CENE 486C - 60% Final Design Report

Montezuma Castle National Monument Parking Lot Addition and Redesign

By: Fahad Alkhaldi, Brian Hernandez-Ng, Rae Johnson, Andrew McLaughlin, Jacob Robinson, Cayla Washington

Table of Abbreviations

ADA: Americans with Disabilities Act
CSP: Corrugated Steel Pipe
FEMA: Federal Emergency Management Agency
FHA: Federal Highway Association
GIS: Geographic Information System
GPS: Global Positioning System
Hr.: Hour
LIDAR: Light Detection and Ranging
Min.: Minute
MCNM: Montezuma Castle National Monument
MTE: Multicultural Technical Engineers
NOAA: National Oceanic and Atmospheric Administration
NPS: National Park Services
RV: Recreational Vehicle
SWPPP: Stormwater Pollution Prevention Plan

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Acknowledgments

The Multicultural Technical Engineers (MTE) would like to thank and acknowledge: Richard Goepfrich Jr., the facility manager at Montezuma Castle National Monument for coordinating site visits and offering assistance as needed. Stephen Irwin for providing excellent guidance on technical aspects of our project. Alarick '*Lar*' Reiboldt for keeping the team on track through the grading process and providing the resources to get the team to and from the project site. Lar and Mark Lamer for providing assistance in the teams presentation skills.

1.0 Project Introduction

The Montezuma Castle National Monument is in central Arizona along the I-17 Highway in Camp Verde. Figure 1 displays the location of Montezuma Castle National Monument in Arizona. Figure 2 displays the parking lot to be redesigned. The team will closely be working with the National Park Service. Our client, Richard Goepfrich Jr., who is the facility manager at Montezuma Castle, has the following concerns about the existing conditions of the visitor parking lot: poor striping and signage, no accessible picnic area for visitors, poor pedestrian facilities, no bus drop off area, and insufficient space for large quantities of buses/RV's and passenger cars. Due to these limitations, when the parking lot fills up, visitors are forced to park on the road shoulder during busy visitation days or even turned away from the site. Frequently, buses giving field trips will have to idle at the Cliff Castle Casino approximately 2.7 miles away.

Figure 1: Statewide view of Montezuma Castle National Monument in Arizona

Figure 2: Parking Lot to be Redesigned

1.1 Project Objectives

The objectives of this project are to:

- Provide a design for improved parking lot layout through a striping and signage plan.
- Provide a design for a new bus, RV, and overflow parking lot.
- Provide a design for bus drop off zone in the existing lot.
- Provide a design for additional sidewalks for pedestrian usage.
- Provide a plan to increase sidewalk usage through improved pedestrian facilities including striping and signage.
- Design a usable and accessible picnic area in the existing center island with an interior sidewalk.
- Verify that proposed changes do not affect the archaeological, ecological, and natural characteristics of the surrounding area through following applicable codes.
- Improve aesthetic appearance of the existing center island in the existing parking lot.
- Not change the existing road alignment that enters/exits the park.
- Provide a safe stopping sight distance and road conditions for drivers turning into and out of the proposed parking lot.
- Determine if a controlled intersection is required for safety of traffic leaving the monument and parking lots.

The intent of this project is to improve the overall accessibility of the Montezuma Castle National Monument parking lot in accordance with the design code fo the Federal Highway Administration and applicable ADA regulations. These improvements are: to provide more parking spaces reflective of the traffic flow and projected growth of the site, design a picnic area that will be available for visitors, improve facilities for pedestrians within the parking area, and provide better accommodations for large vehicles with a drop off zone and additional parking facilities.

1.2 Project Understanding

The following section will provide background on Montezuma Castle National Monument, the current conditions of site, and technical aspects for this project.

1.2.1 Site Background

Montezuma Castle is home to some of the most magnificent cliff dwellings made of local clays, wood, and stone created by the Sinagua people. Estimated to be nearly 800 years old, the structure consists of 45 – 50 rooms that are hidden in the side of the cliff walls. A significant amount of artifacts found within the ruins of the once thriving culture and are now on display at the visitor center of the park [1]. Since Montezuma Castle is in a relatively hidden location it quickly became an adventure from reality for many. On December 8, 1906, Montezuma Castle was officially registered as a National Monument under the authority of President Theodore Roosevelt. Since then it has continued to attract visitors and grow as a landmark of the Southwest.

The peak visitation months for the park are March, April, and October. Figure 3 below conveys the number of visitors for the year of 2016. These months attract visitors for their cool, moderate temperature compared to alternate times of the year. The most popular month was March at 52,776 visitors. The lowest three months are December, January, and August, mainly because they offer the harshest of temperatures from both freezing to heat. The least visited in a month was December at 21,874 visitors. These counts include employee, non-recreational and recreation vehicles on top of the passenger car total.

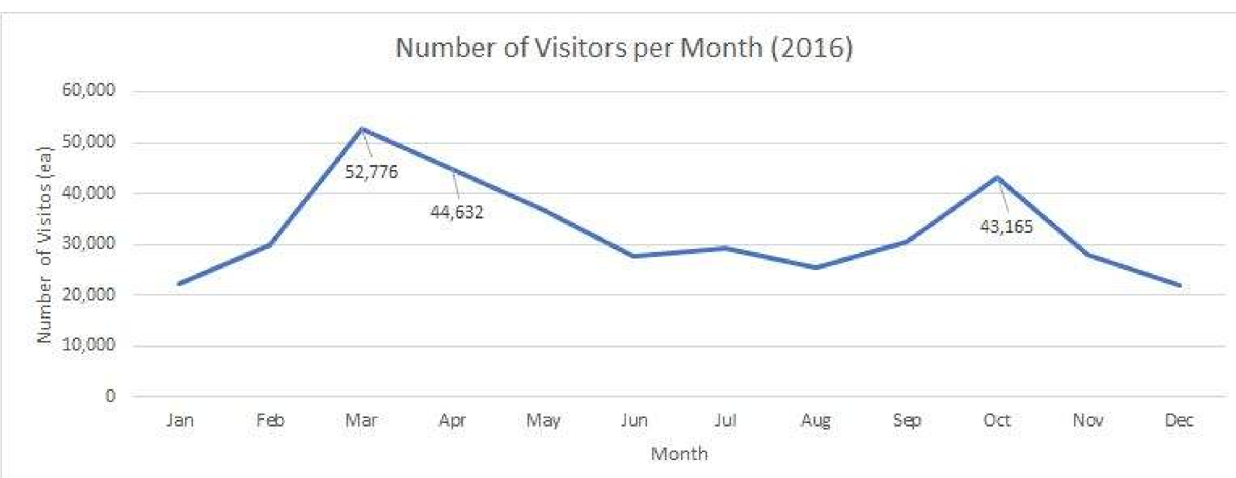


Figure 3: Number of Visitors of Montezuma Castle per Month

1.2.2 Site Description

The parking lot is currently equipped with 60 regular parking spaces, four ADA parking spaces, and four large spaces available for buses/RV's. In the middle of the parking lot there is a small vegetation area. Being that buses/RV's share the parking lot with passenger cars, it is difficult for large vehicles to safely navigate the tear-dropped shaped bend due to their high turning radii, which poses safety threats to passengers and visitors. Pictures of the existing conditions of the site are available in *Figure 4* and more pictures are available in Appendix I.

