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RESOURCE SYSTEMS GROUP, INC.

MEMORANDUM

To: Bret Meldrum and Dave Pettebone, NPS
From: Steve Lawson, PhD and Brett Kiser, MS
Subject: Half Dome Visitor Use Model Simulation Results – Scenarios 1 & 2
Date: 29 November 2010

This memo presents tabular and graphical results of simulations conducted with the Half Dome Visitor Use Model (Tables 1-2 and Figures 1-17 on the following pages). The simulation results include those for baseline conditions during Saturdays and Holidays in 2008 and three alternative visitor use scenarios. The simulation scenarios are described in the following paragraphs.

Scenario 1: During weekends in summer 2010, the National Park Service implemented an interim permit system which was intended to limit daily weekend visitor use on the Half Dome cables to a maximum of roughly 400 people per day. Thus, results of Scenario 1 provide estimates of the daily and hourly mean number of people at one time (PAOT) on the subdome, Half Dome cables, and Half Dome summit when daily visitor use averages 400 people per day. Scenario 1 results also provide estimates of daily and hourly mean cables ascent and descent times when daily visitor use averages 400 people per day.

Scenario 2a: Results of the Half Dome Visitor Use study conducted by RSG in 2008 suggest that under "free flow" conditions, mean cables ascent time is roughly 21 minutes. Further, the results of the 2008 study suggest that even with relatively minimal congestion-related delays of visitors' progress on the cables, one or more visitors can be expected to travel outside the cables. Thus, Scenario 2a "solves for" the maximum daily visitor use that can be accommodated on the Half Dome cables without exceeding mean free flow ascent times, as measured during the 2008 visitor use study. Results for Scenario 2a presented in this memo include daily and hourly mean PAOT on the subdome, Half Dome cables, and Half Dome summit, as well as daily and hourly mean cables ascent and descent times.

Scenario 2b: Results of the Half Dome Visitor Use study conducted by RSG in 2008 suggest that when there are 30 or more people on the Half Dome cables at one time, visitors' ascent times exceed free flow conditions and at least one visitor can be expected to travel outside the cables, Thus, Scenario 2b "solves for" the maximum daily visitor use that can be accommodated on the Half Dome cables without exceeding 30 PAOT on the Half Dome cables under ordinary circumstances. Results for Scenario 2b presented in this memo include daily and hourly mean PAOT on the subdome, Half Dome cables, and Half Dome summit, as well as daily and hourly mean cables ascent and descent times.

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Table 1. Half Dome Visitor Use Model Simulation Results, Baseline, Scenario 1, & Scenario 2 – Cables Ascent and Descent Times.

	Baseline **Saturdays/Holidays, 2008** Mean Daily Use = 631 (± 6.6)		**Scenario 1** **400 people/day** Mean Daily Use = 406 (± 6.3)		**Scenario 2a** **Free Flow (Ascent Time)** Mean Daily Use = 140 (± 3.8)		**Scenario 2b** **Free Flow (PAOT)** Mean Daily Use = 227 (± 4.6)	
	Mean	Max	Mean	Max	Mean	Max	Mean	Max
Ascent Time	32 (± 1.0)	70	26 (± 0.2)	54	21 (± 0.2)	37	23 (± 0.2)	42
Descent Time	23 (± 0.8)	60	21 (± 0.2)	47	17 (± 0.1)	32	18 (± 0.2)	38

NOTE: Numbers in parentheses are 95% confidence interval half-widths.

NOTE: Mean free flow ascent time = 21 minutes (based on 2008 visitor use study).

NOTE: Scenario 2a results = Mean ascent time is not statistically greater than mean free flow ascent time.

NOTE: Scenario 2b results = PAOT on the cables does not exceed 30 under ordinary circumstances.

Table 2. Half Dome Visitor Use Model Simulation Results, Baseline, Scenario 1, & Scenario 2 - PAOT on Subdome, Cables, & Summit

	Baseline **Saturdays/Holidays, 2008** Mean Daily Use = 631 (± 6.6)		**Scenario 1** **400 people/day** Mean Daily Use = 406 (± 6.3)		**Scenario 2a** **Free Flow (Ascent Time)** Mean Daily Use = 140 (± 3.8)		**Scenario 2b** **Free Flow (PAOT)** Mean Daily Use = 227 (± 4.6)	
	Mean	Max	Mean	Max	Mean	Max	Mean	Max
PAOT - Subdome	13 (± 1.0)	67	9 (± 0.2)	40	3 (± 0.1)	19	5 (± 0.1)	25
PAOT - Cables	37 (± 2.8)	146	21 (± 0.4)	83	6 (± 0.2)	29	10 (± 0.3)	52
PAOT - Summit	36 (± 2.5)	126	23 (± 0.4)	86	8 (± 0.3)	36	13 (± 0.3)	52

NOTE: Numbers in parentheses are 95% confidence interval half-widths.

NOTE: Free Flow Threshold = 30 PAOT on the cables (based on 2008 visitor use study).

NOTE: Visitor Informed Standard = 70 PAOT on the cables (based on 2008 visitor use study).

NOTE: Scenario 2a results = Mean ascent time is not statistically greater than mean free flow ascent time.

NOTE: Scenario 2b results = PAOT on the cables does not exceed 30 under ordinary circumstances.

Scenario 1 – 400 people/day

- Simulated Mean Daily Use = 406 (95% confidence interval half-width = 6.3).
- Results identify mean cables ascent and descent times, and mean PAOT on the subdome, cables, and summit when daily visitor use averages 400 people per day (Figures 1-5).

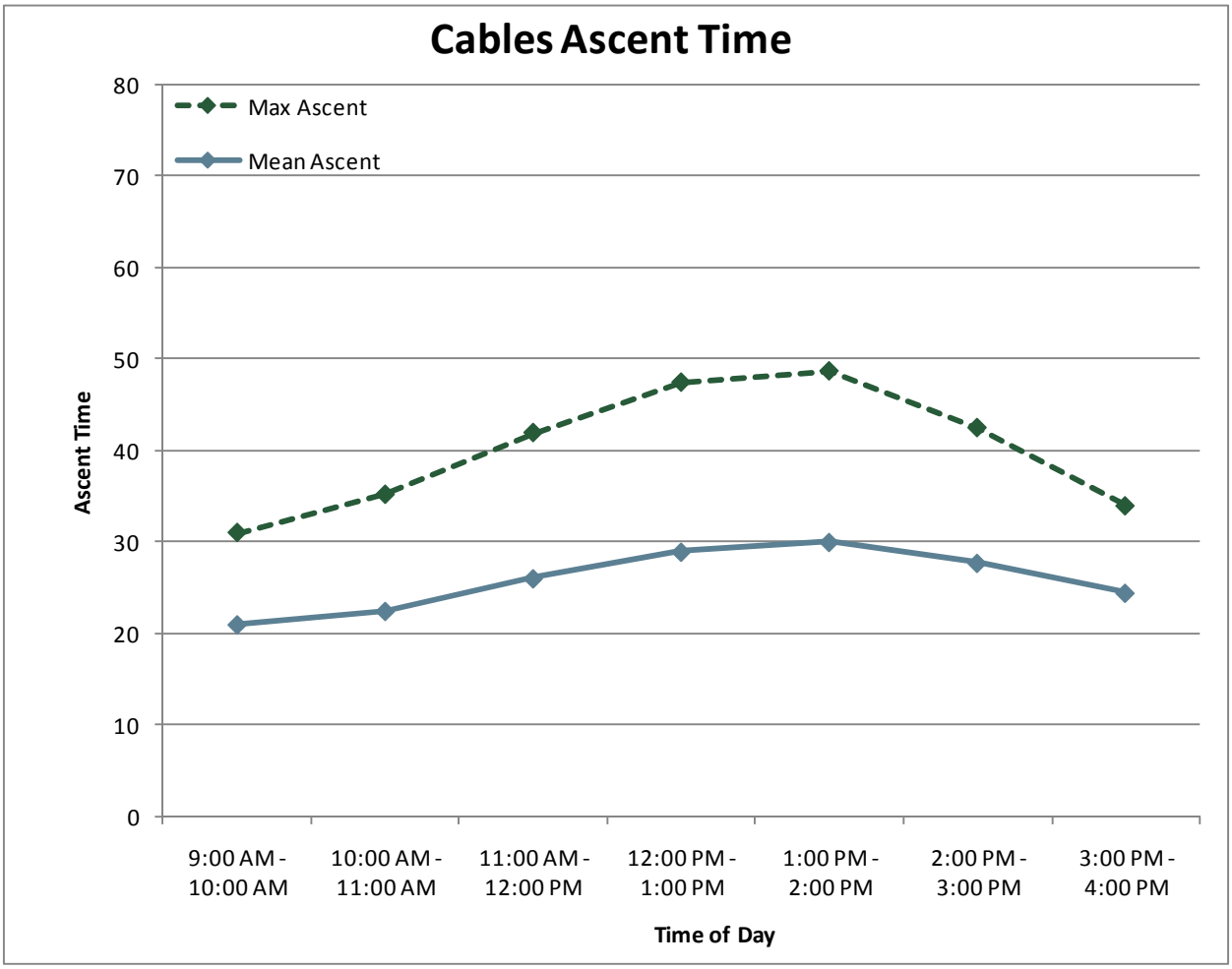

Figure 1. Scenario 1: 400 people/day – Mean and Maximum Cables Ascent Time.

