

To: National Park Services
Montezuma Castle National Monument
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From: Multicultural Technical Engineers

Date: Tuesday - February 13, 2018

Subject: 30% Traffic Report

2.4.1 Vehicle Type

A traffic analysis in relation to the types and amount of vehicles visiting Montezuma Castle National Monument was conducted on February 3, 2018. The analysis took place between 9AM and 11AM, for a total of two hours during a special event at the site in an attempt to observe a period of peak activity. The most common vehicle type was passenger cars. Other vehicle types include: buses, RV's, and motorcycles. Using the data from the 2-hour period, the business hours of the National Monument (8AM - 5PM), estimates for the number of vehicles parking at the National Monument were calculated. Because the schedule for this project is accelerated, the team was unable to do multiple site visits to ensure that peak volumes were observed. As a result, a safety factor of 1.3 was applied to the observed volumes to set a design volume that would better emulate true peak conditions. A summary of the raw and calculated data can be found below.

Table 1: Summary of Types and Amount of Vehicles

Vehicle Type	Vehicles in study period	Projected Vehicles in Business Day (8am-5pm)	Projected Vehicles in Business Day with Safety Factor (1.3)
Passenger Car	85	383	497
Bus	2	9	12
Recreational Vehicle	1	5	6
Motorcycle	1	5	6

*Values calculated off 2-hour period (9am-11am).

2.4.2 Vehicle Duration

The duration study was taken at a peak day on the week during a park event from 9am- 11am. The study consisted of watching 60 vehicles from the time they entered the parking lot and ended when they left the park parking lot. Vehicles were identified by their make and model and

observed to determine the average length of visit. This data can be used to make assumptions about how many cars would need to be in the parking lot at a given time to determine the capacity to design the new parking lot for. The test showed that most visitors were in the park ranging from 45-60 minutes. 60 minutes will be used for design. The figure below displays the data collected for the general duration vehicles are at the park on a peak day.

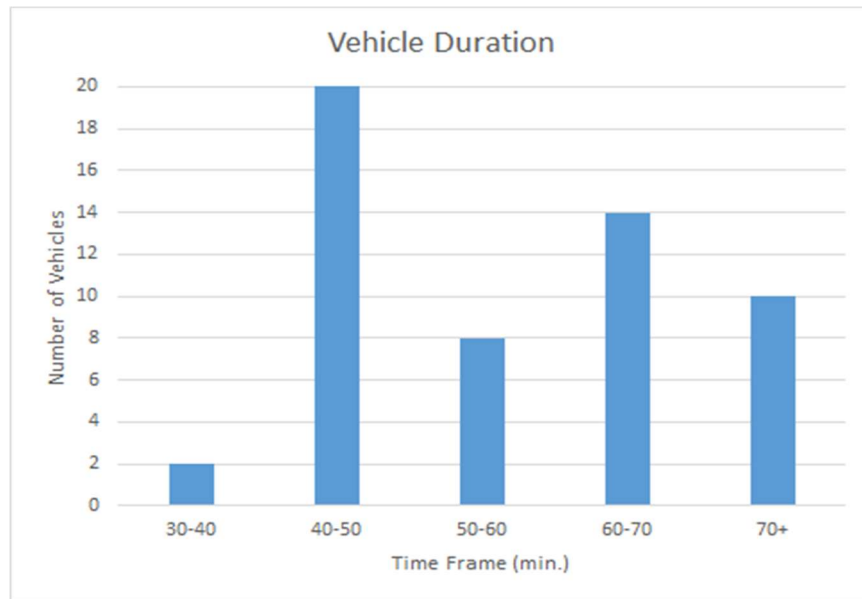


Figure 1: Visitor Travel Duration

2.4.3 Stopping Sight Distance and Turning Movements

The team analyzed the stopping sight distance and turning movements during a site visit. Stopping sight distance is the sum of two values, the time it takes a driver to see and react to an approaching obstacle and the time that it takes for the driver to stop at the posted speed. The driver should be able to see the full distance required to safely react. Horizontal curve requirements are mandated by the American Association of State Highways and Transportation Officials' Policy on Geometric Design of Highways and Streets, which establishes a relationship between speed and the radius of curvature.

The project involves the remodel and redesign of the parking lots that terminate Montezuma Castle Rd. Since design is confined to the parking lots, the project limits are not beyond the service road and therefore stopping sight distance was not a consideration for the design of the parking lot. In a full traffic study of the roadway, it should be considered. The figure below shows a horizontal curve at the entrance to the parking lot that could prove to be an example of inadequate stopping sight distance upon further analysis.



Figure 2: Stopping Sight Distance Example

Turning movements also need to be observed to determine appropriate signage at intersections within the project limits. The intersection of the service road (minor) and Montezuma Castle Rd. (major) is the only intersection within the project limits. With existing signage, the minor approach has a stop sign and the major approach is a through. During a site visit one vehicle was observed turning from the minor roadway onto Montezuma Castle Rd. Information from the client suggests that the current purpose of the roadway is restricted to employees only and demand is concentrated around employees.

