,400
4-Chlorophenyl phenyl ether	520	< 530	< 550	< 2,500	< 750	< 790	< 690
4-Methylphenol,3-	520	< 530	< 550	< 2,500	< 750	< 790	< 690
4-Nitroaniline	2,700	< 2,700	< 2,800	< 13,000	< 3,900	< 4,000	< 3,500
4-Nitrophenol	2,700	< 2,700	< 2,800	< 13,000	< 3,900	< 4,000	< 3,500
Acenaphthene	520	2,900	84,000	7,700	< 750	< 790	< 690
Acenaphthylene	520	< 530	< 550	< 2,500	< 750	< 790	< 690
Anthracene	520	< 530	32,000	4,600	< 750	< 790	< 690
Benz(a)anthracene	1,100	< 530	20,000	4600*	< 750	< 790	< 690
Benzo(a)pyrene	2,700	< 530	20,000	5700*	< 750	1200*	910 *
Benzo(b)fluoranthene	520	< 530	11,000	3700*	880 *	940*	890 *
Benzo(g,h,i)perylene	520	< 530	7800 *	4300*	< 750	1100*	830 *
Benzo(k)fluoranthene	520	< 530	12000 *	4700*	< 750	1200*	< 690
Bis(2-chloroethoxy)methane	520	< 530	< 550	< 2,500	< 750	< 790	< 690
Bis(2-chloroethyl)ether	520	< 530	< 550	< 2,500	< 750	< 790	< 690
Bis(2-chloroisopropyl)ether	520	< 530	< 550	< 2,500	< 750	< 790	< 690
Bis(2-ethylhexyl)phthalate	520	< 530	< 550	< 2,500	3,200	3600*	2,800
Butyl benzyl phthalate	520	< 530	< 550	< 2,500	< 750	< 790	< 690
Carbazole	520	< 530	< 550	< 2,500	< 750	< 790	< 690
Chrysene	1,100	< 530	22,000	5500*	750 *	1100*	690 *
Di-n-butyl phthalate	520	< 530	< 550	< 2,500	< 750	< 790	< 690
Di-n-octyl phthalate	520	< 530	< 550	< 2,500	< 750	< 790	< 690
Dibenz(a,h)anthracene	520	< 530	< 550	< 2,500	< 750	< 790	< 690
Dibenzofuran	520	< 530	4,300	< 2,500	< 750	< 790	< 690
Diethyl phthalate	520	< 530	< 550	< 2,500	< 750	< 790	< 690
Dimethyl phthalate	520	< 530	< 550	< 2,500	< 750	< 790	< 690
Fluoranthene	520	550	27,000	9,100	840	1,200	720
Fluorene	520	1,000	41,000	5,700	< 750	< 790	< 690
Hexachlorobenzene	520	< 530	< 550	< 2,500	< 750	< 790	< 690
Hexachlorobutadiene	520	< 530	< 550	< 2,500	< 750	< 790	< 690
Hexachlorocyclopentadiene	520	< 530	< 550	< 2,500	< 750	< 790	< 690
Hexachloroethane	520	< 530	< 550	< 2,500	< 750	< 790	< 690
Indeno(1,2,3-cd)pyrene	520	< 530	5900 *	2800*	< 750	950*	< 690
Isophorone	520	< 530	< 550	< 2,500	< 750	< 790	< 690
N-Nitrosodi-n-propylamine	520	< 530	< 550	< 2,500	< 750	< 790	< 690
N-Nitrosodiphenylamine	520	< 530	< 550	< 2,500	< 750	< 790	< 690
Naphthalene	520	< 530	< 550	< 2,500	< 750	< 790	< 690
Nitrobenzene	520	< 530	< 550	< 2,500	< 750	< 790	< 690
Pentachlorophenol	2,700	< 2,700	< 2,800	< 13,000	< 3,900	< 4,000	< 3,500
Phenanthrene	1,100	2,600	150,000	7,900	1,300	1,100	1,800
Phenol	520	< 530	< 550	< 2,500	< 750	< 790	< 690
Pyrene	1,100	1,600	85,000	6,400	3,000	1700*	3,300

"A" samples are composites taken from 0-6 inches depth; "B" samples are composites taken from 7-18 inches depth at the same location.
* Designates estimated values

Summary of Constituents in Samples

Washington Gas East Station, Dock/Pump House, Water Street, SE, Washington, DC 20003

Sampling Designation		S13A		S13B	S15A		S15B	WA	
Matrix		Sediment	Sediment	Sediment	Sediment	Sediment	Sediment		
Sampling Date		21-Aug-03	17-Sep-03	21-Aug-03	21-Aug-03	17-Sep-03	21-Aug-03	21-Aug-03	17-Sep-03
Constituents	Detection Limits								
INORGANICS / Units	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Mercury	0.084	0.49	0.32	0.10	0.29	0.37	0.35	0.00026	< 5.0
Aluminum	5.0	17,000	15,000	21,000	15,000	14,000	15,000	2.0	0.00063
Antimony	25	< 25	< 25	< 25	< 25	< 25	< 25	< 0.50	2.5
Arsenic	250	< 250	< 25	< 250	< 250	< 25	< 250	< 0.50	< 0.50
Barium	5.0	170	170	200	210	140	140	0.057	< 0.50
Beryllium	0.25	1.3	1.2	1.4	1.5	1.4	1.5	< 0.0050	0.060
Cadmium	0.50	0.50	1.0	< 0.50	1.3	1.4	1.5	< 0.010	< 0.0050
Calcium	25	2,900	2,300	2,000	9,100	3,000	3,400	26	< 0.010
Chromium	1.0	40	43	30	60	53	57	< 0.020	23
Cobalt	0.50	4.6	< 2.5	2.5	8.7	6.1	7.3	< 0.010	< 0.020
Copper	5.0	92	130	37	99	81	92	< 0.010	< 0.010
Iron	50	43,000	55,000	41,000	38,000	32,000	36,000	2.1	0.015
Lead	50	100	180	27	270	110	140	< 0.10	5.2
Magnesium	5.0	2,900	2,500	3,400	3,800	3,700	4,000	6.6	< 0.10
Manganese	5.0	750	470	1,100	500	360	390	0.16	5.7
Nickel	1.0	35	35	25	46	42	48	< 0.020	0.19
Potassium	5.0	1,400	1,200	1,600	1,400	1,300	1,400	3.9	< 0.020
Selenium	25	< 25	< 25	< 25	< 25	< 25	< 25	< 0.50	4.1
Silver	1.0	1.3	1.9	< 0.99	1.4	1.4	2.1	< 0.020	< 0.50
Sodium	25	110	92	69	160	110	98	18	< 0.020
Thallium	25	< 25	< 25	< 25	< 25	< 25	< 25	< 0.50	16
Vanadium	5.0	54	54	57	60	54	62	< 0.010	< 0.50
Zinc	10	230	270	96	430	330	400	< 0.020	< 0.010
PMOIST - % WT.	0.05	62	64	37	58	63	52		0.054
ORGANICS / Units	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Gasoline Range Organics	13	< 13	27	< 10	< 11	< 10	< 12	< 100	< 100
Diesel Range Organics	10	600	20,000	180	520	580	900	< 100	< 100
TotalPetroleumHydrocarbons	10	3,200	12,000	640	3,400	970	4,300	< 5.0	< 5.0
VOC TCL S / Units	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry	µg/Kg-dry
1,1,1-Trichloroethane	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
1,1,2,2-Tetrachloroethane	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
1,1,2-Trichloroethane	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
1,1-Dichloroethane	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
1,1-Dichloroethene	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
1,2-Dichloroethane	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
1,2-Dichloropropane	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
2-Butanone	8,200	< 16,000	< 14,000	< 8,200	< 13,000	< 14,000	< 13,000	< 100	< 100
2-Hexanone	4,100	< 8,200	< 6,900	< 4,100	< 6,700	< 6,800	< 6,300	< 50	< 50
4-Methyl-2-pentanone	4,100	< 8,200	< 6,900	< 4,100	< 6,700	< 6,800	< 6,300	< 50	< 50
Acetone	8,200	< 16,000	< 14,000	< 8,200	< 13,000	< 14,000	< 13,000	< 100	< 100
Benzene	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
Bromodichloromethane	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
Bromoform	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
Bromomethane	820	< 1,600	< 1,400	< 820	< 1,300	< 1,400	< 1,300	< 10	< 10
Carbon disulfide	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
Carbon tetrachloride	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
Chlorobenzene	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
Chloroethane	820	< 1,600	< 1,400	< 820	< 1,300	< 1,400	< 1,300	< 10	< 10
Chloroform	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
Chloromethane	820	< 1,600	< 1,400	< 820	< 1,300	< 1,400	< 1,300	< 10	< 10
cis-1,2-Dichloroethene	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
cis-1,3-Dichloropropene	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
Dibromochloromethane	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
Ethylbenzene	410	< 820	1,600	< 410	< 670	< 680	< 630	< 5.0	< 5.0
m,p-Xylene	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
Methylene chloride	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
o-Xylene	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
Styrene	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
Tetrachloroethene	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
Toluene	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
trans-1,2-Dichloroethene	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
trans-1,3-Dichloropropene	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
Trichloroethene	410	< 820	< 690	< 410	< 670	< 680	< 630	< 5.0	< 5.0
Vinyl chloride	820	< 1,600	< 1,400	< 820	< 1,300	< 1,400	< 1,300	< 10	< 10
Xylenes, Total	820	< 1,600	< 1,400	< 820	< 1,300	< 1,400	< 1,300	< 10	< 10

"A" samples are composites taken from 0-6 inches depth; "B" samples are composites taken from 7-18 inches depth at the same location.

* Designates estimated values

Summary of Constituents in Samples

Washington Gas East Station, Dock/Pump House, Water Street, SE, Washington, DC 20003

Sampling Designation		S13A		S13B	S15A		S15B	WA	
Matrix		Sediment	Sediment	Sediment	Sediment	Sediment	Sediment		
Sampling Date		21-Aug-03	17-Sep-03	21-Aug-03	21-Aug-03	17-Sep-03	21-Aug-03	21-Aug-03	17-Sep-03
TCL SV S / Units	µg/Kg-dry	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-	µg/Kg-
1,2,4-Trichlorobenzene	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
1,2-Dichlorobenzene	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
1,3-Dichlorobenzene	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
1,4-Dichlorobenzene	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
2,4,5-Trichlorophenol	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
2,4,6-Trichlorophenol	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
2,4-Dichlorophenol	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
2,4-Dimethylphenol	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
2,4-Dinitrophenol	2,700	< 4,500	< 94,000	< 2,700	< 4,000	< 4,600	< 3,500	< 50	< 50
2,4-Dinitrotoluene	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
2,6-Dinitrotoluene	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
2-Chloronaphthalene	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
2-Chlorophenol	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
2-Methylnaphthalene	520	1,800	1,200,000	640	< 790	< 890	< 690	< 10	< 10
2-Methylphenol	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
2-Nitroaniline	2,700	< 4,500	< 94,000	< 2,700	< 4,000	< 4,600	< 3,500	< 50	< 50
2-Nitrophenol	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
3,3'-Dichlorobenzidine	1,100	< 1,800	< 37,000	< 1,100	< 1,600	< 1,800	< 1,400	< 20	< 20
3-Nitroaniline	2,700	< 4,500	< 94,000	< 2,700	< 4,000	< 4,600	< 3,500	< 50	< 50
4,6-Dinitro-2-methylphenol	2,700	< 4,500	< 94,000	< 2,700	< 4,000	< 4,600	< 3,500	< 50	< 50
4-Bromophenyl phenyl ether	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
4-Chloro-3-methylphenol	1,100	< 1,800	< 37,000	< 1,100	< 1,600	< 1,800	< 1,400	< 20	< 20
4-Chloroaniline	1,100	< 1,800	< 37,000	< 1,100	< 1,600	< 1,800	< 1,400	< 20	< 20
4-Chlorophenyl phenyl ether	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
4-Methylphenol,3-	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
4-Nitroaniline	2,700	< 4,500	< 94,000	< 2,700	< 4,000	< 4,600	< 3,500	< 50	< 50
4-Nitrophenol	2,700	< 4,500	< 94,000	< 2,700	< 4,000	< 4,600	< 3,500	< 50	< 50
Acenaphthene	520	8,600	450,000	5,600	< 790	< 890	< 690	< 10	< 10
Acenaphthylene	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
Anthracene	520	7,300	160,000	2,900	< 790	< 890	< 690	< 10	< 10
Benz(a)anthracene	1,100	14,000	130,000	4,400	< 790	< 890	< 690	< 10	< 10
Benzo(a)pyrene	2,700	11,000	120,000	3,300	< 790	1,500	< 690	< 10	< 10
Benzo(b)fluoranthene	520	6,100	33000*	1400 *	< 790	1,400	< 690	< 10	< 10
Benzo(g,h,i)perylene	520	5,300	43000*	1800 *	< 790	1,500	< 690	< 10	< 10
Benzo(k)fluoranthene	520	5,900	54000*	1500 *	< 790	1,700	< 690	< 10	< 10
Bis(2-chloroethoxy)methane	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
Bis(2-chloroethyl)ether	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
Bis(2-chloroisopropyl)ether	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
Bis(2-ethylhexyl)phthalate	520	< 870	< 18,000	< 520	1,900	4,100	2,000	< 10	< 10
Butyl benzyl phthalate	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
Carbazole	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
Chrysene	1,100	16,000	150,000	5,100	< 790	1,300	< 690	< 10	< 10
Di-n-butyl phthalate	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
Di-n-octyl phthalate	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
Dibenz(a,h)anthracene	520	< 870	< 18,000	770 *	< 790	< 890	< 690	< 10	< 10
Dibenzofuran	520	< 870	21,000	< 520	< 790	< 890	< 690	< 10	< 10
Diethyl phthalate	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
Dimethyl phthalate	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
Fluoranthene	520	12,000	130,000	3,800	< 790	1,200	< 690	< 10	< 10
Fluorene	520	6,000	180,000	3,400	< 790	< 890	< 690	< 10	< 10
Hexachlorobenzene	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
Hexachlorobutadiene	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
Hexachlorocyclopentadiene	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
Hexachloroethane	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
Indeno(1,2,3-cd)pyrene	520	4,600	31000*	1300 *	< 790	1,200	< 690	< 10	< 10
Isophorone	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
N-Nitrosodi-n-propylamine	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
N-Nitrosodiphenylamine	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
Naphthalene	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
Nitrobenzene	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
Pentachlorophenol	2,700	< 4,500	< 94,000	< 2,700	< 4,000	< 4,600	< 3,500	< 50	< 50
Phenanthrene	1,100	38,000	760,000	14,000	< 790	1,200	< 690	< 10	< 10
Phenol	520	< 870	< 18,000	< 520	< 790	< 890	< 690	< 10	< 10
Pyrene	1,100	37,000	440,000	13,000	1,500	3,600	1,500	< 10	< 10

"A" samples are composites taken from 0-6 inches depth; "B" samples are composites taken from 7-18 inches depth at the same location.
* Designates estimated values