Figure 4: Existing Site Features

The surrounding topography of the existing parking lot are steep, leading to a very deliberate existing design that fits within the natural features of the area. Beaver Creek, a nearby stream, flows into the Verde River southwest of the site. All existing runoff from the impervious surfaces of the existing parking lot currently flow into Beaver Creek. To assist in the comprehension of the features on site, an existing site schematic has been prepared. The schematic conveys existing passenger car parking, bus/RV parking, the vegetation area, the existing intersection, and beaver creek which runs adjacent to the site. The schematic shows a birds-eye view of the area and it available in Appendix I. The site schematic was developed in BlueBeam Revu.

1.2.3 Technical Aspects

The project has several aspects that will require technical expertise. These technical aspects include: surveying, drainage analysis, drafting, and complying with regulations/codes, which the primary areas of focus.

1.2.3.1 Site Survey

A topographic site survey is critical because of the precarious location of the site and its unconventional arrangement of natural features. The boundaries of the existing parking lot appear to be steep, which explains the unorthodox design. This could potentially cause problems for the new proposed parking lot. It will be important to get precise topographic information to have a clear understanding of the existing conditions. Using GPS surveying technology, the team expects to survey 350-400 points.

1.2.3.2 Drainage Analysis

A drainage analysis of the site will involve considering the changes in impervious area and determining the effect of storm water flow as a result of the proposed design. The site is a National Monument and therefore site design will be under federal jurisdiction, specifically the Federal Highway Administration. For this site, it could become challenging as there is a nearby water source where drainage will end up unless directed elsewhere. If the governing requirements do not allow stormwater to drain to this nearby river, a detention basin may have to be designed to accommodate drainage. There could be potential need for an environmental study evaluating the runoff, which will have to fall outside of the scope of this project.

To assist in the Hydraulics and Hydrology analysis of the site, the team will contact the GIS department in Yavapai County. The team will seek recent LIDAR data in the area which will convey

1.2.3.3 Site Plan Design

Design software such as AutoCAD and Civil 3D will be critical to delivering the final set of construction documents for this project. This construction documents will convey the complete Site Plan Design. Ultimately the goal is to produce a set of plans that can effectively show the proposed changes to the site. The team will have to rely heavily on survey and drafting skills to produce an acceptable set of plans. The complete set of plans will include: a cover sheet, general notes conveying applicable FHA codes, site details, grading/drainage plan, and improvements/demolition plan. The grading/drainage sheets will convey new surfaces and vertical control along with proposed storm drainage containment. The improvements/demolition plan will convey new striping and signage along with any new curbs, gutters, sidewalks, a drop off zone, pedestrian facilities, and any demolition needed to the existing lot.

1.2.3.4 Governing Regulations and Codes

The site is in an interesting jurisdictional position. Though it lies in Yavapai County, research indicates that the National Monument is on federal land. Therefore, all components of the design will be compliant with federal standards. Specifically, the Federal Highway Administrative codes [2]. In design, it is important to have a set of codes to abide by that give direction to the general development of the site.

1.2.4 Potential Challenges and Limitations

The following section discusses the potential challenges the team will encounter during the project. Firstly, the leading challenge the team will face is coordination of all schedules. The team contains six members, which is 1.5 times the typical capstone team. Coordinating each other's schedules to where all members can meet at one time will present problems. For example, conflicting class schedules and work schedules will make meeting times difficult. Secondly, a prominent potential challenge is travel constraints. Montezuma Castle National Monument is located 53 miles south of Flagstaff. Not all team members have access to a personal vehicle, therefore this will make site visits more difficult. Minor challenges for the group include harsh weather impacts and limiting factors of the department such as building availability, limited computer availability, and other resource availability such as survey equipment.

2.0 Technical Analysis

The following sections will provide insight on all of the technical design work that is required to be completed for this project.

2.1 Field Work

The following subsections will discuss the field work that be performed for preliminary design.

2.1.2 Site Reconnaissance and Analysis

Before any design can begin, the team will need to become experts of the site and its surrounding features. To do this, multiple site visits are necessary. Per the schedule of the project, a minimum of three site visits will take place. During these site visits, a site survey will take place, team members will walk the site and note all hydrologic features such as culverts, drainage basins, etc., and data collection regarding traffic analysis will be performed. The team may also need to be on site for a client meeting.

2.1.3 Site Survey

The team conducted a site survey and collected a total of 300 points to make our topographic map displayed_ .

2.3 Hydrology & Hydraulics Summary

Montezuma Castle National Monument (MCNM) is a National Monument under National Park Service jurisdiction. The site is known for the cliff dwellings and is also known for the large amount of rooms this dwelling has. The site is used for educational and destination visits from local and tourists. The site is located 5 miles north from the City of Camp Verde and is located along Beaver Creek. The access to the site is on a single two lane road that comes from the east and south into the current parking lot. National Park Services is proposing a new parking lot to the south of the current drive and parking lot. Site improvements for this project will include a new parking lot, picnic area, sidewalks and water mitigation.

This site currently drains to the south and west and is channeled into Beaver Creek. The hydrology basins are smaller than 200 acres and the existing structures show no sign of lack of efficiency. The proposed drainage will follow the existing drainage patterns.

This project site is located within Zone X of FEMA FIRM Map #04025C2180H effective October 16, 2015. Zone X is described as areas determined to be outside the 0.2% annual chance floodplain. The FEMA map is provided in Appendix A.

2.3.1 Pre-Development Conditions

<u>Procedure of Pre-Development Conditions</u>

The existing runoff is concentrated through two concentration points. Drainage Basin A (DB-A) is located north of the access road and is approximately 5 acres. The Concentration Point A (CP-A) is concentrated through a 15 inch CSP culvert (N/S) that crosses the access road (E/W) and is allowed to naturally run to Beaver Creek to the southwest. This has provided a natural stream to form and deposit water in a low sloped ground where the channel disappears and allows the water to seep into the ground prior to reaching Beaver Creek. Drainage Basin B (DB-B) is located south of the access road and is approximately 8 acres and has a Concentration Point B (CP-B) that sheet flows and natural channels to Beaver Creek to the southwest. There is no definite channel to Beaver Creek but the existing topography shows that the water flows to it. Both of these basins and points were used to determine the pre-development peak flow rates.

There is no evidence that water flows making it from the most upper part of the basin to Beaver Creek. This was determined by extensive topography review and a site walk. There was also no evidence that the existing infrastructure was underperforming or required maintenance.

Results of Pre-Development Conditions

DB-A has a net area of 5.51 acres. The Weighted C was calculated by taking the area (4.89 acres) of natural landscape (C = 0.3) and the area (0.62 acres) of impervious area (C = 0.95) and giving a weighted average of 0.373 because there is significantly more natural landscape than impervious area. The flow from DB-A for the 100-year storm is 7.80 CFS. When analyzing CP-A the use of CulvertMaster was used. With a flow of 7.80 CFS through a 15 inch corrugated steel pipe (CSP) provides an exit velocity of 13.3 FPS. The velocity exiting the CSP is significant and is considered to be an extreme scour velocity that has the potential of destroying landscapes/ property.

DB-B has a net area of 12.98 acres. The Weighted C was calculated by taking the area (12.73 acres) of natural landscape (C = 0.3) and the area (0.25 acres) of impervious area (C = 0.95) and giving a weighted average of 0.31 because there is significantly more natural landscape than impervious area. The flow from DB-B for the 100-year storm is 5.30 CFS.