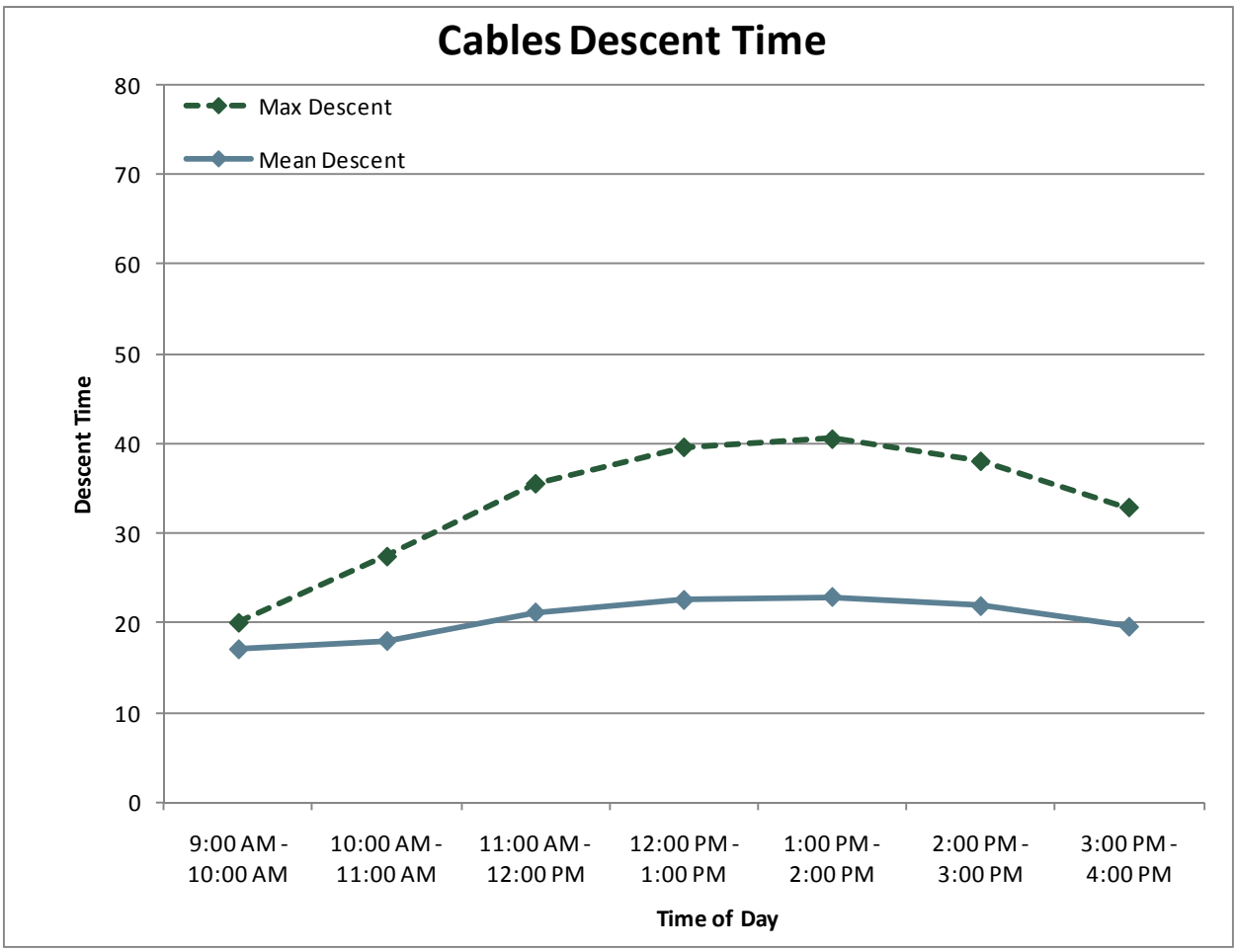

Figure 2. Scenario 1: 400 people/day – Mean and Maximum Cables Descent Time.

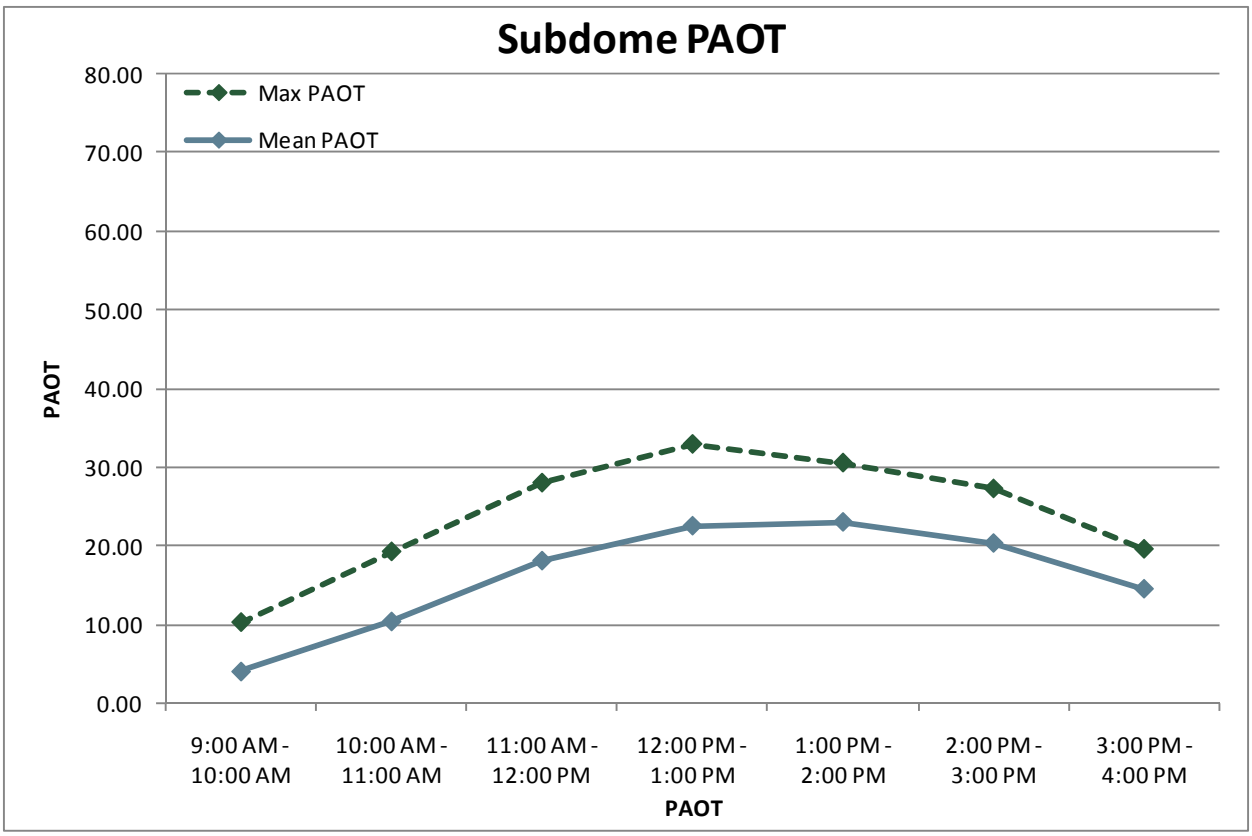

Figure 3. Scenario 1: 400 people/day – Mean and Maximum PAOT on Subdome .