Ecological Risk Assessment
Extracts

Table 9-27
Chemicals of Potential Concern for Ecological Risk Assessment

Chemical	Soils		Site Water		Anacostia R.	
	Surface	0 - 2 ft	Runoff	Ground	Water	Seds.
Metals						
Ag		X				
Al	X	X	X		X	
As		X				X
Cd	X	X		X		X
Cr	X	X		X		X
Cu	X	X				X
Fe	X	X	X		X	
Hg (if MeHg)	X	X	X			X
Mn	X	X				
Ni	X	X				X
Pb	X	X	X	X	X	X
Sb		X				
Se		X				
Tl		X				
V	X	X				
Zn	X	X				X
Other Inorganic Chemicals						
TCN		X				
SVOCs						
PAHs	X	X				X
DEHP						X
Dibenzofuran						X
VOCs						
Benzene		X				
Ethylbenzene		X				
Xylenes		X				

Human-Health Risk Assessment Extracts

TABLE D-2
Chemicals of Potential Concern for Each Data Group

Chemicals of Potential Concern	Data Groups*											
	1	2	3	4	5	6	7	8	9	10	11	12
Inorganics												
Aluminum	X	X		X	X		X				X	
Antimony		X									X	
Arsenic	X	X	X	X	X		X				X	
Beryllium	X	X	X	X	X		X				X	
Cadmium											X	
Chromium	X	X	X	X	X		X				X	
Copper							X				X	
Iron	X	X	X	X	X		X				X	
Lead**							X				X	
Manganese	X	X	X	X	X		X				X	
Mercury		X		X								
Nickel		X		X								
Thallium		X									X	
Vanadium	X	X	X	X	X		X				X	
Total Cyanides		X									X	
Organics												
Total PAHs***	X	X	X	X	X		X				X	X
Acenaphthene							X					
Benzene						X		X	X	X		
Ethylbenzene						X		X	X	X		
Benzo[a]anthracene	X	X	X	X	X		X				X	X
Benzo[a]pyrene	X	X	X	X	X		X				X	X
Benzo[b]fluoranthene	X	X	X	X	X		X				X	X
Benzo[g,h,i]perylene	X	X	X	X	X		X				X	
Benzo[k]fluoranthene	X	X	X	X	X		X				X	X
Bis(2-ethylhexyl) Phthalate	X		X	X	X		X					
Chrysene	X	X	X	X	X		X				X	X
Dibenzo[a,h]anthracene	X	X	X	X	X		X				X	X
Dibenzofuran		X					X				X	
Fluoranthene	X	X	X	X	X		X				X	
Fluorene							X					
Indeno[1,2,3-cd]pyrene	X	X	X	X	X		X				X	X
2-Methylnaphthalene							X					
Naphthalene	X	X	X	X	X		X				X	
Pyrene	X	X	X	X	X		X				X	
Toluene						X		X	X	X		
Xylenes						X		X	X	X		

* Data Groups:
1. Surface Soil Samples Southwest Crnr. of Site (SR16 - SR22, SR24 & SR25)
2. Soil Borings & Surface Soil North of Water Street (SB2 - SB10, 0-2' in depth; SR1 - SR20 & SR23)
3. Surface Soil Sample SR-25
4. Surface Soil Samples North of Water Street (SR-1 through SR-20 and SR-23)
5. Surface Soil Samples South of Water Street (SR-21, SR-22, SR-24, SR-25 and SR-26)
6. Soil Gas Samples Southwest Crnr. of Site (SG20 - SG23, SG25 - SG34 & SG38 - SG42)
7. * Sediment Samples Downstream of East Station (96SD02 - 96SD05 & 96SD07)
8. Soil Borings North of 900-North Grid Line (SB2 - SB8, 0-2' & 2-4' in depth)
9. Soil Gas Sample SG-12
10. All Soil Gas Samples (SG-1 through SG-45)
11. All Soil Borings (SB-1 through SB-13; all three intervals)
12. * Fish Samples Collected by Versar (1993)

** Risk/Hazard was not evaluated for Lead because no RfD or CPS values are available.
*** Total PAH's are the sum of the chemicals listed in Section 8.1.1.2.

TABLE 8-3
SUMMARY OF HUMAN HEALTH RISK ASSESSMENT

Scenario No.	Population	Exposure Location	Exposure Route	Time Frame			HIF Table	Cancer Risk	Hazard Index
				Pres	Trans	Future			
1	Angler	Anacostia R.	Fish Ingestion	x	x	x	1	2.8E-07	4.8E-03
2	Swimmer/ Wader	Anacostia R.	Sediment Ingestion	x	x	x	2	9.7E-07	5.0E-03
3			Sediment Dermal	x	x	x	3	8.9E-06	7.6E-03
4	Offsite Resident	Outside Study Area	Soil VOC Inhalation	x	x	x	4	4.3E-09	4.3E-04
5			Eroded Dust Inhalation	x	x		4	2.4E-09	9.2E-05
6			Bulldozer Dust Inhalation		x		15	8.0E-07	7.4E-01
7			Excav. Soil VOC Inhalation		x		4	5.0E-08	4.8E-03
8	Offsite Office Worker	Outsida Study Area	Soil VOC Inhalation	x	x	x	5	2.2E-10	1.1E-05
9			Eroded Dust Inhalation	x	x		5	1.2E-10	2.3E-06
10			Bulldozed Dust Inhalation		x		14	3.4E-08	3.2E-02
11			Excav. Soil VOC Inhalation		x		5	1.6E-09	7.4E-04
12	Onsite Office Worker	East Station Property	Soil VOC Inhalation			x	5	9.6E-10	4.6E-05
13			Bulldozed Dust Inhalation		x		14	4.9E-07	4.5E-01
14		NPS Property	Vehicular Dust Inhalation	x	x	x	5	2.8E-07	5.1E-03
15		East Station Property	Excav. Soil VOC Inhalation		x		5	2.3E-08	1.1E-03
16			Soil VOC Inhal. via Cracks			x	5	2.8E-10	1.4E-05
17	Onsite Resident	East Station Property	Soil VOC Inhalation			x	4	8.7E-09	8.6E-04
18			Soil VOC Inhal. via Cracks			x	4	2.5E-09	2.6E-04
29			Surface Soil Ingestion			x	16	9.0E-05	9.7E-01
31			Surface Soil Dermal			x	18	2.4E-04	4.6E-01
19	Utility Maint. Worker	Study Area	Subsurface Soil VOC Inhal.	x	x	x	6	5.5E-05	3.9E+00
20			Subsurface Soil Ingestion	x	x	x	7	2.8E-06	4.5E-03
21			Subsurface Soil Dermal	x	x	x	8	1.2E-05	6.4E-03
22	Juvenile Recreation	NPS Property	Soil VOC Inhalation			x	9	1.8E-08	2.2E-03
30			Surface Soil Ingestion			x	17	3.2E-05	2.2E-01
32			Surface Soil Dermal			x	19	3.0E-04	3.5E-01
23	Construction Worker	East Station Property	Soil VOC Inhalation		x		10	1.1E-10	1.5E-04
24			Eroded Dust Inhalation		x		10	1.4E-10	8.2E-05
25*			Bulldozed Dust Inhalation		x		13	3.7E-05	3.5E+01
26			Excav. Soil VOC Inhalation		x		10	2.5E-09	3.5E-03
27			Soil Ingestion		x		11	4.5E-07	3.8E-02
28			Soil Dermal		x		12	1.9E-06	2.7E-02

Shaded areas indicate an exceedance of acceptable risk levels:
Hazard Index > 1.0 Cancer > 1.0E-04

Scenarios are not listed in numerical order (Scenarios 29 - 32 were added later).

HIF Tables are found in Appendix D

* Scenario 25 only applies to the bulldozer operator.

TABLE D-2
Chemicals of Potential Concern for Each Data Group

Chemicals of Potential Concern	Data Groups*											
	1	2	3	4	5	6	7	8	9	10	11	12
Inorganics												
Aluminum	X	X		X	X		X				X	
Antimony		X									X	
Arsenic	X	X	X	X	X		X				X	
Beryllium	X	X	X	X	X		X				X	
Cadmium											X	
Chromium	X	X	X	X	X		X				X	
Copper							X				X	
Iron	X	X	X	X	X		X				X	
Lead**							X				X	
Manganese	X	X	X	X	X		X				X	
Mercury		X		X								
Nickel		X		X								
Thallium		X									X	
Vanadium	X	X	X	X	X		X				X	
Total Cyanides		X									X	
Organics												
Total PAHs***	X	X	X	X	X		X				X	X
Acenaphthene							X					
Benzene						X		X	X	X		
Ethylbenzene						X		X	X	X		
Benzo[a]anthracene	X	X	X	X	X		X				X	X
Benzo[a]pyrene	X	X	X	X	X		X				X	X
Benzo[b]fluoranthene	X	X	X	X	X		X				X	X
Benzo[g,h,i]perylene	X	X	X	X	X		X				X	
Benzo[k]fluoranthene	X	X	X	X	X		X				X	X
Bis(2-ethylhexyl) Phthalate	X		X	X	X		X					
Chrysene	X	X	X	X	X		X				X	X
Dibenzo[a,h]anthracene	X	X	X	X	X		X				X	X
Dibenzofuran		X					X				X	
Fluoranthene	X	X	X	X	X		X				X	
Fluorene							X					
Indeno[1,2,3-cd]pyrene	X	X	X	X	X		X				X	X
2-Methylnaphthalene							X					
Naphthalene	X	X	X	X	X		X				X	
Pyrene	X	X	X	X	X		X				X	
Toluene						X		X	X	X		
Xylenes						X		X	X	X		

* Data Groups:
1. Surface Soil Samples Southwest Cnr. of Site (SR16 - SR22, SR24 & SR25)
2. Soil Borings & Surface Soil North of Water Street (SB2 - SB10, 0-2' in depth; SR1 - SR20 & SR23)
3. Surface Soil Sample SR-25
4. Surface Soil Samples North of Water Street (SR-1 through SR-20 and SR-23)
5. Surface Soil Samples South of Water Street (SR-21, SR-22, SR-24, SR-25 and SR-26)
6. Soil Gas Samples Southwest Cnr. of Site (SG20 - SG23, SG25 - SG34 & SG38 - SG42)
7. Sediment Samples Downstream of East Station (96SD02 - 96SD05 & 96SD07)
8. Soil Borings North of 900-North Grid Line (SB2 - SB8, 0-2' & 2-4' in depth)
9. Soil Gas Sample SG-12
10. All Soil Gas Samples (SG-1 through SG-45)
11. All Soil Borings (SB-1 through SB-13; all three intervals)
12. Fish Samples Collected by Versar (1993)

** Risk/Hazard was not evaluated for Lead because no RfD or CPS values are available.
*** Total PAH's are the sum of the chemicals listed in Section 8.1.1.2.

SCENARIO 1

INTERPRETATION OF ANALYTICAL RESULTS ON FISH IN THE 1992 OIL SPILL AREA OF THE ANACOSTIA RIVER

References: a. Versar, Inc. 1993. *An Assessment of Potential Residual Effects of the January 1992 Oil Spill in the Anacostia River.*

b. USEPA. 1995. *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 1. Fish Sampling and Analysis, Second Edition*, EPA 823-R-95-007, United States Environmental Protection Agency, Office of Water, Washington, DC.

The following 95% Upper Confidence Limit (UCL) values and maximum values, their potencies relative to benzo[a]pyrene (BAP), and their BAP equivalent concentrations are derived from the data obtained by Versar (Reference a):

Analyte	95% UCL Conc. in Fish (mg/kg)	Relative Potency	BAP Equivs. (mg/kg)
Benzo[a]anthracene	0.0014652	0.1	0.00014652
Chrysene	0.0413	0.0001	0.00000413
Benzo[b]fluoranthene	0.0002646	0.1	0.00002646
Benzo[k]fluoranthene	0.000212	0.01	0.00000212
Benzo[a]pyrene (BAP)	0.0001869	1.0	0.00018693
Indeno[1,2,3-cd]pyrene	0.00009	0.1	0.00000900
Dibenzo[a,h]anthracene	0.0002059	1.0	0.00020591
		Total Benzo[a]pyrene	0.000581

Total spill area and downstream PAHs (95% UCL, mg/kg) = 0.346

The sum of 95% Upper Confidence Limits for the BAP equivalents for the seven carcinogenic PAHs found by Versar in the spill area (See figure on Page D-396) and downstream fish tissues (see Group 12 analytical results Pages D-369 to D-395) is 0.000581 mg/kg. (Note that corresponding sum for upstream fish tissues, 0.000940 mg/kg, is actually higher than the spill area/downstream value; however, this 95% UCL value may have been affected by the number of samples.)

Human intake factors (see Table HIF-1 on Page D-144 for derivations):

Highest carcinogenic HIF = 6.60e-05 d^{-1} (adult).
Highest noncarcinogenic HIF = 4.15e-04 d^{-1} (child).

BAP Slope Factor = 7.3 $(mg/[kg \cdot d])^{-1}$ (USEPA Region III).

PAH RfD (that of pyrene) = 0.03 mg/[kg·d].

Cancer risk = (0.000581 mg/kg) (6.6e-05 d^{-1}) $\{7.3\ (mg/[kg \cdot d])^{-1}\}$
= <u>2.8e-07</u>

Hazard quotient = (0.346 mg/kg) (4.15e-04 d^{-1})/0.03 mg/[kg·d]
= <u>4.8e-03</u>

SCENARIO 2

EVALUATION OF ANALYTICAL RESULTS ON SEDIMENT IN THE AREA OF THE ANACOSTIA RIVER NEAR THE WASHINGTON GAS EAST STATION SITE WITH REGARD TO CONSUMPTION OF SUSPENDED SEDIMENT PARTICLES

Reference: a. Smith, R.L., 1996. EPA Region III Risk-Based Concentration Table, United States Environmental Protection Agency, Philadelphia, PA.

Sediment samples taken from the Anacostia River at and below the WG East Station site (See figure on Page D-397)were analyzed, and the 95% upper confidence level for each analyte was calculated (see Group 7 data on pages D-270 to D-297).

Human (juvenile) intake factors (HIFs) for ingestion of suspended sediment (see Table HIF-2 on Page D-145) were as follows:

Ingestion carcinogenic HIF = 3.28e-09 d^{-1}
Ingestion noncarcinogenic HIF = 1.91e-08 d^{-1}

Ninety-five percent upper confidence levels of the means (or highest levels) for the indicator analytes were multiplied by CPS_o values (see Reference a) and by the HIF value appropriate for carcinogens (3.28e-09 d^{-1}) to obtain the cancer risk by ingestion for each compound:

Analyte	95% UCL Conc. in Sed. (mg/kg)	CPS_o (kg · d/mg)	Cancer Risk
Benz[a]anthracene	16.000	0.73	3.83e-08
Chrysene	16.000	0.0073	3.83e-10
Benzo[b]fluoranthene	9.200	0.73	2.20e-08
Benzo[k]fluoranthene	9.500	0.073	2.27e-09
Benzo[a]pyrene	27.000	7.3	6.46e-07
Indeno[1,2,3-cd]pyrene	6.300	0.73	1.51e-08
Dibenz[a,h]anthracene	6.900	7.3	1.65e-07
Bis(2-ethylhexyl) phthalate	7.200	0.014	3.31e-10
Arsenic	11.85	1.5	5.83e-08
Beryllium	1.59	4.3	2.24e-08
		Total Cancer Risk =	9.7e-07

Ninety-five percent upper confidence levels of the means (or highest levels) for all polynuclear aromatic hydrocarbons (PAHs), carcinogenic or not, were summed to get a total 95% UCL for the PAHs, i.e., 232.14 mg/kg. It is assumed here that all these PAHs have the reference dose (RfD) of pyrene, namely 0.03 mg/(kg·day). To obtain hazard quotients, one multiplies concentration in the sediment by the non-carcinogenic HIF (1.91e-08 d^{-1}) and divides by the appropriate RfD.