2.3.2 Post-Development Conditions

Procedure of Post-Development Conditions

The proposed site grading in the post-development condition will not change the size of either drainage basins. DB-A will be unchanged in size and in surface types. DB-B will be unchanged in size but will have an increase in impervious area due to the addition of a parking lot with associated sidewalks. The drainage with not change within the parking lot with the proposed picnic area because the addition of sidewalk is minimal considered the overall size of the drainage basin and will be mitigated through the addition of landscape and proper grading. The overall post-development peak runoff will be increased due to the addition of impervious area with no change in the overall drainage base size.

DB-A is routed under the access road via CSP and will be routed through DB-B with an open channel to Beaver Creek. The open channel will include the runoff from DB-A and DB-B.

The Federal Highway Administration Urban Design Manual does not provide applicable moments when a detention basin is required. If the site was located in a municipality a detention pond would be heavily designed and be required for implementation. Multicultural Technical Engineers recommends an implementation of a Low Impact Development basin or a detention basin. We will provide a simple and conceptual detention basin that will be required to be heavily analyzed.

Results of Post-Development Conditions

DB-A did not change in size or in surface types. The amount of flow through CP-A is 7.80 CFS with 13.3 FPS.

DB-B did not change in size but there was an increase of impervious area by 1.45 acres. Using the Rational Method again the net flow with additional impervious area is increased to 7.00 CFS.

DB-A and DB-B will be drained into a single open channel and deposited through CP-B at Beaver Creek. FlowMaster was used to determine the normal depth and velocity of the channel. In Appendix C includes the generated reports for each section of the channel including the culvert. The amount of freeboard through the channel is 1 to 3 feet. The depth is between 0.28 and .9 feet. The velocities are between 10.66 to 3.0 FPS. The channel flow was increased from 7.8 CFS to 10.8 CFS as the channel moves southeast to Beaver Creek.

The proposed parking lot will be graded to drain to the open channel. There is locations where water will be graded to drain within proposed green spaces to help alleviate the amount of water to the channel but the channel will be designed to hold the entire amount. The green spaces will include existing vegetation or vegetation the client believes will survive. MTE does not hold responsibility or liability for plant specifications/ locations and types for the area of the green spaces.

The detention basin was sized by using Bentley PondPack as running a pre- and post-development Modified Rational Method for the 100-year storm.

2.4 Traffic Analysis

The following subsections will discuss the traffic analysis involved in this project.

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.

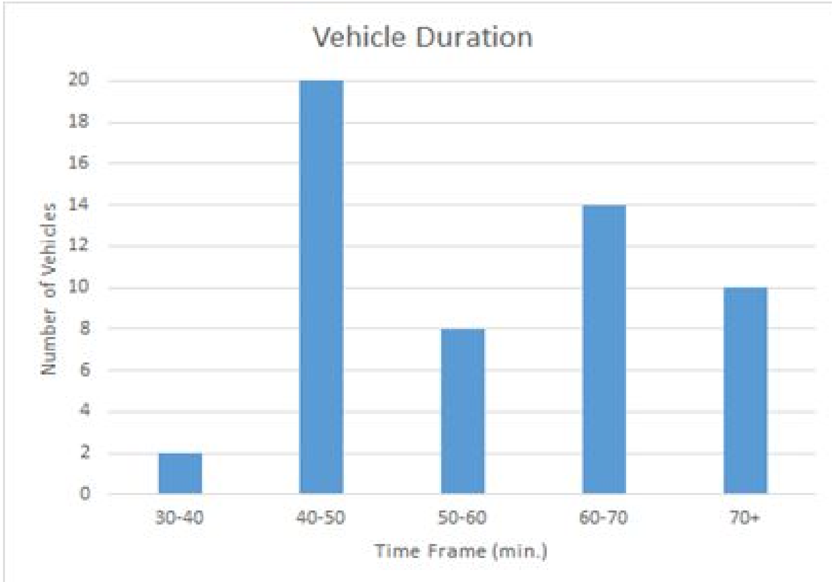


Figure 6: Visitor Travel Duration

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 stopping distance required to safely react to their situation. 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 Road. 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 7: 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 Road (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 movement. During a site visit one vehicle was observed turning from the minor roadway onto Montezuma Castle Road. Information from the client suggests that the current purpose of the roadway is restricted to employees only and demand is concentrated around employees.

2.4.4 Pedestrian Movements

In a second site visit, 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 or walking in the middle of the parking lot.

Table 2 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 was applied to vehicle traffic counts.

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 visitors at the national park are not using the existing sidewalks and walking in the middle of the existing parking lot. 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, there were numerous visitors arriving on buses during the 2-hour study period. The number of people within vehicles 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.

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 number of observed visitors 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 be 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	32	4	1

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 (buses and RV's), and 2 motorcycles. The existing parking lot holds 64 passenger cars. Combined, restriping the existing parking lot and the additional parking lot will accomodate 60 additional passenger cars, 5 large vehicles, and 2 motorcycle spots.

2.5 Site Design Components

The following subsections will discuss the design components of the proposed parking lot along with site signage and the proposed picnic area … and other stuff

2.5.1 Parking Lot Design

The parking lot design was chosen to be user friendly, aesthetic, and low in construction cost. The design wanted to optimize efficiency while minimizing costs associated with construction and maintenance. The chosen final design has a footprint with very minimal change in topography, which will reduce the costs associated with cut and fill of material to the site. This final design can be seen in appendix x. The site very gradually slopes southward, which will assist in drainage (refer to section XX). The parking lot has two proposed landscape areas that will have native plants and serve as detention basins. There are proposed pedestrian facilities from the new lot to the park entrance, as seen on the plans.

2.5.2 Site Layout & Site Signage Plan

To further the design process of the existing and proposed parking lots, a site layout equipped with an adequate signage plan was developed. The construction document containing the Site Layout & Site Signage Plan is available in Appendix _. Regarding specific elements of the lot, certain design aspects were implemented in order to keep traffic flowing and avoid congestion. In the existing parking lot, the current bus parking has been converted into a 15-minute maximum loading and unloading zone. This will alleviate traffic build up from busses who will now be required to park in the new proposed lot. The currently roadway to the proposed lot currently restricts all access to the public. This restricted access will be eliminated so that all visitors can utilize the roadway to access the new parking lot.

The new parking facility was designed to be one way only, similar to the existing lot. There are two rows of passenger car parking and two seperate areas designated for bus and RV parking only. There is one spot for motorcycle parking only. Visitors of Montezuma Castle National Monument will enter the newly designed lot from the south side and will exit from the north side. Refer to appendix X for the signage plan and associated traffic flow.

There will be two “Restricted Area” signs that only permit employee access beyond those points so that the road can continue to maintain functionality for its existing purpose. There is an existing stop sign that will serve as sufficient intersection control. Larger vehicles have a much larger turning radii, therefore most of the large vehicles cannot safely navigate the right turn to return back up the main road to exit the property. Therefore, these vehicle types will be restricted from turning right to ensure safety of other vehicles. They will be required to turn left, travel through the existing parking lot, then continue straight to exit the monument.

Some of the existing signs will be kept such as, the speed limit of 15 MPH, and the "No Parking Anytime" signs that are placed on the sides of the main road. There are four existing ADA Spots in the existing lot. Four of the current passenger car parking spots in the existing lot will be converted into additional ADA spots in compliance with FHA Design Codes, resulting in minor restriping of the existing lot and eight total ADA spots at the front entrance.

2.5.3 Sidewalk Placement

Sidewalks will be placed adjacent to the parking spots and along the edge of the road leading to and from the visitor center. Additional sidewalk will need to be placed along the south side of the existing parking lot to the east of the bus drop off zone.

