Ponds and Reservoirs

Wet playa – a terminal basin playa with near-surface groundwater that becomes an ephemeral lake following heavy precipitation. *Example: Soda Dry Lake.*

Ephemeral pond – a natural depression for runoff, often modified by earthwork to hold more water. *Example: Ford Dry Lake.*

Pit lake (groundwater) – open pit mining excavation into a perched aquifer. A pond is formed in the bottom of the open pit after termination of mining and dewatering. *Example: Morningstar Mine.*

Pit lake (surface water) – precipitation collected in the bottom of an open pit mine forming an ephemeral pond, typically with poor water quality. *Example: Vulcan Mine.*

Excavated pond – a pond constructed by excavating into shallow groundwater that may need regular refilling by pumping water. Distinguished from a groundwater pit lake by intent and purpose. Distinguished from a stock pond by permanence. *Example: Lake Tuendae.*

Stock pond – a basin excavated in sediments usually for livestock watering. Typically, these take advantage of natural drainage features and hold water only intermittently. *Example: Lecyr stock pond.*

Ford Dry Lake following a rainy season

Morningstar Mine groundwater pit lake

Guzzlers

Big game guzzler – a water collection system consisting of a check dam in a natural drainage piped to one or more storage tanks that supply water to a small drinker. In the Preserve, these were built for bighorn sheep but may be used by other animals. *Example: Kerr guzzler.*

Small game guzzler – also known as gallinaceous guzzlers as they are intended for gallinaceous bird species. These guzzlers consist of a concrete apron leading to a subsurface concrete or fiberglass storage tank. Birds and small animals enter the storage tank through a small opening.

Large tanks at a big game guzzler

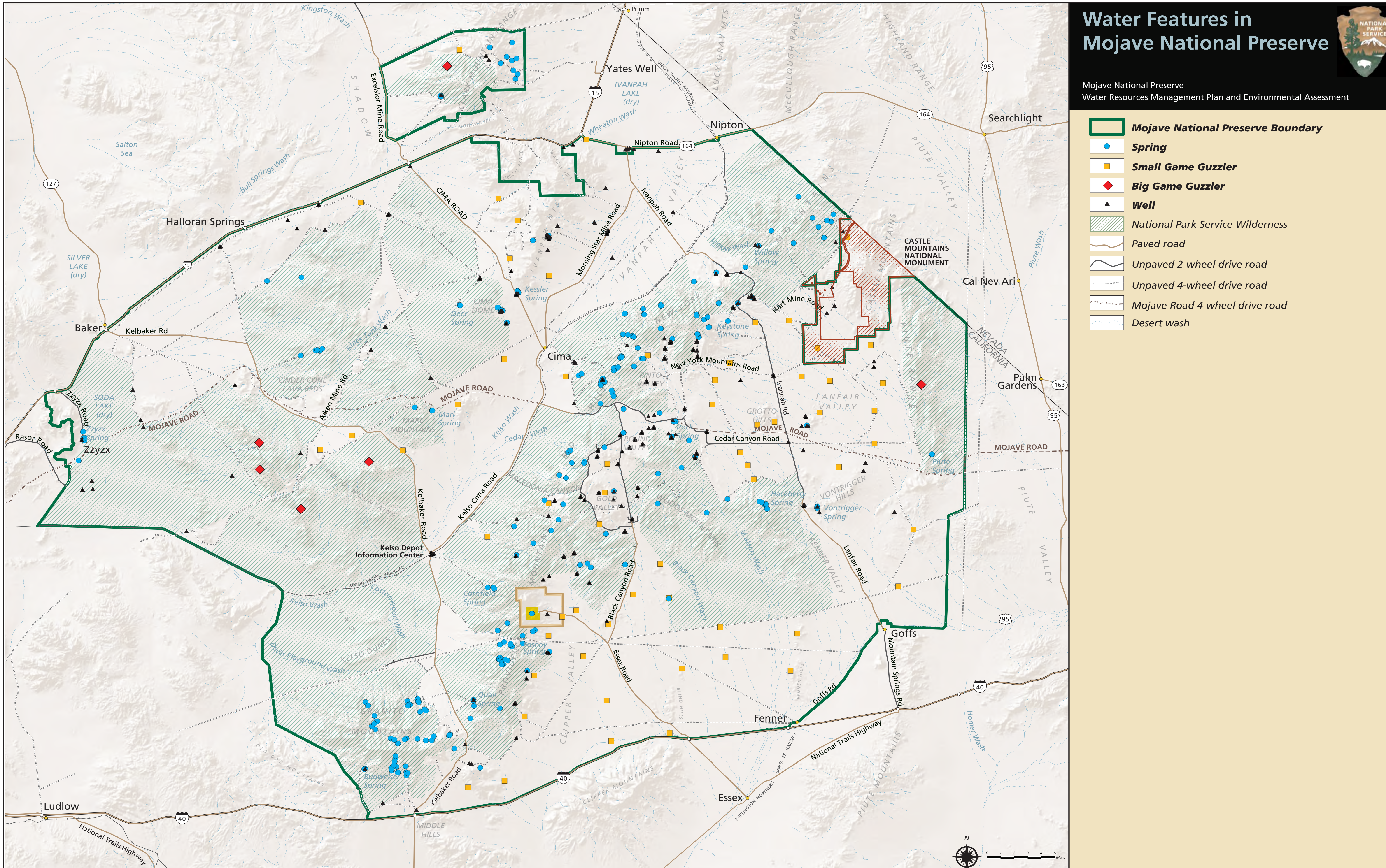
Small game guzzler with a concrete apron and underground tank