Analyte	95% UCL Conc. in Sed. (mg/kg)	RfD_o (mg/kg/d)	Hazard Quotient
Total PAHs	252.44	0.03	1.61e-04
Bis(2-ethylhexyl) phthalate	7.200	0.02	6.88e-06
Aluminum	22,900	1.00	4.37e-04
Arsenic	11.85	0.0003	7.54e-04
Beryllium	1.59	0.005	6.07e-06
Chromium	63.73	0.005	2.43e-04
Copper	324.0	0.04	1.55e-04
Iron	39,400	0.3	2.51e-03
Manganese	678.00	0.023	5.63e-04
Vanadium	65.21	0.007	1.78e-04
Sum of hazard quotients = hazard index =			5.0e-03

SCENARIO 3

EVALUATION OF ANALYTICAL RESULTS ON SEDIMENT IN THE AREA OF THE ANACOSTIA RIVER NEAR THE WASHINGTON GAS EAST STATION SITE WITH REGARD TO DERMAL CONTACT

Reference: a. Smith, R.L., 1996, EPA Region III Risk-Based Concentration Table, United States Environmental Protection Agency, Philadelphia, PA.

Sediment samples taken from the Anacostia River at and below the WG East Station site (see figure Page D-398) were analyzed, and the 95% upper confidence level for each organic analyte was calculated (see Group 7 data Pages D-270 to D-297).

Human (juvenile) intake factors (HIFs) for dermal exposure to sediment (see Table HIF-3 on Page D-146) were as follows:

Dermal carcinogen HIF = 3.21e-07 d^{-1} ABS
Dermal noncarcinogen HIF = 1.87e-06 d^{-1} ABS

The dermal absorption factors (ABS) for the indicator analytes are: 0.1 for organics, 0.032 for arsenic, and 0.01 for all other inorganics.

Ninety-five percent upper confidence levels of the means for the indicator analytes were multiplied by CPS_o values (see Reference a), by the HIF value appropriate for carcinogens (3.21e-07 d^{-1}) and by the appropriate ABS value to obtain the cancer risk by dermal contact for each analyte:

Analyte	95% UCL Conc. in Sed. (mg/kg)	ABS Factor	CPS_o (kg · d/mg)	Cancer Risk
Benz[a]anthracene	16.000	0.1	0.73	3.75e-07
Chrysene	16.000	0.1	0.0073	3.75e-09
Benzo[b]fluoranthene	9.200	0.1	0.73	2.16e-07
Benzo[k]fluoranthene	9.500	0.1	0.073	2.23e-08
Benzo[a]pyrene	27.000	0.1	7.3	6.33e-06
Indeno[1,2,3-cd]pyrene	6.300	0.1	0.73	1.48e-07
Dibenz[a,h]anthracene	6.900	0.1	7.3	1.62e-06
Bis(2-ethylhexyl) phthalate	7.200	0.1	0.014	3.24e-09
Arsenic	11.85	0.032	1.5	1.83e-07
Beryllium	1.59	0.01	4.3	2.19e-08
			Total Cancer Risk =	8.9e-06

Ninety-five percent upper confidence levels of the means for all polynuclear aromatic hydrocarbons (PAHs), carcinogenic or not, were summed to get a total 95% UCL for the PAHs, i.e., 232.14 mg/kg. It is assumed here that all these PAHs have the reference dose (RfD) of pyrene, namely 0.03 mg/(kg·day). To obtain hazard quotients, one multiplies concentration in the sediment by the non-carcinogenic HIF (1.87e-06 d^{-1}) and the corresponding ABS value and then divides by the appropriate RfD.

Analyte	95% UCL Conc. in Sed. (mg/kg)	ABS Factor	RfD_o (mg/kg/d)	Hazard Quotient
Total PAHs	252.44	0.1	0.03	1.57e-03
Bis(2-ethylhexyl) phthalate	7.200	0.1	0.02	6.73e-05
Aluminum	22,900	0.01	1.00	4.28e-04
Arsenic	11.85	0.01	0.0003	7.39e-04
Beryllium	1.59	0.01	0.005	5.95e-06
Chromium	63.73	0.01	0.005	2.38e-04
Copper	324.0	0.01	0.04	1.51e-04
Iron	39,400	0.01	0.3	2.46e-03
Manganese	678.00	0.032	0.023	1.76e-03
Vanadium	65.21	0.01	0.007	1.74e-04
Sum of hazard quotients = hazard index =				7.6e-03

APPENDIX 6

Sediment Capping Research Study by Louisiana State University, 2002

LOUISIANA STATE UNIVERSITY

Client Sample ID: ANACOSTIA RIVER SEDIMENT SITE 2

TOTAL Metals

Lot-Sample #...: H2G230151-002 Matrix.....: SOLID
Date Sampled...: 07/19/02 Date Received..: 07/22/02
% Moisture.....: 58

PARAMETER	RESULT	REPORTING LIMIT	UNITS	METHOD	PREPARATION-ANALYSIS DATE	WORK ORDER #
Prep Batch #...: 2210115						
Mercury	0.34	0.078	mg/kg	SW846 7471A	07/29/02	E456G1AG
		Dilution Factor: 1		Analysis Time..: 13:29	MDL.....: 0.019	
Prep Batch #...: 2210118						
Aluminum	14500	47.4	mg/kg	SW846 6010B	07/29-07/30/02	E456G1AM
		Dilution Factor: 1		Analysis Time..: 14:13	MDL.....: 2.4	
Antimony	ND	14.2	mg/kg	SW846 6010B	07/29-07/30/02	E456G1AN
		Dilution Factor: 1		Analysis Time..: 14:13	MDL.....: 0.69	
Arsenic	7.5	2.4	mg/kg	SW846 6010B	07/29-07/30/02	E456G1AP
		Dilution Factor: 1		Analysis Time..: 14:13	MDL.....: 0.40	
Barium	128	47.4	mg/kg	SW846 6010B	07/29-07/30/02	E456G1AQ
		Dilution Factor: 1		Analysis Time..: 14:13	MDL.....: 0.12	
Beryllium	1.8	1.2	mg/kg	SW846 6010B	07/29-07/30/02	E456G1AR
		Dilution Factor: 1		Analysis Time..: 14:13	MDL.....: 0.047	
Cadmium	1.5	1.2	mg/kg	SW846 6010B	07/29-07/30/02	E456G1AT
		Dilution Factor: 1		Analysis Time..: 14:13	MDL.....: 0.12	
Calcium	2900	1180	mg/kg	SW846 6010B	07/29-07/30/02	E456G1AU
		Dilution Factor: 1		Analysis Time..: 14:13	MDL.....: 4.3	
Chromium	56.6	2.4	mg/kg	SW846 6010B	07/29-07/30/02	E456G1AV
		Dilution Factor: 1		Analysis Time..: 14:13	MDL.....: 0.21	
Cobalt	22.3	11.8	mg/kg	SW846 6010B	07/29-07/30/02	E456G1AW
		Dilution Factor: 1		Analysis Time..: 14:13	MDL.....: 0.26	
Copper	84.6	5.9	mg/kg	SW846 6010B	07/29-07/30/02	E456G1AX
		Dilution Factor: 1		Analysis Time..: 14:13	MDL.....: 0.62	
Iron	32600	23.7	mg/kg	SW846 6010B	07/29-07/30/02	E456G1A0
		Dilution Factor: 1		Analysis Time..: 14:13	MDL.....: 12.1	
Lead	123	0.71	mg/kg	SW846 6010B	07/29-07/30/02	E456G1A1
		Dilution Factor: 1		Analysis Time..: 14:13	MDL.....: 0.33	

(Continued on next page)

LOUISIANA STATE UNIVERSITY

Client Sample ID: ANACOSTIA RIVER SEDIMENT SITE 2

TOTAL Metals

Lot-Sample #...: H2G230151-002

Matrix.....: SOLID

PARAMETER	RESULT	REPORTING LIMIT	UNITS	METHOD	PREPARATION-ANALYSIS DATE	WORK ORDER #
Magnesium	3730	1180	mg/kg	SW846 6010B	07/29-07/30/02	E456G1A2
		Dilution Factor: 1		Analysis Time..: 14:13	MDL.....: 2.6	
Manganese	380	3.6	mg/kg	SW846 6010B	07/29-07/30/02	E456G1A3
		Dilution Factor: 1		Analysis Time..: 14:13	MDL.....: 0.12	
Nickel	42.6	9.5	mg/kg	SW846 6010B	07/29-07/30/02	E456G1A4
		Dilution Factor: 1		Analysis Time..: 14:13	MDL.....: 0.31	
Potassium	1230	1180	mg/kg	SW846 6010B	07/29-07/30/02	E456G1A5
		Dilution Factor: 1		Analysis Time..: 14:13	MDL.....: 11.8	
Selenium	ND	1.2	mg/kg	SW846 6010B	07/29-07/30/02	E456G1A6
		Dilution Factor: 1		Analysis Time..: 14:13	MDL.....: 1.1	
Silver	ND	2.4	mg/kg	SW846 6010B	07/29-07/30/02	E456G1AA
		Dilution Factor: 1		Analysis Time..: 14:13	MDL.....: 0.19	
Sodium	ND	1180	mg/kg	SW846 6010B	07/29-07/30/02	E456G1AC
		Dilution Factor: 1		Analysis Time..: 14:13	MDL.....: 48.1	
Thallium	ND	2.4	mg/kg	SW846 6010B	07/29-07/30/02	E456G1AD
		Dilution Factor: 1		Analysis Time..: 14:13	MDL.....: 0.97	
Vanadium	58.2	11.8	mg/kg	SW846 6010B	07/29-07/30/02	E456G1AE
		Dilution Factor: 1		Analysis Time..: 14:13	MDL.....: 0.26	
Zinc	368	4.7	mg/kg	SW846 6010B	07/29-07/30/02	E456G1AF
		Dilution Factor: 1		Analysis Time..: 14:13	MDL.....: 0.55	

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

LOUISIANA STATE UNIVERSITY

Client Sample ID: ANACOSTIA RIVER SEDIMENT SITE 2

GC/MS Volatiles

Lot-Sample #...: H2G230151-002 Work Order #...: E456G1AK Matrix.....: SOLID
Date Sampled...: 07/19/02 Date Received..: 07/22/02
Prep Date.....: 07/23/02 Analysis Date..: 07/23/02
Prep Batch #...: 2204309
Dilution Factor: 1
% Moisture.....: 58 Method.....: SW846 8260B

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Chloromethane	ND	24	ug/kg
Bromomethane	ND	24	ug/kg
Vinyl chloride	ND	12	ug/kg
Chloroethane	ND	24	ug/kg
Methylene chloride	5.3 J,B	12	ug/kg
Acetone	87	47	ug/kg
Carbon disulfide	ND	12	ug/kg
1,1-Dichloroethene	ND	12	ug/kg
1,1-Dichloroethane	ND	12	ug/kg
1,2-Dichloroethene (total)	ND	12	ug/kg
Chloroform	ND	12	ug/kg
1,2-Dichloroethane	ND	12	ug/kg
2-Buranone	20 J	47	ug/kg
1,1,1-Trichloroethane	ND	12	ug/kg
Carbon tetrachloride	ND	12	ug/kg
Bromodichloromethane	ND	12	ug/kg
1,2-Dichloropropane	ND	12	ug/kg
cis-1,3-Dichloropropene	ND	12	ug/kg
Trichloroethene	ND	12	ug/kg
Dibromochloromethane	ND	12	ug/kg
1,1,2-Trichloroethane	ND	12	ug/kg
Benzene	ND	12	ug/kg
trans-1,3-Dichloropropene	ND	12	ug/kg
Bromoform	ND	12	ug/kg
4-Methyl-2-pentanone	ND	47	ug/kg
2-Hexanone	ND	47	ug/kg
Tetrachloroethene	ND	12	ug/kg
1,1,2,2-Tetrachloroethane	ND	12	ug/kg
Toluene	ND	12	ug/kg
Chlorobenzene	ND	12	ug/kg
Ethylbenzene	ND	12	ug/kg
Styrene	ND	12	ug/kg
Xylenes (total)	ND	12	ug/kg

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Dibromofluoromethane	93	(76 - 125)
1,2-Dichloroethane-d4	98	(74 - 122)
Toluene-d8	106	(80 - 122)
Bromofluorobenzene	136	(68 - 141)

(Continued on next page)

LOUISIANA STATE UNIVERSITY

Client Sample ID: ANACOSTIA RIVER SEDIMENT SITE 2

GC/MS Semivolatiles

Lot-Sample #...: H2G230151-002 Work Order #...: E456G1AL Matrix.....: SOLID
Date Sampled...: 07/19/02 Date Received..: 07/22/02
Prep Date.....: 07/29/02 Analysis Date..: 07/31/02
Prep Batch #...: 2210111
Dilution Factor: 2
% Moisture.....: 58 Method.....: SW846 8270C

PARAMETER	RESULT	REPORTING LIMIT	UNITS
Phenol	ND	1600	ug/kg
bis(2-Chloroethyl)-ether	ND	1600	ug/kg
2-Chlorophenol	ND	1600	ug/kg
1,3-Dichlorobenzene	ND	1600	ug/kg
1,4-Dichlorobenzene	ND	1600	ug/kg
1,2-Dichlorobenzene	ND	1600	ug/kg
2-Methylphenol	ND	1600	ug/kg
2,2'-oxybis(1-Chloro-propane)	ND	1600	ug/kg
4-Methylphenol	ND	1600	ug/kg
N-Nitrosodi-n-propyl-amine	ND	1600	ug/kg
Hexachloroethane	ND	1600	ug/kg
Nitrobenzene	ND	1600	ug/kg
Isophorone	ND	1600	ug/kg
2-Nitrophenol	ND	1600	ug/kg
2,4-Dimethylphenol	ND	1600	ug/kg
bis(2-Chloroethoxy) methane	ND	1600	ug/kg
2,4-Dichlorophenol	ND	1600	ug/kg
1,2,4-Trichloro-benzene	ND	1600	ug/kg
Naphthalene	ND	1600	ug/kg
4-Chloroaniline	ND	1600	ug/kg
Hexachlorobutadiene	ND	1600	ug/kg
4-Chloro-3-methylphenol	ND	1600	ug/kg
2-Methylnaphthalene	ND	1600	ug/kg
Hexachlorocyclopenta-diene	ND	7600	ug/kg
2,4,6-Trichloro-phenol	ND	1600	ug/kg
2,4,5-Trichloro-phenol	ND	1600	ug/kg
2-Chloronaphthalene	ND	1600	ug/kg
2-Nitroaniline	ND	7600	ug/kg
Dimethyl phthalate	ND	1600	ug/kg
Acenaphthylene	270 J	1600	ug/kg

(Continued on next page)