2.5.4 Bus Drop off

2.5.5 Picnic Area

A preliminary design of the proposed picnic area was developed using Google SketchUp. Per client request, the picnic area will replace the existing vegetation area in the existing parking lot. By adding a safe and accessible picnic area, this will in turn attract more visitors to Montezuma Castle. Figure X and X below display two viewpoints of the Google SketchUp draft of the picnic area.

Figure X: Google Sketch-Up of Proposed Picnic Area looking from the Northwest to the South East of the lot (Front View)

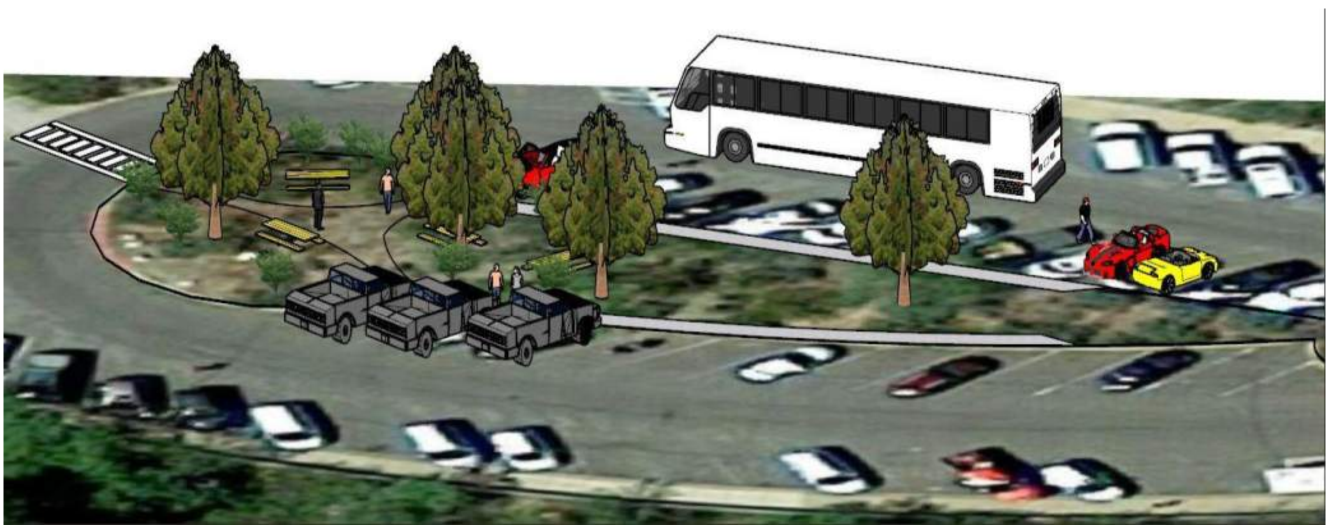


Figure X: Google Sketch-Up of Proposed Picnic Area from the South end of the lot to the North (Side View)

As seen in the figure above, there are multiple picnic tables for the visitors to use. The four tree's shown are indigenous to the property, thus, they will not be removed during the construction process, requested by the client. The proposed picnic area is safely accessible through the implementation of a high visibility crosswalk near the visitors center to the middle island. The picnic area creates a sense of place, drawing visitor to the center island to walk. The sidewalks added to the island leading to the monument will therefore draw visitors to the safety of the sidewalks and away from the center of the drive aisle, which is the current preferred pedestrian route. To preserve the landscape the sidewalk is only along the outside rim of the island and then cuts through the picnic area to the cross walk.

2.6 Cost of Implementation

Can not be determined until drawings are finalized. Estimation of cost will not be provided because MTE will not commit on a cost until then.

3.0 Summary of Engineering Work

4.0 Summary of Engineering Costs

Engineering costs will be determined towards the end when we can correctly estimate the amount of hours was put into each section of design. MTE will not commit on a cost until then.

5.0 Conclusion

The design provided will ease congestion and provide a safe access for additional motorists and pedestrians. *This will be worked out for 100%*

6.0 References

[] “Park Statistics,” *National Park Service: Montezuma Castle*, Feb. 2018. Available: https://www.nps.gov/moca/learn/management/statistics.htm

[] “Chapter 5: Parking Spaces,” *U.S. Access Board*, March 2018. Online. Available: https://www.access-board.gov/guidelines-and-standards/buildings-and-sites/about-the-ada-standards/guide-to-the-ada-standards/chapter-5-parking

7.0 Appendices

Appendix HA

FEMA Floodplain Map

National Flood Hazard Layer FIRMette

FEMA

34°36'52.70"N

111°50'27.47"W

111°49'50.02"W

34°36'23.09"N

Feet 1:6,000

0 250 500 1,000 1,500 2,000

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth
- Regulatory Floodway *Zone AE, AO, AH, VE, AR*

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN — Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- B 20.2 / 17.5 — Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 — Coastal Transect
- 513 — Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The base map shown complies with FEMA's base map accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 2/28/2018 at 11:51:19 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: base map imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures.** Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 12. The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum.** For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242,** or visit its website at http://www.ngs.noaa.gov/.

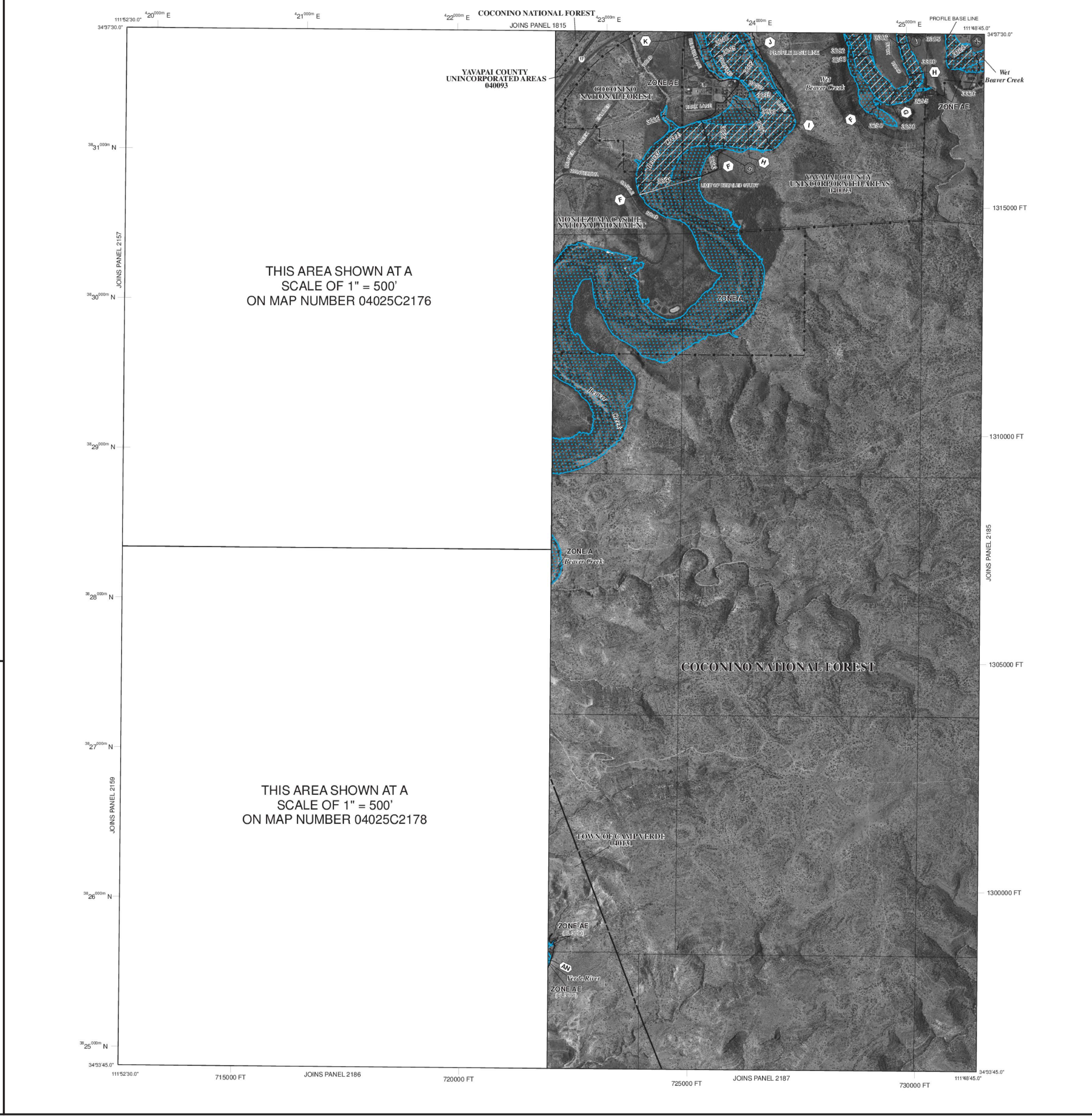
Base map information shown on this FIRM was derived from Arizona Digital Orthophoto Quadrangles (DOQs) with a resolution of 1 ft. per pixel from the USDA Aerial Photography Field Office dated 2010.