Combinations

Features can occur in various combinations, such as a verdant seep with a tunnel, or a bog plus a well. Features may also vary seasonally and may be described by combinations of terms, such as *ephemeral excavated flowing spring* (e.g., Mail Spring following a rainy season). Many features exist somewhere between definitions. For example, Ivanpah Spring could be either a tunnel or an adit, while Cane Spring could be either a bog or a pond.

Water Features in Mojave National Preserve

Mojave National Preserve
Water Resources Management Plan and Environmental Assessment



Springs

The most numerous water features in the Preserve are springs and seeps. A *spring* has visible flow, while a *seep* occurs where the ground surface is occasionally wet and riparian vegetation is often present (NPS 1999). For the purposes of this plan, both types of water features are referred to as "springs." Springs in the Preserve can be broadly classified by their topographic location as either montane or valley basin springs (Dekker and Hughson 2014). There are 238 recorded locations of springs and seeps in the Preserve (see Table 12 and Figure 14) (NPS 2010b, 2013b). While some provide reliable surface water all the time, others are reduced to a small muddy patch or even disappear during dry years. The NPS does not have uniform monitoring of all criteria at all springs, particularly the presence of surface water, which is evaluated by citizen-scientist volunteers on a sporadic basis for some springs.

Table 12. Documented Springs in the Preserve

Spring Characteristics	Documented	% of Total	Notes
Total known springs	238	n/a	Current inventory; actual number is uncertain
Located in wilderness	182	76	N/A
Historic	85	36	Based on NPS field evaluation
Prehistoric	47	20	Based on NPS field evaluation
Less than 500 meters to road	120	50	Proximity of access for potential management
Water observed	218	92	Based on volunteer monitoring of water presence

Montane springs are most common and are typically found in canyons, ravines, arroyos, or other drainage features at the base of mountain ranges between 4,000 and 6,000 feet (1,219 and 1,829 meters) in elevation. Most of these springs are fed by a mountain watershed catchment area with the sediment and fractured bedrock capacity to store precipitation in a shallow aquifer (see Figure 13). Surface water expressions occur where shallow bedrock is exposed, subsurface drainage channels are constricted, or a geologic structure such as a fault, a dike; or contacts of different rock types intercepts subsurface flows (Dekker and Hughson 2014).

Springs that are caused exclusively by geological structures, such as those on Cima Dome or Mail Spring, are less common and may have a perennial water supply despite their small watershed. In many cases, multiple water expressions occur in proximity, resulting in a group or complex of associated springs (Dekker and Hughson 2014).

Valley basin springs occur at the low point of large alluvial basins that are fed by runoff from a large watershed area. The two springs in the Preserve fed by deep alluvial aquifers are Piute Spring, which is believed to be fed at least in part by the Lanfair Valley aquifer, and Soda Springs, which are believed to be fed by a

