STATE ROUTE 64 PRELIMINARY PASSING LANE DESIGN

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List of Abbreviations

ADOT: Arizona Department of Transportation

SR-64: State Route 64

NAU: Northern Arizona University

ROW: Right of Way

NRCS: Natural Resources Conservation Service

USDA: United States Department of Agriculture

CMP: Corrugated Metal Pipe

ABC: Aggregate Base Course

AC: Asphaltic Concrete

Acknowledgements

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Special thanks goes to Taylor Layland for helping with the Civil 3D work.

Disclaimer: The following design, was created based on NRCS 30 meter grid cell/ 1 meter contour data. Due to this, the SR-64 Capstone team recommends that surveying and a geotechnical analysis be done before taking the design into implementation.

1.0 Project Introduction

The Arizona Department of Transportation requested a preliminary passing lane design on State Route 64 (SR-64), between mile markers 201 and 204 in the southbound direction. The project is located in Northern Arizona (Coconino County) between Williams, AZ and the Grand Canyon National Park south entrance. Figure 1, depicts the state location, project site and its correlation to cities within the area. Currently, SR-64 is a fully functioning 2-lane highway. Initially constructed in the late 1940's, the highway has experienced minor additions and repairs such as new surfacing and the addition of passing lanes. The roadway consists of two 12-foot asphaltic lanes, accompanied by 4-foot shoulders on both sides of the road. On either side of the shoulders is rip-rap consisting of crushed stone or larger rocks depending on the grade leading up to and away from the shoulders.

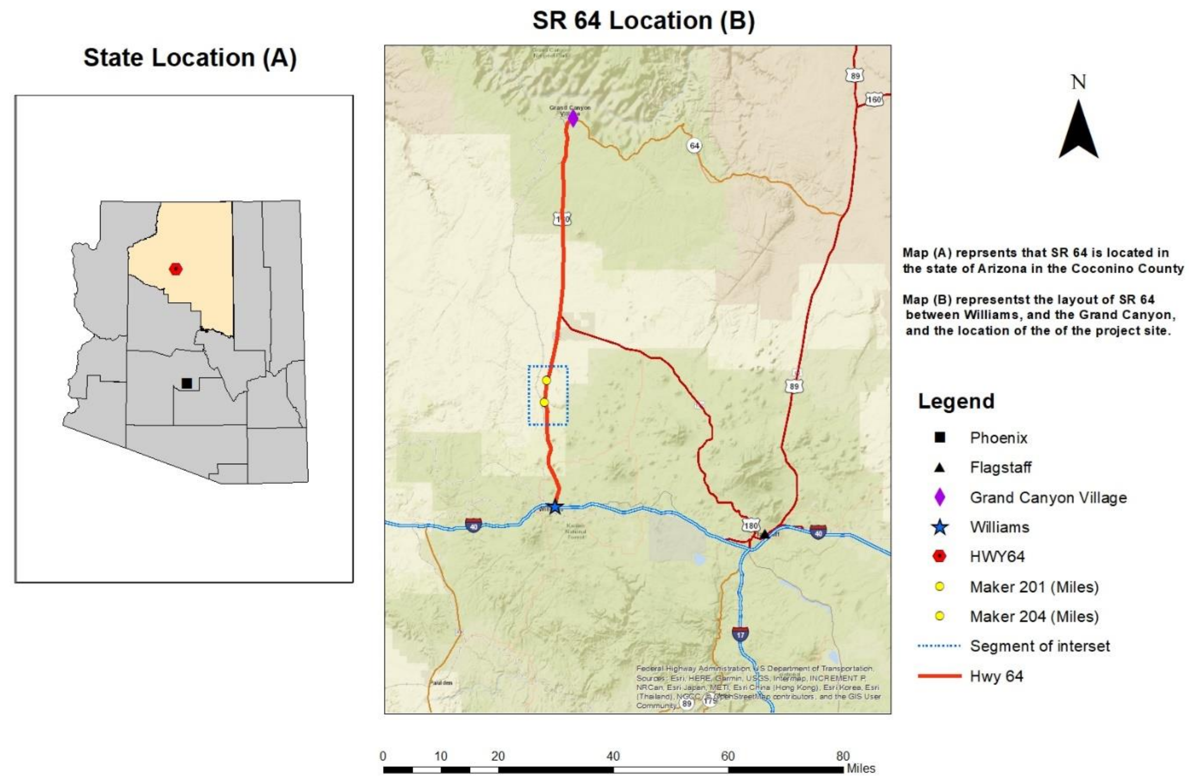


Figure 1: Project Location, which specify that the project is located in Coconino County/ SR64 is located between Williams and the Grand Canyon village.

State Route 64, is a tourist route from Williams to the Grand Canyon village, with larger semi-trucks transporting goods to the Grand Canyon along that route. The project area experiences congestion during busy travel period due to the holiday season. The location was chosen because of vehicles could not pass slower moving vehicles during the busiest times. Due to sight obstructions along the roadway, which include vertical and horizontal curves, minimal passing can be done during areas of flat, straight corridors. As a consequence, traffic queues increase, as well as people becoming more aggressive during passing operations, leading to an increase of accidents. A passing lane would decrease traffic queues and minimize accidents.

SR-64 Passing Lane Addition requires that the existing culvert pass a 50 year storm. The existing alignment has been modified to include the passing lane in the southbound direction, including tapers leading in and out of the lane. A cut and fill report, along with highway cross-sections, traffic control/signage plan and a cost report have been created, with the control plan includes new signage dictated by the Arizona Department of Transportation Highway Manual.

2.0 Existing Conditions

2.1 General Road Condition

SR 64 asphalt and shoulder condition of the road, between mile markers 201-204 are found to be in good condition, with no potholes or large cracks/deformities. According to ADOT Roadway Design Guidelines [1], the addition of a lane with a 12 foot width, will have a minimum of 300 feet of taper (Figure 2A, reinforces that there will no site obstruction in implementing this taper length). In the case of dropping of a lane [1], with a 12 foot width and a 75 mph design speed, there will be a need of at least 900 feet of taper to exit the lane (Figure 2B, reinforces that there will no site obstruction in implementing this taper length and will allow vehicles to safely incorporate themselves into 1 lane again).

Figure 2: Figure A shows that there is enough room without any sight distance issue for the 300-ft of entrance pavement that is required (taper) so that vehicles are able to get over with sufficient time and space. Figure B shows that there will be no problems implementing 900-ft of taper, so that vehicles may safely exit the passing lane.

As a result of soil samples not being collected, a geotechnical analysis was not conveyed. The structural design of the roadway and box culverts were also not looked at. Mile Post 200-215 have 100-feet of ROW on each side of the centerline, 200 feet in total [2]. With the addition of a 12-foot passing lane in the southbound direction and a 4 foot shoulder on each side, the southbound direction will have an excess of 72-feet from end of shoulder to ROW boundary. The Northbound direction will have an excess of 84-feet from end of shoulder to ROW boundary [2]. This determines that there will be more than enough ROW available for the passing lane to be constructed.

2.2 Drainage Conditions

Based on the drainage condition assessment, the culverts within the project constraints were located, as well as their condition and the integrity of the wash leading to and from each culvert, which were found to be in pristine condition. The location of the bigger boxed culverts at mile marker 202 showed that this section of the road had the biggest inclination, while the 5 culverts found at mile marker 203 showed that while the road does not have as much inclination, the inclination happens over a longer stretch of the road and in order to avoid excess water at one culvert, separate culverts were built to remediate flooding. Figure 3 Step1, shows a site map with the location of each culvert on the road, while also presenting what stream leads into culverts A, F and H. Appendix O-Q show a picture of culvert A, F, and H, taken during the site visit, Figure 3 Step 1.

3.0 Hydrology and Hydraulics Analysis

3.1 Hydrology

In order to determine the culvert watershed, a hydrology analysis is done, this analysis determines whether each culvert will pass a 50 year 24 hour storm and will determine if any of the culverts that are currently located within the passing lane additional will need to be reconstructed and made bigger

A Digital Elevation Map (DEM) is downloaded from the Natural Resources Conservation Service, United States Department of Agriculture (NRCS USDA) for the specific county that the project is located in. Due to the large that was provided, the area was clipped to only include the area that is of interest to the project. All of the errors that were included within the file were can be fixed through the “Fill Sinks” tool within ArcGIS, Figure 3 Step 1.

Next, a direction of flow was found for the area, often referred to as the “Flow Direction” within ArcGIS. Figure 3 Step 2, depicts the flow direction of the watershed. The areas colored blue represent the flow moving to the east, the green areas represent the flow moving to the north, the red areas represent the flow moving to the south, and the yellow areas represent the flow moving to the west. This was done through the hydrology section of the ArcGIS Toolbox and created an image that showed the direction in which water is flowing in the area.

Once the streams are present on the map, a “Catchment Grid Delineation” was made that shows the sub-watersheds of the area. This tool is found within the hydrology section uses all of the previous data to create the boundaries that define these areas which are drawn from the “Catchment Polygon Processing.”

Now that the areas for each sub-watershed are known, a map showing the soil conditions for each of these areas was found from the NRCS USDA website. This soil data was categorized into four different groups, A, B, C, and D. A “Soil A” classification represents a soil that is sand, loamy sand, or sandy loam. “Soil B” is classified as silt loam or loam. “Soil C” is classified as sandy clay loam, and “Soil D” is classified as clay loam, silty clay loam, sandy clay, silty clay, and clay [3].

The land usage map of the areas was required and shows what the land in this area is being used for as shown in Figure 3 Step 4. Typical examples include an evergreen forest, shrubs, developed, water, and other different categories. This map can be downloaded from NRCS USDA and will be placed over the DEM and stream delineations above. Typical examples include an evergreen forest, shrubs, developed, water, and other different categories. This map can be downloaded from NRCS USDA and will be placed over the DEM and stream delineations above.

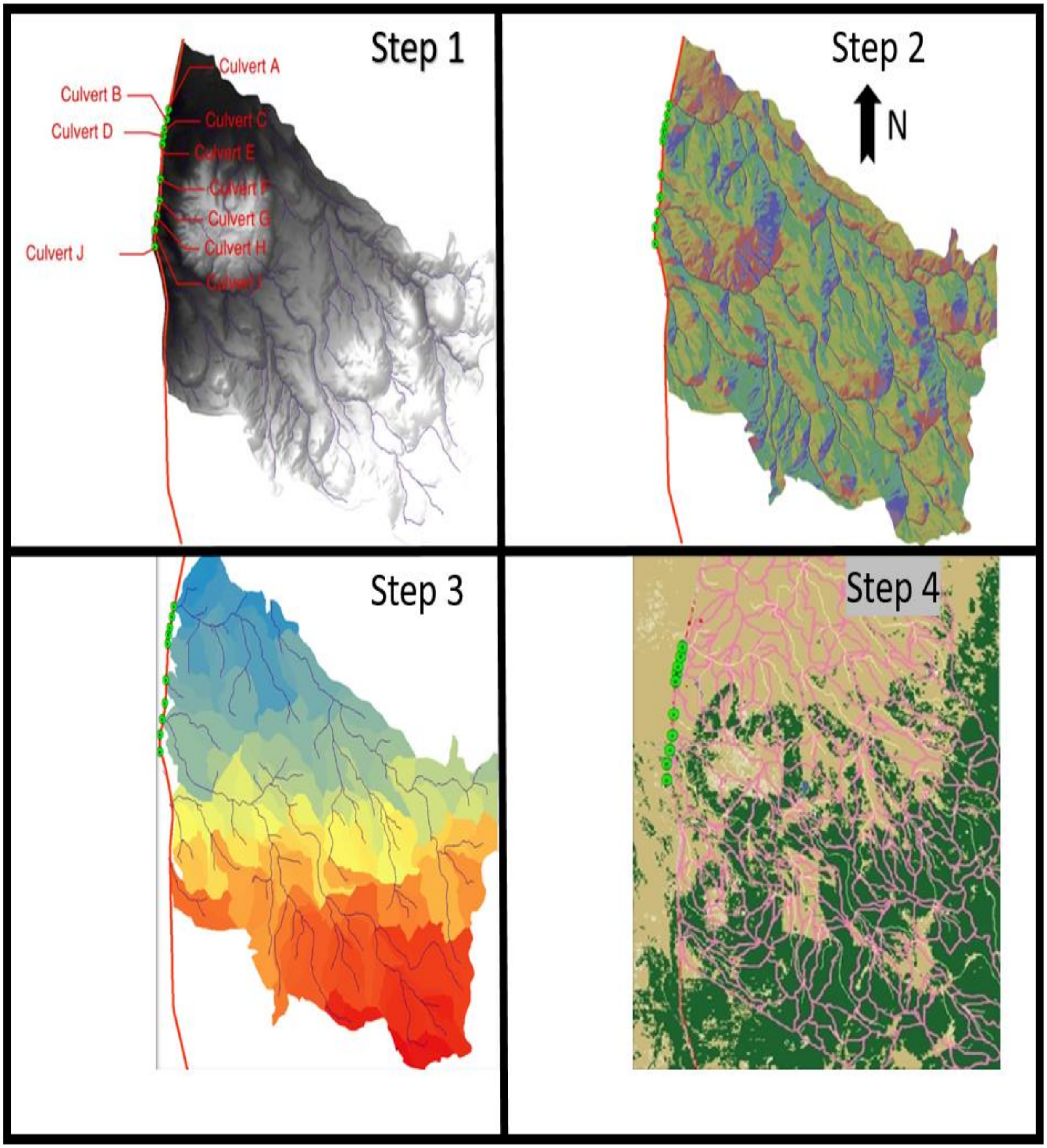


Figure 3: Step 1 shows the DEM map of the approximate water shed areas that would contribute flow to each culvert. This is then used to find the flow direction map shown in Step 2 and then to find the stream accumulation points in the area (Step 3). Once these are completed watersheds can be drawn out in the map indicating which sub-watershed leads to each culvert (Step 4).