This map may reflect more detailed or up to date stream channel configurations than those shown on the previous FIRM. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations and improved topographic data. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products or the National Flood Insurance Program in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the **FEMA Map Service Center** website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website. Users may determine the current map date for each FIRM panel by visiting the **FEMA Map Service Center** website or by calling the FEMA Map Information eXchange.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

~~ 513 ~~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

(A)———(A)	Cross section line
(23)- - - - -(23)	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N	1000-meter Universal Transverse Mercator grid ticks, zone 12
6000000 FT	5000-foot grid ticks: Arizona State Plane coordinate system, central zone (FIPSZONE 0202), Transverse Mercator
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
June 6, 2001
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
September 3, 2010
October 16, 2015 -to change Special Flood Hazard Areas, to change Base Flood Elevations, and to reflect updated topographic information.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 2180H

FIRM
FLOOD INSURANCE RATE MAP
YAVAPAI COUNTY, ARIZONA
AND INCORPORATED AREAS

PANEL 2180 OF 3900
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
YAVAPAI COUNTY	040093	2180	H
CAMP VERDE, TOWN OF	040131	2180	H

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

**MAP NUMBER
04025C2180H**

**MAP REVISED
OCTOBER 16, 2015**

Federal Emergency Management Agency

Appendix HB

NRCS Soil Map

111° 50' 15" W

111° 50' 8" W

111° 50' 15" W

111° 50' 8" W

Map Scale: 1:862 if printed on B portrait (11" x 17") sheet.

N

Meters: 0 10 20 40 60

Feet: 0 40 80 160 240

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:31,700.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Beaver Creek Area, Arizona
Survey Area Data: Version 7, Sep 11, 2017

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 28, 2014—Feb 13, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Gu	Guest clay	5.7	90.1%
Re	Retriever loam	0.6	9.9%
Totals for Area of Interest		**6.3**	**100.0%**

Appendix HC

FlowMaster Channel Analysis

Worksheet for 00+00.00 to 00+10.00

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	46.5000	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	2.00	ft
Discharge	7.80	ft³/s

Results

Normal Depth	0.28	ft
Flow Area	0.73	ft²
Wetted Perimeter	3.27	ft
Hydraulic Radius	0.22	ft
Top Width	3.14	ft
Critical Depth	0.63	ft
Critical Slope	0.02530	ft/ft
Velocity	10.66	ft/s
Velocity Head	1.77	ft
Specific Energy	2.05	ft
Froude Number	3.89	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.28	ft
Critical Depth	0.63	ft
Channel Slope	46.5000	%

Worksheet for 00+00.00 to 00+10.00

GVF Output Data

Critical Slope	0.02530	ft/ft

Worksheet for 00+10.00 to 00+51.85

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	13.2600	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	2.00	ft
Discharge	7.80	ft³/s

Results

Normal Depth	0.40	ft
Flow Area	1.13	ft²
Wetted Perimeter	3.80	ft
Hydraulic Radius	0.30	ft
Top Width	3.61	ft
Critical Depth	0.63	ft
Critical Slope	0.02530	ft/ft
Velocity	6.89	ft/s
Velocity Head	0.74	ft
Specific Energy	1.14	ft
Froude Number	2.17	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.40	ft
Critical Depth	0.63	ft
Channel Slope	13.2600	%

Worksheet for 00+10.00 to 00+51.85

GVF Output Data

Critical Slope	0.02530	ft/ft

Worksheet for 00+51.85 to 02+46.70

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	6.1900	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	2.00	ft
Discharge	10.80	ft³/s

Results

Normal Depth	0.59	ft
Flow Area	1.87	ft²
Wetted Perimeter	4.63	ft
Hydraulic Radius	0.40	ft
Top Width	4.36	ft
Critical Depth	0.75	ft
Critical Slope	0.02424	ft/ft
Velocity	5.77	ft/s
Velocity Head	0.52	ft
Specific Energy	1.11	ft
Froude Number	1.55	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.59	ft
Critical Depth	0.75	ft
Channel Slope	6.1900	%

Worksheet for 00+51.85 to 02+46.70

GVF Output Data

Critical Slope	0.02424	ft/ft

Worksheet for 02+46.70 to 05+19.98

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	2.7100	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	2.00	ft
Discharge	10.80	ft³/s

Results

Normal Depth	0.73	ft
Flow Area	2.52	ft²
Wetted Perimeter	5.26	ft
Hydraulic Radius	0.48	ft
Top Width	4.92	ft
Critical Depth	0.75	ft
Critical Slope	0.02424	ft/ft
Velocity	4.28	ft/s
Velocity Head	0.28	ft
Specific Energy	1.01	ft
Froude Number	1.05	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.73	ft
Critical Depth	0.75	ft
Channel Slope	2.7100	%

Worksheet for 02+46.70 to 05+19.98

GVF Output Data

Critical Slope	0.02424	ft/ft

Culvert Designer/Analyzer Report
Under Maintenance Road
05+19.98 to 05+49.98

Analysis Component			
Storm Event	Design	Discharge	10.80 cfs

Peak Discharge Method: User-Specified			
Design Discharge	10.80 cfs	Check Discharge	7.80 cfs

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.			
Discharge	10.80 cfs	Bottom Elevation	0.00 ft
Depth	0.66 ft	Velocity	3.09 ft/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	2-18 inch Circular	10.80 cfs	1.34 ft	3.06 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
Under Maintenance Road
05+19.98 to 05+49.98

Component:Culvert-1

Culvert Summary					
Computed Headwater Eleva	1.34	ft	Discharge	10.80	cfs
Inlet Control HW Elev.	1.27	ft	Tailwater Elevation	0.66	ft
Outlet Control HW Elev.	1.34	ft	Control Type	Entrance Control	
Headwater Depth/Height	0.90				