Natural Springs

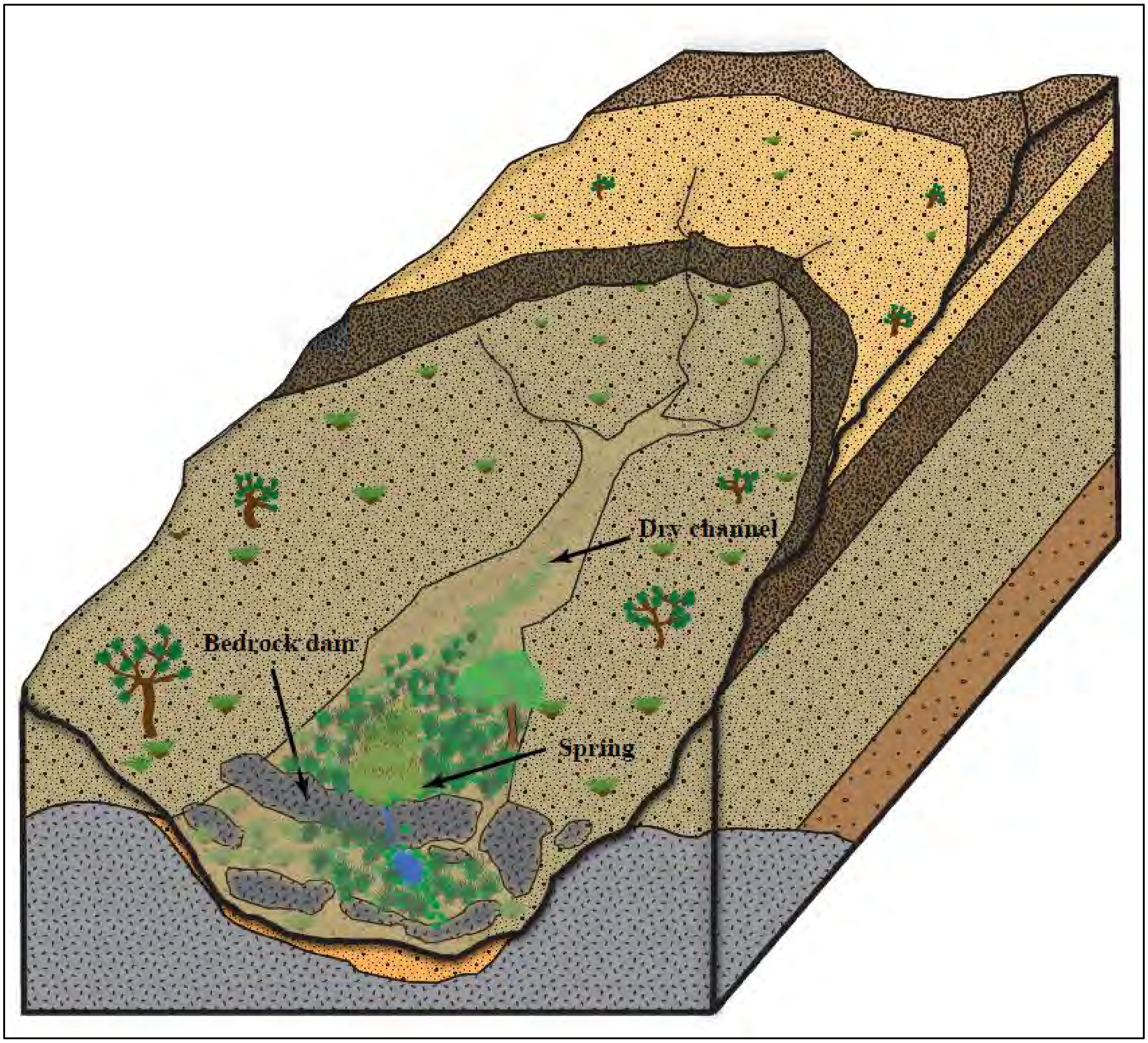
"Natural" springs are those that are physically unaltered and surface water expressions occur without human intervention or development. Natural springs are rare since most water sources have been manipulated by humans at some time. There are many examples of "natural-looking" or undisturbed seeps and springs in the Preserve. While some of the more remote examples may be truly untouched by human intervention, most of these were developed or manipulated at some time, and those interventions are no longer evident.

- Piute Spring and Soda Springs are the best examples of springs that are reliable in the absence of human intervention—both are valley basin springs fed in part by deep alluvial aquifers.
- Arrowweed and Kessler Springs are two examples of springs that were highly developed in the past and now have a natural appearance because the developed infrastructure has deteriorated or has been removed.

combination of mountain front and deep alluvial aquifers. Piute Spring is an important perennial water resource that provides openly flowing water and supports riparian vegetation for about one mile downstream from its source (Lilburn Corporation 1997), while Soda Springs include Lake Tuendae and MC Spring, which provides habitat for the endangered Mohave tui chub. As surface expressions of deep alluvial aquifers, Piute Springs and Soda Springs are vulnerable to excessive groundwater extraction.

While a few springs are known to occur as natural water expressions, about half of the springs have been modified, developed, or enhanced to facilitate human activity related to mining or ranching (see Figure 11). Typical water developments include excavations, tunnels, springboxes, adits, check dams, pipes, tanks, and troughs, which were intended to create or improve surface water expressions. In many cases, water discharge depends on developments (such as tunnels and pipes) (Dekker and Hughson 2014). When those developments are removed or are in disrepair, the discharge is diminished or ceases altogether.