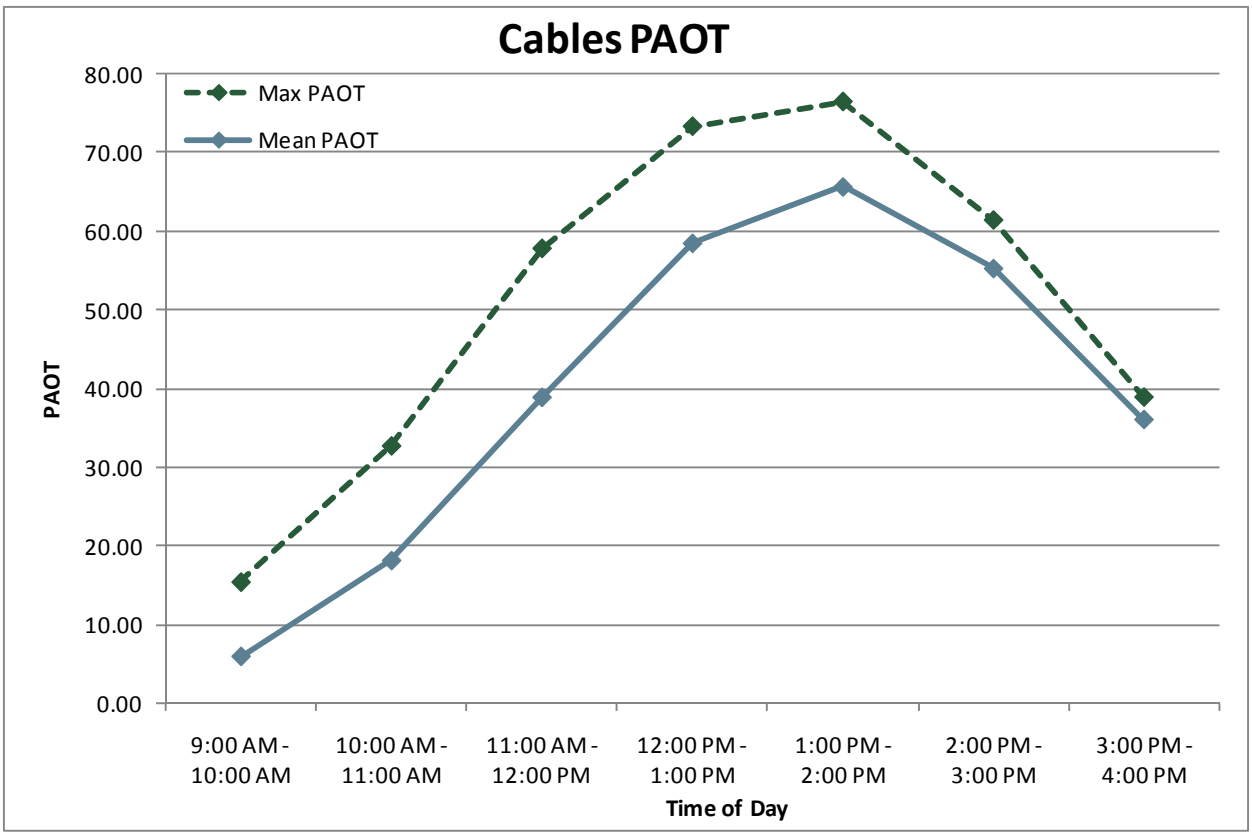

Figure 4. Scenario 1: 400 people/day – Mean and Maximum PAOT on Cables.

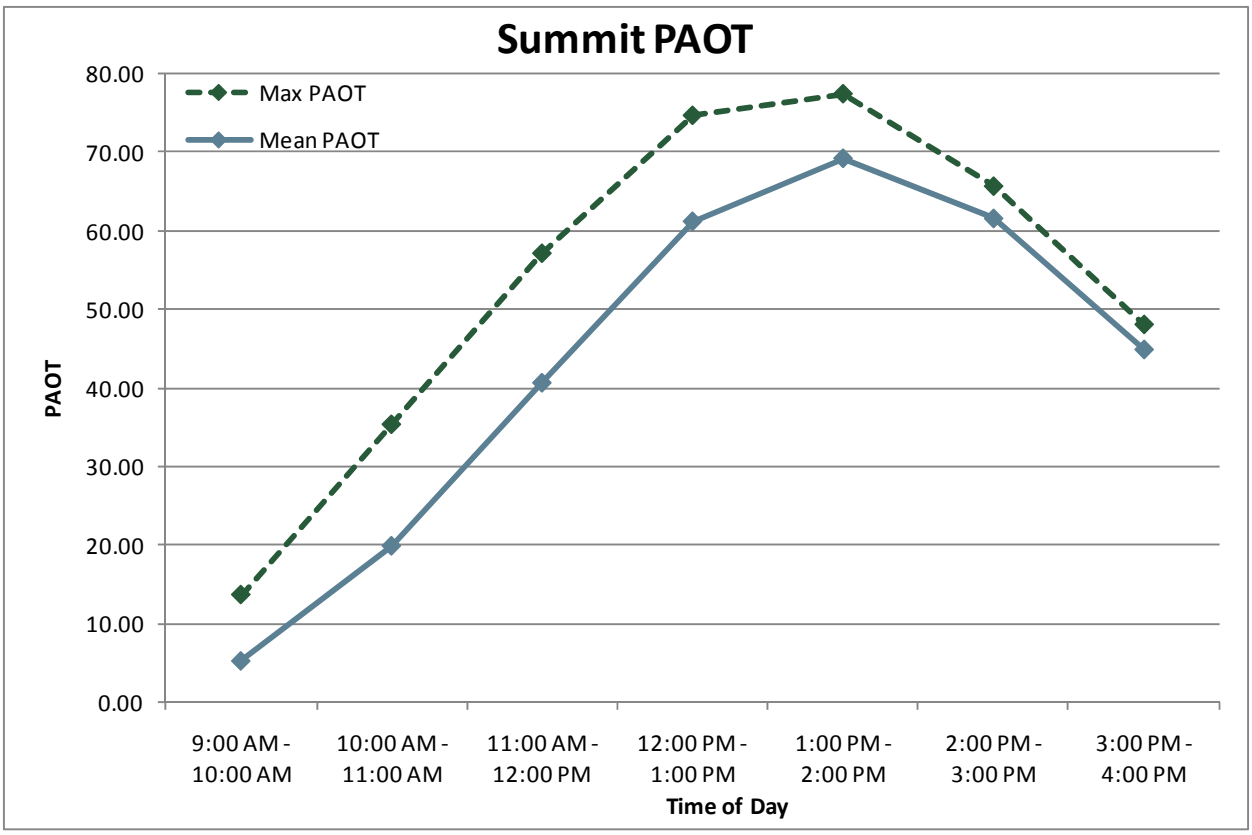

Figure 5. Scenario 1: 400 people/day – Mean and Maximum PAOT on Summit.

Scenario 2a – Free Flow (Ascent Time)

- Simulated Mean Daily Use = 140 (95% confidence interval half-width = 3.8).
- Results identify maximum daily visitor use that can be accommodated without exceeding mean free flow ascent times, as measured during the 2008 Half Dome Visitor Use study. Corresponding mean cables ascent and descent times, and mean PAOT on the subdome, cables, and summit are reported (Figures 6-10).