With the land usage map and soil classification a curve number was selected from Table 2-2 of USDA TR-55. [4] This value was then used to find the potential maximum retention after runoff begins of the area (S) and is shown below in Equation 1. The initial abstraction (I_a) from the potential maximum retention is then calculated in Equation 2. The precipitation data (P) for the area was found using NOAA Atlas 14 [5], for a 24 hour 50 year storm. The amount of runoff in units of length can now be calculated using Equation 3. Since this runoff is in units of length and not in units for discharge it must be converted by using Equation 4, which multiples this value by the sub-watershed area found in ArcGIS above and then dividing it by the storm duration time, or the length of the storm.

Equation 1: Calculate Soil and Cover Conditions

$$S = \frac{1000}{CN} - 10$$

Where: S = potential maximum retention after runoff begins in inches

CN = curve number found in Table 2-2 [4]

Equation 2: Find I_a, Total Losses From Soil and Cover Conditions

$$I_a = 0.2S$$

Where: I_a = initial abstraction in inches

S = potential maximum retention after runoff begins in inches

Equation 3: Calculate Q, Runoff of Water in Inches

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S}$$

Where: Q = runoff of water in inches

P = precipitation of rainfall for area of interest

I_a = initial abstraction in inches

S = potential maximum retention after runoff begins in inches

Equation 4: Convert Q to Q_t, Flow Volume

$$Q_t = \frac{Q * A}{t}$$

Where: Q_t = total runoff of water, volume

A = area of sub-watershed

t = storm time duration

Note that the Q_t calculated above is only for one sub-watershed that is contributing flow to the pour point. A single pour point can have many different sub-watersheds that are contributing to it, so the flows (Q_t) from all of these sub-watersheds are going to be added to together to get the overall total flow of water that is flowing into each pour point.

The curve number for each individual sub-watershed was needed to calculate the total flow of water that will flow through each culvert. This curve number represents the amount of water that infiltrates into the soil due to the soil conditions in the area. The soil conditions include the type of soil that is present within the area, along with the land usage of that soil. The leftover runoff from the rainfall then becomes the total flow rate for the sub-watershed. This can be seen in Table 2, where the area for culvert A was calculated.

Equation 5: Rational Method

$$Q = CiA$$

Where: Q = Peak Discharge (ft^3/s)

C = Runoff Coefficient (unitless)

i = Design Storm Rainfall Intensity (in/hr)

A = Drainage Area (acres)

With the extension of the passing lane additional runoff will be created by the roadway. Using the Rational Method the additional runoff was calculated. The runoff coefficient was found to be 0.85 for asphaltic concrete, being used in the project, and the intensity was found to be 0.157 in/hr for a 50-year 24-hour storm event. The drainage area is found from the additional passing lane and shoulder adding to 15 feet wide and stretching along three miles, giving an area of 6.18 acres. The tapers are also taken into consideration with the entrance taper being 300 ft. in length, with it meeting up with the 15 ft. wide passing lane and shoulder, giving an area of 2250 ft^2 (0.05 acres). The exit taper is 900 ft. long and starts out as 15 ft. wide, giving an area of 7650 ft^2 (0.18 acres). Adding the area from the passing lane along the three mile stretch and the tapers gives a total area of 6.41 acres. The peak discharge for the additional passing lane and shoulder is calculated to be 0.85 ft^3/s.

Table 1: Curve Number that was used to find the discharge

Area #	Area	Land Usage	Classificat	CN	P	S	Ia	Q	Volume	Discharge
	ft^2				in	in	in	ft	ft^3	cfs
1	5429311	Shrub	C	85	3.92	1.76	0.35	0.20	1079724.74	12.50
2	4737192	Shrub	C	85	3.92	1.76	0.35	0.20	942083.38	10.90
3	10595983	Shrub	C	85	3.92	1.76	0.35	0.20	2107218.55	24.39
4	14291230	Shrub	C	85	3.92	1.76	0.35	0.20	2842090.68	32.89
5	15631336	Shrub	C	85	3.92	1.76	0.35	0.20	3108596.89	35.98
6	5575700	Shrub	C	85	3.92	1.76	0.35	0.20	1108837.07	12.83
7	4441185	Shrub	C	85	3.92	1.76	0.35	0.20	883216.55	10.22
8	6103131	Shrub	C	85	3.92	1.76	0.35	0.20	1213727.06	14.05
9	13642167	Shrub	C	85	3.92	1.76	0.35	0.20	2713011.77	31.40
10	7727404	Shrub	C	85	3.92	1.76	0.35	0.20	1536745.42	17.79
11	3484274	Shrub	C	85	3.92	1.76	0.35	0.20	692916.14	8.02
12	11367755	Evergreen	B	75	3.92	3.33	0.67	0.13	1522246.17	17.62
13	24332872	Evergreen	B	75	3.92	3.33	0.67	0.13	3258393.81	37.71
14	8828551	Evergreen	B	75	3.92	3.33	0.67	0.13	1182223.57	13.68
15	1062397	Shrub	C	85	3.92	1.76	0.35	0.20	211278.41	2.45
16	47402063	Evergreen	B	75	3.92	3.33	0.67	0.13	6347569.08	73.47
17	17064011	Evergreen	B	75	3.92	3.33	0.67	0.13	2285026.85	26.45
18	19232937	Shrub	C	85	3.92	1.76	0.35	0.20	3824845.69	44.27
										426.62

3.2 Hydraulics

Hydrology and hydraulics is needed to perform an assessment on the current conditions of flow going into each culvert on the site location, as well as to analyze future extension of these culverts when the passing lane is added.

Culverts A, F and H were analyzed in ArcGIS, while culverts: B, C, D, E, G, I, J, were taken from the "Feasibility Report" [1]. The process of creating a Digital Elevation Model (DEM) and how each sub-basin was created can be found below in Figure 3. Culvert locations can also be found with the use of Figure 3.

"Quick Culvert Calculator" was used to analyze all of the culverts found along the three miles of roadway, by comparing a computed headwater elevation to the maximum allowable headwater. To solve for headwater elevation, the discharge rate of flow in cubic feet per second, maximum allowable headwater in feet, type of culvert including the shape, material, and size, as well as the length and entrance type of the culvert were. Appendix 13.5-13.14 below, show the inputted values into CulvertMaster, as well as the headwater elevations calculated from each. All ten culverts are currently allowing the 50-year storm at a 24-hour duration to flow through them with no issues rise for the existing conditions.

Table 2 illustrates the discharge that will run through each culvert, as well as the maximum allowable headwater, the shape, material, size and length of the culvert. With the use of CulvertMaster we were then able to compute the maximum allowable headwater and determine whether each culvert size would suffice for the amount of discharge. CulvertMaster used this data to calculate the headwater for both outlet and inlet control, then selects the worst case scenario for the culvert, which is the control that creates the higher headwater. If the headwater found is larger than that of the maximum allowable headwater then the water will start to flow over the top of the roadway and could cause damage to the culvert, road, and the drivers on the road. Therefore, if the culvert is found to have an existing condition in which the water is flowing over onto the roadway, then it must be removed and a recommendation for the size used to replace it that will fit the needs of the discharge flowing through the area was made.

Table 2: Existing Culvert Analysis (Discharge, Dimensions, Allowable HW, Computed HW, Pass/Fail)

Culvert	Inputs						Outputs	
	Discharge (cfs)	Max Allowable HW (ft)	Shape	Material	Size	Length (ft)	Computed HW (ft)	
A	426.6175	8.5	Circular	CMP	78"	52.0	11.69	Fail
B	5.137906	4.0	Circular	CMP	30"	42.5	2.36	Pass
C	2.159898	8.5	Circular	CMP	30"	68.0	2.06	Pass
D	2.697454	3.8	Circular	CMP	24"	57.0	2.42	Pass
E	1.829324	3.0	Circular	CMP	24"	45.0	1.91	Pass
F	38.98193	6.5	Box	Concrete	8 x 4 ft	39.5	1.91	Pass
G	4.064084	8.0	Circular	CMP	30"	87.0	2.92	Pass
H	604.0946	14.0	Box	Concrete	10 x 6 ft	70.0	10.27	Pass
I	2.77633	5.0	Circular	CMP	36"	65.0	2.42	Pass
J	1.290884	3.0	Circular	CMP	24"	54.0	2.62	Pass

Table 3: Proposed Culvert Analysis (Discharge, Dimensions, Allowable HW, Computed HW, Pass/Fail)

Culvert	Inputs						Outputs	
	Discharge (cfs)	Max Allowable HW (ft)	Shape	Material	Size	Length (ft)	Computed HW (ft)	
A	426.6175	8.5	Circular	CMP	78"	52.0	11.69	Fail
B	5.137906	4.0	Circular	CMP	30"	42.5	2.36	Pass
C	2.159898	8.5	Circular	CMP	30"	68.0	2.06	Pass
D	2.697454	3.8	Circular	CMP	24"	57.0	2.42	Pass
E	1.829324	3.0	Circular	CMP	24"	45.0	1.91	Pass
F	38.98193	6.5	Box	Concrete	8 x 4 ft	39.5	1.91	Pass
G	4.064084	8.0	Circular	CMP	30"	87.0	2.92	Pass
H	604.0946	14.0	Box	Concrete	10 x 6 ft	70.0	10.27	Pass
I	2.77633	5.0	Circular	CMP	36"	65.0	2.42	Pass
J	1.290884	3.0	Circular	CMP	24"	54.0	2.62	Pass

As seen in Table 3, Culvert A does not support a 50 year 24 hour storm, based on the “Feasibility Report” [1] and on our calculations. As seen in Table 3, it is recommend for Culvert A to be made a 8’x4’ double barrel box culvert, instead of the current 78 inch CMP.

4.0 Proposed Passing Lane Design

The existing highway design provides a basis in creating the new design to the section that will include the passing lane, turning lanes, and other features that the roadway may have. A Digital Elevation Model (DEM) was downloaded from NRCS USDA for the specific county that the project is located in. A completed DEM file is shown in Appendix R with a SR-64 “Tigerline” layered on top.

Next, the DEM file within ArcGIS was converted into a Civil 3D file, that showed contour line for every 1 meter of elevation change. Once these contours were created, they are inputted into Civil 3D as the base contour map. From this contour map a surface is created for the area of interest, this surface will contain 2 foot minor to 10 foot major contour lines. This surface represents the existing ground surface elevations and slopes for the area, not including the road surface elevations, and is shown in Appendix S.

A “Tigerline” shape file from NRCS USDA was found with the latest centerline census data and was placed over the surface created. The alignment tool is now used within Civil 3D and is traced over the “Tigerline” that was previously inputted. A profile is now created using the alignment created and the contours acting as a base profile for the overall file. A new profile is now created over the existing one that includes the road surface elevations taken from the “Feasibility Study” [1].

An assembly for each part of the roadway was created with the “Assembly” tool and includes the pavement thickness, subbase, shoulders, and cut slopes. A typical assembly was first created which is used for the roadway segments between intersections. Two “entering” assemblies were then created and used where the roadway enters the intersections at Howard Mesa Rd. and Cinder Pit. Another two “leaving” assemblies were created for and used where the roadway is exiting these two intersections.

A corridor for the roadway can now be created using the assemblies and profile using the “Corridor” tool within Civil 3D. Since there are a total of five different assemblies, five different corridors were created and connected together. The corridor were used to calculate the cut and fill volume that the roadway is creating when traversing the landscape, as well as being used to obtain the cross section views needed at specific points along the roadway. One such example of these cross sections can be seen below in Figure 4. With these complete, a plan set can be produced showing the plan and profile views, along with the cross sections for every 1+00 station. The completed surface, alignment and corridor can be seen in Appendix T.