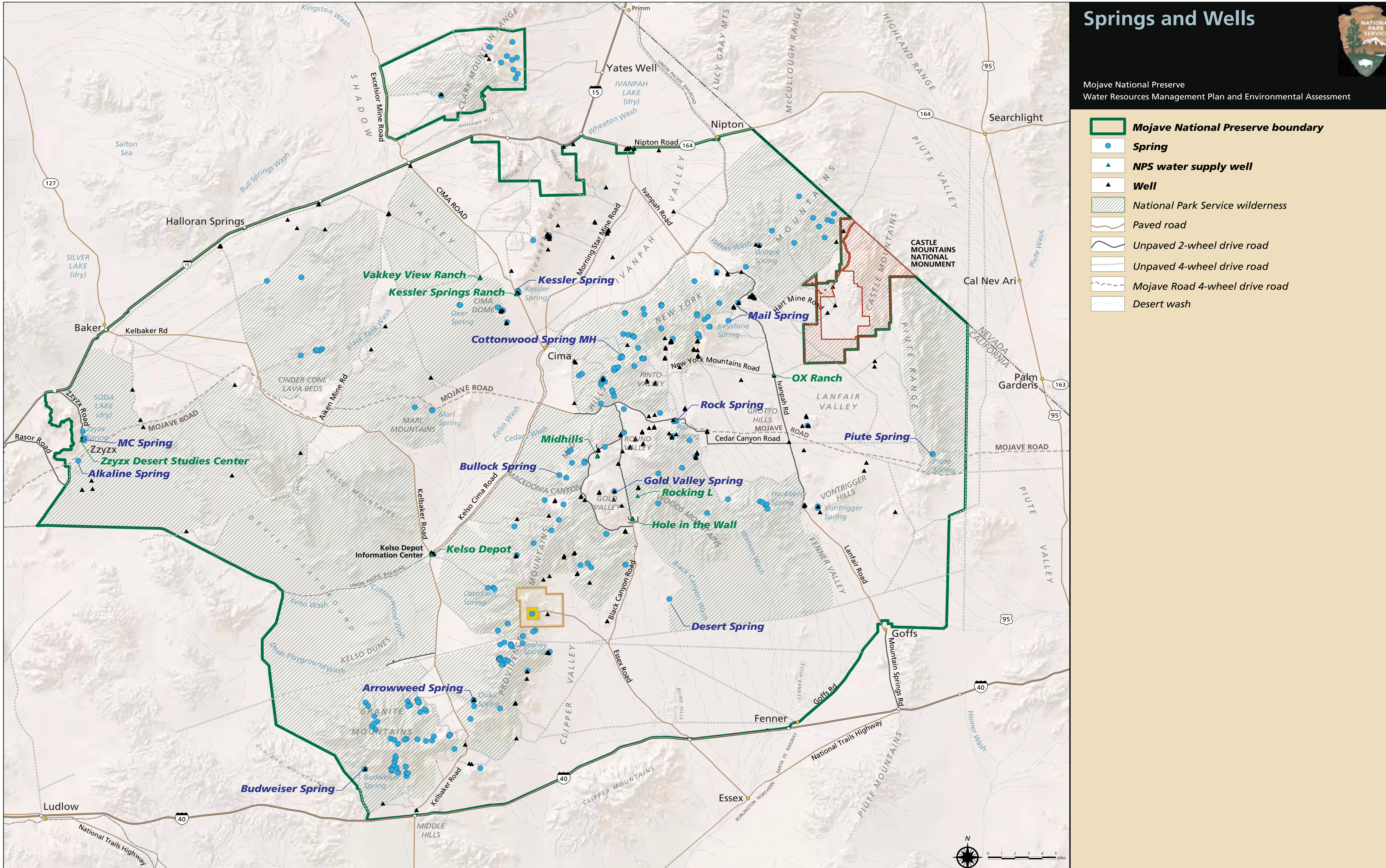
Figure 13. Montane Spring Schematic



Source: Dekker and Hughson 2014.

Springs and Wells

Mojave National Preserve
Water Resources Management Plan and Environmental Assessment



Wells

The installation of wells was an important component of the original ranching and railroad development in what is now the Preserve. There are 73 documented wells in the Preserve, of which 8 are used for NPS water supply and 15 are used to support grazing permits (Figure 14). Wells are vertical excavations to access water, which is mechanically lifted to the surface. While some shallow hand-dug wells exist in the Preserve, most are drilled wells that range in depth from several feet to about 1,400 feet (427 meters) below the surface (Table 13).

There is currently a plan to add a new water supply well in the Hole in the Wall area of the Preserve to support NPS operations. Other known wells in the Preserve are used for water quality monitoring, or are not in use (Table 13). Another 19 private wells are located on private land within inholdings or adjacent to the Preserve. About 49 additional wells in the Preserve have been destroyed in the past (NPS 2008, 2010b). The exact number and status of wells in the Preserve is not known. Historic hand-dug wells are listed and described separately under "Springs."

Table 13. Water Supply Wells in the Preserve

Well	Characteristics	Notes
Kelso Depot	1,400′ depth	Drilled during renovation of depot
Kessler Springs Ranch	Unknown	Water supply for ranch house; good production
Mid Hills area	123′ depth	Supplies Mid Hills campground
OX Ranch	700–800′ depth (est.)	Well and windmill; supplies ranch headquarters; believed to have caved in
Rockin' L	Unknown	Supplies campground and fire center
Hole in the Wall	Unknown	
Valley View Ranch	200′ depth (est.)	Supplies ranch house and corrals
Zzyzx Desert Studies Center (DSC)	50′ depth	Water supply for DSC and fire suppression

According to State of California regulations, a well is considered "abandoned" or permanently inactive if it has not been used for one year, unless the owner demonstrates the intention to use the well again (Water Well Standards, Section 115700 of the California Health and Safety Code). All abandoned wells should be destroyed (Section 22, General Requirements of the California Health and Safety Code).

Guzzlers

Throughout the southwestern United States, wildlife managers and conservation groups have constructed water development structures to enhance wildlife habitat by providing reliable water sources. These wildlife water developments are referred to as "guzzlers." Most guzzlers in the Mojave Desert region have been constructed to promote populations of game birds (such as quail and chukar) and ungulates (such as desert bighorn sheep) (Rosenstock et al. 1999). The two main types of guzzlers in the Preserve are big game guzzlers and small game guzzlers, described as follows.