Grades					
Upstream Invert	0.00	ft	Downstream Invert	-1.50	ft
Length	30.00	ft	Constructed Slope	5.0000	%

Hydraulic Profile					
Profile	CompositePressureProfileS1S2		Depth, Downstream	2.16	ft
Slope Type	N/A		Normal Depth	0.47	ft
Flow Regime	N/A		Critical Depth	0.90	ft
Velocity Downstream	3.06	ft/s	Critical Slope	0.5064	%

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	1.50	ft
Section Size	18 inch		Rise	1.50	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.34	ft	Upstream Velocity Head	0.37	ft
Ke	0.20		Entrance Loss	0.07	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.27	ft	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	3.5	ft²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Worksheet for 05+49.98 to 07+05.00

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	3.3800	%
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	2.00	ft
Discharge	10.80	ft³/s

Results

Normal Depth	0.69	ft
Flow Area	2.33	ft²
Wetted Perimeter	5.08	ft
Hydraulic Radius	0.46	ft
Top Width	4.76	ft
Critical Depth	0.75	ft
Critical Slope	0.02424	ft/ft
Velocity	4.64	ft/s
Velocity Head	0.33	ft
Specific Energy	1.02	ft
Froude Number	1.17	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.69	ft
Critical Depth	0.75	ft
Channel Slope	3.3800	%

Worksheet for 05+49.98 to 07+05.00

GVF Output Data

Critical Slope	0.02424	ft/ft

Appendix HD

Bentley PondPack – Detention Basin Analysis

Appendix HE

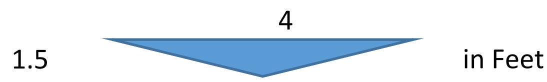
Modified Rational Method

North Watershed into Proposed Lot

Flow Segment	Length (ft)	Beginning Elevation (ft)	End Elevation (ft)	Slope (ft/ft)	Manning's Coefficient (n)
Sheet Flow	145	3320.43	3300.00	0.14089655	0.2
Shallow	None - Straight into Roadside Channel				
Channel	876	3300.00	3228.50	0.081621	

Channel Analysis

$V = (K_u/n)\, R^{2/3}\, S^{1/2}$		Units/ Location Found
V	13.501	Ft/s
K_u	1.49	Known
n	0.02	Table 3-4
R	0.45	--->
S	0.0952	From Topo



$T_{t3} = L/(60\,V)$

T_t3	0.6	Minute(s)
L	450	From Topo

Shallow Flow Analysis

$V = K_u\, k\, S_p^{0.5}$

V	0.2258	ft/s
K_u	3.28	Given
k	0.46	Table 3-3
S_p	15%	%, Topo

$T_{t2} = L/(60\,V)$

T_t2	6.6425	Minutes
L	90	

Sheet Flow $T_{ti} = \frac{K_u}{I^{0.4}}\left(\frac{n\,L}{\sqrt{S}}\right)^{0.6}$ 3.2.2.3 FHA Code Book Equ 3-3

Tsf	11.119	Minutes
K_u	0.933	Given
I	2.03	in/hr (NOAA) 50Y1HR
n	0.2	Table 3-2
L	215	ft,Topo
S	0.186	ft/ft, Topo

Total, Tc	18.3	Minutes

North Watershed into Proposed Lot

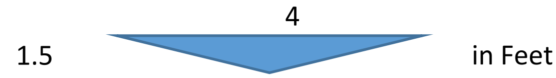
$Q = (CIA)/K_u$		Weighted C	0.373	/
		I_10Y30M	2.21	in/hr
		I_25Y30M	2.78	
		I_50Y30M	3.26	
		I_100Y30M	3.78	
		Area	5.51	acres
		K_u	1	Unit adjustment
Q_10Y30M	4.5438	CFS		
Q_25Y30M	5.7157	CFS		
Q_50Y30M	6.7026	CFS		
Q_100Y30M	7.7717	CFS		

South Watershed Pre-Development

Channel Analysis

$V = (K_u/n) R^{2/3} S^{1/2}$

		Units/ Location Found
V	13.501	Ft/s
K_u	1.49	Known
n	0.02	Table 3-4
R	0.45	--->
S	0.0952	From Topo



$T_{t3} = L/(60\ V)$

T_t3	0.0	Minute(s)
L	0	From Topo

Reason to believe there is no dedicated or topographic channel displayed for water to run through.

Shallow Flow Analysis

$V = K_u\ k\ S_p^{0.5}$

V	0.0813	ft/s
K_u	3.28	Given
k	0.46	Table 3-3
S_p	5.4%	%, Topo

$T_{t2} = L/(60\ V)$

T_t2	95.349	Minutes
L	465	

Sheet Flow $T_{ti} = \frac{K_u}{I^{0.4}}\left(\frac{n\ L}{\sqrt{S}}\right)^{0.6}$ 3.2.2.3 FHA Code Book Equ 3-3

Tsf	20.756	Minutes
K_u	0.933	Given
I	2.03	in/hr (NOAA) 50Y1HR
n	0.2	Table 3-2
L	475	ft,Topo
S	0.1134	ft/ft, Topo

Total, Tc	116.1	Minutes

South Watershed Pre-Development

$Q = (CIA)/K_u$		Weighted C	0.31	/
		I_10Y120M	0.777	in/hr
		I_25Y120M	0.972	
		I_50Y120M	1.13	
		I_100Y120M	1.31	
		Area	12.98	acres
		K_u	1	Unit adjustment
Q_10Y120M	3.157	CFS		
Q_25Y120M	3.949	CFS		
Q_50Y120M	4.591	CFS		
Q_100Y120M	5.322	CFS		

South Watershed Post-Development

Channel Analysis

$$V = (K_u/n)\, R^{2/3}\, S^{1/2}$$

		Units/ Location Found
V	13.501	Ft/s
K_u	1.49	Known
n	0.02	Table 3-4
R	0.45	--->
S	0.0952	From Topo

4

1.5  in Feet

$$T_{t3} = L/(60\,V)$$

T_t3	0.0	Minute(s)
L	0	From Topo

Reason to believe there is no dedicated or topographic channel displayed for water to run through.

Shallow Flow Analysis

$$V = K_u\, k\, S_p^{0.5}$$

V	0.0813	ft/s
K_u	3.28	Given
k	0.46	Table 3-3
S_p	5.4%	%, Topo

$$T_{t2} = L/(60\,V)$$

T_t2	95.349	Minutes
L	465	

Sheet Flow $$T_{ti} = \frac{K_u}{I^{0.4}}\left(\frac{n\,L}{\sqrt{S}}\right)^{0.6}$$ 3.2.2.3 FHA Code Book Equ 3-3

Tsf	20.756	Minutes
K_u	0.933	Given
I	2.03	in/hr (NOAA) 50Y1HR
n	0.2	Table 3-2
L	475	ft,Topo
S	0.1134	ft/ft, Topo

Total, Tc	116.1	Minutes

South Watershed Post-Development

$$Q = (CIA)/K_u$$

Weighted C	0.39	/
I_10Y120M	0.777	in/hr
I_25Y120M	0.972	in/hr
I_50Y120M	1.13	in/hr
I_100Y120M	1.31	in/hr
Area	12.98	acres
K_u	1	Unit adjustment