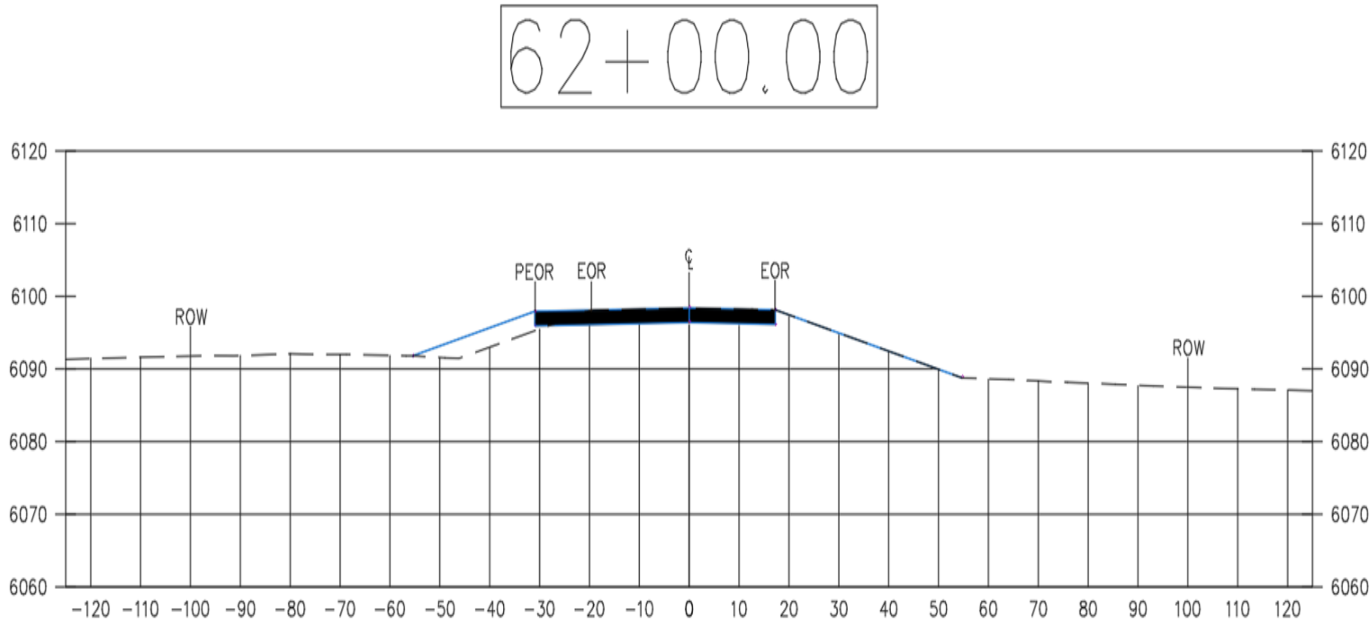


Figure 4: Civil 3D generated Station 62+00 Cross-Section/ Road Centerline, Right of Way, Edge of Shoulder, with Existing Edge of Road, and Proposed Edge of Road

5.0 Traffic Control Plan

The traffic control plan will consist of several items such as a Temporary Concrete Barrier, Barricades, Portable Sign Stand, Warning Lights, Embedded Sign Post, Changeable Message Board, a Pilot Vehicle with Driver and Flagging Services, Table 4 illustrates the total for each item, as well as whether the total is in linear feet per day, quantity or working hours. The sequence of the passing lane construction can be seen in Table 5, where the entire construction phase is divided into 8 activities. Activity 1 will consist of mobilization, signage and the barrier setup, while activity 2 will consist of clearing and grubbing, activity 3 shall perform the culvert extension of culvert B-J and the replacement of culvert A, as well as the rough grade of the road. Activity 4 will pertain to the placement of the Aggregate Base Course (ABC) subgrade, while activity 5 will consist of the final grade, with activity 6 performing Asphalt Aggregate Course Placement. Activity 7 will place signage and stripping, while activity 8 will be demobilization, removal of temporary signage and barriers. Each activity will refer to Traffic Control plan shown in the Detailed SA-3 Traffic Plan, which is located in Appendix U. Each activity will also have any corresponding comments with further activities that are considered important. The Traffic Control Plan will be used for a 141 working days.

Table 4: Traffic Control Plan Equipment Quantities

ITEM #	APPROXIMATE TRAFFIC CONTROL QUANTITIES									UNIT	TOTAL
	ITEM	ACTIVITY NUMBER									
		1	2	3	4	5	6	7	8		
	ESTIMATED DAYS IN USE	3	30	50	15	16	65	16	3		
7016020	Temporary Concrete Barrier (In Use)	34080	340800	681600	85200	170400	937200	119280	34080	LF-Day	2402640
7016031	Barricade (Type III, High Level Flag Trees)	4	40	80	10	20	110	14	4	EA-Day	282
7016032	Portable Sign Stand (Rigid)	20	200	400	50	100	550	70	20	EA-Day	1410
7016035	Warning Lights (Type A)	150	1500	3000	375	750	4125	525	150	EA-Day	10575
7016039	Embedded Sign Post	4	40	80	10	20	110	14	4	EA-Day	282
7016067	Changeable Message Board	6	60	100	30	32	130	32	6	EA-Day	396
7016071	Pilot Vehicle With Driver	72	720	1200	360	384	1560	384	72	Hour	4752
7016075	Flagging Services (Civilian)	72	720	1200	360	384	1560	384	72	Hour	4752

Table 5: Sequence of Passing Lane Construction

MAINTENANCE OF CONSTRUCTION SEQUENCE			
ACTIVITY NUMBER	CONSTRUCTION ACTIVITY	TRAFFIC CONTROL	COMMENTS
1	Mobilization, signage and barrier setup	Traffic Control as shown in Detailed SA-3 Traffic Plan	Sings are to be placed on embedded posts for the duration of the project
2	Clearing and Grubbing	Traffic Control as shown in Detailed SA-3 Traffic Plan	This activity will have to be started early, to ensure that at least on lane is open to traffic. Contractor shall maintain traffic control during night
3	Culvert Extension/Replacement, Rough Grade (Cut and Fill)	Traffic Control as shown in Detailed SA-3 Traffic Plan	The Contractor shall maintain at least one lane of traffic at all times
4	Placement of ABC Subgrade	Traffic Control as shown in Detailed SA-3 Traffic Plan	The Contractor shall maintain at least one lane of traffic at all times
5	Final Grade (ABC)	Traffic Control as shown in Detailed SA-3 Traffic Plan	The Contractor shall maintain at least one lane of traffic at all times
6	AC Placement (Asphaltic Concrete)	Traffic Control as shown in Detailed SA-3 Traffic Plan	The Contractor shall maintain at least one lane of traffic at all times
7	Signage and Stripping	Traffic Control as shown in Detailed SA-3 Traffic Plan	The Contractor shall maintain at least one lane of traffic at all times
8	Demobilization, Removal of signage and barriers	Traffic Control as shown in Detailed SA-3 Traffic Plan	The contractor is responsible for the proper removal of signs

6.0 Cost of Implementing the Design

The cost of implementing the project takes into consideration the cost of materials, along with labor and heavy machinery hours. The prices were initially gather from a 2008 report given by the client, these prices were adjusted at 8% per year inflation in order to reflect today's prices, Appendix V represents the original pricing sheet. Clearing and grubbing of the surrounding area will be done to eliminate any composing material that will cause unwanted compaction of the road, the shoulder of the existing roadway will also be removed as it contains the rumble strip. Per seen in Table 5, due to the different prices per ton of the aggregate base, bituminous tack coat, asphalt binder, and the asphaltic concrete, these materials will be separated into different categories. Due to the different sizes in corrugated metal pipes (CMP), each pipe will have its own category, as a result we will have three 24” CMP, three 30 and only one 36” and 78” pipe. Structural concrete will also be needed to extend the two box culverts found on the site to fit the addition of the passing lane.

Additional materials will include, 215 Type II Barricades which will be needed to cover the entire length of the construction job, for a total of 198 days that will be priced on a per day basis. There will also be a need for two Type III Barricades for the same amount of days. 18 portable stands will be used to slow down driver approaching the construction site. Two traffic control lights will be used instead of flaggers, allowing for the project to control traffic easily, as well as during the night, these can be found in Table 6 under the warning lights section.

Recessed pavement markers will be used in order to avoid snow plow damage. Each marker is to be placed twenty feet apart, which results in 792 markers for the project. A striping line will be painted on the finished roadway delineating the two lanes from one another, as well as a solid white line being added to separate the lane from the shoulder, these two lines can be found under the permanent pavement marking section in Table 6. A lump sum will be given to the contractor for quality control and construction surveying and layout. A price for crack sealant was also added to Table 6, to represent the need to fix cracks within the roadway. Lastly, a new eight-inch wide rumble strip will be implemented to the 3 mile passing lane. In Table 6, each quantity is multiplied by the adjusted unit price, this can be seen in the “Amount” column, each item cost amount is then added up, giving us a total price for materials.

Table 6: Cost of Passing Lane Implementation

	Item Description	Unit	Planned Qty.	Unit Price (2008)	Unit Price (2019)	Amount
2010011	Clearing and Grubbing	ACRE	18	$ 1,600	$ 3,731	$67,833
2020038	Removal of Asphaltic Concrete Pavement	CU. YD.	5867	$ 4	$ 9	$54,724
3030022	Aggregate Base, Class 2	CU. YD.	16427	$ 45	$ 105	$1,723,815
4040111	Bituminous Tack Coat	TON	20	$ 450	$ 1,049	$20,988
4040116	Apply Bituminous Tack Coat	HOUR	50	$ 140	$ 326	$16,324
4040264	Asphalt Binder (PG 64-22)	TON	307	$ 550	$ 1,283	$393,758
4160004	Asphaltic Concrete (3/4" Mix) (End Product)	TON	10980	$ 43	$ 100	$1,101,030
5010011	CMP, 24"	L. FT.	74	$ 75	$ 175	$13,004
5010017	CMP, 30"	L. FT.	81	$ 85	$ 198	$16,119
5010019	CMP, 36"	L. FT.	22	$ 95	$ 222	$4,896
2030301	Roadway Excavation	CU. YD.	2000	$ 15	$ 35	$69,960
6010002	Structural Concrete (Class S)	CU. YD.	28	$ 650	$ 1,516	$42,670
7016020	Temporary Concrete Barrier (In Use)	LF-DAY	2402640	$ 0.20	$ 0.47	$1,120,591
7016031	Barricade (Type III, High Level Flag Trees)	EACH-DAY	282	$ 1	$ 2	$658
7016032	Portable Sign Stands (Rigid)	EACH-DAY	1410	$ 1	$ 2	$3,288
7016035	Warning Lights (Type A)	EACH-DAY	10575	$ 0.25	$ 1	$6,165
7016039	Embedded Sign Post	EACH-DAY	282	$ 0.15	$ 0.35	$99
7016067	Changeable Message Board	EACH-DAY	396	$ 25	$ 58	$23,087
7016071	Pilot Vehicle with Driver	HOUR	4752	$ 40	$ 93	$443,267
7016075	Flagging Services (Civilian)	HOUR	4752	$ 22	$ 51	$243,797
7060101	Pavement Marker, Recessed, Type D	EACH	792	$ 5	$ 12	$9,235
7080001	Permanent Pavement Marking (Painted)	L. FT.	17040	$ 0.15	$ 0.35	$5,961
9240170	Contractor Quality Control	L. SUM		$ 49,000	$ 114,268	$114,268
9240183	Miscellaneous Work (Seal Cracks)	LB.	350	$ 3	$ 6	$2,041
9250001	Construction Surveying and Layout	L. SUM		$ 34,000	$ 79,288	$79,288
-------	Embankment	CU.YD.	28000	$ 19	$ 45	$1,260,000
9280036	Ground-In Rumble Strip (8 in.)	L. FT.	17040	$ 0.20	$ 0.47	$7,947
					Total Price	**$6,844,812**
	Construction Engineering	% of Total	--------	--------	14	$958,274
	Construction Design Services	% of Total	--------	--------	1	$68,448
	Contingency	% of Total	--------	--------	5	$342,241
					Total Project Cost	**$8,213,774**

7.0 Summary of Engineering Work

Due to weather and team scheduling, the initial start of the project was pushed back two weeks as can be seen in Appendix C (Original Schedule) and Appendix D (Updated Schedule). An initial miscommunication between the client and capstone team resulted in a push back of the schedule for the geotechnical analysis portion of the requirements in order to organize insurance from NAU, implement traffic control plans, and receive paperwork from ADOT. After discussion the geotechnical and structural portion of the plans were discarded, resulting in the schedule returning to its normal state. Appendix C shows the original schedule and Appendix D shows the updated schedule after geotechnical analysis and soil sampling was removed.

Located in Appendix D, the duration for the hydrology and hydraulics portion of the project was faster than expected. Appendix C shows the whole section taking 30 working week days, but with Appendix D it can be seen that it only took 10 working week days to complete due to working on weekends and longer hours during each day. Shown in Table 7 is the initial estimated staffing hours dedicated to the project, Table 8 is the updated staffing hours dedicated to the project.

Table 7: Old Staffing Plan

	STAFF (hours)				
Task Name	Project Manager	Senior Engineer	Engineer Step I	Drafter	Task Total
1 Site Assessment	30	30	20	32	112
2 Hydrology and Hydraulics Analysis	0	12	18	24	54
3 Geotechnical Analysis	0	35	45	0	80
4.0 Highway Design	26	21	29	50	126
5 Traffic Control Plan	36	0	0	0	36
6 Design Plan Sets	102	106	88	88	384
6.1 Face Sheet	8	4	4	12	28
6.2 Roadway Sections Plan Sheets	0	10	10	10	30
6.3 Existing Conditions Plan Sheets	0	10	10	10	30
6.4 Roadway Construction Plan Sheets	0	10	10	10	30
6.5 Drainage Plan Sheets	0	10	20	20	50
6.6 SWPPP Sheet	0	10	0	10	20
6.7 Traffic Control Plan Sheets	2	12	6	16	36
6.8 Cost Estimate Report Sheet	92	40	28	0	160
7 Project Management	47	45	55	47	194
STAFF TOTAL	194	204	200	241	839