Big Game Guzzlers

In the Preserve, there are six big game guzzlers, which are all built and maintained to support desert bighorn sheep populations but may be used by other animals (Figure 15). Big game guzzlers in the Preserve typically consist of a water collection system with a check dam or impermeable apron in a natural drainage to collect surface water runoff, which is then piped to one or more large storage tanks. From the storage tanks, a pipe supplies water to a small drinker box for wildlife use. A float valve in the drinker box controls the water flow. The six big game guzzlers are:

- ***Kerr*** – Old Dad Mountains, south of Jackass Canyon
- ***Kelso*** – Kelso Mountains near Kelso Peak (a.k.a. John Doll)
- ***Vermin*** – Old Dad Mountains
- ***Old Dad*** – Old Dad Mountains
- ***Piute*** – Piute Range, north of Piute Spring
- ***Clark*** – Clark Mountains (a.k.a. Bickett-Landell).

Kerr guzzler, Mojave National Preserve (NPS photo)

All of the big game guzzlers are in wilderness designated by the 1994 CDPA. This has proven to be a challenge for the maintenance, monitoring, and water replenishment necessary for the guzzlers to function. Many of these activities require motorized vehicle access to bring in materials, tools, and equipment. In cases where replenishment is needed, proximate access by large (300- to 500-gallon) water tank trucks with motorized pumps and hoses is needed to refill depleted storage tanks. The NPS has allowed these activities under special use (NPS 2008). Most of the maintenance and replenishment activities are conducted by volunteers.

Small Game Guzzlers

In the Preserve, numerous small game guzzlers are located in diverse types of habitat and in various stages of function. A total of 131 small game guzzlers are documented to exist in the Preserve, of which 71 are located outside of wilderness and 26 are in desert tortoise critical habitat (see Table 14 and Figure 17). Small game guzzlers are also known as game bird guzzlers and gallinaceous guzzlers, as they are intended for gallinaceous bird species.

Small game guzzlers typically consist of a concrete apron leading to a subsurface concrete or fiberglass storage tank. Birds and small animals enter the storage tank through a small opening. Most guzzlers are close to roads or broad washes (Whitaker et al. 2004).

Table 14. Small Game Guzzler Status

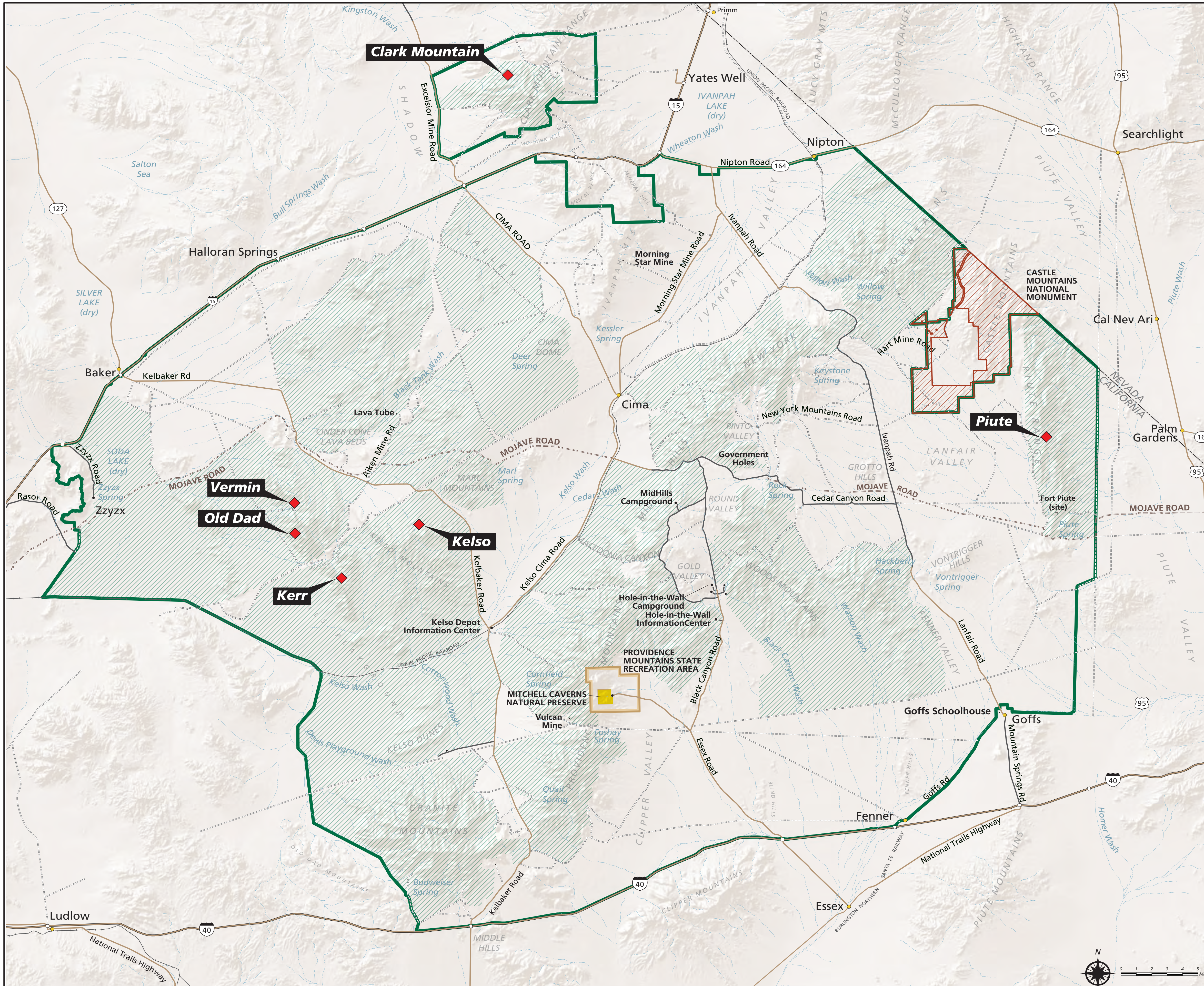
Status	Documented Number (% of Total)
Total small game guzzlers	131
Located in wilderness	60 (42)
Located outside of wilderness	71 (54)
Repaired 2006–2013	64 (49)
In desert tortoise critical habitat	26 (20)