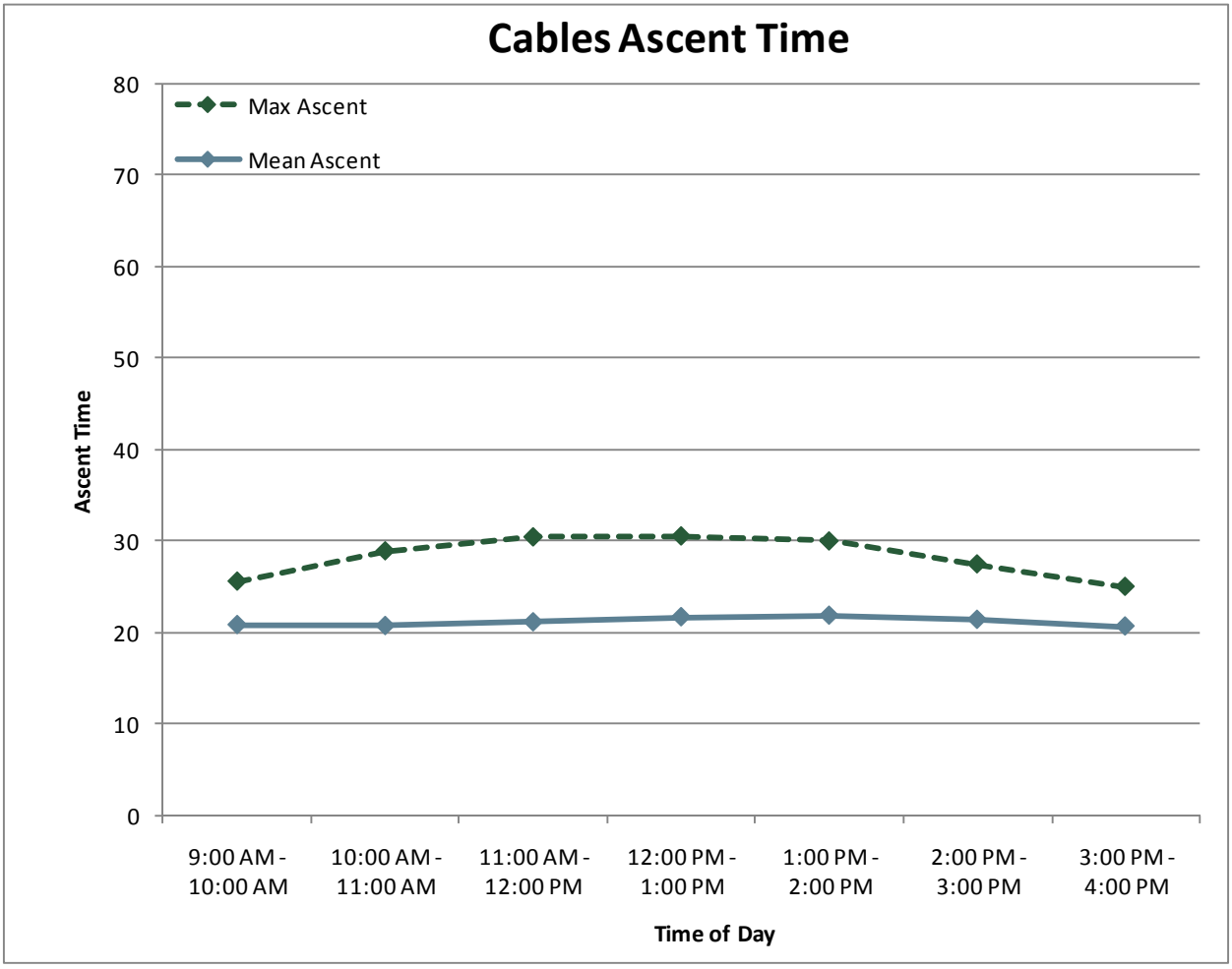

Figure 6. Scenario 2a: Free Flow (Ascent Time) – Mean and Maximum Cables Ascent Time.

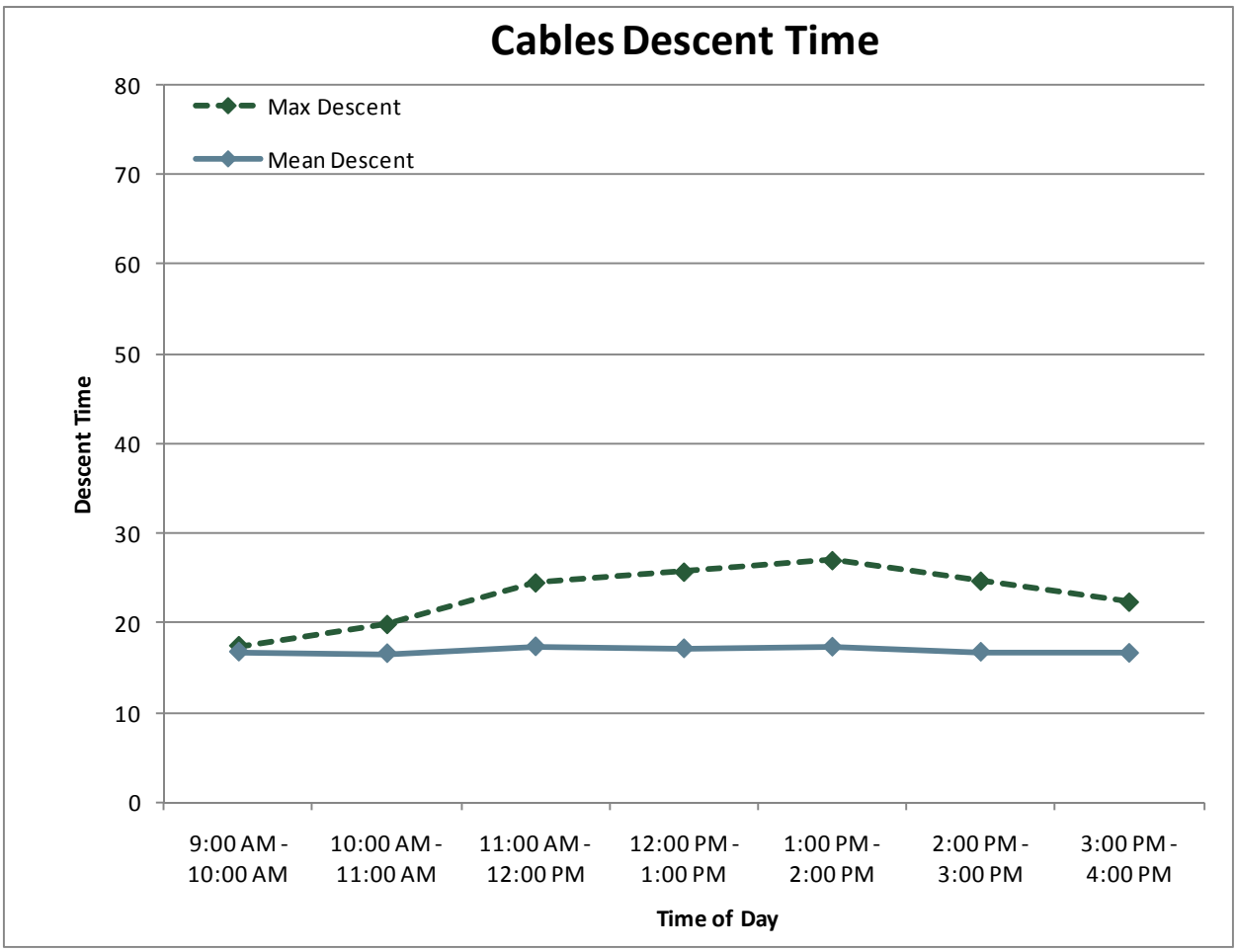

Figure 7. Scenario 2a: Free Flow (Ascent Time) – Mean and Maximum Cables Descent Time.