Table 8: Current Staffing Plan

	STAFF (hours)				Task Total
Task Name	Project Manager	Senior Engineer	Engineer Step I	Drafter	
1 Site Assessment	11	13	14	12	50
1.1 Road Condition Assessment	5	6	6	5	22
1.1.1 Asphalt Condition	3	4	4	3	14
1.1.2 Shoulder Condition	2	2	2	2	8
1.2 Drainage Condition Assessment	6	7	8	7	28
1.2.1 Culvert Condition and Location	3	3	4	3	13
1.2.2 Wash Integrity	3	4	4	4	15
2 Hydrology and Hydraulics Analysis	12	17	24	23	76
2.1 Map Culverts	4	6	7	10	27
2.2 Aquire Existing Contour Maps	4	4	6	8	22
2.3 Drainage Analysis	4	7	11	5	27
3 Highway Design	15	22	24	52	113
3.1 Cross Sections	10	15	15	45	85
3.2 Extension of Existing Drainage Structures	5	7	9	7	28
4 Traffic Control Plan	8	13	12	10	43
4.1 Phasing	3	4	5	5.5	17.5
4.2 Quantities	3	4	4	2.5	13.5
4.3 Duration	2	5	3	2	12
5 Design Plan Sets	86	107	87	143	423
5.1 Face Sheet	3	4	3	8	18
5.2 Roadway Sections Plan Sheets	7	7	6	20	40
5.3 Existing Conditions Plan Sheets	5	6	6	18	35
5.4 Structural Plan Sheets	7	7	10	9	33
5.5 Drainage Plan Sheets	8	8	5	16	37
5.6 Traffic Control Plan Sheets	5	6	5	16	32
5.7 Cost Estimate Report Sheet	51	69	52	56	228
5.8 Scoping	6	9	10	8	33
5.8.1 Work Plan	6	9	10	8	33
5.9 Preliminary Engineering Design	14	18	21	25	78
5.9.1 Plan Sheets	7	7	5	16	35
5.9.2 Geotechnical Investigation	2	3	6	3	14
5.9.3 Drainage Report	5	8	10	6	29
5.10 Construction Implementation	14	24	13	13	64
5.10.1 Site Obstruction Removal	6	7	4	5	22
5.10.2 Excavation, Backfill, Embankment	3	9	4	4	20
5.10.3 Construction	5	8	5	4	22
5.11 Mobilization and Administration Costs	17	18	8	10	53
5.11.1 Contractor Mobilization	5	6	2	2	15
5.11.2 Traffic Control	5	7	3	5	20
5.11.3 Administrative	7	5	3	3	18
6 Project Management	20	20	20	20	80
STAFF TOTAL	152	192	181	260	**785**

8.0 Summary of Engineering Costs

The engineering costs for the project is based on the amount of hours that the staff worked on the project as well as benefits and profit percent for each employee. Table 9 represents the breakdown of billing rates for each staff member. Table 10 represents the total estimated amount of hours for each employee, along with each employee's cost per hour, giving the total cost for each employee involved with the project and the total engineering cost. Table 11 represents the total amount of hours for each employee, along with each employee's cost per hour, giving the total cost for each employee involved with the project and the total engineering cost.

Table 9: Billing Rates of Staff involved with the project

Billing Rates				
Staff	Cost per Hour	Benefits (%)	Profit (%)	Cost Per Hour
Project Manager	$ 129	30	10	$ 181
Senior Engineer	$ 80	30	10	$ 112
Engineer Step I	$ 24	30	10	$ 34
Drafter	$ 26	30	10	$ 36

Table 10: Initial Cost Estimate for Staff Members/Total Hours

Billable Services			
Staff	Hours	Cost per Hour	Cost Per Staff
Project Manager	194	$ 181	$ 35,114
Senior Engineer	204	$ 112	$ 22,848
Engineer Step I	200	$ 34	$ 6,800
Drafter	241	$ 36	$ 8,676
Totals	**839**	**-----**	**$ 73,438**

Table 11: Final Cost for Staff Members/Total Hours

Billable Services			
Staff	Hours	Cost per Hour	Cost Per Staff
Project Manager	152	$ 181	$ 27,512
Senior Engineer	192	$ 112	$ 21,504
Engineer Step I	181	$ 34	$ 6,154
Drafter	260	$ 36	$ 9,360
Totals	**785**	**-----**	**$ 64,530**

9.0 Impacts

SR-64 Passing Lane Addition analyzed that by adding a passing lane between mile markers 201 and 204, there will be a improve in the road safety and a reduction of crashes from the 0 to 0.35 crashes per million vehicle miles traveled that happen within these mile markers, it will also eliminate the need to cross into the upcoming traffic to bypass slower traffic. With the addition of the lane resulting in fewer crashes, there will also be a reduction in police crash reports, emergency vehicle responses, as well as a cutback in road cleaning and fixing. All of this was done with goal of reducing travel time between Grand Canyon Village, AZ and Williams, AZ.

10.0 Conclusion

SR-64 Passing Lane Addition excluded a Geotechnical Analysis, Surveying and a new Culvert Design at the request of the client. The Hydrology and Hydraulics portion of the analysis demonstrated that Culvert A will need to be rebuilt at the beginning of the construction of the passing lane, from a 78” CMP culvert to a 8’x4’ double barrel concrete culvert. Total cost for implementation of the passing lane was estimated to be $8,213,774.00, with the project duration being 198 days, with 148 working days. Finally, please refer to the pages 1-33 of exiting conditions and proposed plans that are located within the SR-64 Capstone Plan Sheets.

11.0 References

[1] Engineering, Jacobs, "Final Feasibility Report State Route 64: I-40 to Moqui Williams - Grand Canyon - Cameron Highway," Arizona Department of Transportation, Phoenix, Arizona , March 2006.

[2] Arizona Right of Way Divison, "Arizona Department of Transportatin," 6 June 1946. [Online]. Available: https://www.azdot.gov/files/ROW/Plans/State_Route_64/3-T-291.pdf. [Accessed February 2019].

[3] JE Fuller Hydrology and Geomorphology Inc., "AZ Department of Transportation," January 2014. [Online]. Available: https://www.azdot.gov/docs/default-source/roadway-engineering-library/2014_adot_hydrology_manual.pdf?sfvrsn=6. [Accessed 8 February 2019].

[4] Division, Conservation Engineering, "Urban Hydrology for Small Watersheds TR-55," United States Department of Agriculture, June 1986.

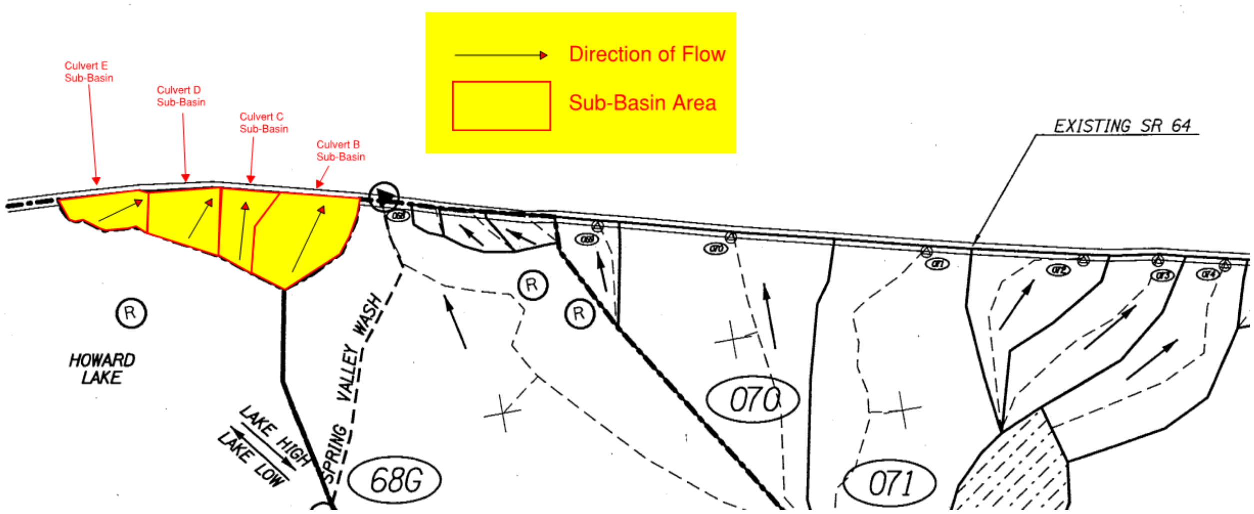
[5] National Oceanic and Atmospheric Administration, "NOAA Atlas 14 Point Precipitation Frequency Estimates: KS," 21 April 2017. [Online]. Available: https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html. [Accessed 9 March 2019].

[6] Arizona Department of Transportation, "ARIZONA DEPARTMENT OF TRANSPORTATION," May 2014. [Online]. Available: https://www.azdot.gov/docs/default-source/business/roadway-design-guidelines.pdf?sfvrsn=8. [Accessed 8 February 2019].

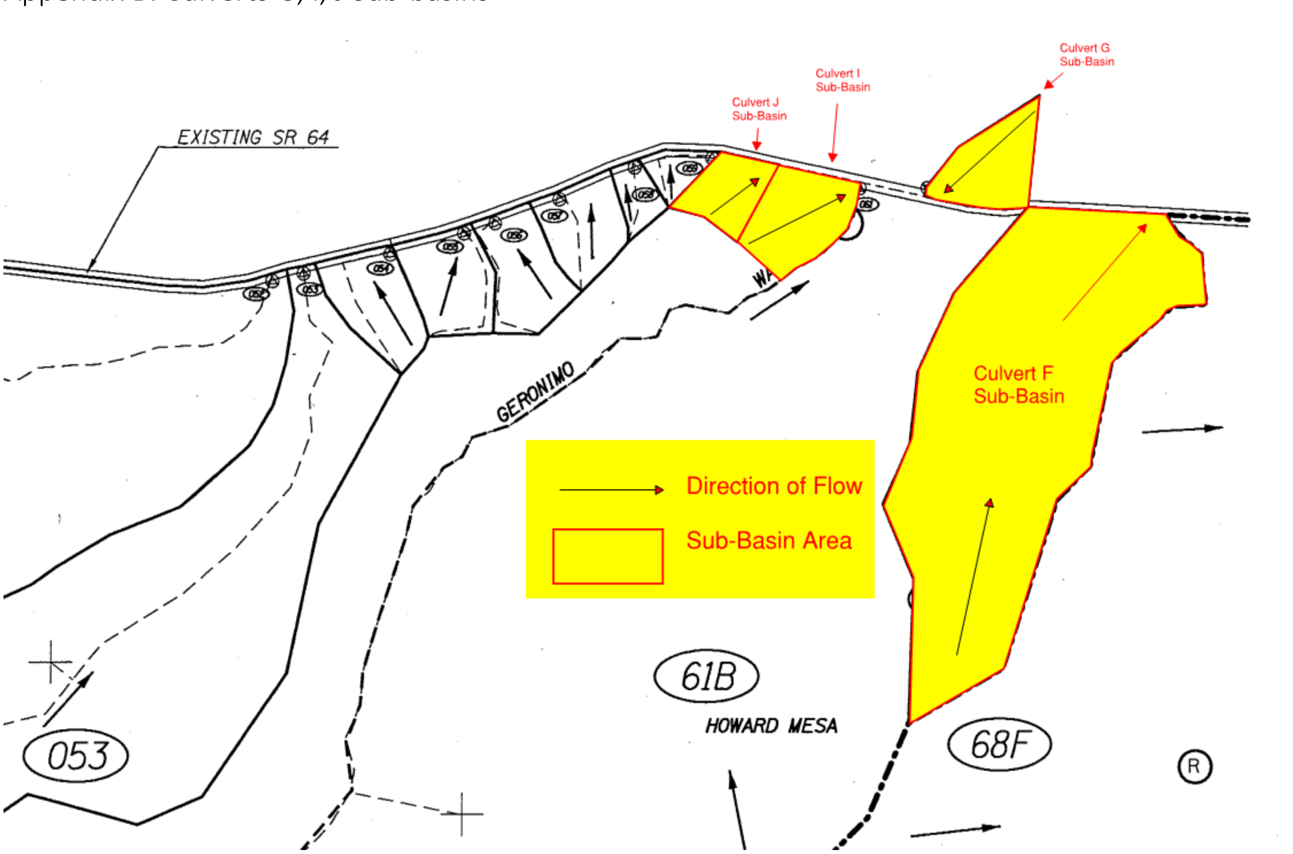
[7] A. D. O. TRANSPORTATION, "TRAFFIC CONTROL DESIGN GUIDELINES 2010," ADOT, 2011.