LOUISIANA STATE UNIVERSITY

Client Sample ID: ANACOSTIA RIVER SEDIMENT SITE 2

GC/MS Semivolatiles

Lot-Sample #...: H2G230151-002 Work Order #...: E456G1AL Matrix.....: SOLID

PARAMETER	RESULT	REPORTING LIMIT	UNITS
2,6-Dinitrotoluene	ND	1600	ug/kg
3-Nitroaniline	ND	7600	ug/kg
Acenaphthene	390 J	1600	ug/kg
2,4-Dinitrophenol	ND	7600	ug/kg
4-Nitrophenol	ND	7600	ug/kg
Dibenzofuran	ND	1600	ug/kg
2,4-Dinitrotoluene	ND	1600	ug/kg
Diethyl phthalate	170 J,B	1600	ug/kg
4-Chlorophenyl phenyl ether	ND	1600	ug/kg
Fluorene	330 J	1600	ug/kg
4-Nitroaniline	ND	7600	ug/kg
4,6-Dinitro-2-methylphenol	ND	7600	ug/kg
N-Nitrosodiphenylamine	ND	1600	ug/kg
4-Bromophenyl phenyl ether	ND	1600	ug/kg
Hexachlorobenzene	ND	1600	ug/kg
Pentachlorophenol	ND	7600	ug/kg
Phenanthrene	1600	1600	ug/kg
Anthracene	360 J	1600	ug/kg
Carbazole	ND	1600	ug/kg
Di-n-butyl phthalate	ND	1600	ug/kg
Fluoranthene	2600	1600	ug/kg
Pyrene	2800	1600	ug/kg
Butyl benzyl phthalate	ND	1600	ug/kg
3,3'-Dichlorobenzidine	ND	7600	ug/kg
Benzo(a)anthracene	1300 J	1600	ug/kg
Chrysene	1800	1600	ug/kg
bis(2-Ethylhexyl) phthalate	5900 B	1600	ug/kg
Di-n-octyl phthalate	230 J	1600	ug/kg
Benzo(b)fluoranthene	1800	1600	ug/kg
Benzo(k)fluoranthene	1400 J	1600	ug/kg
Benzo(a)pyrene	1500 J	1600	ug/kg
Indeno(1,2,3-cd)pyrene	1100 J	1600	ug/kg
Dibenz(a,h)anthracene	460 J	1600	ug/kg
Benzo(ghi)perylene	1300 J	1600	ug/kg

(Continued on next page)

APPENDIX 7

Sediment Sampling Results from the Removal of ST Services' Pier, December 2002 and January 2003

PAHs in Sediment Samples Collected by Gascoyne at ST Services Pier
Dec 2002 - January 2003

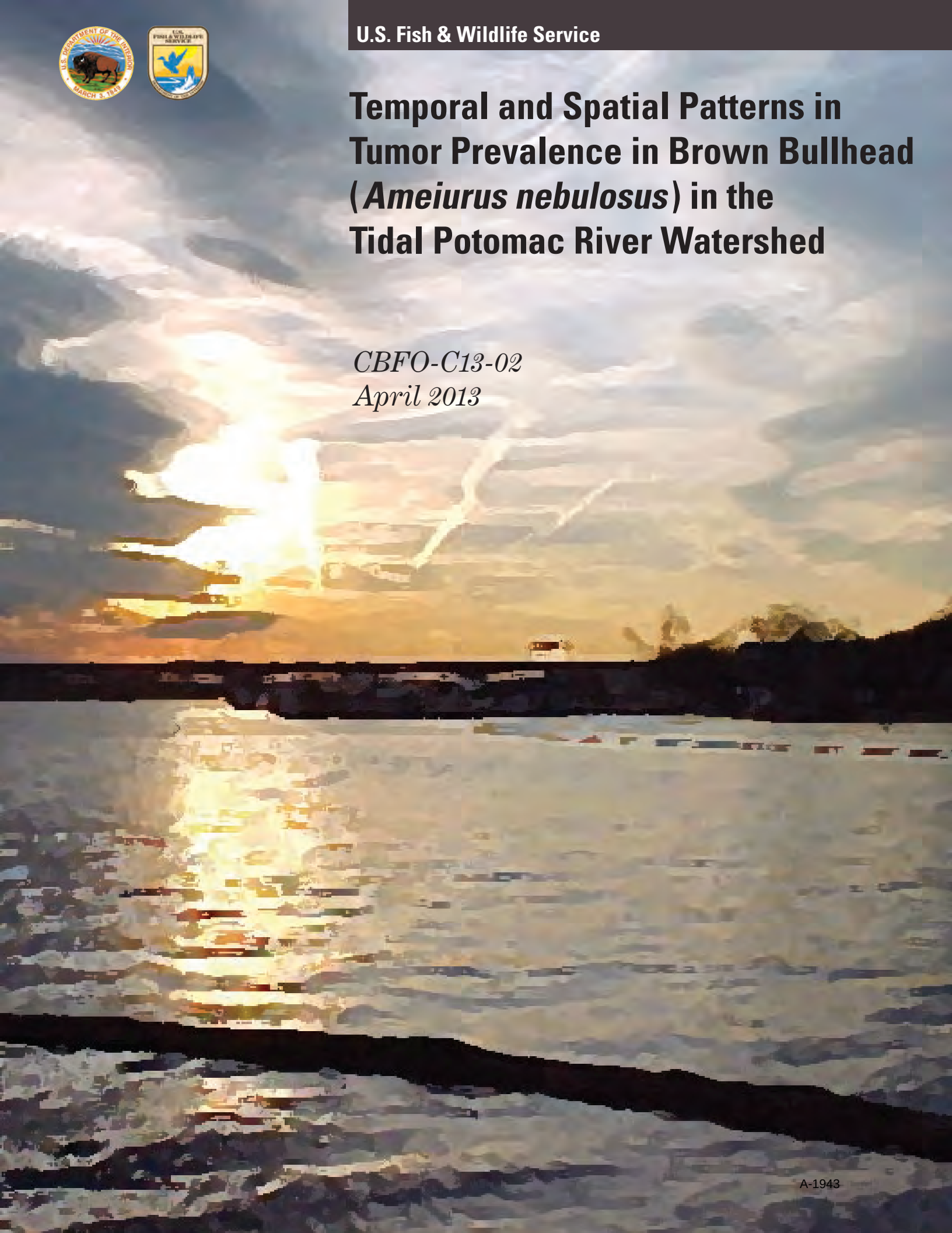
PAH	Dolphin 2 (µg/kg)	Dolphin 4 (µg/kg)	Dolphin 6 (µg/kg)	#1 Grab (µg/kg)	#2 Grab (µg/kg)	#3 Grab (µg/kg)	#4 Grab (µg/kg)
Acenaphthene	930	ND	1,000	ND	1,500	ND	ND
Fluorene	1,300	ND	950	ND	1,600	ND	ND
Phenanthrene	6,400	ND	3,100	ND	5,800	1,100	900
Anthracene	700	ND	ND	ND	970	ND	ND
Fluoranthene	7,000	1,400	1,800	1,500	4,800	1,300	960
Pyrene	16,000	2,900	4,200	2,200	8,600	2,700	2,200
Benz(a)anthracene	3,100	860	1,100	ND	2,600	ND	ND
Chrysene	4,700	1,500	1,600	1,200	3,300	1,100	1,000
Benzo(b)fluoranthene	2,600	1,300	1,300	ND	1,000	ND	ND
Benzo(k)fluoranthene	1,800	860	ND	ND	1,100	ND	ND
Benzo(a)pyrene	1,600	900	920	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	990	860	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	1,200	1,000	940	ND	ND	ND	ND
Total PAHs	48,320	11,580	16,910	4,900	31,270	6,200	5,060
Maximum Conc.	48,320	µg/kg					
Minimum Conc.	4,900	µg/kg					
Average Conc.	17,749	µg/kg					

ND - Not Detected above Practical Quantation Limit
Samples "Dolphin 2-6" collected with core sampler. Sampling method for other samples unknown.

U.S. Fish & Wildlife Service

Temporal and Spatial Patterns in Tumor Prevalence in Brown Bullhead (*Ameiurus nebulosus*) in the Tidal Potomac River Watershed

CBFO-C13-02
April 2013



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Temporal and Spatial Patterns in Tumor Prevalence in Brown Bullhead (*Ameiurus nebulosus*) in the Tidal Potomac River Watershed

CBFO-C13-02

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April 2013

Abstract

Liver tumors in bottom-dwelling fish are caused by exposure to polynuclear aromatic hydrocarbons (PAHs) in sediment. Tumor surveys are used to monitor the status of freshwater, estuarine, and marine habitats, often tracking improvement after cleanup actions. Here we describe five brown bullhead (*Ameiurus nebulosus*) tumor surveys conducted in 2009–2011 in the tidal Potomac River watershed. The focus was on the Anacostia River (Washington, DC), a Chesapeake Bay Region of Concern for contamination. Logistic regression, used to analyze the Chesapeake Bay bullhead tumor database from 1992–2011 (n=1404), showed that both liver and skin tumor prevalence were higher in females and increased with total length. We report statistically significant decreases in the probabilities of a 280 mm bullhead from the Anacostia River having a liver tumor between the 1996 and 2001 samplings (female: 78.2%, male: 42.5%) and the 2009–2011 samplings (female: 42.6%, male: 13.3%). Liver and skin tumor prevalence were similar in collections from the Anacostia River (2009–2011), Potomac River in Washington, DC (2009) and Piscataway Creek (2011) which suggests a regional problem rather than one restricted to the Anacostia. Despite the improvement, bullheads from the Anacostia River and several Potomac watershed locations still have liver tumor prevalence significantly higher than estimated Bay-wide background (280 mm bullheads: liver—9.7% female, 2.3% male; skin—3.7% female, 2.4% male). There are inadequate data to establish a cause-effect relationship between the reduced liver tumor prevalence in Anacostia River bullheads and actions that may have reduced PAH exposure. A new Anacostia sediment chemistry survey is needed to determine if PAH concentrations have decreased since the last survey in 2000.

We recommend monitoring tumor prevalence in the Anacostia and Potomac on a 5-year cycle, along with sediment chemistry analyses from the collection locations, so that this indicator can continue to track changes in habitat quality. The present study which sampled the Anacostia in 2009, 2010, and 2011, provided confidence in the status circa 2010 by sampling three years. Surveys in 2014, 2015, and 2016 would provide a similar level of confidence for the next five year interval. Further evidence for causation could be provided by coupling the tumor survey and sediment sampling with measurement of polycyclic aromatic compound (PAC)-DNA adducts in the liver of a subset of fish. We recommend further research into the causes of bullhead skin tumors, by applying state-of-the-art techniques to identify possible viruses and evaluating the immune status of affected and unaffected fish. Additional sampling of Chesapeake Bay Reference Group locations would be useful to update and further refine the estimates of regional background.

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Introduction

Tumor prevalence in bottom dwelling fish has been used to monitor the quality of freshwater habitats such as the Laurentian Great Lakes (Baumann and Harshbarger 1998; Rafferty et al. 2009); estuarine habitats such as Chesapeake Bay (Pinkney et al. 2009; Vogelbein and Unger 2006) and Puget Sound (Myers et al. 2003, 2008); and marine habitats along the Pacific coast of the United States (Myers et al. 1994). The brown bullhead (*Ameiurus nebulosus*) has been the most frequently used freshwater species in North American tumor surveys. This is attributable to its benthic life history, propensity to develop liver tumors and highly visible orocutaneous tumors, and small home range (Millard et al. 2009; Sakaris et al. 2005). Because the brown bullhead is frequently found in tidal waters with salinities up to about 8 parts per thousand (Jenkins and Burkhead 1993), the species has been used for tumor surveys in Chesapeake (Pinkney et al. 2001; 2004a, b; 2009; 2011) and Delaware (Pinkney et al. 2004c; Steyermark et al. 1999) Bay tributaries.

The strongest evidence for chemical etiology of liver tumors in wild fish exists for polynuclear aromatic hydrocarbons (PAHs) (e.g., Baumann and Harshbarger 1998; Myers et al. 2003, 2008; Vogelbein and Unger 2006). Experimental studies have demonstrated a cause and effect relationship between PAHs and liver tumors or preneoplastic lesions (e.g., Hawkins et al. 1990; Schiewe et al. 1991). A linkage between PAHs and liver tumors in brown bullheads was established by Baumann and Harshbarger (1998) from surveys conducted in the 1980s and 1990s in the Black River, Ohio, USA. They observed that tumor prevalence increased and decreased consistently with similar changes in sediment PAH concentrations. Further evidence of an association between sediment PAHs and bullhead liver tumors was demonstrated by Pinkney et al. (2004a) in the Anacostia River (Washington, DC), using polycyclic aromatic compound (PAC)-DNA adducts as a biomarker of response to PAH exposure (Reichert et al. 1998). The 1996, 2000, and 2001 samplings from three locations in the Anacostia River (Fig. 1, total of six collections of 175 bullheads) resulted in a liver tumor prevalence of 50% to 68%, equivalent to the highest reported for this species in North America. Sediment total PAH concentrations averaged 15.2 ppm to 30.9 ppm at the sampling sites and mean liver DNA adduct concentrations in Anacostia bullheads were 16 to 28 times greater than in those from the Tuckahoe River (Maryland) which flows through an agricultural watershed. There was a strong diagonal radioactive zone in chromatograms of the Anacostia bullhead livers (Pinkney et al. 2004a), which is diagnostic for PAC-DNA adducts (Reichert et al. 1998).

Skin tumors in brown bullheads have been induced by repeatedly painting the skin with sediment extracts containing high PAH concentrations (Black et al. 1985). Baumann et al. (1996) reported that higher oral and cutaneous tumor prevalence occurred in PAH-contaminated Great Lakes tributaries compared with reference sites. Grizzle et al. (1984) observed an increased prevalence of papillomas in black bullhead (*Ameiurus melas*) exposed to chlorinated wastewater effluent, and prevalence decreased when chlorination was lowered. Poulet et al. (1994), however, noted the occurrence of orocutaneous tumors in 94 brown bullheads collected from 17 locations (both contaminated and uncontaminated) in New York state. They found that the distribution of lesions did not suggest a strong correlation with exposure to known chemical carcinogens. Pinkney et al. (2011) did not find any relationship between brown bullhead skin tumors and

exposure to PAHs or alkylating agents in surveys of several Chesapeake Bay tributaries using DNA adducts as biomarkers. Bunton (2000) concluded that, although skin tumors in brown bullhead are associated with bottom dwelling, feeding and contact with contaminated sediments, other (unknown) factors may be involved. Oncogenic viruses, which induce skin tumors in other fish species (Getchell et al. 1998), have never been identified in brown bullhead (Poulet et al. 1993; Poulet and Spitsbergen 1996).

Since 1992, the U.S. Fish and Wildlife Service, Chesapeake Bay Field Office (CBFO) has conducted brown bullhead tumor surveys in Chesapeake Bay tributaries (Pinkney et al. 1995; 2001; 2004a, b; 2009; 2011; Pinkney and Harshbarger 2005, 2008; Fig. 1). The goal of these surveys has been to assess the utility of liver and skin tumor prevalence as an environmental indicator. Pinkney et al. (2009) evaluated the database through 2006 and concluded that liver tumor prevalence met all six U.S. Environmental Protection Agency (2006) criteria for an environmental indicator with a clear association with sediment PAH contamination. Skin tumor prevalence did not meet the criteria because the linkages with contaminants are uncertain. Pinkney et al. (2009) recommended conducting bullhead tumor surveys within the Chesapeake watershed on a regular basis to evaluate habitat status and the success of cleanup actions.