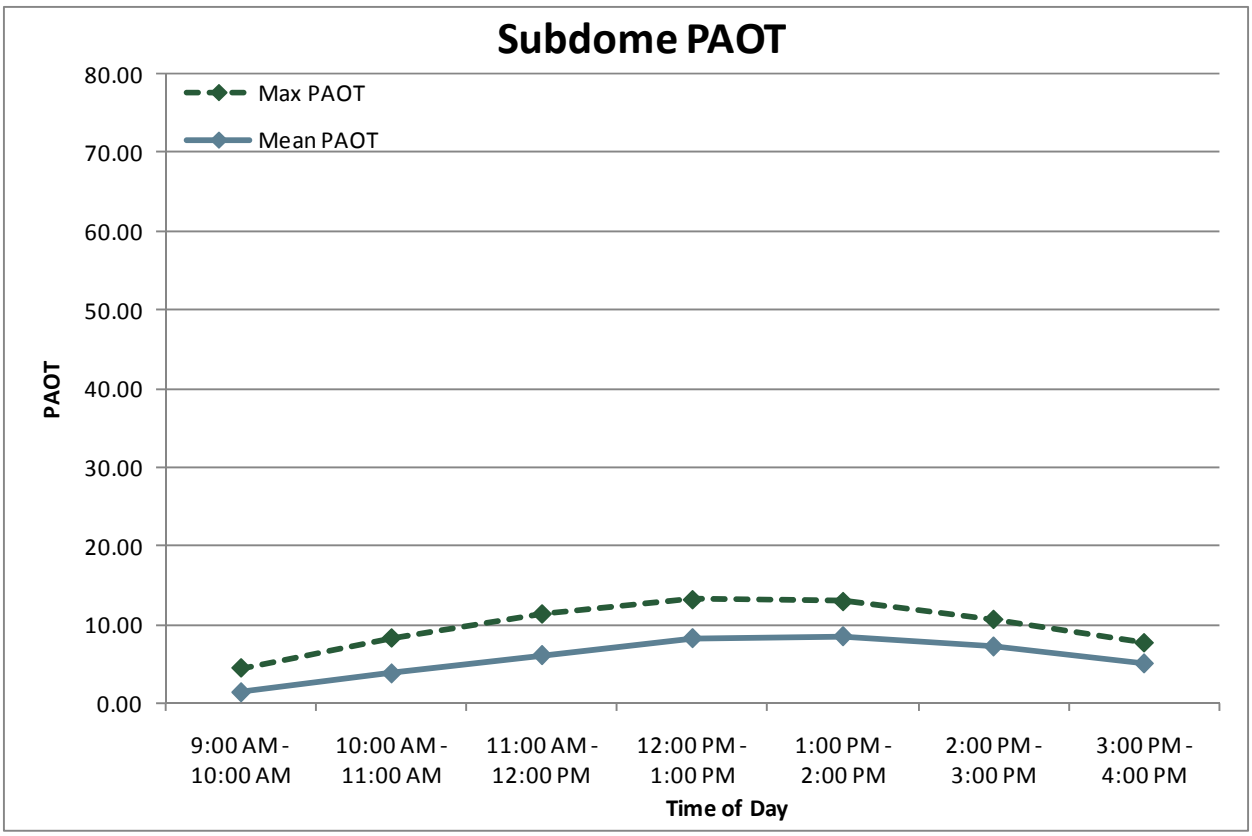

Figure 8. Scenario 2a: Free Flow (Ascent Time) – Mean and Maximum PAOT on Subdome.

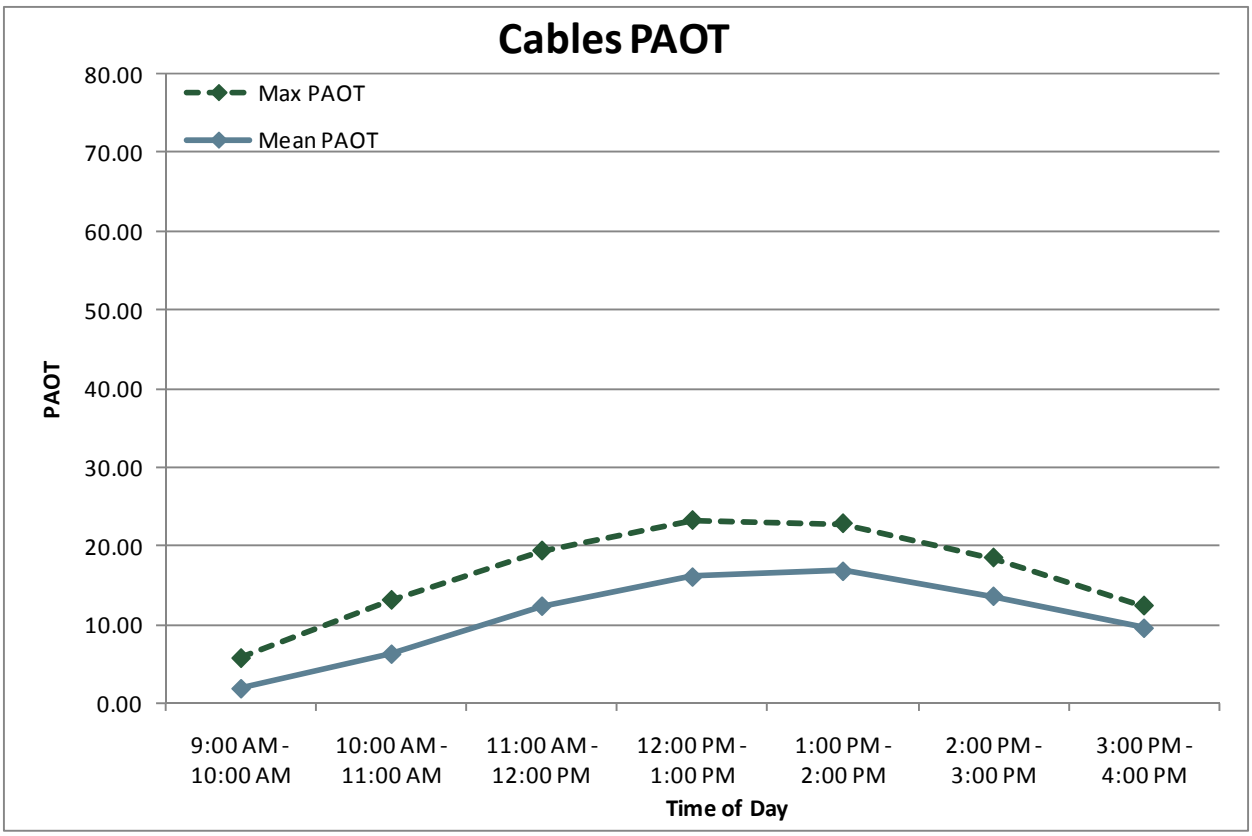

Figure 9. Scenario 2a: Free Flow (Ascent Time) – Mean and Maximum PAOT on Cables.

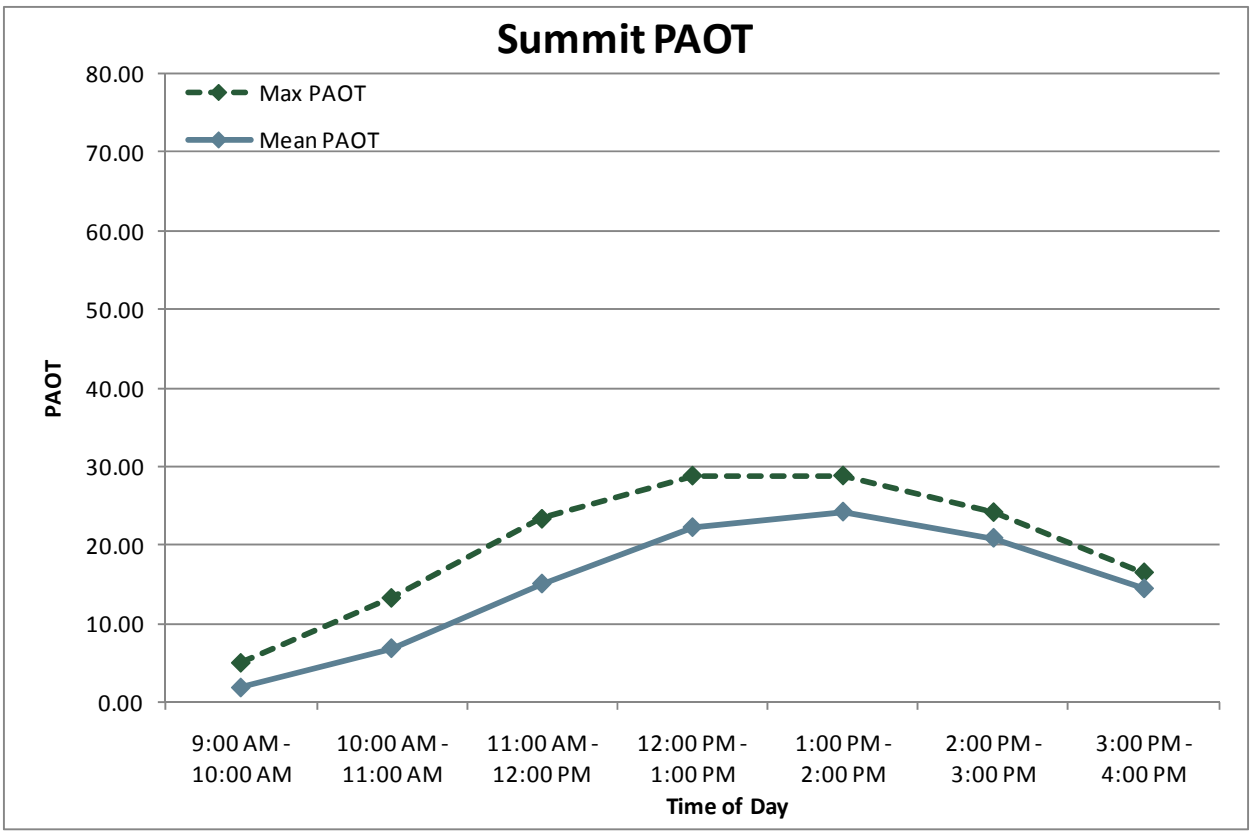

Figure 10. Scenario 2a: Free Flow (Ascent Time) – Mean and Maximum PAOT on Summit.