12.0 Appendices

Appendix A: Culverts B-E Sub-basins

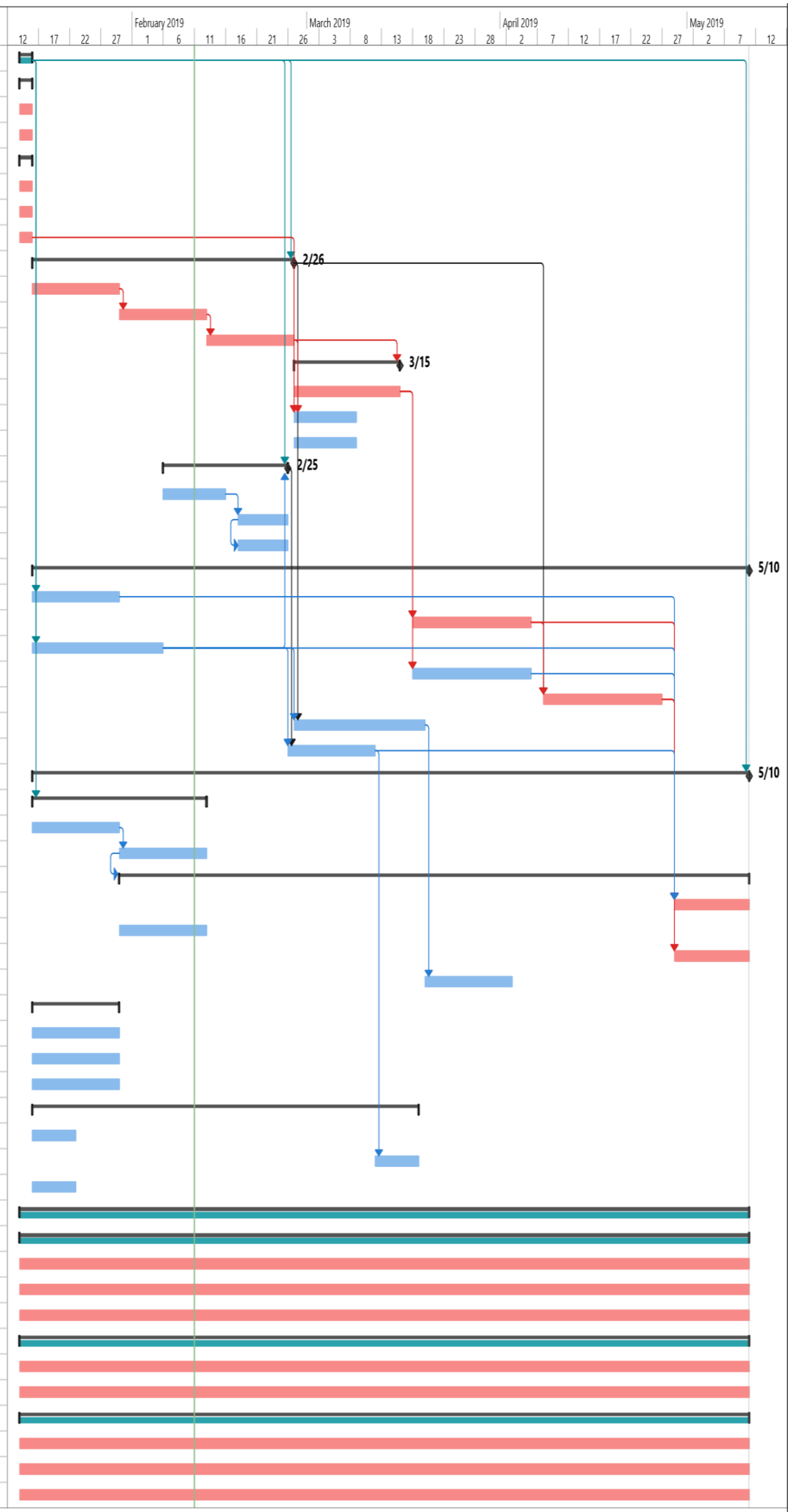


Appendix B: Culverts G, I, J Sub-basins



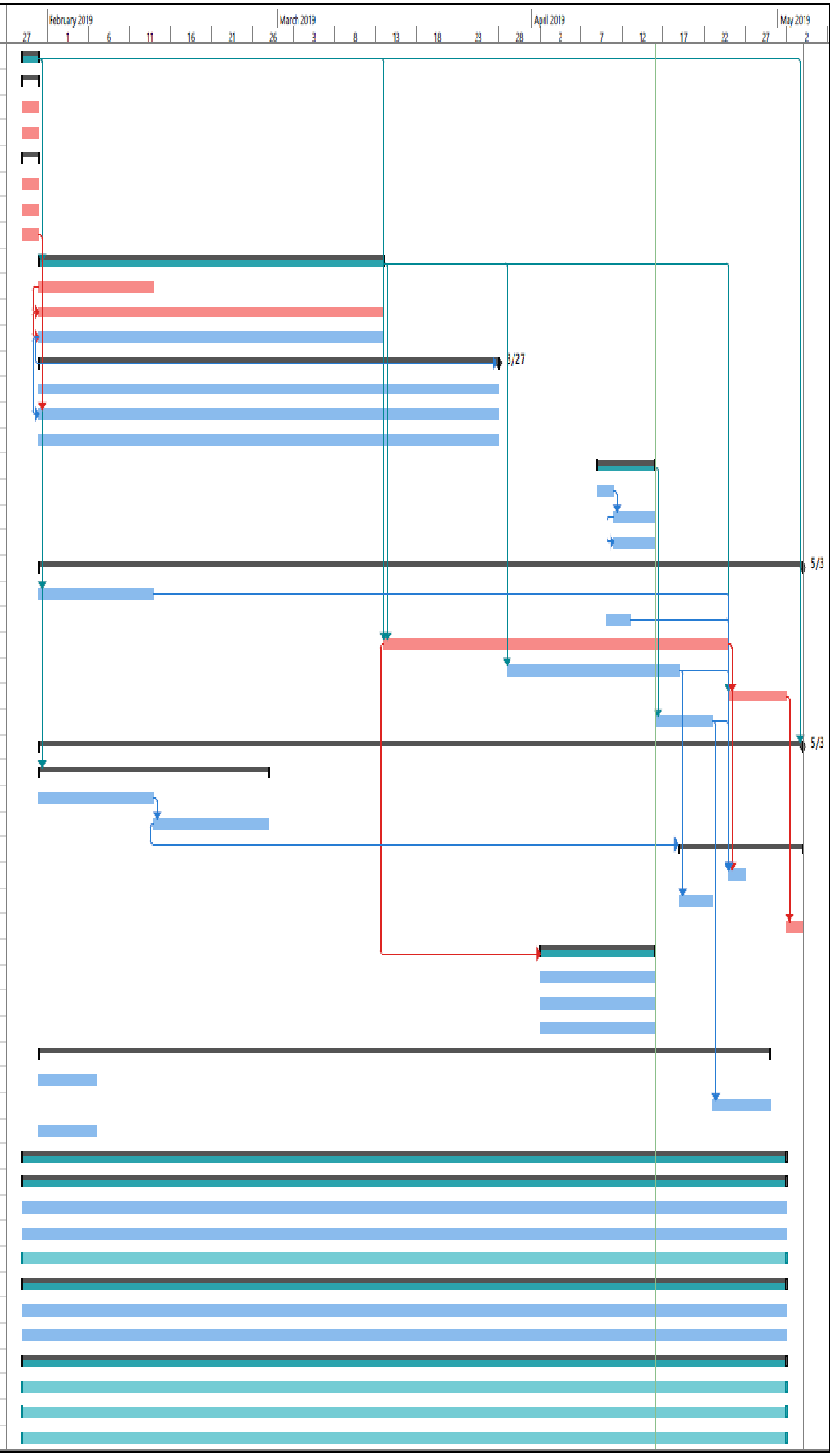
Appendix C: Original Project Schedule

ID	Task Name	Duration	Start	Finish
1	1 Site Assessment	2 days	Mon 1/14/19	Tue 1/15/19
2	1.1 Road Condition Assessment	2 days	Mon 1/14/19	Tue 1/15/19
3	1.1.1 Asphalt Condition	2 days	Mon 1/14/19	Tue 1/15/19
4	1.1.2 Shoulder Condition	2 days	Mon 1/14/19	Tue 1/15/19
5	1.2 Drainage Condition Assessment	2 days	Mon 1/14/19	Tue 1/15/19
6	1.2.1 Culvert Condition and Location	2 days	Mon 1/14/19	Tue 1/15/19
7	1.2.2 Wash Integrity	2 days	Mon 1/14/19	Tue 1/15/19
8	1.3 Right of Way Assessment	2 days	Mon 1/14/19	Tue 1/15/19
9	2 Hydrology and Hydraulics Analysis	30 days	Wed 1/16/19	Tue 2/26/19
10	2.1 Map Culverts	10 days	Wed 1/16/19	Tue 1/29/19
11	2.2 Hydrology	10 days	Wed 1/30/19	Tue 2/12/19
12	2.3 Hydraulics	10 days	Wed 2/13/19	Tue 2/26/19
13	3 Highway Design	13 days	Wed 2/27/19	Fri 3/15/19
14	3.1 Cross Sections	13 days	Wed 2/27/19	Fri 3/15/19
15	3.2 Plan View	8 days	Wed 2/27/19	Fri 3/8/19
16	3.3 Profile View	8 days	Wed 2/27/19	Fri 3/8/19
17	4 Traffic Control Plan	14 days	Wed 2/6/19	Mon 2/25/19
18	4.1 Phasing	8 days	Wed 2/6/19	Fri 2/15/19
19	4.2 Quantities	6 days	Mon 2/18/19	Mon 2/25/19
20	4.3 Duration	6 days	Mon 2/18/19	Mon 2/25/19
21	5 Design Plan Sets	83 days	Wed 1/16/19	Fri 5/10/19
22	5.1 Face Sheet	10 days	Wed 1/16/19	Tue 1/29/19
23	5.2 Roadway Sections Plan Sheets	15 days	Mon 3/18/19	Fri 4/5/19
24	5.3 Existing Conditions Plan Sheets	15 days	Wed 1/16/19	Tue 2/5/19
25	5.4 Structural Plan Sheets	15 days	Mon 3/18/19	Fri 4/5/19
26	5.5 Drainage Plan Sheets	15 days	Mon 4/8/19	Fri 4/26/19
27	5.6 SWPPP Sheet	15 days	Wed 2/27/19	Tue 3/19/19
28	5.7 Traffic Control Plan Sheets	10 days	Tue 2/26/19	Mon 3/11/19
29	5.8 Cost Estimate Report Sheet	83 days	Wed 1/16/19	Fri 5/10/19
30	6.8.1 Scoping	20 days	Wed 1/16/19	Tue 2/12/19
31	6.8.1.1 Survey	10 days	Wed 1/16/19	Tue 1/29/19
32	6.8.1.2 Work Plan	10 days	Wed 1/30/19	Tue 2/12/19
33	6.8.2 Preliminary Engineering Design	73 days	Wed 1/30/19	Fri 5/10/19
34	6.8.2.1 Plan Sheets	10 days	Mon 4/29/19	Fri 5/10/19
35	6.8.2.2 Geotechnical Investigation	10 days	Wed 1/30/19	Tue 2/12/19
36	6.8.2.3 Drainage Report	10 days	Mon 4/29/19	Fri 5/10/19
37	6.8.2.4 SWPPP	10 days	Wed 3/20/19	Tue 4/2/19
38	6.8.3 Construction Implementation	10 days	Wed 1/16/19	Tue 1/29/19
39	6.8.3.1 Site Obstruction Removal	10 days	Wed 1/16/19	Tue 1/29/19
40	6.8.3.2 Excavation, Backfill, Embankment	10 days	Wed 1/16/19	Tue 1/29/19
41	6.8.3.3 Construction	10 days	Wed 1/16/19	Tue 1/29/19
42	6.8.4 Mobilization and Administration Costs	44 days	Wed 1/16/19	Mon 3/18/19
43	6.8.4.1 Contractor Mobilization	5 days	Wed 1/16/19	Tue 1/22/19
44	6.8.4.2 Traffic Control	5 days	Tue 3/12/19	Mon 3/18/19
45	6.8.4.3 Administrative	5 days	Wed 1/16/19	Tue 1/22/19
46	7 Project Management	85 days	Mon 1/14/19	Fri 5/10/19
47	**7.1 Project Meetings**	**85 days**	**Mon 1/14/19**	**Fri 5/10/19**
48	7.1.1 Client Meetings	85 days	Mon 1/14/19	Fri 5/10/19
49	7.1.2 Team Meetings	85 days	Mon 1/14/19	Fri 5/10/19
50	7.2 Deliverables	85 days	Mon 1/14/19	Fri 5/10/19
51	**7.3 Documentation**	**85 days**	**Mon 1/14/19**	**Fri 5/10/19**
52	7.3.1 Meetings	85 days	Mon 1/14/19	Fri 5/10/19
53	7.3.2 Hours	85 days	Mon 1/14/19	Fri 5/10/19
54	**7.4 Manage Resources**	**85 days**	**Mon 1/14/19**	**Fri 5/10/19**
55	7.4.1 Equipment	85 days	Mon 1/14/19	Fri 5/10/19
56	7.4.2 Materials	85 days	Mon 1/14/19	Fri 5/10/19
57	7.4.3 Transportation	85 days	Mon 1/14/19	Fri 5/10/19