Many of the Chesapeake Bay surveys were conducted within the tidal Potomac River watershed along tidal creeks and tributaries that drain subwatersheds with varying landuse. At one extreme is the highly urban Anacostia River, Washington, DC, one of three Chesapeake Bay Regions of Concern for chemical contamination. Other surveys were conducted in suburban tributaries, some of which flow through or adjacent to National Wildlife Refuge lands (Table 1).

This paper reports and interprets the results of five brown bullhead tumor surveys conducted between 2009 and 2011 in the tidal Potomac River watershed. The objectives were to 1) compare tumor prevalence in Anacostia River bullheads collected in 2009, 2010, and 2011 with those from 1996, 2000, and 2001; 2) compare tumor prevalence at various locations within the Potomac River watershed; and 3) statistically analyze the 1992-2011 Chesapeake Bay bullhead tumor database to identify reference locations and covariates.

Methods

Potomac River watershed survey locations

In 2009–2011 boat electroshocking was used to obtain five collections of brown bullheads within the Potomac River watershed (Fig. 1, Table 1). Some collections were compiled from more than one day of electroshocking often spread over several months. At least 30 brown bullheads ($\geq$ 250 mm total length) were targeted for each collection; sample numbers are shown in Table 2. Fish were collected randomly (*i.e.*, no selections were based on external appearance), transported in aerated site water to CBFO, and held without feeding for up to two days until necropsy.

Three collections were obtained from the Anacostia River near the CSX Railroad Bridge in April and May 2009, May 2010, and May and June 2011. This location had been sampled in 1996 and 2001 (Tables 1, 2). We sampled the Potomac River in Washington, DC near Theodore

Roosevelt Island (PRTRI) in September 2009 (approximately 5 km upstream of the mouth of the Anacostia). This urban area of the Potomac receives inputs from several nearby combined sewer outfalls, stormwater outfalls, and discharge from Rock Creek. Piscataway Creek, a 29.9 km tributary of the Potomac in Prince Georges County, MD, enters the Potomac about 17 km downriver from the confluence of the Anacostia and Potomac. In July and September 2011the tidal reach of Piscataway Creek was sampled, with fish collected approximately1.5 km from its confluence with the Potomac River and within 0.5 km of the Fort Washington Marina (see Table 1 for location descriptions).

Laboratory procedures

Bullheads were measured for total length (mm), weighed (g), euthanized in tricaine methanesulfonate (99.5% pure, Argent Chemical Laboratories, Inc., Redmond, WA, USA), and necropsied. Condition factor (K) was determined ([weight X 10^5]/ $length^3$; Carlander 1969). Histopathology was performed on all livers and all external, raised orocutaneous lesions. These were usually associated with the mouth (Fig. 2a), often on the dental ridge, and less frequently on the ventral portion of the operculum. Internal organs were exposed by a longitudinal, ventral abdominal incision, and the liver was excised. Sex was determined and recorded. Livers were weighed and the hepatosomatic index (HSI) was calculated as liver weight divided by body weight. Fish were aged with pectoral spines according to Baumann et al. (1990).

Four blocks of hepatic tissue cut from each liver by scalpel were placed in a numbered cassette and submerged in a dedicated bottle containing 10% buffered neutral formalin. Intact lesions with adjacent tissue were removed with a bone cutter as most external lesions were too hard to cut by scalpel due to underlying bone. After fixation, bone was decalcified for 3-5 days in a solution of 10% citric acid trisodium salt dehydrate (99% Sigma Chemical, St. Louis, MO) (w/v) dissolved in 22.5% formic acid (90% grade (Fisher Scientific, Pittsburgh, PA, USA) diluted in deionized water). The softened tissues were cut, and tissue blocks placed in cassettes. Cassettes containing the fixed tissues were rinsed 8-24 hours in running tap water, and shipped to Mass Histology Services, Inc. (Worcester, MA, USA) where they were dehydrated, infiltrated with paraffin, and embedded in paraffin blocks. Paraffin blocks were sectioned with a microtome at 4–5 microns. Tissue sections were mounted on glass microscope slides, deparaffinized, stained with hematoxylin and eosin, coverslipped, cleaned, and labeled (Luna 1968).

Finished slides were evaluated using the diagnostic terminology recommended by Blazer et al. (2006, 2007). Hepatocellular neoplasms were classified as hepatocellular adenomas (non-invasive) and hepatocellular carcinomas (invasive). Bile duct neoplasms were classified as cholangiomas (non-invasive) and cholangiocarcinomas (invasive). Raised pink areas on the skin were diagnosed as papillomas (non-invasive) or squamous cell carcinomas (invasive).

Data analysis

Raw data from the 2009-2011 tidal Potomac watershed collections were tallied and summarized for each type of lesion (Table 2). We integrated the results of these new collections into the database containing all Chesapeake Bay watershed bullhead surveys conducted from 1992 through 2011 (Fig. 1). Brief descriptions of the tidal Potomac watershed locations are in

Table 1, with data on other Chesapeake locations in Pinkney and Harshbarger (2008) and Pinkney et al. (2009, 2011). Two additional sites (outside of the Potomac watershed) were sampled recently and included in the logistic regression analysis of the Chesapeake Bay database. The Chester River (n=42) collection was obtained in September and October 2010 by trawling a reach from the Crumpton Bridge to about 3 km downstream. The Upper Chester watershed is largely agricultural (69% in Kent County, 63% in Queen Anne's County) and forested (29% Kent, 33% Queen Anne's), with only about 2-4% developed (Maryland Department of Natural Resources 2005). The Middle River collection (n=45) was obtained by electroshocking and trawling in an area within two km of Martin Airport in October and November 2011. In the Middle River watershed, about 62% of the land has been developed for residential, commercial, or industrial purposes and 27% is forested (Versar 2001).

Logistic regression (Kutner et al. 2004) was used to determine which covariates best describe the prevalence of skin or liver tumors. We tested models that included age, length, sex, weight, and all possible combinations of two or more of these covariates without interaction, as well as a no-covariate model. Biomarkers were not considered in the analysis because these data were only available for a small number of fish in the database. For each model, the effect of each location was included as a constant term, as was sex. The remaining covariates were included as linear terms when needed. In order to fit the model to year and location combinations in which none of the observed fish had tumors, we used a Bayesian approach that involved standardizing the data and assuming weak, non-informative priors for all parameters (Gelman et al. 2008). By using weakly informative priors on the parameter describing tumor rates, reasonable estimates are obtained when no tumors are observed. Data were standardized by taking each observation and subtracting the mean of the dataset and dividing by a constant such that the resulting standardized data had a standard deviation of 0.5. Given that the data were standardized, prior distributions on the parameters were chosen to be Cauchy distributions with a mean of zero and standard deviation of 2.5 (Gelman et al. 2008). Model parameters were estimated using the R statistical software package (R Core Team 2012) and the "arm" package (Gelman et al. 2012). Model fit was evaluated using the Bayes Information Criterion (BIC; Schwartz, 1978), defined as: $BIC = -2\ln L + k\ln(n)$, where $\ln L$ is the log-likelihood of the model, or how well the model fits the data. For logistic regression, this is $\sum_{i=1}^{n}\left(P_{i,obs} - P_{i,pred}\right)^2$ where P is the tumor prevalence for the ith fish, k is the number of parameters in the model, and n is the number observations used to fit the model.

The model with the lowest BIC can be considered that which best fits the data with the least complexity compared to the other tested models. Models were fit to the liver tumor data and skin tumor data separately. Initially, only bullheads with age, length, weight, and sex recorded were considered for each model. If, for example, age was not included among the best set of covariates, then individuals lacking age data could be added to the data set. Once the models were established, regression curves showing the influence of the covariates were constructed.

For every location with multiple collections, BIC values were compared for models with and without the collections combined over years. When combining years resulted in lower BIC values, the tumor prevalence was considered to be similar across years and the collections combined. To compare locations, the liver and skin tumor prevalence were estimated separately

for the average values of the important covariates using a Bayesian hierarchical logistic regression model. The hierarchical modeling framework was used to account for the consequences of combining collections over years by fitting a second level of intercept parameters for each year in a combined collection (Gelman and Hill 2006). As before, the data was centered and weak, non-informative (Cauchy distributions) priors were used for all estimated parameters. Model parameters were estimated with the Gibbs sampler JAGS (Just Another Gibbs Sampler; Plumer 2012). The lengths of the Gibbs sampler chains were chosen such that $\hat{R}$ (an estimate of the factor by which the variance would be reduced if the Gibbs sampler chain was infinitely long) for all parameters approached one, indicating convergence (Gelman et al. 2004). Collections or locations (multiple collections at the same location) for skin and liver tumor prevalence were grouped together as not being different if the 95% highest probability density interval (HPDI, a Bayesian analogue of a 95% confidence interval) for the difference in tumor prevalence contained zero, indicating no difference.

To group locations into a "Chesapeake Bay Reference Group (CBRG)," a location with the lowest combined rank in liver and skin tumor probabilities was selected as the initial location. Then each location was tested against the initial location using logistic regression with the same hierarchical modeling framework as described above. Locations that were not significantly different (using the 95% HPDI) from the initial location for both liver and skin tumors were added to the CBRG. This approach was modeled after a similar effort in Lake Erie (Rutter 2010).

Results

Pathology of bullheads in the 2009–2011 tidal Potomac collections

Gross examination revealed the presence of raised pink, oval or round, solid (in texture) lesions in the mouth area (Fig. 2a) of bullheads from all five collections (Table 2). After histopathological examination, nearly all of these visible lesions were diagnosed as either non-invasive epidermal papillomas or invasive squamous cell carcinomas (Fig. 2b). Skin tumor prevalence was highest in the Anacostia River collections ranging from 13.0% to 17.8% , slightly lower in the PRTRI collection (12.5%), and lowest in the Piscataway Creek collection (8.7%; Table 2).

Only one liver tumor was suspected based on the gross appearance of the organ (Fig. 3a). The raised white portion was confirmed histologically as a cholangiocarcinoma (Fig. 3b). This liver was also diagnosed with a hepatocellular carcinoma (Fig. 3c). Liver tumor prevalence was similar among the five Potomac watershed collections: PRTRI (2009)—30.0%, Anacostia River (2009-2011)—21.6% to 26.7%, and Piscataway Creek (2011)—26.1%.

Logistic regression analysis

The entire Chesapeake Bay tumor database of 1451 fish from 39 collections obtained from 1992 through 2011 was screened to retain only fish that were aged (n = 1193, based on 34 collections). For liver tumors, the set of covariates with the lowest BIC was the model that used length and sex. Since age was not included in the set of best covariates, additional fish for which

age was not determined were added to the data set. Hence, the data set included a total of 1404 fish from all 39 collections (those not identified as male or female were excluded) and again the best model (with the lowest BIC) used length and sex as covariates. In all cases for liver tumors, we were able to pool multiple collections from a location based on BIC. For skin tumors, the results were similar with the best model including only length and sex. For this analysis, multiple collections from a location were pooled except for collections from Neabsco Creek and the Severn River. For both skin and liver tumors, increased length and being female resulted in higher probabilities.

The Choptank River was the first location assigned to the CBRG, based on having the lowest combined rank in skin and liver tumor probabilities. Based on the HPDI analyses, fish from the Furnace Creek, Rhode River, Tuckahoe Creek, Chester River, Quantico Embayment, Farm Creek, and Marumsco Creek locations were added to the CBRG. Fish from the Back River and South River were not added despite their low liver tumor prevalence because their skin tumor prevalence was high. The Middle River location was excluded due to high liver tumor prevalence. Fish from the Severn River location were not included because for one year (2004), skin tumor prevalence was high.

Combining fish from the eight locations listed above resulted in 390 fish being included in the CBRG (Table 3). The mean estimates for female and male liver tumor prevalence for the CBRG were 9.7% and 2.3%, respectively. The mean estimates for female and male skin tumor prevalence were 3.7% and 2.4%, respectively (Table 3). Combining fish from different sites and increasing sample size resulted in narrower HPDIs for the CBRG compared with those for the individual locations (Tables 3–5).

For the Potomac River watershed locations, there were several distinct statistical groupings for liver tumor probabilities (Table 4, with length–prevalence curves in Figure 4). The highest probability group (group f) was the 1996, 2000, and 2001 collections from the three Anacostia River locations (six collections). Mean probabilities of a 280 mm bullhead having a liver tumor were 77.5% to 89.0% in females and 43.0% to 63.4% in males. At the Anacostia CSX Railroad Bridge location, sampled twice in 1996, once in 2001, and once in 2009, 2010, and 2011, the probability of a 280 mm female having a liver tumor went from 77.5% in the 1996-2001 grouping (n=90) to 42.2% in 2009-2011 (n=150), a 46% decrease. In males, the change was from 43.0% to 13.6%, a 68% decrease. The 2009-2011 Anacostia River collections, PRTRI location and Neabsco Creek formed a separate statistical group (group e) with mean probabilities ranging from 34.2% to 44.5% in females and 10.0% to 14.8% in males. The liver tumor probabilities for the PRTRI location (44.5% in females, 14.8% in males) were nearly identical with the pooled Anacostia 2009-2011 collections (42.2% in females, 13.6% in males). Within the Potomac watershed, bullheads from the Piscataway, Neabsco, Anacostia, and PRTRI locations had significantly greater liver tumor probabilities than those from the CBRG (Table 4).

For skin tumors, there were several overlapping statistical groupings for the Potomac watershed locations (Table 5, with length–prevalence curves in Figure 5). The probabilities of skin tumors in 280 mm bullheads for Anacostia 2009-2011 (17.2% for females, 11.8% for males) while lower, were not statistically different from the 1996, 2000, 2001 Anacostia collections (27.5% for females, 19.6% for males). At the Anacostia CSX Railroad Bridge location, the

probability of a 280 mm female brown bullhead having a skin tumor went from 27.5% in the 1996, 2001 grouping (n=90) to 17.2% in 2009-2011 (n=150), a 37% decrease. In males, the change was from 19.6% to 11.8%, a 40% decrease. These changes in the skin tumor prevalence of the Anacostia bullheads over time were not statistically significant. Within the Potomac River watershed, bullheads from all Anacostia locations and from the 1992 Neabsco collection had significantly greater skin tumor probabilities than those from the CBRG (Table 5).

Discussion

PAHs and decreased tumor prevalence in the Anacostia River bullheads

The findings of statistically significant and substantial (46% in females, 68% in males) decreases in liver tumor prevalence at the Anacostia CSX location over time, coupled with the literature linking these tumors with PAHs, led us to analyze for causation. According to Myers et al. (2003), the classic epidemiological criteria for causation include 1) strength of the association between the chemical exposure and effect, 2) consistency of the association, 3) toxicological and biological plausibility, 4) temporal sequence (exposure precedes effect, and effect decreases after exposure decreases), 5) biological gradient, 6) specificity of the association, and 7) experimental evidence supporting the cause-effect relationship. These criteria were met in field studies in Black River, Ohio (Baumann and Harshbarger 1998), Puget Sound (Myers et al. 2003, 2008), and Elizabeth River, Virginia (Vogelbein and Unger 2006, 2011) that linked improvements in liver tumor prevalence in resident fish to decreased PAH exposure after the completion of remedial actions.