Scenario 2b – Free Flow (PAOT)

- Simulated Mean Daily Use = 227 (95% confidence interval half-width = 4.6).
- Results identify maximum daily visitor use that can be accommodated without exceeding 30 PAOT on the Half Dome cables under ordinary circumstances. Corresponding mean cables ascent and descent times, and mean PAOT on the subdome, cables, and summit are reported (Figures 11-15).

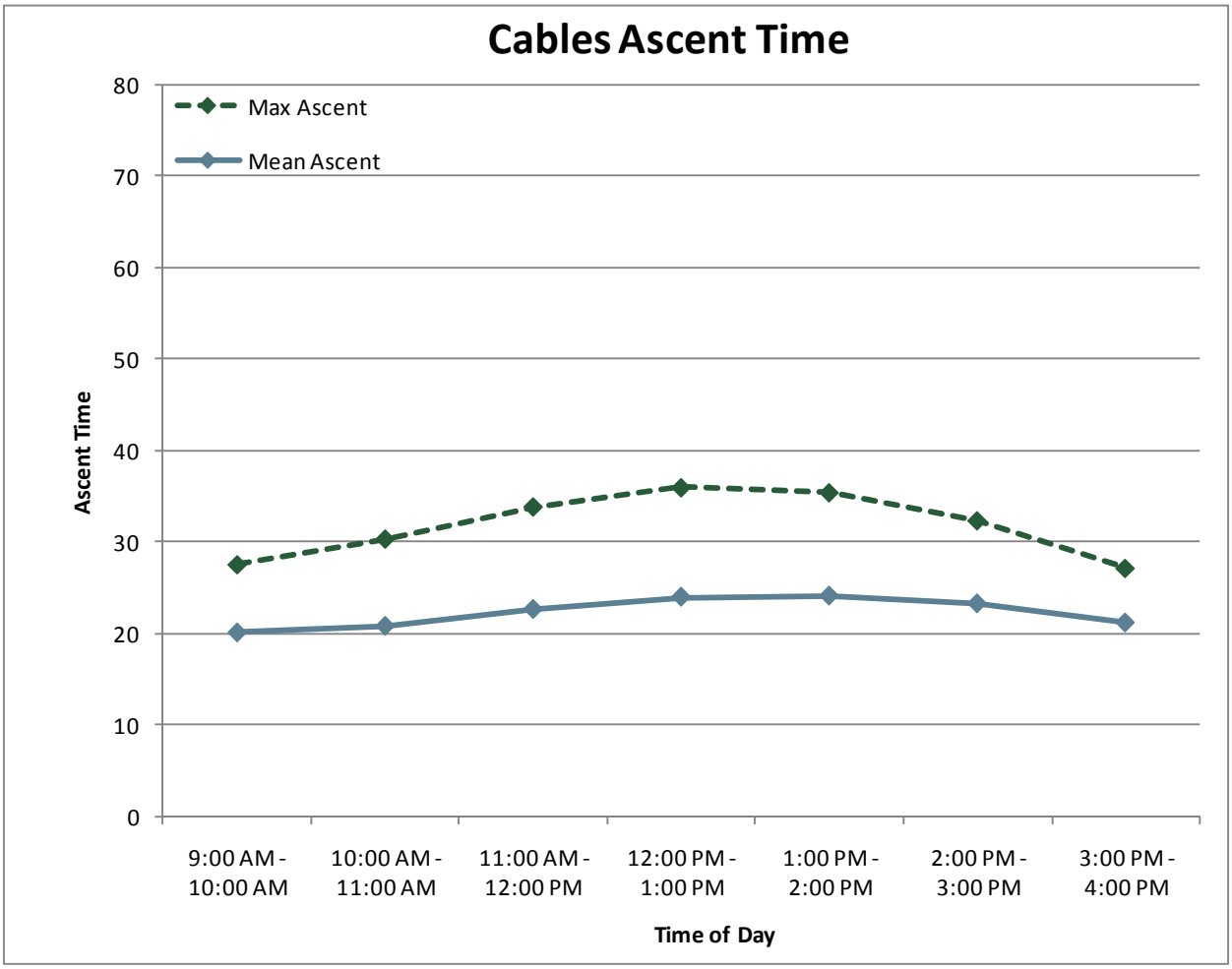

Figure 11. Scenario 2b: Free Flow (PAOT) – Mean and Maximum Cables Ascent Time.

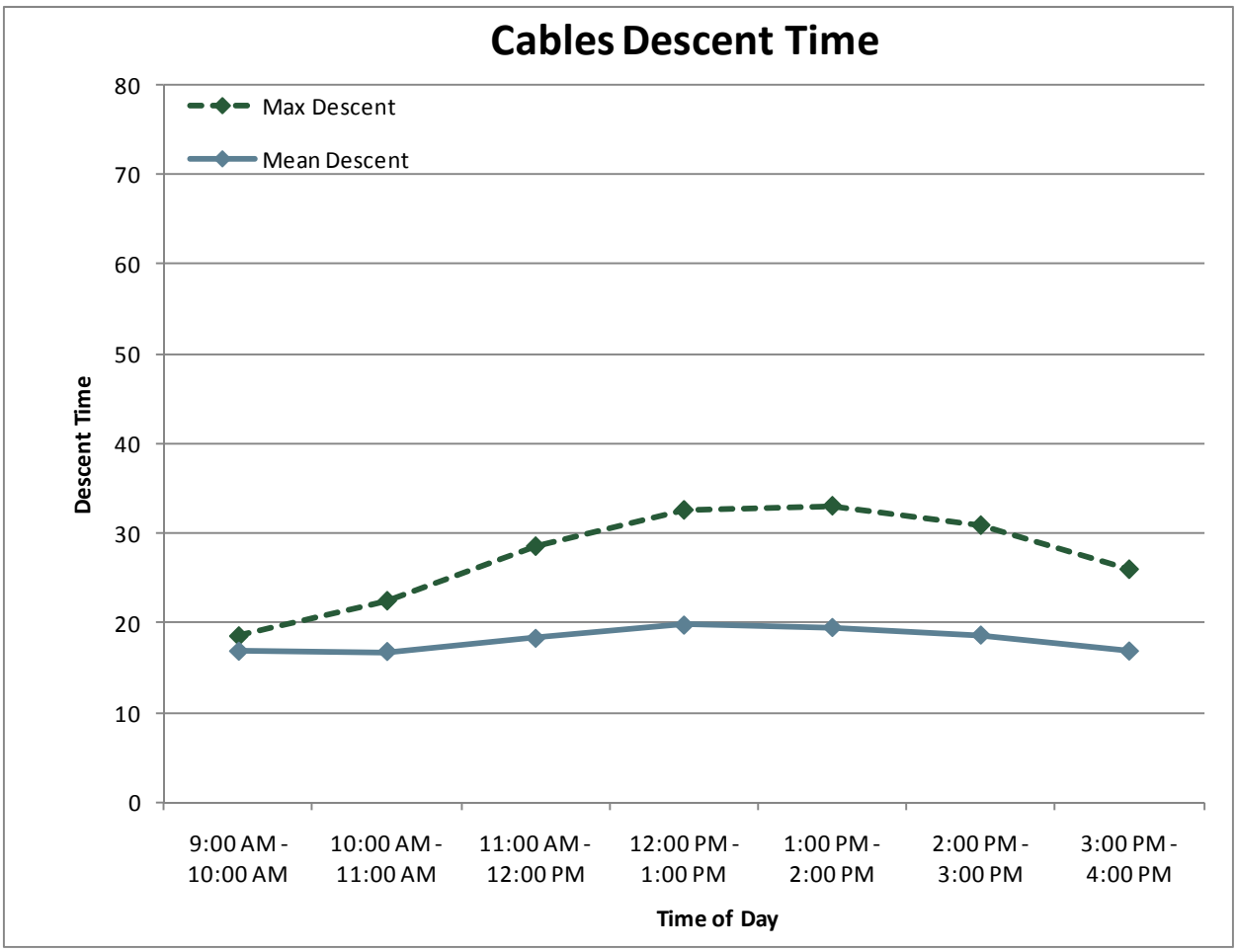

Figure 12. Scenario 2b: Free Flow (PAOT) – Mean and Maximum Cables Descent Time.