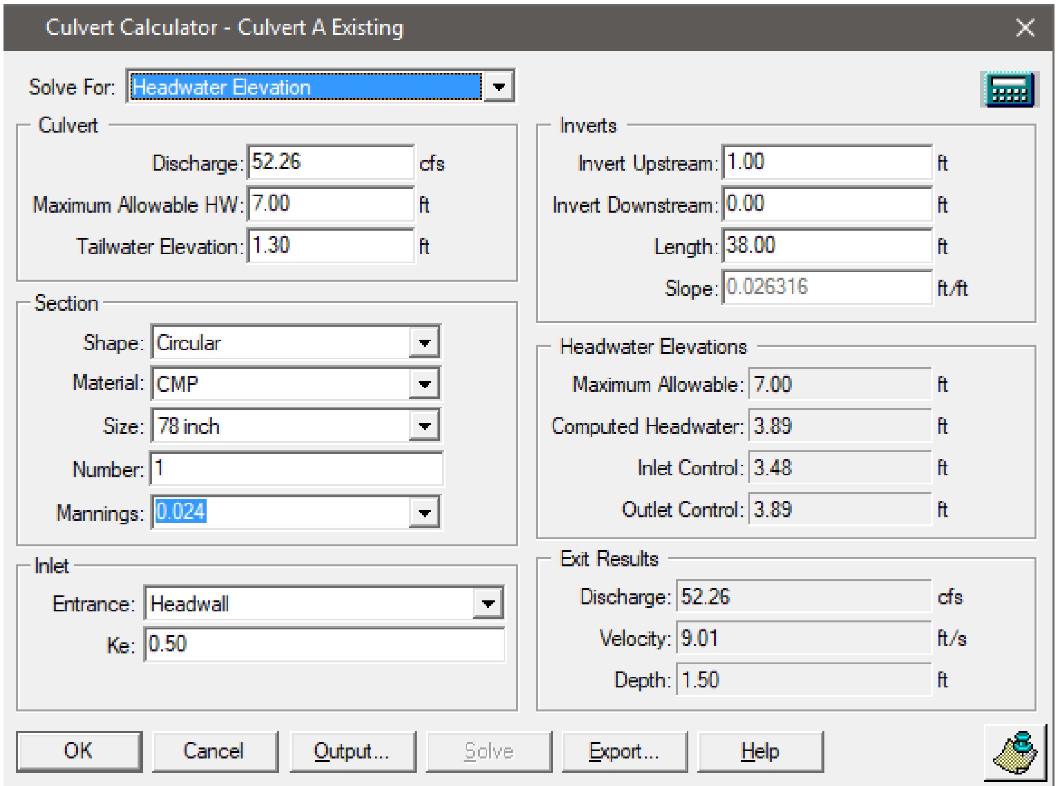


Appendix D: Current Project Schedule

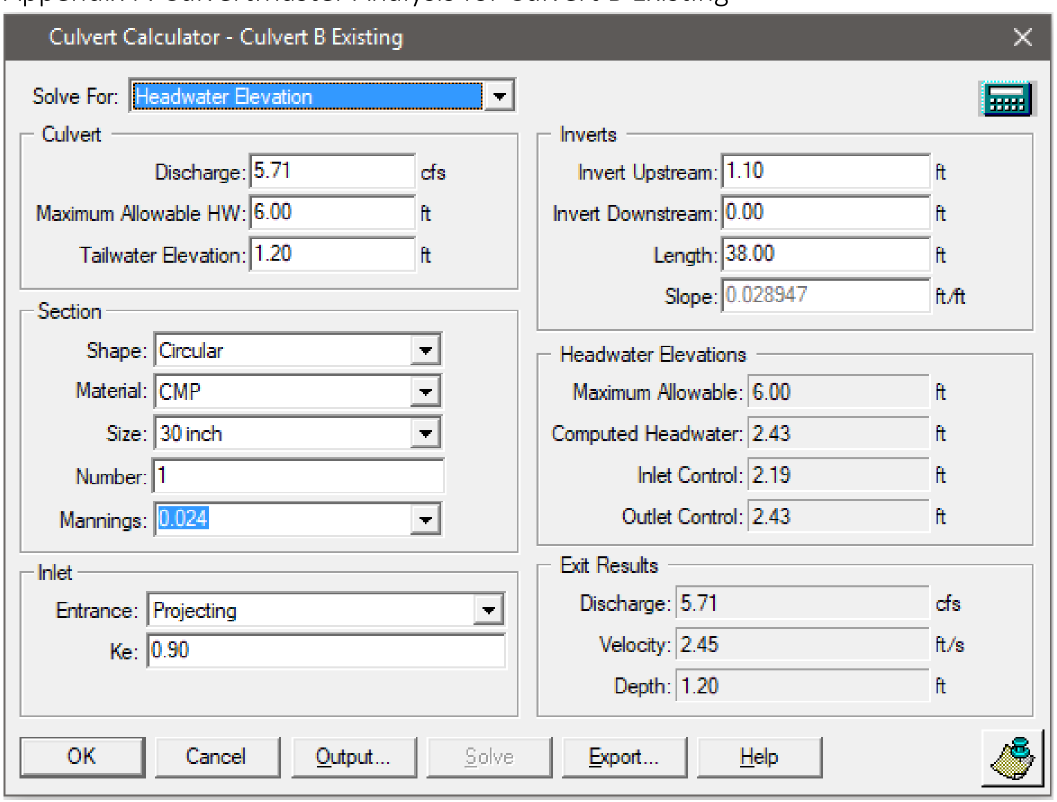
Task Name	Duration	Start	Finish
1 Site Assessment	2 days	Tue 1/29/19	Wed 1/30/19
1.1 Road Condition Assessment	2 days	Tue 1/29/19	Wed 1/30/19
1.1.1 Asphalt Condition	2 days	Tue 1/29/19	Wed 1/30/19
1.1.2 Shoulder Condition	2 days	Tue 1/29/19	Wed 1/30/19
1.2 Drainage Condition Assessment	2 days	Tue 1/29/19	Wed 1/30/19
1.2.1 Culvert Condition and Location	2 days	Tue 1/29/19	Wed 1/30/19
1.2.2 Wash Integrity	2 days	Tue 1/29/19	Wed 1/30/19
1.3 Right of Way Assessment	2 days	Tue 1/29/19	Wed 1/30/19
2 Hydrology and Hydraulics Analysis	30 days	Thu 1/31/19	Wed 3/13/19
2.1 Map Culverts	10 days	Thu 1/31/19	Wed 2/13/19
2.2 Hydrology	30 days	Thu 1/31/19	Wed 3/13/19
2.3 Hydraulics	30 days	Thu 1/31/19	Wed 3/13/19
3 Highway Design	40 days	Thu 1/31/19	Wed 3/27/19
3.1 Cross Sections	40 days	Thu 1/31/19	Wed 3/27/19
3.2 Plan View	40 days	Thu 1/31/19	Wed 3/27/19
3.3 Profile View	40 days	Thu 1/31/19	Wed 3/27/19
4 Traffic Control Plan	5 days	Tue 4/9/19	Mon 4/15/19
4.1 Phasing	2 days	Tue 4/9/19	Wed 4/10/19
4.2 Quantities	3 days	Thu 4/11/19	Mon 4/15/19
4.3 Duration	3 days	Thu 4/11/19	Mon 4/15/19
5 Design Plan Sets	67 days	Thu 1/31/19	Fri 5/3/19
5.1 Face Sheet	10 days	Thu 1/31/19	Wed 2/13/19
5.2 Roadway Sections Plan Sheets	3 days	Wed 4/10/19	Fri 4/12/19
5.3 Existing Conditions Plan Sheets	30 days	Thu 3/14/19	Wed 4/24/19
5.5 Drainage Plan Sheets	15 days	Fri 3/29/19	Thu 4/18/19
5.6 SWPPP Sheet	5 days	Thu 4/25/19	Wed 5/1/19
5.7 Traffic Control Plan Sheets	5 days	Tue 4/16/19	Mon 4/22/19
5.8 Cost Estimate Report Sheet	67 days	Thu 1/31/19	Fri 5/3/19
5.8.1 Scoping	20 days	Thu 1/31/19	Wed 2/27/19
5.8.1.1 Survey	10 days	Thu 1/31/19	Wed 2/13/19
5.8.1.2 Work Plan	10 days	Thu 2/14/19	Wed 2/27/19
5.8.2 Preliminary Engineering Design	11 days	Fri 4/19/19	Fri 5/3/19
5.8.2.1 Plan Sheets	2 days	Thu 4/25/19	Fri 4/26/19
5.8.2.2 Drainage Report	2 days	Fri 4/19/19	Mon 4/22/19
5.8.2.3 SWPPP	2 days	Thu 5/2/19	Fri 5/3/19
5.8.3 Construction Implementation	10 days	Tue 4/2/19	Mon 4/15/19
5.8.3.1 Site Obstruction Removal	10 days	Tue 4/2/19	Mon 4/15/19
5.8.3.2 Excavation, Backfill, Embankment	10 days	Tue 4/2/19	Mon 4/15/19
5.8.3.3 Construction	10 days	Tue 4/2/19	Mon 4/15/19
5.8.4 Mobilization and Administration Costs	63 days	Thu 1/31/19	Mon 4/29/19
5.8.4.1 Contractor Mobilization	5 days	Thu 1/31/19	Wed 2/6/19
5.8.4.2 Traffic Control	5 days	Tue 4/23/19	Mon 4/29/19
5.8.4.3 Administrative	5 days	Thu 1/31/19	Wed 2/6/19
6 Project Management	67 days	Tue 1/29/19	Wed 5/1/19
6.1 Project Meetings	67 days	Tue 1/29/19	Wed 5/1/19
6.1.1 Client Meetings	67 days	Tue 1/29/19	Wed 5/1/19
6.1.2 Team Meetings	67 days	Tue 1/29/19	Wed 5/1/19
6.2 Deliverables	67 days	Tue 1/29/19	Wed 5/1/19
6.3 Documentation	67 days	Tue 1/29/19	Wed 5/1/19
6.3.1 Meetings	67 days	Tue 1/29/19	Wed 5/1/19
6.3.2 Hours	67 days	Tue 1/29/19	Wed 5/1/19
6.4 Manage Resources	67 days	Tue 1/29/19	Wed 5/1/19
6.4.1 Equipment	67 days	Tue 1/29/19	Wed 5/1/19
6.4.2 Materials	67 days	Tue 1/29/19	Wed 5/1/19
6.4.3 Transportation	67 days	Tue 1/29/19	Wed 5/1/19



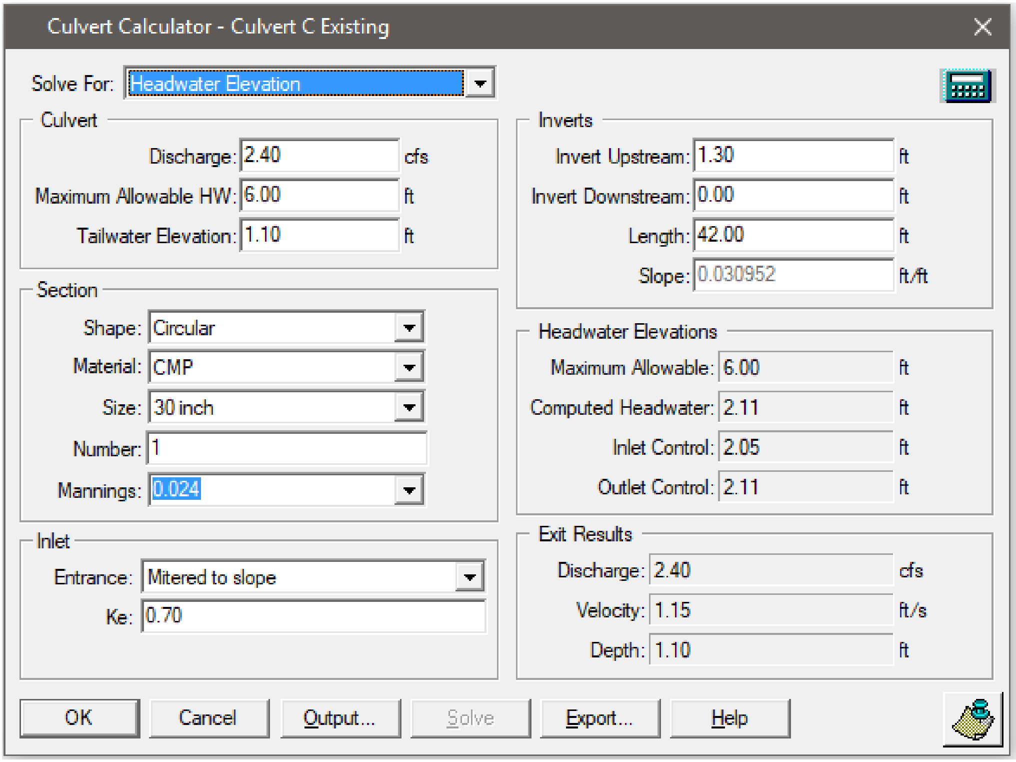
Appendix E: CulvertMaster Analysis for Culvert A Existing



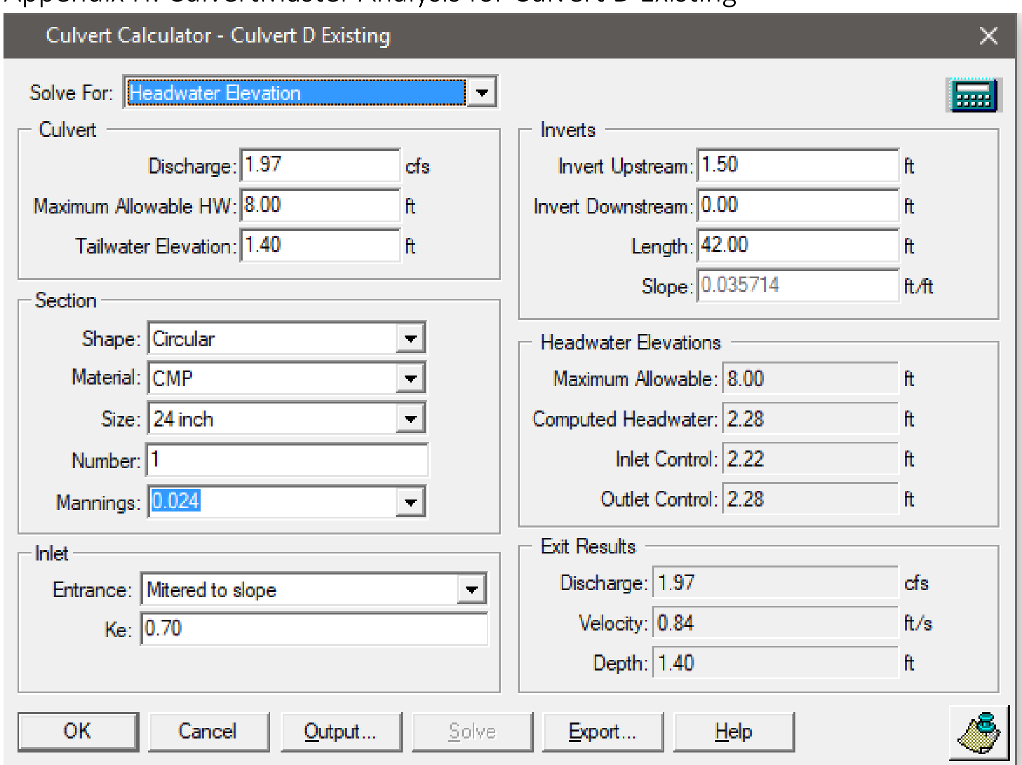
Appendix F: CulvertMaster Analysis for Culvert B Existing