In the Black River, Baumann and Harshbarger (1998) tracked changes in liver tumor prevalence in 3-year old brown bullhead. They reported 60% liver tumor prevalence in 1980, with a total PAH sediment concentration of 1096 ppm near the collection site. In 1983, a coking plant that was the primary source of contamination closed. Sediment total PAH concentrations decreased to 4.3 ppm in 1987, when the tumor prevalence was 30%. Remedial dredging in 1990 resulted in the presence of a plume of resuspended contaminated sediments. The increase in tumor prevalence in 1992 (60%, 16.6 ppm total PAH) and 1993 (62%, no sediment data) was attributed to the 1990 exposure of age-one and young-of-the-year bullheads, respectively. A subsequent drop in tumor prevalence in 3-year old bullhead in 1994 to 20% (total PAH of 9.8 ppm) was attributed to their lack of exposure to the plume. In a 1998 collection, Blazer et al. (2009a) reported an 8.9% prevalence of liver tumors.

At the Eagle Harbor Superfund Site, Puget Sound, Washington, Myers et al. (2008) reported that liver tumor and preneoplastic lesion prevalence in resident English sole (*Parophrys vetulus*) decreased dramatically after placement of a 22-hectare and later a 6-hectare sand cap over creosote-contaminated sediments. Decreased sediment PAH concentrations and decreased concentrations of hepatic PAC-DNA adducts were documented. After dredging and capping of creosote-contaminated sediments in the Elizabeth River, Virginia, Vogelbein and Unger (2011) reported a decrease in the prevalence of liver tumors and preneoplastic lesions in mummichog (*Fundulus heteroclitus*).

In these cases, the key pieces of evidence that fulfilled the criteria for causation included "before" and "after" data for sediment PAHs, tumors and preneoplastic lesion prevalence, PAC-DNA concentrations, and documentation of one or more major cleanup actions. The Anacostia case does not fulfill those criteria. Although we have clearly documented an improvement in liver tumor prevalence in the Anacostia bullheads, only "before" sediment data were available (Velinsky and Ashley 2001; Table 1). No single remedial action such as a plant closure or remedial dredging has occurred. Such an action would have occurred in the 2000-2006 period to be reflected in the tumor prevalence of the mostly 3-5 year old bullheads collected in 2009-2011. Also, although there has been marked improvement compared with 1996–2001, both the liver and skin tumor probabilities for the 2009–2011 Anacostia bullheads remain significantly elevated compared with our estimate of Bay-wide background (Tables 4, 5).

Although current ('after") sediment PAH data are lacking, analysis of PAC-DNA adduct suggests a possible decline in PAH exposure. Pinkney et al. (2004a) reported mean (± one standard deviation) PAC-DNA concentrations of 1146 ±472 nmol adducts/mol normal nucleotides (n=14) from bullheads collected at the Anacostia CSX Railroad Bridge in 2001. In a 2009 sampling from the same location, Pinkney et al. (2011) reported mean PAC-DNA concentrations of 122 ±44 nmol adducts/mol normal nucleotides (n=7). Because of differences in DNA quantification methods, direct comparison of the two results is somewhat difficult, precluding the use of statistics. The 2009 samples, DNA concentrations were quantified using spectrophotometric absorption, whereas Pinkney et al. (2004a) quantified DNA by labeling normal DNA nucleotides, which underestimates the amount of DNA nucleotides by 50 to 75%, depending on the nucleotide (L. Balk, unpublished data). Multiplying the 2009 results by 2 to 4 gives a rough estimate mean of 244 to 488 nmol adducts/mol for comparison with the older method. Thus, although there is considerable uncertainty, this analysis resulted in a greater than 50% decline between the two sampling periods. Future samplings using the newer DNA adduct quantitation methods would reduce this uncertainty and enable trends to be analyzed.

The lesser decline in skin tumors in the Anacostia bullheads is further evidence that the triggers for skin tumors are more complex (Bunton 2000; Pinkney et al. 2009, 2011). Recently, Pennsylvania Department of Environmental Protection (PADEP 2012) recommended delisting of the Presque Isle Bay Great Lakes Area of Concern for the Fish Tumor and Other Deformity Beneficial Use Impairment. The agency reported that although the liver tumor rate in Presque Isle Bay was statistically equivalent to the designated reference area, the external skin tumor prevalence was still elevated. They concluded, however, that the linkage between skin tumors and contaminant exposure was insufficient to maintain the Beneficial Use Impairment.

Remedial activities in the Anacostia River

Lacking the large-scale cleanups of the above-cited cases, we catalogued actions that may have reduced bullhead exposure to PAHs and/or are likely to do so in the future. At present, it is not possible to evaluate these actions quantitatively because of a lack of sufficient data to estimate the total loadings of PAHs into the river. The most recent modeling of contaminant inputs to the Anacostia was the Behm et al. (2003) application of the Tidal Anacostia Model/Water Quality Analysis Simulation Program (TAM/WASP) which simulates the loading, fate, and transport of contaminants including PAHs. The model estimated a total input of 886 kg

per year for total PAHs, with 549 kg/year (62%) from the Northeast and Northwest Branch tributaries, 155 kg/year (17%) from the Lower Beaverdam Creek tributary, 91 kg/year (10%) from separate stormwater outfalls, 36 kg/year (4%) from combined sewer outfalls, 34 kg/year (4%) from groundwater contamination from the Washington Gas site, and 22 kg/year (2%) from Watts Branch tributary. Behm et al. (2003) estimated losses of 246 kg/year (28%) to the Potomac River and 218 kg/year (25%) to volatilization and decay.

Behm et al. (2003) acknowledged the uncertainties in the model and stated that the load estimates may be inaccurate from -50% to +300%. Water column load data are based largely on a one-year study conducted in 1995–1996 (Foster et al. 2000) that measured chemical concentrations during four storms and six base flow periods. Behm et al. (2003) recommended obtaining additional and updated storm water monitoring data for the upstream tributaries, Lower Beaverdam Creek, and the separate and combined sewer systems.

Foster et al. (2000) determined that 95% of the Northeast Branch and 99% of the Northwest Branch loads are from particle-bound rather than dissolved PAHs. Thus, any actions that reduced the volume of runoff and the amount of suspended sediment flowing into the tributaries and sewers likely reduced PAH loading into the Anacostia. The sediment Total Maximum Daily Load (TMDL) prepared by MDE and DC Department of Health (DOH) (2007) calls for an 85% overall reduction of sediment/TSS from the baseline loads determined for 1995-1997 of (46,906 tons/year) [4.25×10^7 kg/year] to 7097.6 tons/year [6.44×10^6 kg/year]. Strategies to achieve these reductions include the implementation of Environmental Site Design (ESD), i.e., the use of small-scale stormwater management practices, nonstructural techniques, and better site planning to mimic natural hydrologic cycling of rainwater and minimize the impact of land development on water resources (Biohabitats, Inc. 2012). Actions aimed at reducing point and non-point source pollution within the District of Columbia were documented in its 2012 Water Quality Assessment (District Department of the Environment (DDOE) 2012). It states that since the promulgation of stormwater management regulations in 1998, over 2000 stormwater Best Management Practices (BMPs) have been installed throughout Washington, DC at new development and redevelopment projects for nonpoint source pollution control. Control of stormwater has been improved by DDOE's aggressive maintenance and inspection program to ensure that BMPs are operating efficiently. Street sweeping, one of the activities promoted by the District to meet stormwater goals and reduce sediment loading, also reduces PAH loading (Biohabitats Inc. 2012).

Stream restoration projects are also an important component of the load reduction, because, according to MDE and DOH (2007), stream channel erosion contributes 67% of the total annual sediment load to the Anacostia River, followed by urban land at 23%. For example, the 2.9 km restoration of the Watts Branch tributary completed in 2011 was estimated to reduce erosion of the reach by 75% (M. Secrist, U.S. Fish and Wildlife Service, personal communication).

The District of Columbia issued a TMDL addressing the loading of organics including PAHs into the Anacostia (DC DOH 2003), based on the TAM/WASP model (Behm et al. 2003). The document calls for 98% to 99.6% reductions in the loadings from the tributaries and combined sewer outfalls and a complete cessation of loadings from the Washington Gas

hazardous waste site. This site was a coal-gas manufacturing plant from 1888 until 1948. Contamination of oil and tar was discovered when non-aqueous phase liquid was discovered in the river in 1976. Capture of groundwater contamination from the waste site was achieved through a pump and treat system started in 1996, with additional wells added in 2003 (Hydro-Terra Inc. 2005). An estimated 41 kg per year of PAH were captured in the treatment system and prevented from migrating to the river (M.J. Brady, Washington Gas, personal communication).

Source control actions in the 446 hectare Hickey Run subwatershed have also reduced PAH loadings to the Anacostia River. Hickey Run has a long history of oil pollution; in the 1930s it caught fire (US ACE 2010). The chronic oil pollution likely results from illegal dumping and the upstream loadings from automotive repair facilities (US EPA 2005). In 1998, a TMDL was developed by DOH for oil and grease that called for a reduction in point source loads by 89% and for nonpoint source loads by 30%. Part of the TMDL implementation in 2002-2003 included block by block surveys and site inspections of automobile repair shops within the Hickey Run watershed by DOH (Ngbatana 2004). The surveys identified the deficiencies in operations and waste handling that led to spills and illegal dumping. DOH initiated the Environmental Education Compliance of Auto Repair Shops (EE-CARS) Program in which automotive shops were instructed on how to decrease loadings. US EPA (2005) reported that the 10 mg/L water quality standard for oil and grease was achieved and Hickey Run was removed from the list of impaired waters. A 77% reduction in daily loadings was calculated (US EPA 2005), which amounted to an annual decrease of 4470 kg of oil and grease. Using the average of four estimates of the PAH/Oil and Grease Ratio (Washington Department of Ecology 2008), the estimated decreased annual PAH loading in Hickey Run amounted to 1.2 kg per year.

Velinsky et al. (2011) concluded that coal tar- and asphalt-based pavement sealants were one source of PAHs to the Anacostia River. A recent ban on the use of coal tar pavement sealants, which yield higher amounts of PAHs, was enacted in 2009. Since the ban, eight sites that were illegally coated (a total area of 0.06 square kilometers) were remediated (K. Judson, DDOE, personal communication). Using an annual release rate of 0.51 grams total PAH/square meter (Scoggins et al. 2009), the total amount of PAHs prevented from entering the river is estimated at 30.5 kg per year. Note that the timing of this action was too late to have affected the tumor prevalence data for 2009-2011.

Spatial comparisons within the Potomac River watershed

A major finding of this study was the similarity in liver and skin tumor prevalence in the 2009–2011 Anacostia bullhead collections, PRTRI, and Piscataway Creek (Tables 2, 4-5; Figures 4, 5). Unfortunately, it is difficult to characterize the extent of sediment contamination at the latter two locations. We identified only three sediment samples collected within 1.5 km of PRTRI. Foster and Cui (2008) collected these samples in 2000 and reported a mean total PAH concentration of 4.4 ppm (Table 1). No sediment PAH data have been identified from areas near the Piscataway Creek fish collection.

The similar tumor prevalence at all locations suggests that the tumor issue may be a more regional problem than one restricted to the Anacostia River. Thus, possibly due to the cleanup activities described above, the current liver tumor prevalence in the Anacostia now reflects the

overall urban loading in the Washington, DC area rather than a special case. A repeat sampling of the PRTRI and Piscataway Creek locations as well as new locations extending downriver from Washington, DC, supported by sediment PAH analyses would be needed to verify this suggestion.

Logistic regression analysis of the Chesapeake Bay tumor database

The logistic regression analysis of liver tumors was consistent with the previous Chesapeake Bay data base analyses (Pinkney et al. 2009, 2011), which also identified length and sex as covariates. The higher prevalence in longer fish is most likely related to age. As discussed in Pinkney et al. (2009), the ages in the database were based on spines, which are less precise than otoliths and tend to underestimate the ages of larger fish (Maceina and Sammons 2006). This would result in a narrower age spread, which is better captured by length as a covariate. The increased prevalence in females is consistent with Cooke and Hinton (1999) who reported greater liver tumor prevalence in females of six fish species and theorized that increased endogenous estrogens serve as tumor promoters. Nunez et al. (1989) first demonstrated that 17-β-estradiol promotes hepatocellular carcinoma in fish. Interestingly, Rutter (2010) in an analysis of 459 bullheads from Lake Erie did not identify sex as a significant covariate for liver tumors.

In contrast to Pinkney et al. (2009), which did not identify any covariates as predictors for skin tumors and Pinkney et al. (2011) which identified only length, the present analysis identified both length and sex as covariates, with females having a higher probability. Both Blazer et al. (2009b) and Rutter (2010) reported significant positive relationships between otolith age and orocutaneous tumors in brown bullheads from Lake Erie locations. A powerful age effect was reported by Blazer et al. (2009b) in bullheads from the Presque Isle Bay area of Lake Erie, in which the skin tumor prevalence increased steadily from 5.9% in age-4 bullheads to 100% at age-12. There was a similar pattern at the Long Point Inner Bay (reference) site, on the northern shore of the lake. No skin tumors were noted until age-7 (7.1%) and the prevalence increased to 36.4% in age-10 bullhead. Age and length were also reported to be significant covariates by Rutter (2010) who used Bayesian methods to analyze 459 brown bullheads from five Lake Erie sites. These analyses were based largely on otoliths rather than spines. As mentioned above, we suspect that our covariate, length, is a surrogate for otolith age.

In contrast to the current study, Rutter (2010) did not identify sex as a significant covariate in his analysis of Lake Erie bullheads. We cannot identify a toxicological mechanism for increased skin tumor prevalence in female bullheads and the differing results further highlight the uncertainty associated with skin tumors. We recommend further research into bullhead skin tumor etiology. Such studies should utilize molecular biology techniques (e.g., Nakamura et al. 2009) that facilitate the discovery of previously unidentified viruses and should determine the immune status of bullheads (e.g., Iwanowicz et al. 2012) with and without skin tumors.

Conclusions and recommendations

The key finding was a statistically significant decrease of roughly 50% in the probability of liver tumors in the Anacostia River bullheads (standardized to 280 mm length) between 2001

and 2009–2011. Although these tumors are clearly linked with exposure to PAHs, there were inadequate data to establish a cause-effect relationship between a theorized decrease in exposure and the lower prevalence. An updated sediment chemistry survey of the river is needed to establish whether a reduction in sediment PAH exposure has occurred. A second important finding was the similar tumor prevalence in the Anacostia, Potomac River in Washington, DC and Piscataway Creek. There were few sediment data available for the latter two locations to characterize the extent of PAH exposure. A repeat survey of those and other Potomac River locations supported by sediment PAH measurements is needed to verify the suggestion that the elevated tumor prevalence is a regional rather than Anacostia issue. By analyzing the Chesapeake Bay database, we provided an estimate of "regional background" and showed that, while improved, the tumor prevalence in Anacostia bullheads and those from other Potomac watershed locations remain elevated.

We recommend monitoring of tumor prevalence at the Anacostia CSX Railroad Bridge location on a 5-year cycle, along with an updated sediment survey, so that this indicator can continue to track changes in habitat quality. The present study which sampled the Anacostia in 2009, 2010, and 2011, provided confidence in the status circa 2010 by sampling three years. Surveys in 2014, 2015, and 2016 would provide a similar level of confidence for the next five year interval. Further evidence for causation could be provided by coupling the tumor survey and sediment sampling with measurement of PAC–DNA adducts using the methods described in Pinkney et al. (2011). We recommend further research into bullhead skin tumor etiology, by applying state-of-the-art techniques to identify possible viruses and evaluating the immune status of affected and unaffected fish. Additional sampling of CBRG locations would be useful to update and further refine the estimates of regional background.