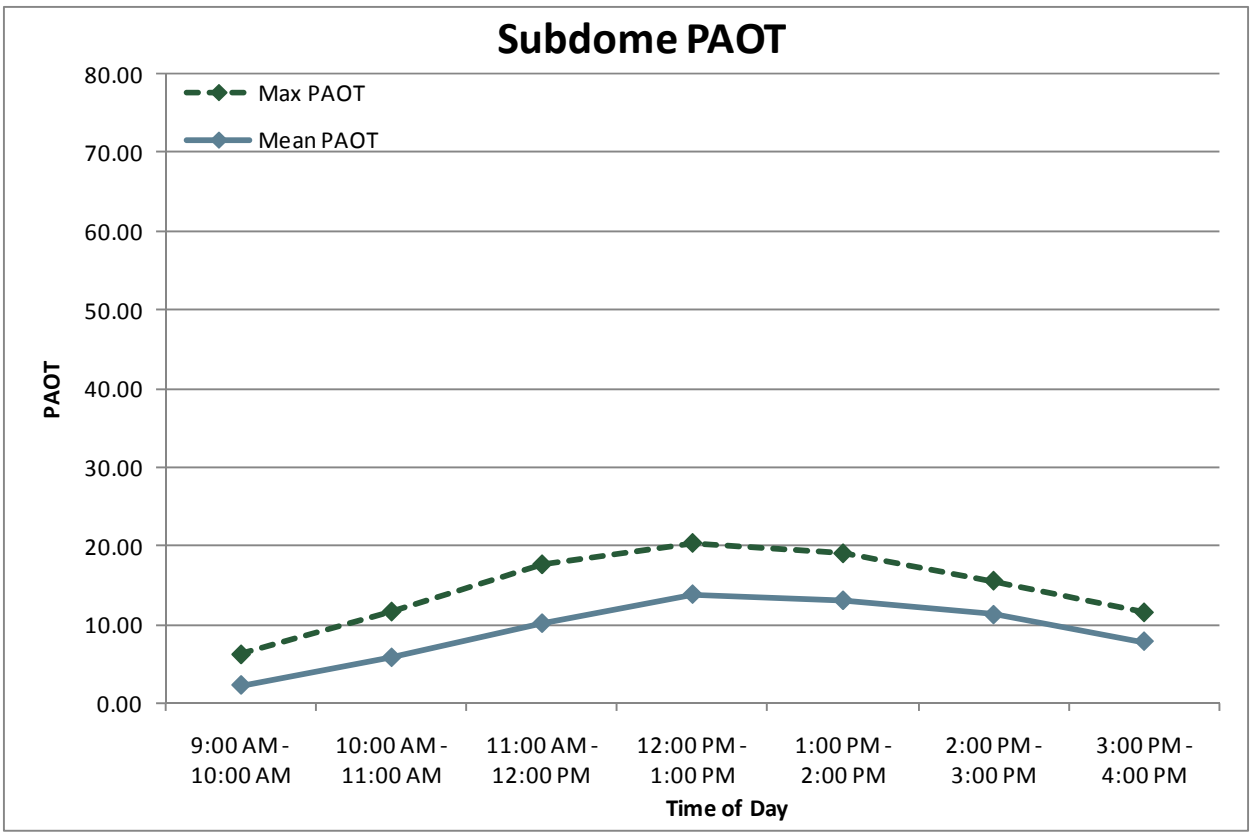

Figure 13. Scenario 2b: Free Flow (PAOT) – Mean and Maximum PAOT on Subdome.

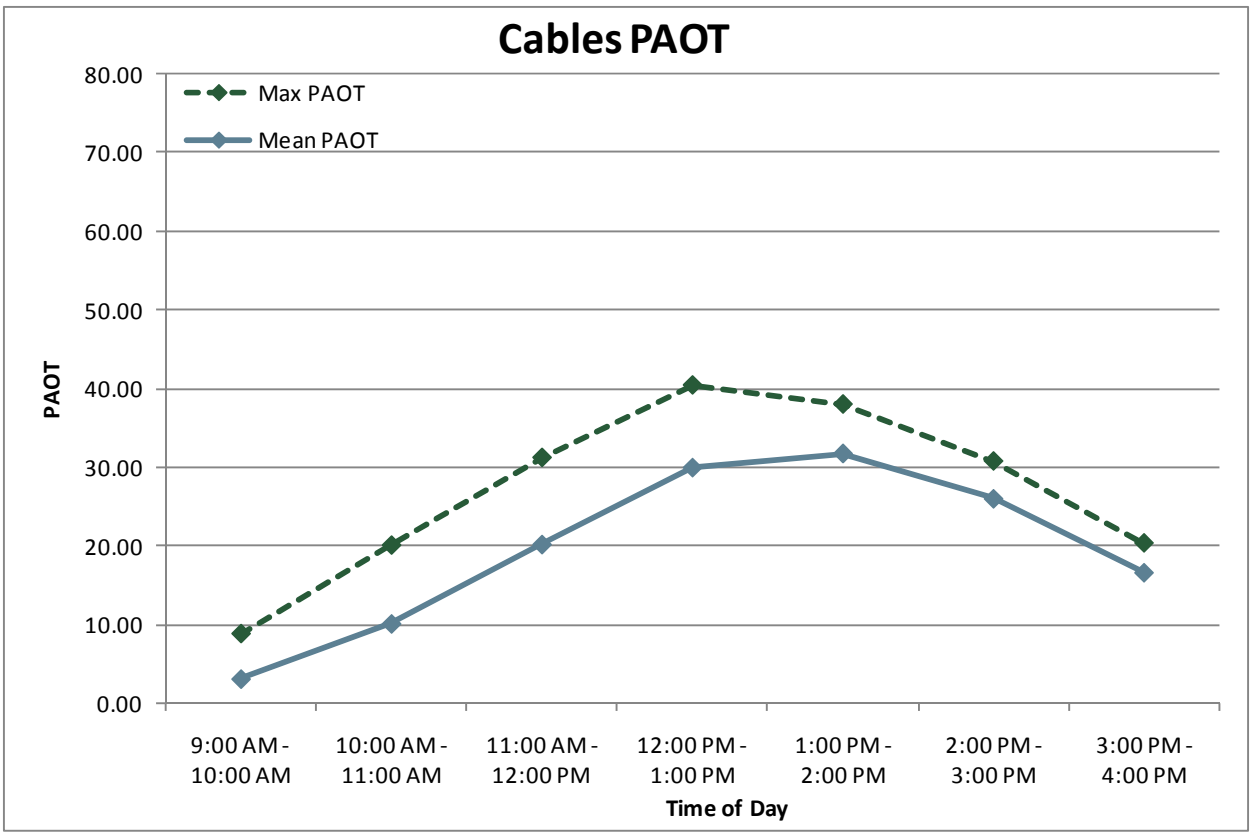

Figure 14. Scenario 2b: Free Flow (PAOT) – Mean and Maximum PAOT on Cables.