Source: NPS 2013a.

Big Game Guzzlers

Mojave National Preserve
Water Resources Management Plan and Environmental Assessment

- Mojave National Preserve boundary
- Big game guzzler
- National Park Service wilderness
- Paved road
- Unpaved 2-wheel drive road
- Unpaved 4-wheel drive road
- Mojave Road 4-wheel drive road
- Desert wash



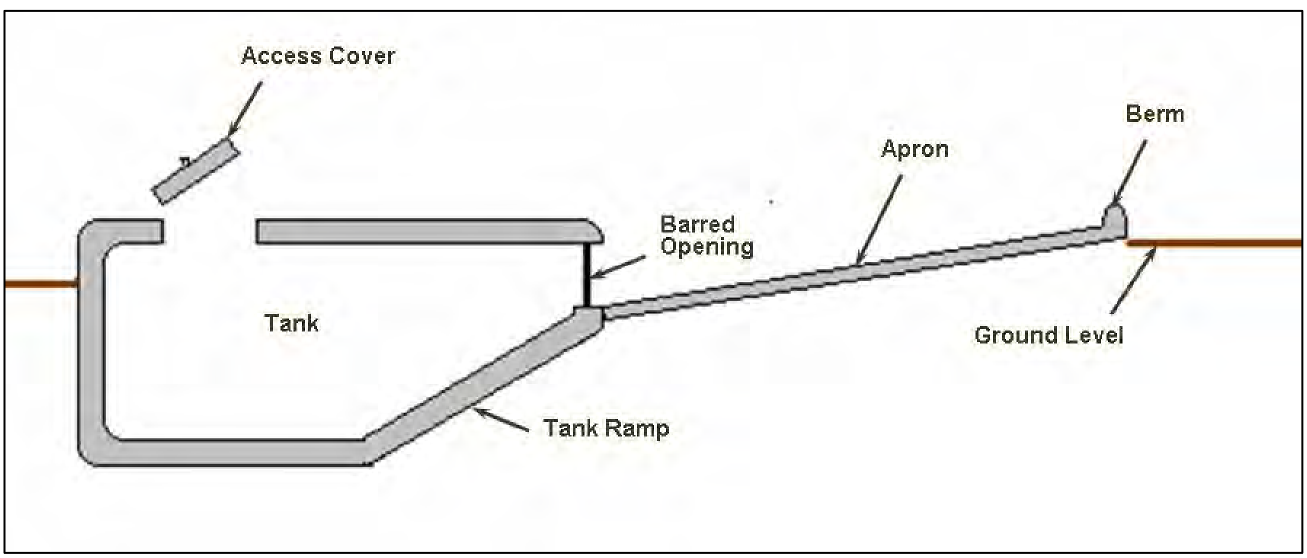
Small game guzzler, Mojave National Preserve (NPS photo)

Most small game guzzlers have ramps installed made from wire mesh or other coarse material that allows wildlife that enter the water to escape. These were installed because of concerns about mortality of desert tortoise drowning in guzzlers (Hoover 1995; Bleich et al. 2005). A schematic of a typical small game guzzler is shown in Figure 16.