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TABLES

Table 1. Descriptions of the Potomac River watershed sampling locations including sediment polynuclear aromatic hydrocarbon (PAH) concentration data. Locations sampled in 2009–2011 are in bold. Surface sediment sampling data are within 1-1.5 km of the bullhead collection locations.

Location	Description/type of watershed	Sediment PAH concentrations (mean ± SD, ppm dry weight)
Anacostia R. near O St. Combined Sewer Outfall	2.5 km from mouth, sampled adjacent to combined sewer outfalls and Washington Navy Yard Superfund site (primarily PCBs), 1.4 km downriver from Washington Gas site (PAHs); urban	2000: n= 31[a] Carcinogenic PAHs[b]: 16.4 ± 8.9 Total PAHs: 30.9 ± 18.2
Anacostia R. at CSX RR Bridge	5.8 km from river mouth, sampling range extended upriver 1.2 km to the East Capital Street Bridge and downriver 0.6 km to the Pennsylvania Avenue Bridge; near combined sewer outfalls; and 1.7 km upriver from the Washington Gas site; urban	1996: n=3[c] Carcinogenic PAHs[b]: 9.0 ± 0.4 Total PAHs: 26.8 ± 2.9 2000: n=21[a] Carcinogenic PAHs[b]: 14.0 ± 7.3 Total PAHs: 28.1 ± 17.3
Anacostia R. just below Route 50 Bridge	10 km from river mouth, near Kenilworth Landfill waste site (elevated PAHs in soil) and mouth of Little Beaverdam Creek with small dump sites; urban	2000: n=16[a] Carcinogenic PAHs[b]: 7.9 ± 5.0 Total PAHs: 15.3 ± 9.2
Farm Creek	1.6 km tidal creek flows through Featherstone National Wildlife Refuge (NWR); suburban	1991: n= 6[d] Carcinogenic PAHs[b]: 0.030 ± 0.010 Total PAHs: 0.10 ± 0.05 1992: n= 3[d] Carcinogenic PAHs: 0.34 ± 0.04 Total PAHs: 12.0 ± 1.7
Marumsco Creek	0.7 km tidal creek bordering Occoquan Bay NWR; suburban	1992: n=3 [d] Carcinogenic PAHs: 0.63 ± 0.34 Total PAHs: 10.5 ± 1.3
Neabsco Creek	0.5 km navigable tidal creek adjacent to two marinas and bordering Featherstone NWR; suburban	1991: n= 6[d] Carcinogenic PAHs[b]: 0.21 ± 0.08 Total PAH: 0.65 ± 0.23 1992: n= 3[d] Carcinogenic PAHs[b]: 1.4 ± 1.2 Total PAHs: 14.9 ± 9.3 1996: n= 3[c]

		Carcinogenic PAHs[b]: 1.4 ± 2.2 Total PAHs: 4.8 ± 6.8
Piscataway Creek	0.5 km from creek mouth, near Fort Washington marina, suburban	No data available
Potomac R. at Theodore Roosevelt Island	Sampling circumnavigated this 36 ha island in the Potomac River between the Kennedy Center/Georgetown area of Washington, DC and northern Virginia; urban	2000: n=3[e] Carcinogenic PAHs[b]: 2.1 ±1.1 Total PAHs: 4.4 ± 2.0
Quantico embayment	78-ha embayment of the Potomac River adjacent to the Marine Corps Base Quantico and the Old Landfill Superfund site (PCBs and DDT compounds)	1996: n=3[c] Carcinogenic PAHs[b]: 5.1 ± 4.7 Total PAHs: 1.2 ± 1.0

[a] Velinsky and Ashley (2001)
[b] Sum of the following PAHs: benzo(a)pyrene, benz(z)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(ghi)fluoranthene, chrysene, dibenzo(ah)anthracene, and indeno(1,2,3-c,d)pyrene
[c] Pinkney et al. (2001)
[d] Pinkney et al. (1995)
[e] Foster and Cui (2008)

Table 2. Summary of lesion data for the Potomac River watershed brown bullhead (*Ameiurus nebulosus*) collections (number affected with percentage in parentheses). Five current (2009-2011) collections are listed first, then historic (1992-2001) collections.

		Anacostia			Potomac		Anacostia			Anacostia	
	RR Bridge	RR Bridge	RR Bridge	Piscataway	Theo. Roosevelt I.	RR Bridge	RR Bridge	RR Bridge	Upper	Upper	O St.
Mo./Yr.	(4,5/09)	(5/10)	(5,6/11)	(7,9/11)	(9/09)	(4/96)	(10/96)	(4/01)	(10/00)	(4,5/01)	(4,5,6/01)
Lesion[a]	(n=45)	(n=51)	(n=54)	(n=46)	(n=40)	(n=30)	(n=30)	(n=30)	(n=30)	(n=30)	(n=25)
FHA	4 (9)	6 (12)	4 (7)	0	0	8 (27)	6 (20)	18 (60)	17 (57)	16 (53)	14 (56)
HA	0	3 (6)	2 (4)	2 (4)	0	3 (10)	8 (27)	9 (30)	14 (47)	4 (13)	8 (32)
HC	9 (20)	8 (16)	11 (20)	5 (11)	11 (28)	8 (27)	9 (30)	17 (57)	10 (33)	10 (33)	12 (48)
C	0	0	0	0	0	1 (3)	1 (3)	1 (3)	2 (7)	4 (13)	3 (12)
CC	2 (4)	1 (2)	1 (2)	6 (13)	1 (2)	5 (17)	4 (13)	1 (3)	3 (10)	4 (13)	2 (8)
TLT	11 (24)	11 (22)	13 (24)	12 (26)	11 (28)	14 (47)	18 (60)	18 (60)	17 (57)	15 (50)	17 (68)
EP	4 (9)	2 (4)	2 (4)	2 (4)	4 (10)	7 (23)	3 (10)	5 (17)	3 (10)	3 (10)	1 (3)
SC	4 (9)	5 (10)	5 (11)	3 (6)	1 (2)	4 (13)	0	4 (13)	3 (10)	2 (7)	0
TST	8 (18)	7 (14)	7 (16)	5 (11)	5 (12)	11 (37)	3 (10)	7 (23)	6 (20)	5 (17)	1 (3)

Table 2.
continued

Mo./Yr. Lesion[a]	Neabsco (4/92) (n=30)	Neabsco (9/96) (n=30)	Farm (4/92) (n=29)	Marumsco (4/92) (n=30)	Quantico (6/96) (n=30)
FHA	1 (3)	1 (3)	1 (3)	4 (13)	0
HA	0	1 (3)	2 (7)	0	0
HC	3 (10)	2 (7)	0	1 (3)	0
C	2 (7)	0	0	1 (3)	0
CC	1 (3)	3 (10)	0	0	0
TLT	5 (17)	5 (17)	2 (7)	2 (7)	2 (7)
EP	6 (20)	1 (3)	0	0	1 (3)
SC	10 (33)	0	1 (3)	3 (10)	0
TST	11 (37)	1 (3)	1 (3)	3 (10)	1 (3)

[a] FHA = foci of hepatocellular alteration; HA = hepatocellular adenoma; HC = hepatocellular carcinoma; CC = cholangiocarcinoma; TLT = total liver tumors (individuals having either HA, HC, or CC); EP = epidermal papilloma; SC = squamous cell carcinoma; TST = total skin tumors (individuals having either EP or SC)

Table 3. Tumor prevalence probabilities of a 280 mm brown bullhead (*Ameiurus nebulosus*) from locations within the Chesapeake Bay watershed included in the Chesapeake Bay Reference Group (CBRG) (mean percent with 95 percent Highest Posterior Density Interval (HPDI).

Loc.[a]	n=	Liver		Skin	
		Female	Male	Female	Male
CHOP	91	7.0 (0.4–19.1)	1.6 (0.1–4.6)	2.0 (0.0–7.5)	1.3 (0.0–5.1)
FURN	44	0.1 (0.0–5.6)	0.0 (0.0–1.2)	8.4 (1.2–23.6)	5.7 (0.7–16.6)
RHOD	18	7.8 (0.0–26.2)	1.7 (0.0–7.0)	5.0 (0.0–19.9)	3.3 (0.0–14.1)
TUCK	108	12.2 (3.3–24.4)	2.8 (0.7–6.2)	1.4 (0.0–5.8)	0.9 (0.0–3.8)
CHES	40	12.2 (3.3–24.4)	3.2 (0.1–10.1)	0.3 (0.0–7.4)	0.2 (0.0–5.0)
QUAN	30	13.1 (1.0–35.4)	3.0 (0.2–10.0)	4.6 (0.0–17.2)	3.0 (0.0–12.0)
FARM	29	14.1 (0.5–37.2)	3.3 (0.1–10.7)	3.5 (0.0–14.9)	2.3 (0.0–10.0)
MARU	30	17.5 (1.2–43.5)	4.1 (0.2–12.8)	10.4 (1.1–29.3)	7.0 (0.6–20.4)
CBRG	390	9.7 (5.4–15.6)	2.3 (1.1–3.8)	3.7 (1.3–6.6)	2.4 (1.0–4.3)

[a]CHOP: Choptank R. (2008), FURN: Furnace Creek (1998), RHOD: Rhode R. (2007), TUCK: Tuckahoe R. (1996, 1998, 2000, 2001), CHES: Chester R. (2010), QUAN: Quantico Embayment (1996), FARM: Farm Creek (1992), MARU: Marumsco Creek (1992)

Table 4. Comparison of liver tumor probabilities of a 280 mm brown bullhead (*Ameiurus nebulosus*) from locations within the Potomac River watershed (in bold), other Chesapeake Bay locations, and the Chesapeake Bay Reference Group (CBRG) (mean percent with 95 percent Highest Posterior Density (HPD) confidence interval).

	Female	Male	Stat. group[a]
Little Blackwater R. (up)	0.6 (0.0–13.4)	0.1 (0.0–3.1)	abcde
Severn R.	2.6 (0.1–7.3)	0.6 (0.0–1.7)	a
Little Blackwater R. (down)	6.3 (0.0–21.3)	1.4 (0.0–5.6)	abcd
South R.	8.4 (3.9–13.9)	1.9 (0.7–3.4)	ab
CBRG	9.7 (5.4–15.6)	2.3 (1.1–3.8)	abc
Middle R.	23.3 (6.8–44.0)	6.1 (1.4–14.2)	bcde
Back R.	24.8(8.6–44.7)	6.7 (1.5–13.9)	cde
Piscataway Crk.	32.3 (11.5–54.6)	9.2 (1.9–19.6)	de
Neabsco Crk.	34.2 (14.0–53.8)	10.0 (3.0–19.6)	e
Anacostia CSX (2009-2011)	42.2 (27.2–57.2)	13.6 (7.2–21.7)	e
Potomac R. Theo. Roosevelt I.	44.5 (20.3–68.7)	14.8 (3.1–29.2)	e
Anacostia CSX (1996, 2001)	77.5 (65.2–88.6)	43.0 (26.4–58.4)	f
Anacostia Upriver	82.0 (68.1–92.9)	49.2 (30.0–67.7)	f
Anacostia O Street	89.0 (72.0–98.1)	63.4 (33.7–86.3)	f

[a] Locations with different letters are significantly different at $p<0.05$based on 95% HPDI based on average of male and female probabilities.
[b] CBRG (Chesapeake Bay Reference Group) consists of bullheads from the following locations: Chester R., Choptank R., Farm Creek, Furnace Creek, Marumsco Creek, Quantico Embayment, Rhode R., Tuckahoe Creek

Table 5. Comparison of skin tumor probabilities of a 280 mm brown bullhead (*Ameiurus nebulosus*) from locations within the Potomac River watershed (in bold), other Chesapeake Bay locations, and the Chesapeake Bay Reference Group (CBRG) (mean percent with 95 percent Highest Posterior Density (HPD) confidence interval).

	Female	Male	Stat. group [a]
Neabsco Crk. (1996)	0.2 (0.0–9.1)	0.1 (0.0–6.1)	abcd
CBRG	3.7 (1.3–6.6)	2.4 (1.0–4.3)	a
Middle R.	4.7 (0.2–16.1)	3.1 (0.1–10.7)	abc
Severn R. (2007, 2008)	5.6 (1.1–13.0)	3.7 (0.6–8.6)	ab
Piscataway Crk.	9.0 (1.1–24.9)	6.0 (0.5–17.6)	abcd
Potomac R. Theo. Roosevelt I.	12.4 (2.1–31.3)	8.3 (0.9–21.9)	abcd
Back R.	14.3 (4.5–27.5)	9.7 (3.1–19.3)	bcd
Anacostia CSX (2009-2011)	17.2 (7.2–30.5)	11.8 (4.5–20.7)	bcd
Little Blackwater R. (down)	18.4 (2.7–42.6)	12.7 (1.6–31.9)	bcde
Anacostia O Street	22.7 (3.1–50.9)	15.7 (2.2–40.1)	bcde
Anacostia Upriver	23.8 (7.0–43.3)	16.6 (5.2–32.9)	cde
Anacostia CSX (1996, 2001)	27.5 (13.1–45.2)	19.6 (8.1–33.4)	de
Little Blackwater R. (up)	31.7 (8.3–62.4)	23.1 (3.6–48.8)	cde
Neabsco Crk. (1992)	33.7 (9.4–62.4)	24.7 (5.7–50.0)	de
Severn R. (2004)	35.9 (11.3–66.0)	26.2 (6.1–53.4)	de
South R.	42.5 (29.9–55.7)	32.2 (21.5–43.9)	e

[a] Locations with different letters are significantly different at $p<0.05$based on 95% HPDI based on average of male and female probabilities.
[b] CBRG (Chesapeake Bay Reference Group) consists of bullheads from the following locations: Chester R., Choptank R., Farm Creek, Furnace Creek, Marumsco Creek, Quantico Embayment, Rhode R., Tuckahoe Creek

FIGURES

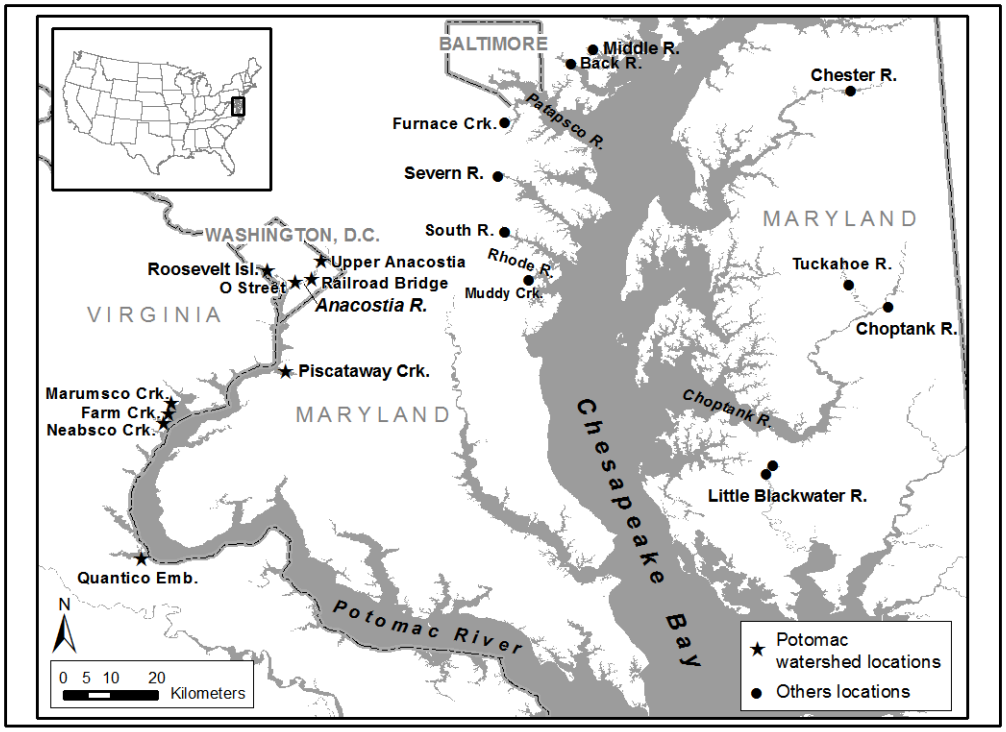


Fig. 1. Brown bullhead *(Ameiurus nebulosus)* collection locations in the Chesapeake Bay watershed.