Q_10Y120M	3.889	CFS
Q_25Y120M	4.865	CFS
Q_50Y120M	5.656	CFS
Q_100Y120M	6.557	CFS

Parking Lot Influence

$Q = (CIA)/K_u$		Weighted C	0.95	/
		I_10Y120M	5.26	in/hr
		I_25Y120M	6.62	
		I_50Y120M	7.75	
		I_100Y120M	8.99	
		Area	1.45	acres
		K_u	1	Unit adjustment
Q_10Y120M	7.241	CFS		
Q_25Y120M	9.113	CFS		
Q_50Y120M	10.668	CFS		
Q_100Y120M	12.375	CFS		

Channel Characteristics

		Station	Length (ft)	Upstream Elevation (ft)	Downstream Elevation (ft)	Slope (%)	Flows (CFS)	Flow (FT/s)	Normal Depth (ft)
Surface Elevations	1	00+00.00	10.00	3216.52		33.40	7.8	9.51	0.31
		00+10.00			3213.18				
	2	00+10.00	41.85	3213.18		13.02	7.8	6.84	0.41
		00+51.85			3207.73				
	3	00+51.85	194.85	3207.73		6.10	10.8	5.74	0.59
		02+46.70			3195.84				
	4	02+46.70	258.64	3195.84		2.26	10.8	4.01	0.76
		05+19.98			3190				
	5	05+19.98	30.00	3190		0.00	10.8	3.06	0.9
		05+49.98			3190				
	6	05+49.98	155.02	3190		5.16	10.8	5.40	0.62
		07+05.00			3182				

		Station	Length (ft)	Upstream Elevation (ft)	Downstream Elevation (ft)	Slope (%)	Flows (CFS)	Flow (FT/s)	Normal Depth (ft)	Freeboard (FT)
Channel Elevations	1	00+00.00	10.00	3216.52		46.50	7.8	10.66	0.28	1.03
		00+10.00			3211.87					
	2	00+10.00	41.85	3211.87		13.26	7.8	6.89	0.4	1.01
		00+51.85			3206.32					
	3	00+51.85	194.85	3206.32		6.19	10.8	5.77	0.59	1
		02+46.70			3194.25					
	4	02+46.70	258.64	3194.25		2.71	10.8	4.28	0.73	2.03
		05+19.98			3187.24					
	5	05+19.98	30.00	3187.24		5.00	10.8	3.06	0.9	3.36
		05+49.98			3185.74					
	6	05+49.98	155.02	3185.74		3.38	10.8	4.64	0.69	0.81
		07+05.00			3180.5					

Appendix HF

CulvertMaster Analysis

Culvert Analysis Report
Culvert under Montezuma Castle Road (Into Proposed Parking Lot)

Analysis Component			
Storm Event	Design	Discharge	7.80 cfs

Peak Discharge Method: User-Specified			
Design Discharge	7.80 cfs	Check Discharge	6.70 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-15 inch Circular	7.80 cfs	3,223.44 ft	13.31 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
Culvert under Montezuma Castle Road (Into Proposed Parking Lot)

Component:Culvert-1

Culvert Summary

Computed Headwater Elevation	3,223.44 ft	Discharge	7.80 cfs
Inlet Control HW Elev.	3,223.44 ft	Tailwater Elevation	N/A ft
Outlet Control HW Elev.	3,223.37 ft	Control Type	Inlet Control
Headwater Depth/Height	1.80		

Grades

Upstream Invert	3,221.19 ft	Downstream Invert	3,208.61 ft
Length	56.00 ft	Constructed Slope	22.4643 %

Hydraulic Profile

Profile	S2	Depth, Downstream	0.60 ft
Slope Type	Steep	Normal Depth	0.60 ft
Flow Regime	Supercritical	Critical Depth	1.11 ft
Velocity Downstream	13.31 ft/s	Critical Slope	4.4482 %

Section

Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.25 ft
Section Size	15 inch	Rise	1.25 ft
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev.	3,223.37 ft	Upstream Velocity Head	0.72 ft
Ke	0.50	Entrance Loss	0.36 ft

Inlet Control Properties

Inlet Control HW Elev.	3,223.44 ft	Flow Control	N/A
Inlet Type	Headwall	Area Full	1.2 ft^2
K	0.00780	HDS 5 Chart	2
M	2.00000	HDS 5 Scale	1
C	0.03790	Equation Form	1
Y	0.69000		

Culvert Analysis Report
Under Maintenance Road

Analysis Component			
Storm Event	Design	Discharge	10.80 cfs

Peak Discharge Method: User-Specified			
Design Discharge	10.80 cfs	Check Discharge	7.80 cfs

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.			
Discharge	10.80 cfs	Bottom Elevation	0.00 ft
Depth	0.66 ft	Velocity	3.09 ft/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	2-18 inch Circular	10.80 cfs	1.34 ft	3.06 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
Under Maintenance Road

Component:Culvert-1

Culvert Summary

Computed Headwater Elevation	1.34 ft	Discharge	10.80 cfs
Inlet Control HW Elev.	1.27 ft	Tailwater Elevation	0.66 ft
Outlet Control HW Elev.	1.34 ft	Control Type	Entrance Control
Headwater Depth/Height	0.90		

Grades

Upstream Invert	0.00 ft	Downstream Invert	-1.50 ft
Length	30.00 ft	Constructed Slope	5.0000 %

Hydraulic Profile

Profile	CompositePressureProfileS1S2	Depth, Downstream	2.16 ft
Slope Type	N/A	Normal Depth	0.47 ft
Flow Regime	N/A	Critical Depth	0.90 ft
Velocity Downstream	3.06 ft/s	Critical Slope	0.5064 %

Section

Section Shape	Circular	Mannings Coefficient	0.012
Section Material	Corrugated HDPE (Smooth Interior)	Span	1.50 ft
Section Size	18 inch	Rise	1.50 ft
Number Sections	2		

Outlet Control Properties

Outlet Control HW Elev.	1.34 ft	Upstream Velocity Head	0.37 ft
Ke	0.20	Entrance Loss	0.07 ft

Inlet Control Properties

Inlet Control HW Elev.	1.27 ft	Flow Control	N/A
Inlet Type	Groove end projecting	Area Full	3.5 ft²
K	0.00450	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	3
C	0.03170	Equation Form	1
Y	0.69000		