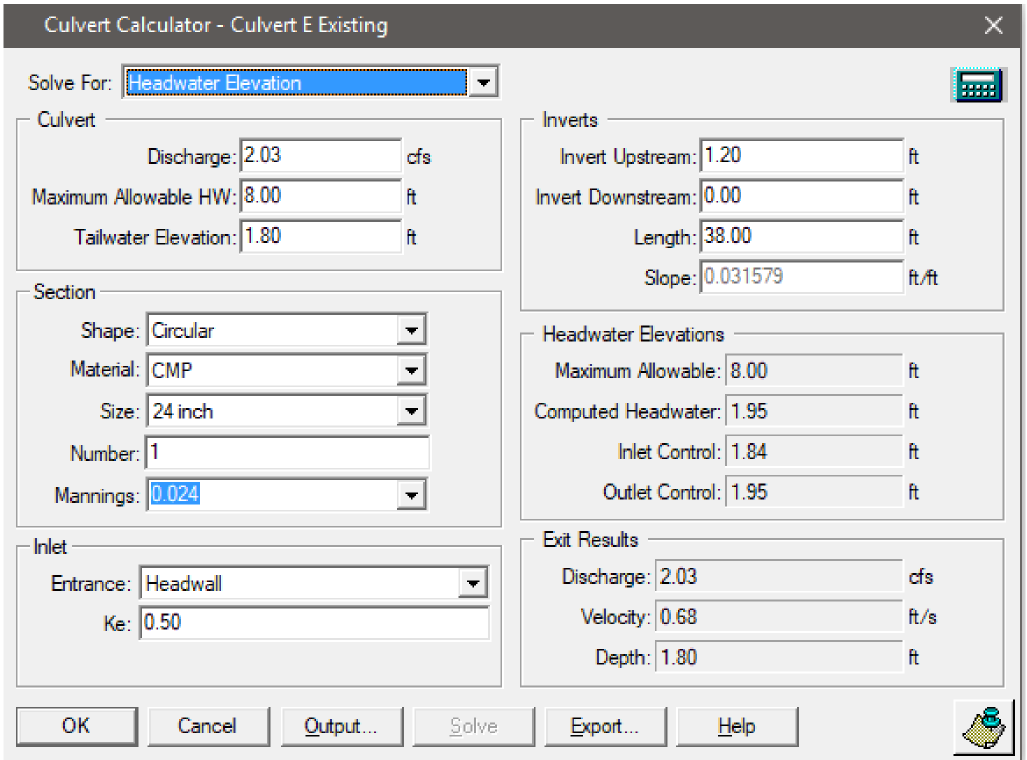
Appendix G: CulvertMaster Analysis for Culvert C Existing



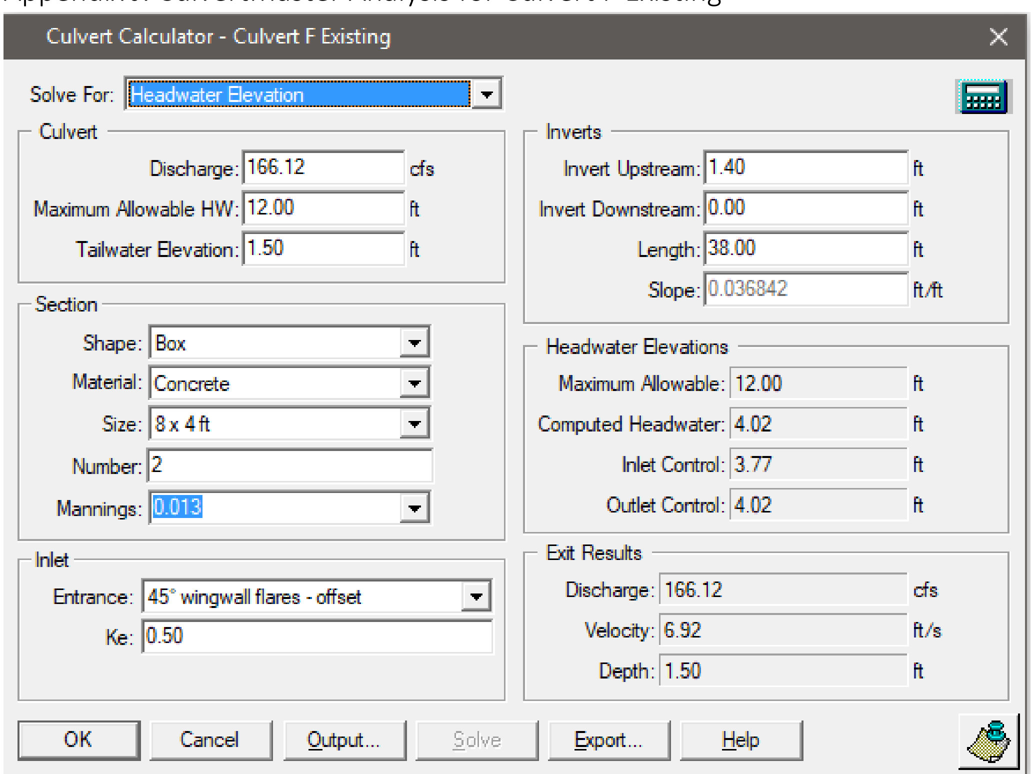
Appendix H: CulvertMaster Analysis for Culvert D Existing



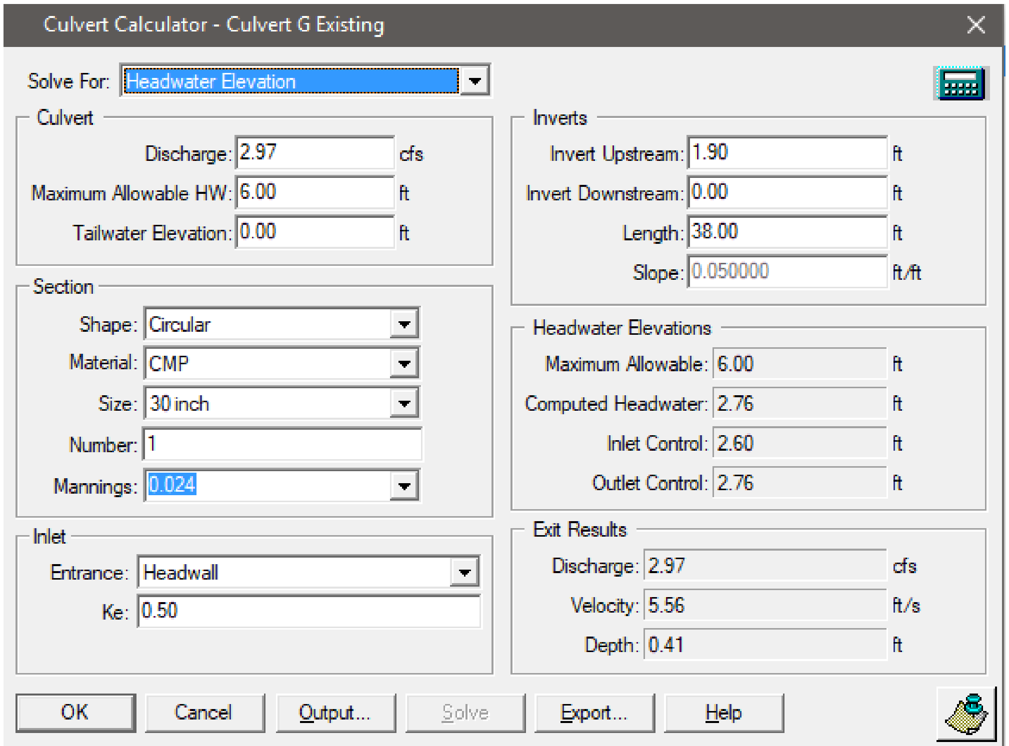
Appendix I: CulvertMaster Analysis for Culvert E Existing



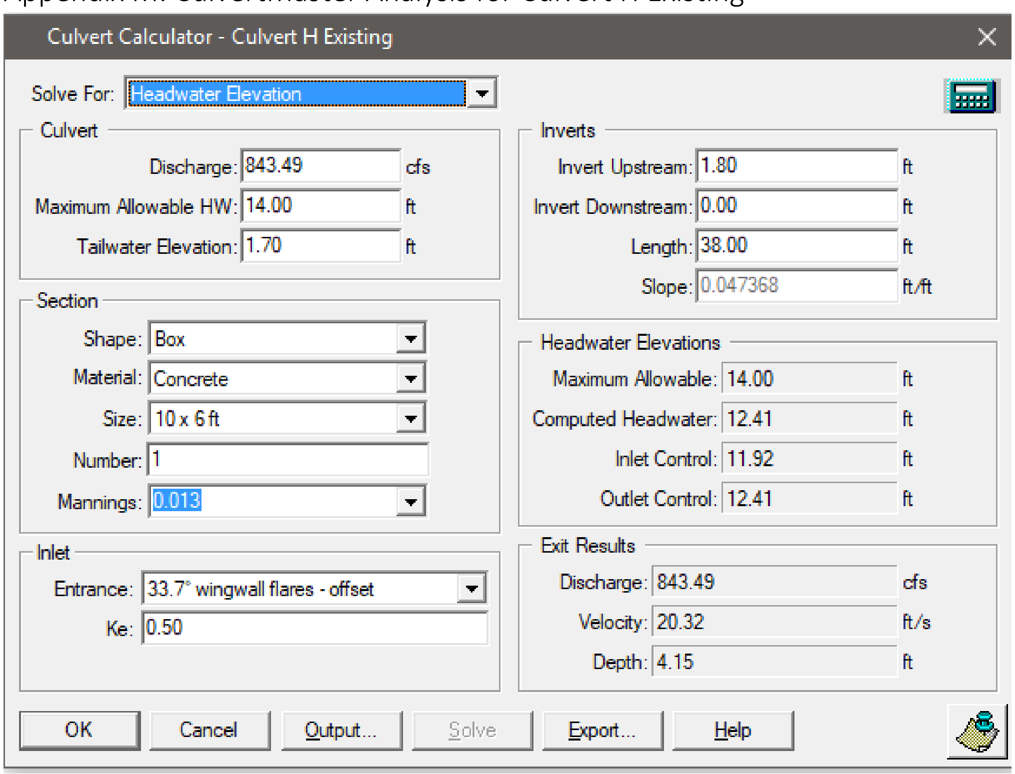
Appendix J: CulvertMaster Analysis for Culvert F Existing



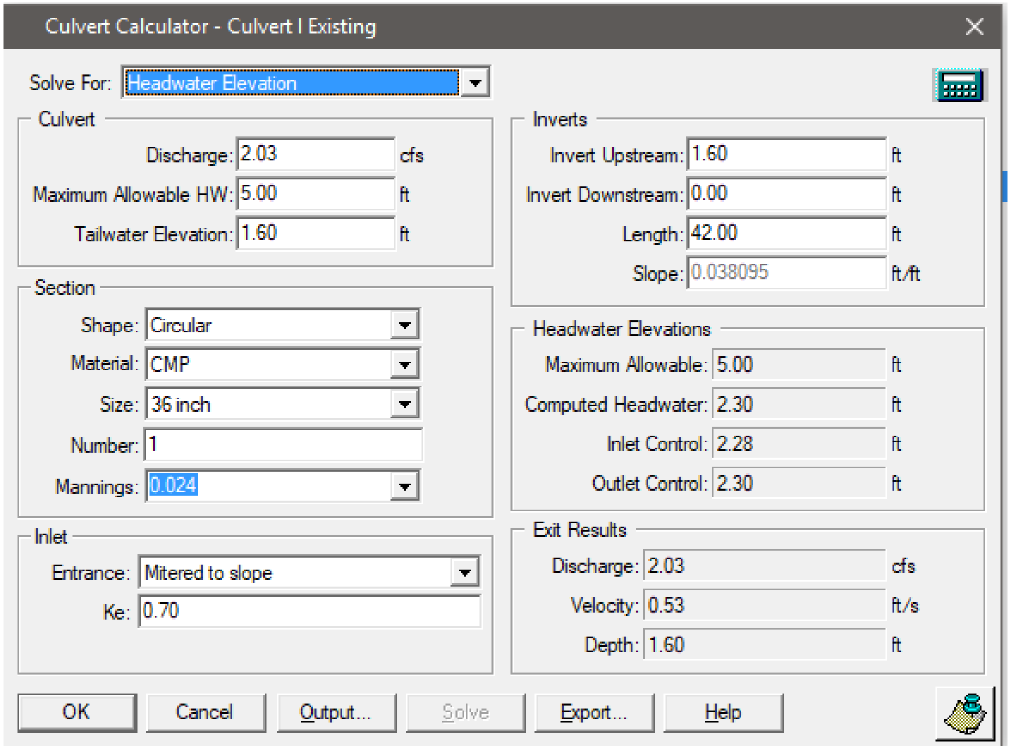
Appendix K: CulvertMaster Analysis for Culvert G Existing