INSERT ANALYSIS ABOUT FUTURE PARKING SIZE TO DETERMINE IF THREE-WAY STOP IS WARRANTED.

Vehicles were also recorded by how many entered and exited over the course of the study period. It was found that from 9am-11pm, 70% of the observed cars were entering the site.

2.4.4 Pedestrian Movements

The team conducted a study regarding the number of pedestrians and usage of the sidewalks at the National Monument. This ran concurrent with the types and number of vehicles visiting the National Monument. During the two-hour period from 9AM to 11AM, observations would determine the number of visitors to the National Monument and whether they were using the sidewalks located along the edges of the existing parking lot. The table below summarizes the number of visitors within the two-hour study period and their walking patterns. Pedestrians were counted both entering and exiting the park. Using the percentage calculated from vehicle movements (70% entering, 30% existing) the same ratio was applied to determine the total visitors over the duration of the study. Estimates for the number of visitors during a full business day (nine hours) and for a business day with the same 1.3 safety factor applied to vehicle traffic are also included.

Table 2: Types of Pedestrian Movements and Paths

Pedestrian Movement	Pedestrians in study period	Projected Pedestrians in Business Day (8am-5pm)	Projected Pedestrians in Business Day with Safety Factor (1.3)
Sidewalk	121	545	708
Asphalt	303	1364	1773
Total Pedestrians (Total x0.7)	297	1336	1736

*Values calculated off 2-hour period.

Of the pedestrian movements recorded, it was found that 71% of the visitors to the national park are not using the existing pedestrian facilities in place and walking in the drive lane. This indicates that additional signage and sidewalks should be implemented into the parking lot remodel to increase the safety of the visitors to the site.

In relation to table above, bus visitors were among those who visited the National Monument during the 2-hour study period. The number of people per vehicle is significantly higher for buses than those who travel in passenger cars, RV's, or motorcycles. The number of visitors who arrived on buses is summarized in the table below. Bus visitors were excluded from the total pedestrian count above. Bus visitors will be accommodated with the proposed bus drop off lane.

Table 3: Number of Bus Visitors out of Total Pedestrian Movements

	Pedestrians in study period	Projected Pedestrians in Business Day (8am-5pm)	Projected Pedestrians in Business Day with Safety Factor (1.3)
Bus Visitors	16	72	94

*Values calculated off 2-hour period.

2.4.5 Parking Lot Demand and expected Growth

The observed pedestrian data (Section 2.4.4) and vehicle type and duration (2.4.1-2) over the two hour time period can be used to make assumptions necessary to determine the required parking lot capacity. Using the total visitors (297) and the total passenger cars (85) the calculated visitors per passenger car is 3.49. 3 visitors/vehicle will be used for design. The projected passenger cars per day is 497 and the design duration is 60 minutes. Based on the "Park Statistics," the visitor traffic at Montezuma Castle is at its highest in xx [x]. The observed visitors accurately/do not accurately represent this value.

National parks and monuments are a growing attraction in the United States due to a number of different factors. The social media age has provided more exposure to some of the most sacred natural wonders in the country. As people live in an increasingly urban environment, the desire to spend time in a structured outdoor setting continues to increase. The global climate of terrorism is keeping United States visitors traveling within the country and more specifically away from man made attractions, making a national park and monument vacation an even more appealing prospect. Several of the larger parks have seen a growth of 100% since 1980 [x]. This correlates to a growth rate of approximately 2.5% a year. Assuming the same growth rate for Montezuma Castle, and designing the parking lot for expected **10-year growth**, a total growth of 25% will be applied to current visitor counts for the final design capacity.

The tables below show the calculations used to determine the capacity required by the remodel and proposed additional parking lot.

Table 4: Design Calculations by Vehicle Type

	Current Daily	Daily w/ Growth	Peak (Design)
		Current Daily x 1.25	Daily w/ Growth x 0.2
Passenger Cars	497	621	124
Large Vehicles	18	23	5
Motorcycles	6	8	2

Table 5: Additional Spaces Required

	Passenger Cars	Large Vehicles	Motorcycles
Existing	64	0	0
Needed Spaces	60	5	2

Assuming the peak hours 10am-1pm provided by the client see an even distribution of 60% of the total visitors of the day (20% of the daily total per hour) and a growth of 25%, the parking lot capacity needs to accommodate 125 passenger cars, 5 large vehicles (busses and RVs), and 2 motorcycles. The existing parking lot holds 64 passenger cars. Restriping the existing parking lot

and adding the additional parking lot 60 additional passenger cars, 5 large vehicles, and 2 motorcycle spots will need to be accommodated.

<https://e360.yale.edu/features/greenlock-a-visitor-crush-is-overwhelming-americas-national-parks>