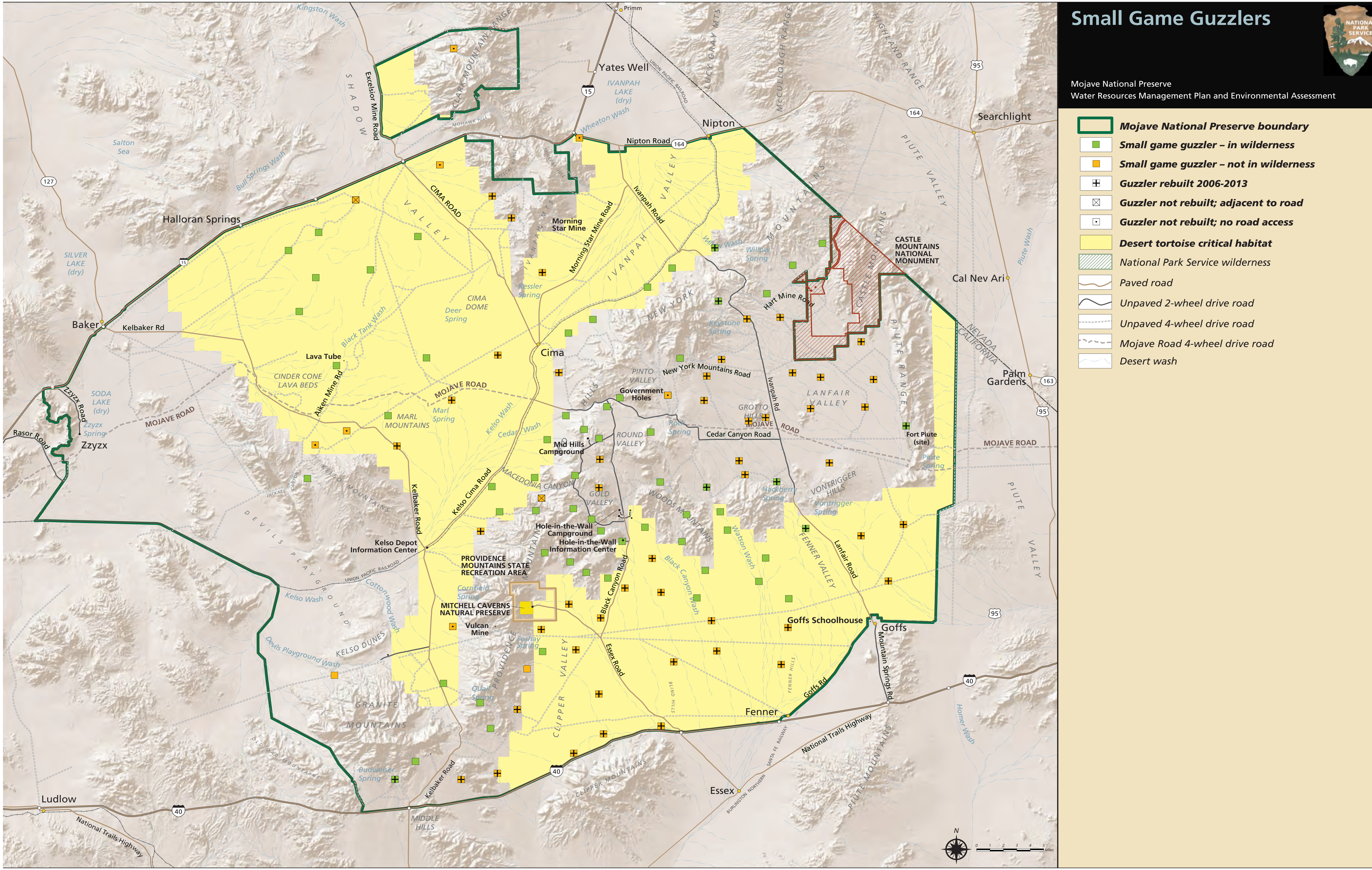
Between 2006 and 2013, volunteers repaired or rebuilt 60 guzzlers in non-wilderness locations. While about four wilderness guzzlers were repaired at some point, none of the wilderness guzzlers have been repaired in at least the past decade. Small game guzzlers that were repaired or rebuilt between 2006 and 2013 are not expected to require additional major repairs within the 20-year life of this plan.

Eight non-wilderness guzzlers have not been recently rebuilt and could be subject to major repairs or rebuilds during the life of this plan. However, only two of these are adjacent to existing roads. The remaining six would require non-motorized access for equipment, materials, and personnel.

Figure 16. Typical Small Game Guzzler Cross-Section



Source: Whittaker et al. 2004.