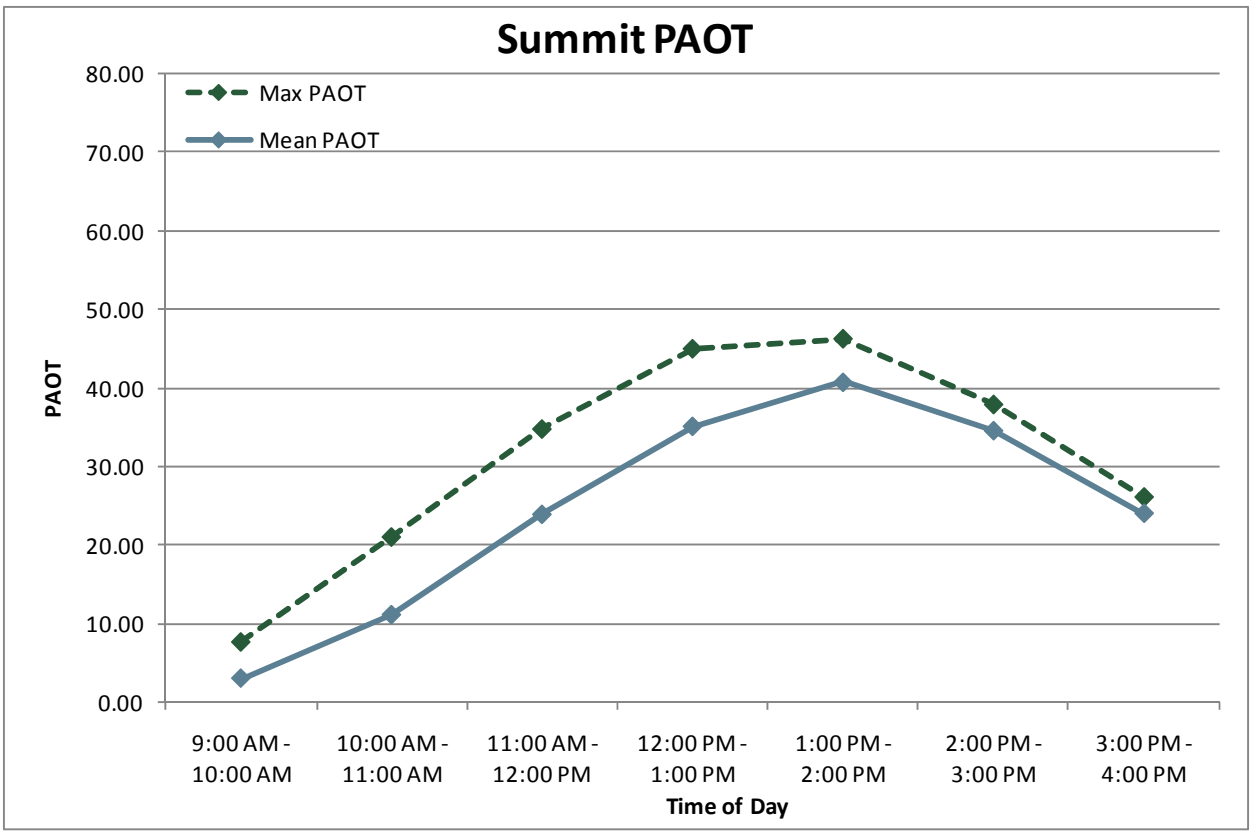

Figure 15. Scenario 2b: Free Flow (PAOT) – Mean and Maximum PAOT on Summit.

Cross Validation: NPS Regression Lines and RSG Simulation Estimates

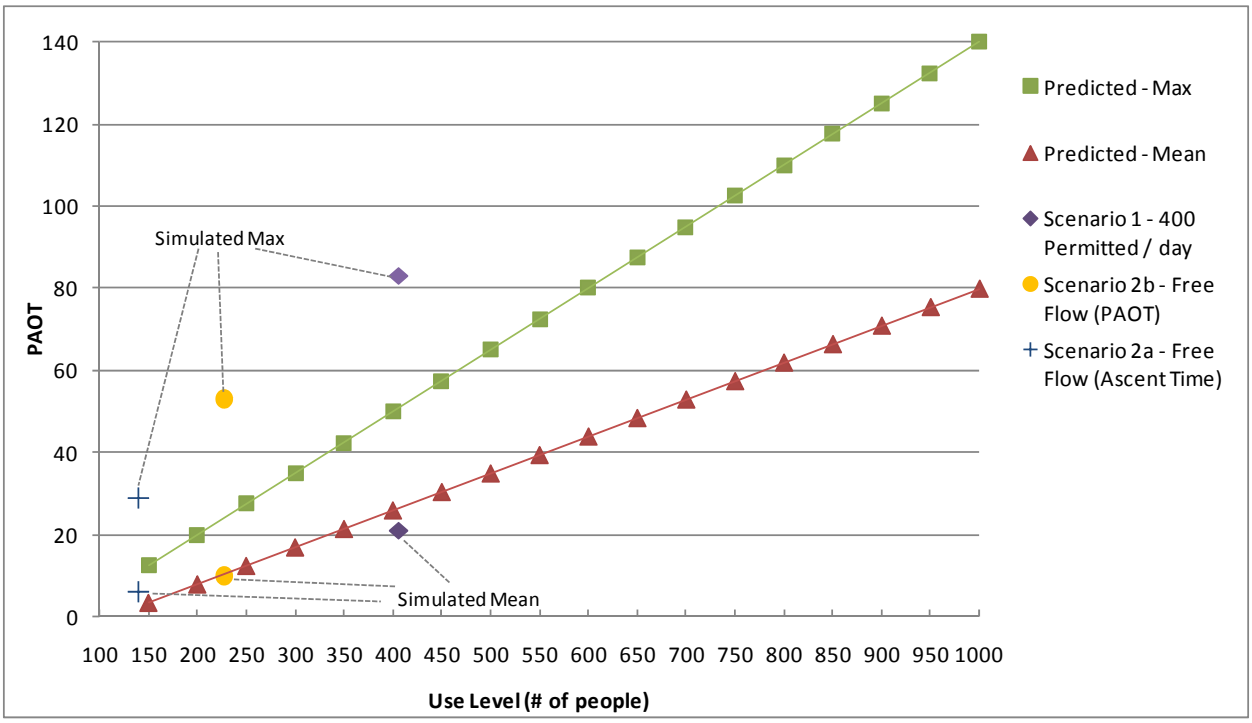

Figure 16. Cables PAOT.

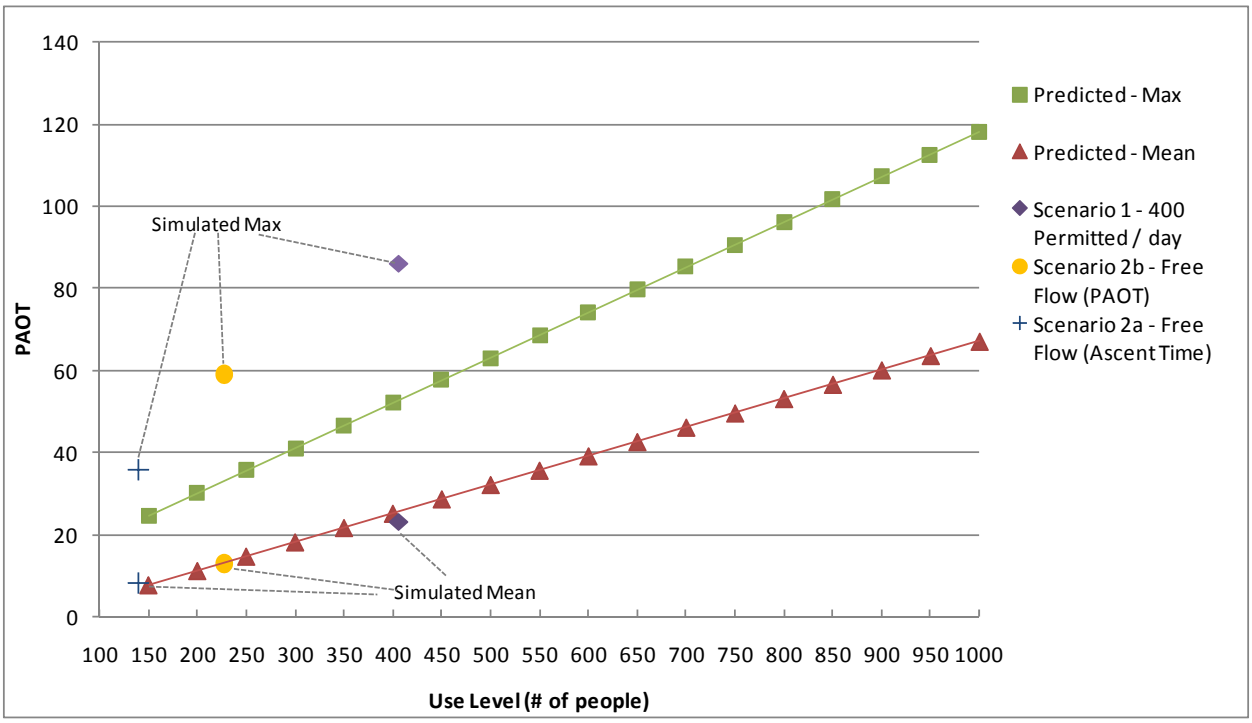

Figure 17. Summit PAOT.