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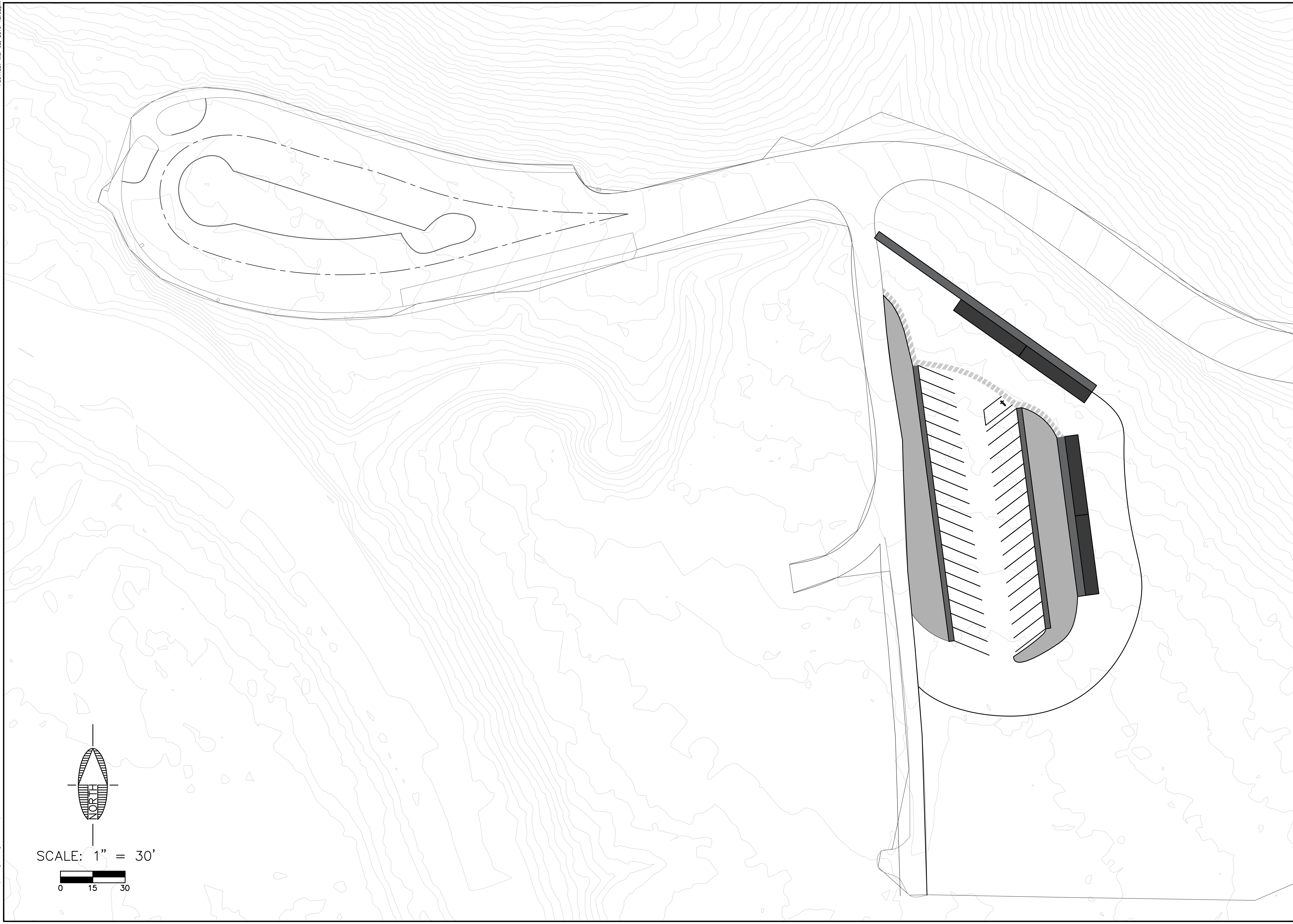

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NO.	DESCRIPTION	DATE	BY

MTE

3600 S. LAS VEGAS BLVD
LAS VEGAS, NV 89109

PRELIMINARY
NOT FOR CONSTRUCTION, BIDDING OR RECORDING

JOB NO:	2018001
DATE:	Mar–2018
SCALE:	N/A
DRAWN:	RNJ/JJR
DESIGN:	MTE
CHECKED:	MTE

PARKING LOT IMPROVMENTS AND REDESIGN

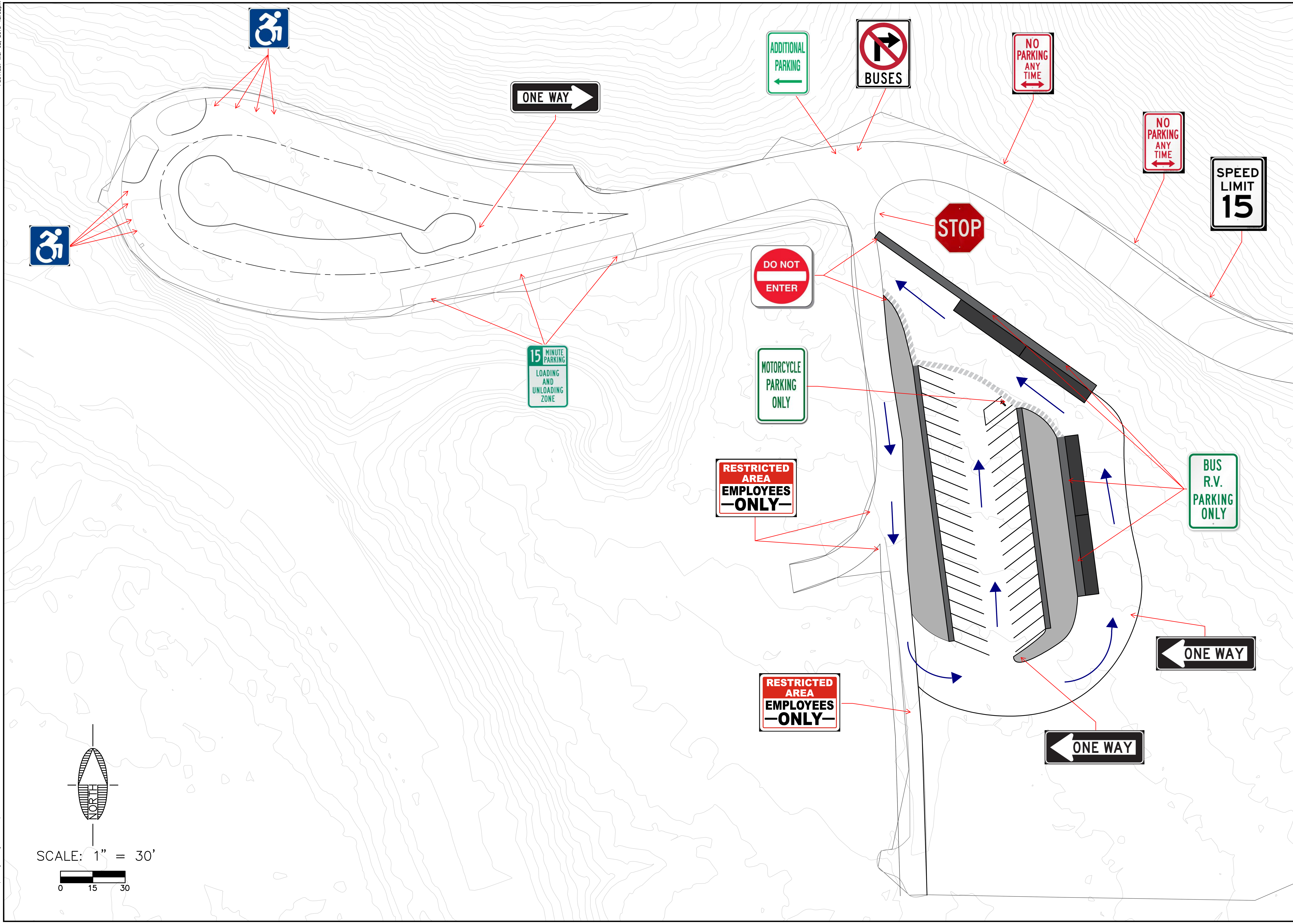
MONTEZUMA CASTLE
ARIZONA

PROPOSED PARKING LOT DESIGN

DRAWING NO. 1

SHT NO. 1 OF 1

PLOTTED: Mar 02, 2018-12:52pm



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DRAWING NO. 1

SHT NO. 1 OF 1

MONTEZUMA CASTLE
ARIZONA

PARKING LOT IMPROVMENTS AND REDESIGN

PROPOSED PARKING LOT DESIGN

JOB NO:	2018001
DATE:	Mar-2018
SCALE:	N/A
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DESIGN:	MTE
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LAS VEGAS, NV 89109

NO.	DESCRIPTION	DATE	BY