Small Game Guzzlers
Mojave National Preserve
Water Resources Management Plan and Environmental Assessment
Mojave National Preserve boundary
Small game guzzler – in wilderness
Small game guzzler – not in wilderness
Guzzler rebuilt 2006-2013
Guzzler not rebuilt; adjacent to road
Guzzler not rebuilt; no road access
Desert tortoise critical habitat
National Park Service wilderness
Paved road
Unpaved 2-wheel drive road
Unpaved 4-wheel drive road
Mojave Road 4-wheel drive road
Desert wash
Primm
Kingston Wash
Yates Well
IVANPAH LAKE (dry)
Wheaton Wash
Nipton
Nipton Road
Searchlight
CLARK MOUNTAIN RANGE
Excelsior Mine Road
SHADOW VALLEY
Salton Sea
Bull Springs Wash
Halloran Springs
SILVER LAKE (dry)
Baker
Kelbaker Rd
CIMA ROAD
Morning Star Mine
Morning Star Mine Road
Ivanpah Road
IVANPAH VALLEY
Kessler Spring
CIMA DOME
Deer Spring
Black Tank Wash
Cima
Lava Tube
CINDER CONE LAVA BEDS
Aiken Mine Rd
MOJAVE ROAD
MARL MOUNTAINS
Marl Spring
Kelso Wash
Cedar Wash
SODA LAKE (dry)
Zzyzx Road
Zzyzx Spring
Zzyzx
Rasor Road
Mid Hills Campground
Government Holes
PINTO VALLEY
New York Mountains Road
NEW YORK MOUNTAINS
Keystone Spring
Willow Spring
Hart Mine Road
CASTLE MOUNTAINS NATIONAL MONUMENT
Cal Nev Ari
LANFAIR VALLEY
PIUTE RANGE
GROTTO HILLS
Rock Spring
Cedar Canyon Road
Ivanpah Rd
Fort Piute (site)
Piute Spring
MOJAVE ROAD
Palm Gardens
NEVADA
CALIFORNIA
ROUND VALLEY
MACEDONIA CANYON
GOLD VALLEY
WOODS MOUNTAINS
Hackberry Spring
VONTRIGGER HILLS
Vontrigger Spring
Kelso Cima Road
Kelbaker Road
Hole-in-the-Wall Campground
Hole-in-the-Wall Information Center
Kelso Depot Information Center
PROVIDENCE MOUNTAINS STATE RECREATION AREA
Cornfield Spring
MITCHELL CAVERNS NATURAL PRESERVE
Vulcan Mine
Black Canyon Road
Black Canyon Wash
Watson Wash
FENNER VALLEY
Lanfair Road
Goffs Schoolhouse
Goffs
DEVILS PLAYGROUND
Devils Playground Wash
KELSO DUNES
Cotton Wood Wash
Foshay Spring
CLIPPER VALLEY
Essex Road
Quail Spring
GRANITE MOUNTAINS
Budweiser Spring
Kelbaker Road
Fenner
Goffs Rd
Mountain Springs Rd
National Trails Highway
Essex
CLIPPER MOUNTAINS
Ludlow
MIDDLE HILLS
National Trails Highway
PIUTE VALLEY
Piute Wash
Homer Wash
PIUTE MOUNTAINS
HIGHLAND RANGE
MCCULLOUGH RANGE
LUCY GRAY MTS
UNION PACIFIC RAILROAD
SANTA FE RAILWAY
BURLINGTON NORTHERN
N
Miles

Wildlife

Desert Bighorn Sheep

Desert bighorn sheep (*Ovis canadensis nelsoni*) inhabit desert mountain ranges throughout the Sonoran, Mojave, and Great Basin Deserts. Their habitat is typically rough, rocky, and broken by canyons and washes (Hansen 1982), with vegetative communities ranging from upland pinyon-juniper to desert scrub (Browning and Monson 1980). Forage, water, and escape terrain are considered crucial components of desert bighorn habitat (Risenhoover and Bailey 1985; Turner 1973; Krausman et al. 1989). Bighorn sheep favor open terrain and generally avoid dense vegetation that blocks their visibility of predators. Their diet includes cacti, grasses, herbaceous plants, shrubs, and trees. Bighorn sheep diet varies by season because new plant growth is most nutritious. Compared with populations in higher mountain ranges, lower-elevation bighorn populations typically have poorer forage quality and are subject to higher temperatures and less precipitation (Epps et al. 2004). The availability of forage close to water is an important component of bighorn sheep habitat (Leslie and Douglas 1979).

Population Status

Desert bighorn sheep are found in most of the Preserve's mountainous terrain, with the largest populations occurring in the Old Dad Mountain, Kelso Peak, and Clark Mountain areas. Currently, six desert bighorn sheep populations occur in the Preserve. These populations are generally considered to occur in the Old Dad/Kelso/Indian, Clark, Granite, Providence, Woods/Hackberry, and Piute/Castle habitat patches. Potential habitat also occurs in the Mescal/Ivanpah Range, which is currently unoccupied by bighorn sheep.

The current population of desert bighorn sheep in the Preserve is estimated to be between 680 and 1,075 individuals. Throughout the region, bighorn populations have become increasingly isolated and vulnerable to loss of habitat and genetic diversity, due primarily to a combination of habitat fragmentation and climate change (Epps et al. 2005; Longshore et al. 2009; Creech et al. 2014).

Desert bighorn sheep are classified by the State of California as a *Fully Protected* species (California Fish and Game Code 4902; see http://www.dfg.ca.gov/wildlife/nongame/t_e_spp/fully_pro.html).

Movement and Persistence of Populations

Desert bighorn sheep are most active during daylight and move to steeper terrain at night. During summer, bighorn typically rest in the shade during the hottest part of the day. Desert bighorn habitat areas are often small and isolated. Flat sparsely vegetated desert valleys between rugged mountain ranges results in a naturally fragmented distribution (Bleich et al. 1990) and typically populations number fewer than 100 individuals (Torres et al. 1994). These conditions leave desert bighorn populations vulnerable to detrimental changes in habitat availability because of low female dispersal rates and the long distances between populations (Epps et al. 2004; Epps et al. 2007). Epps et al. (2004) found that elevation, precipitation, presence of reliable natural springs, and absence of domestic sheep allotments positively correlated with persistence of desert bighorn sheep populations. In addition, genetic and demographic connectivity are important for bighorn sheep metapopulation dynamics and the recolonization of habitat patches that have become extirpated, and maintaining intact habitat patches and corridors between patches is vital to metapopulation viability (Creech et al. 2014).

Regarding connectivity and fragmentation between bighorn populations, Creech et al. (2014) described the importance of demographic and genetic connectivity of bighorn metapopulations,