a)

b)

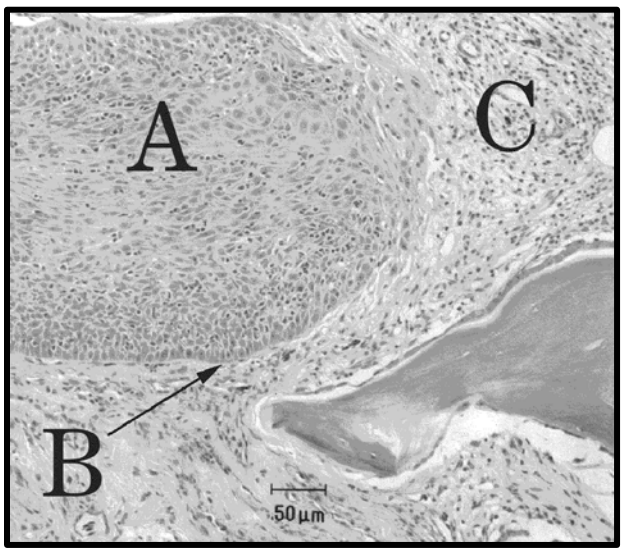


Fig. 2. a) Brown bullhead (217 mm total length) from the Anacostia River with lip lesions (lower: 1.5 x 0.8 cm, upper: 1.0 x 0.5 cm) later diagnosed as squamous cell carcinomas. b) Squamous cell carcinoma: a peg of neoplastic epithelium (A) from the lip breached the basal cell layer (B) and invaded the connective tissue (C).

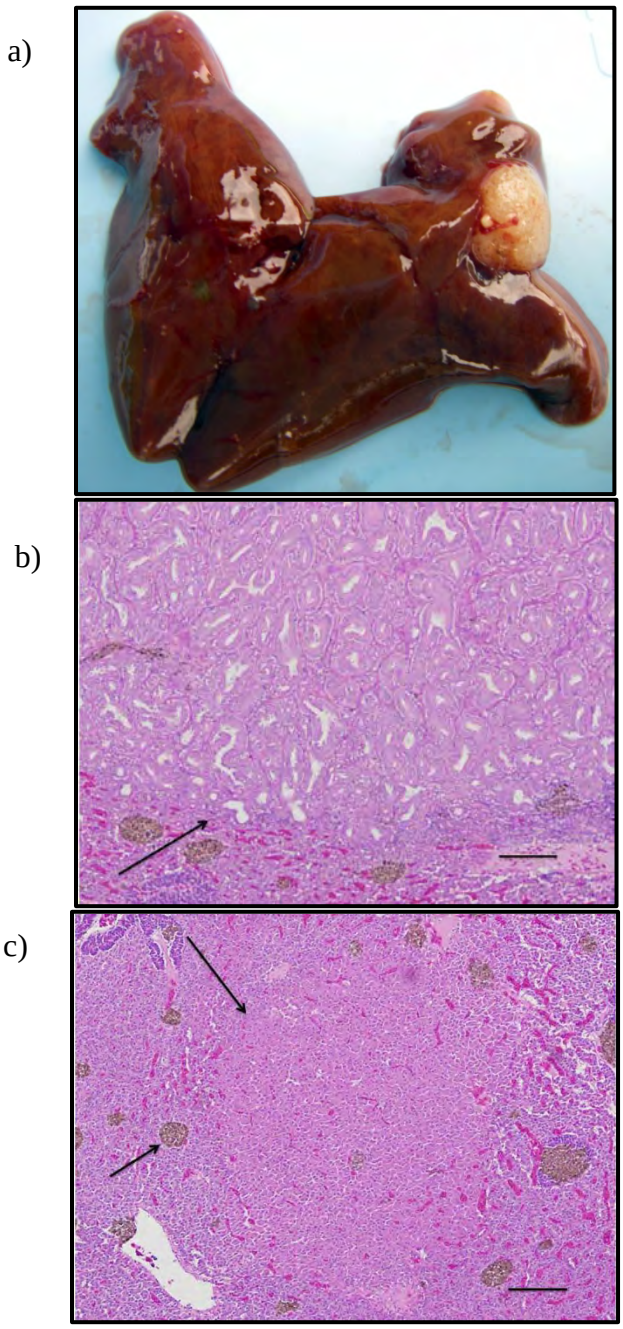
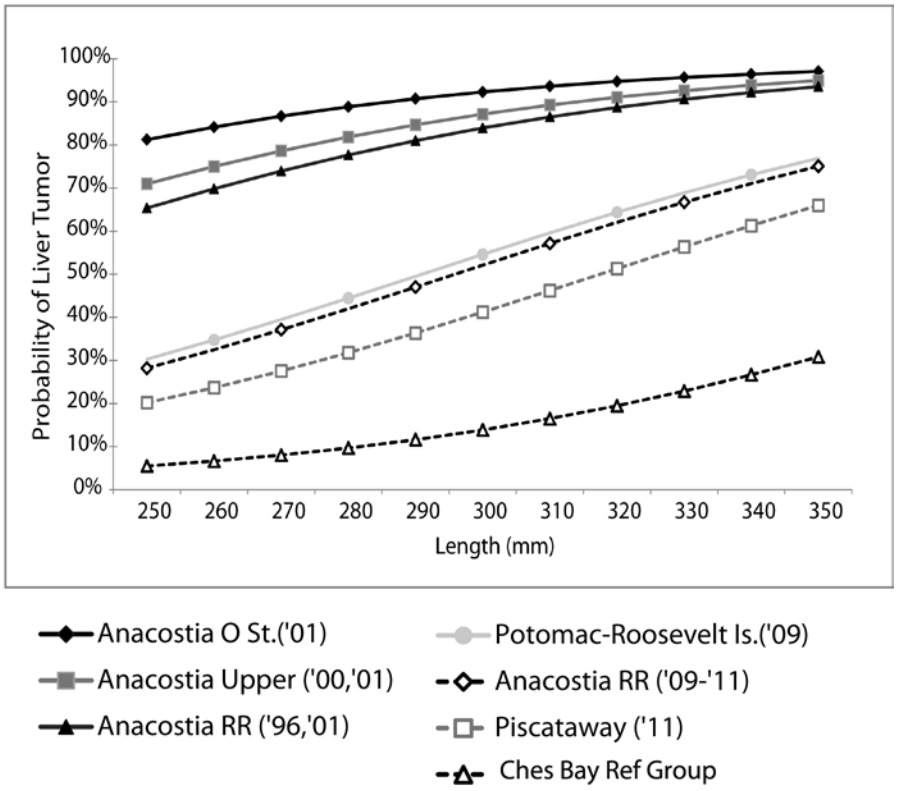


Fig. 3. Brown bullhead (mm total length) collected from the Potomac River Theodore Roosevelt Island location. a) Photograph showing granular white lesion 8 mm diameter and 3-4 mm thick; b) Cholangiocarcinoma: Arrow passing between two macrophage aggregates identifies unencapsulated, poorly-differentiated, cancer of bile duct origin. The tumor consists of poorly formed ducts with irregular lumens and thickened walls. Bar = 300 µm. c) Hepatocellular carcinoma: Top arrow points southeast to an unencapsulated, highly cellular, homogeneous, acidophilic tumor mass. The growing tumor has marginated macrophage aggregates indicated by the lower arrow pointing northeast. Bar = 300 µm.



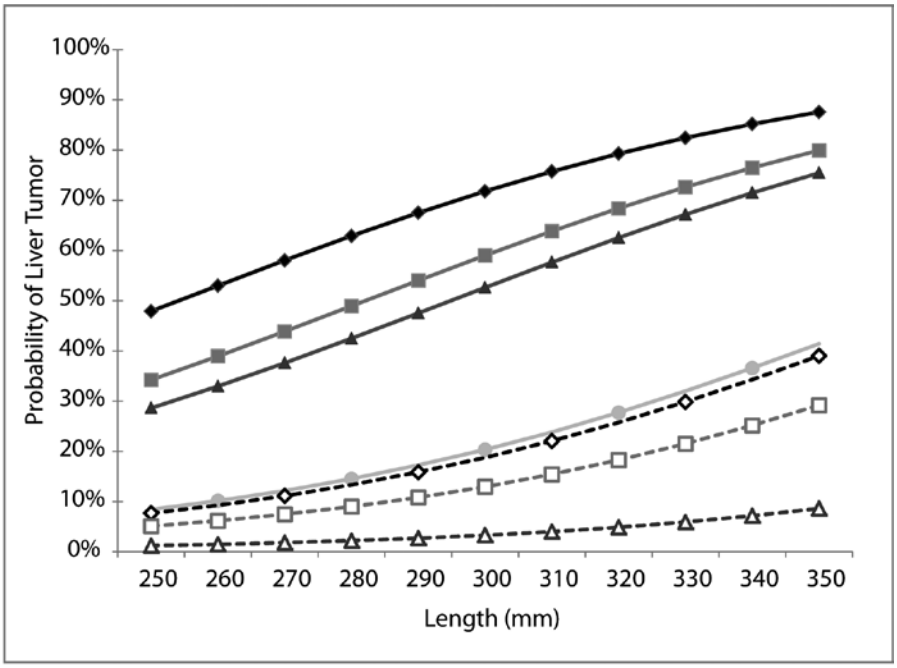
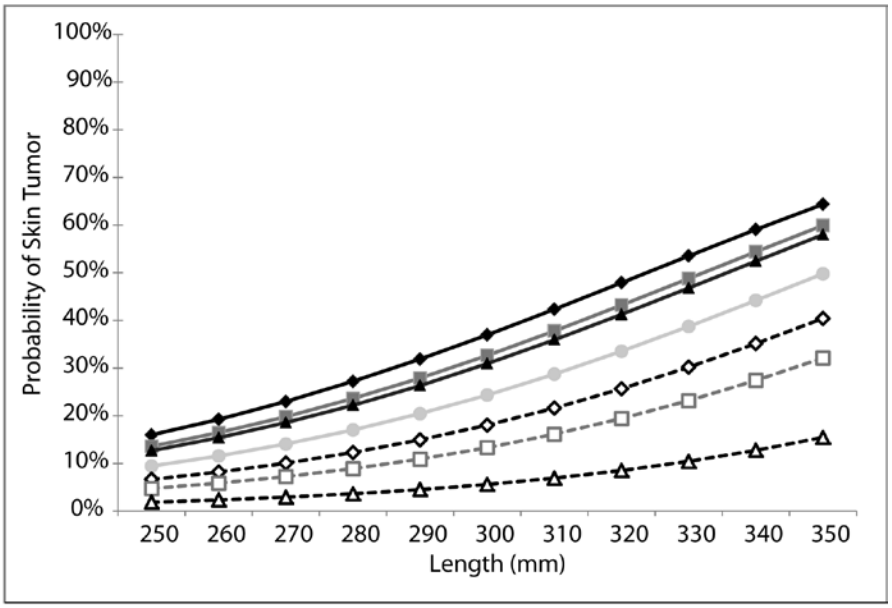


Fig. 4. Probability of liver tumors in brown bullhead (*Ameiurus nebulosus*) from selected collections from the Potomac River watershed and the Chesapeake Bay Reference Group (CBRG): a) Female, b) Male.



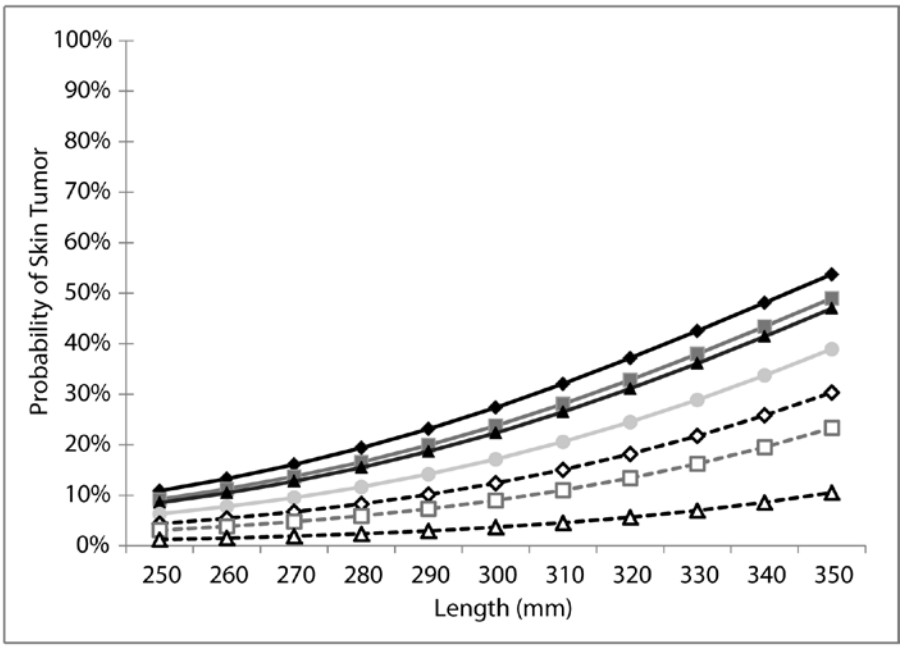


Fig. 5. Probability of skin tumors in brown bullhead (*Ameiurus nebulosus*) from selected collections from the Potomac River watershed and the Chesapeake Bay Reference Group (CBRG): a) Female, b) Male

Appendix A: Glossary of pathological terms

Abbreviation	Definition
FHA	Foci of hepatocellular alteration (often a precancerous condition)
HA	Hepatocellular adenoma (a non-invasive liver tumor)
HC	Hepatocellular carcinoma (an invasive liver tumor)
C	Cholangioma (a non-invasive bile duct tumor)
CC	Cholangiocarcinoma (an invasive bile duct tumor)
TLT	Total liver tumors (all fish with either HA, HC, C, or CC)
EP	Epidermal papilloma (a non-invasive skin tumor)
SC	Squamous cell carcinoma (an invasive skin tumor)
TST	Total skin tumors (all fish with either EP or SC)
H.S.I.	Hepatosomatic index (liver wt/body wt)
K	Condition factor (wt x 100,000 divided by length cubed)

Squamous: Scaly or platelike

Neoplasm: tumor; any new and abnormal growth, specifically one in which cell multiplication is uncontrolled and progressive. Neoplasms may be benign or malignant (invasive).