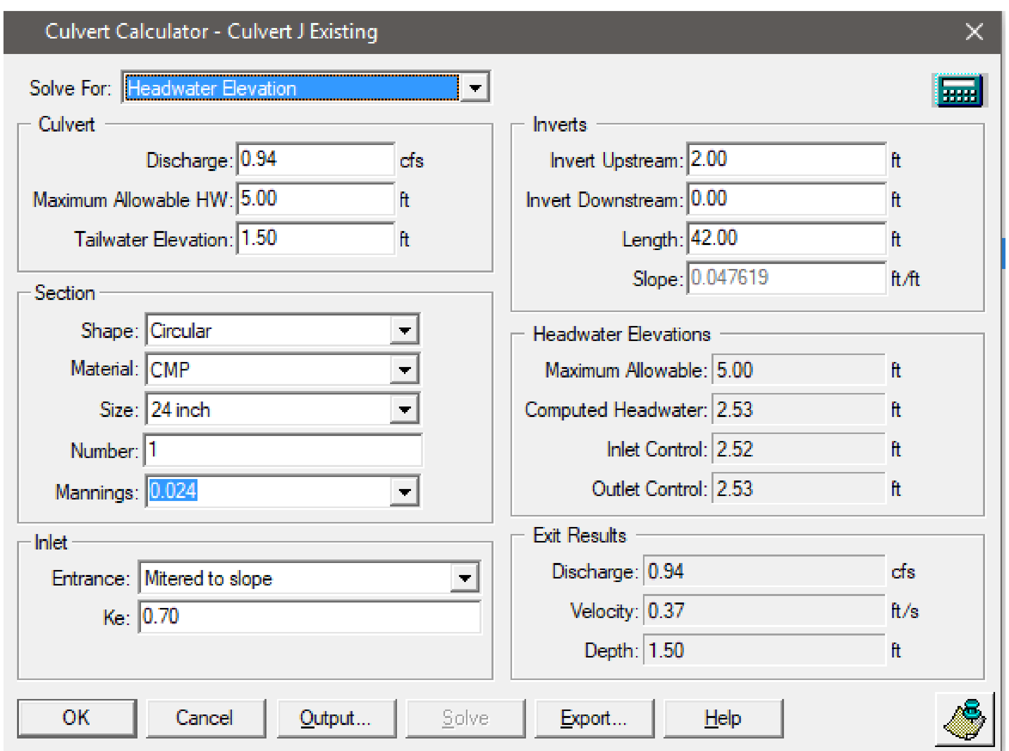
Appendix M: CulvertMaster Analysis for Culvert H Existing



Appendix L: CulvertMaster Analysis for Culvert I Existing



Appendix N: CulvertMaster Analysis for Culvert J Existing

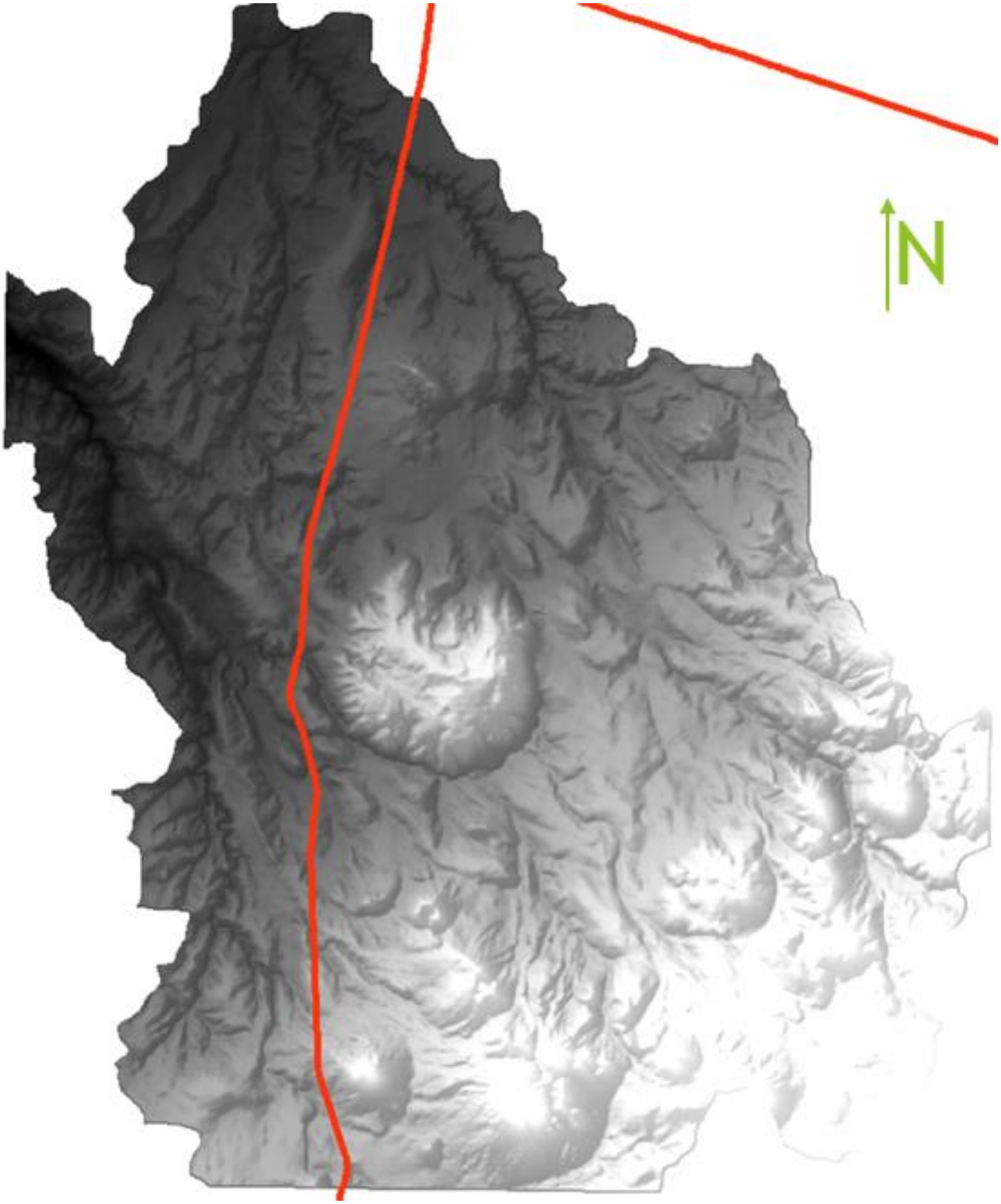


Appendix O: Culvert A, Site Visit

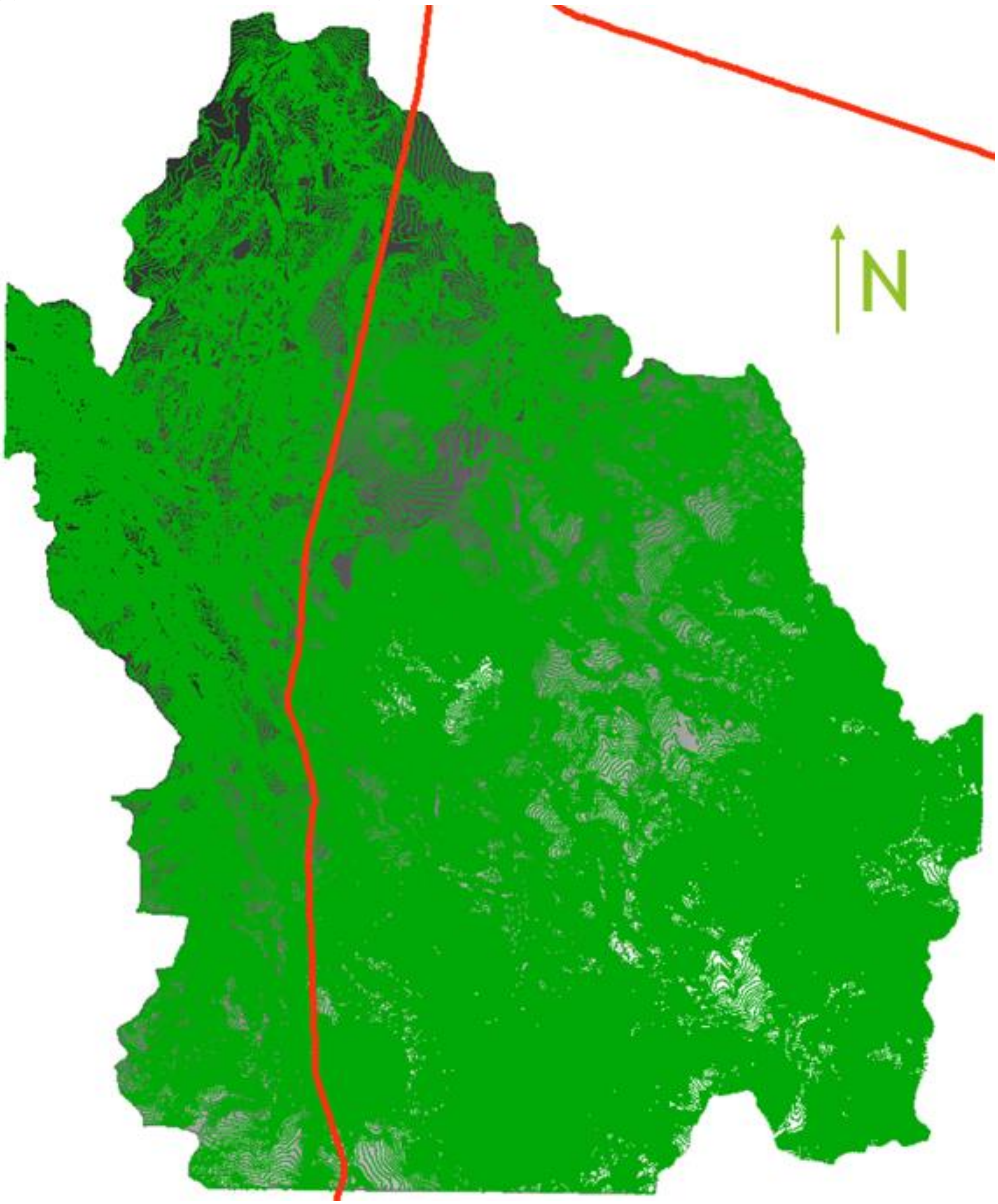
Appendix P: Culvert F, Site Visit

Appendix Q: Culvert H, Site Visit

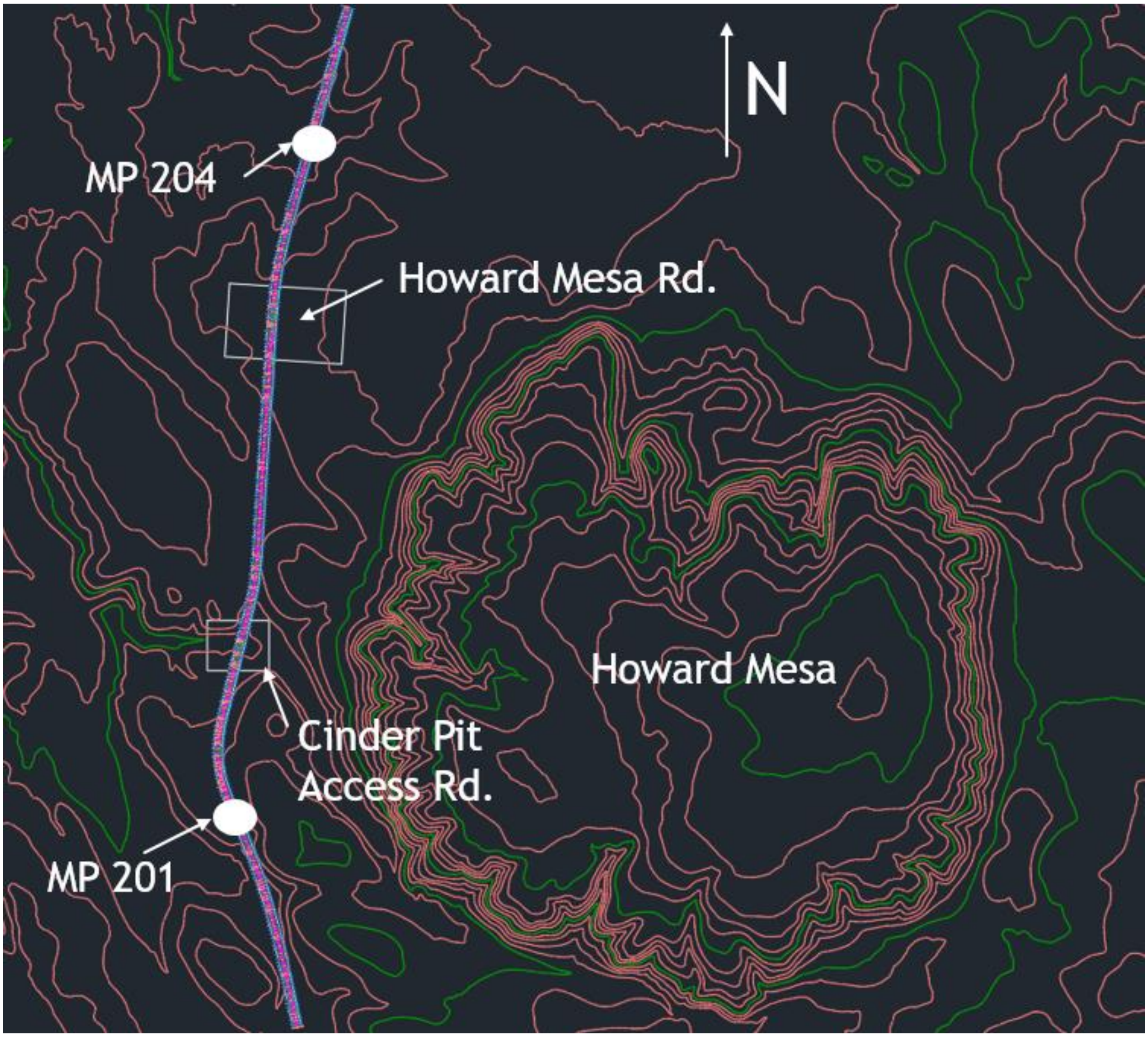
Appendix R: Digital Elevation Model In ArcGIS



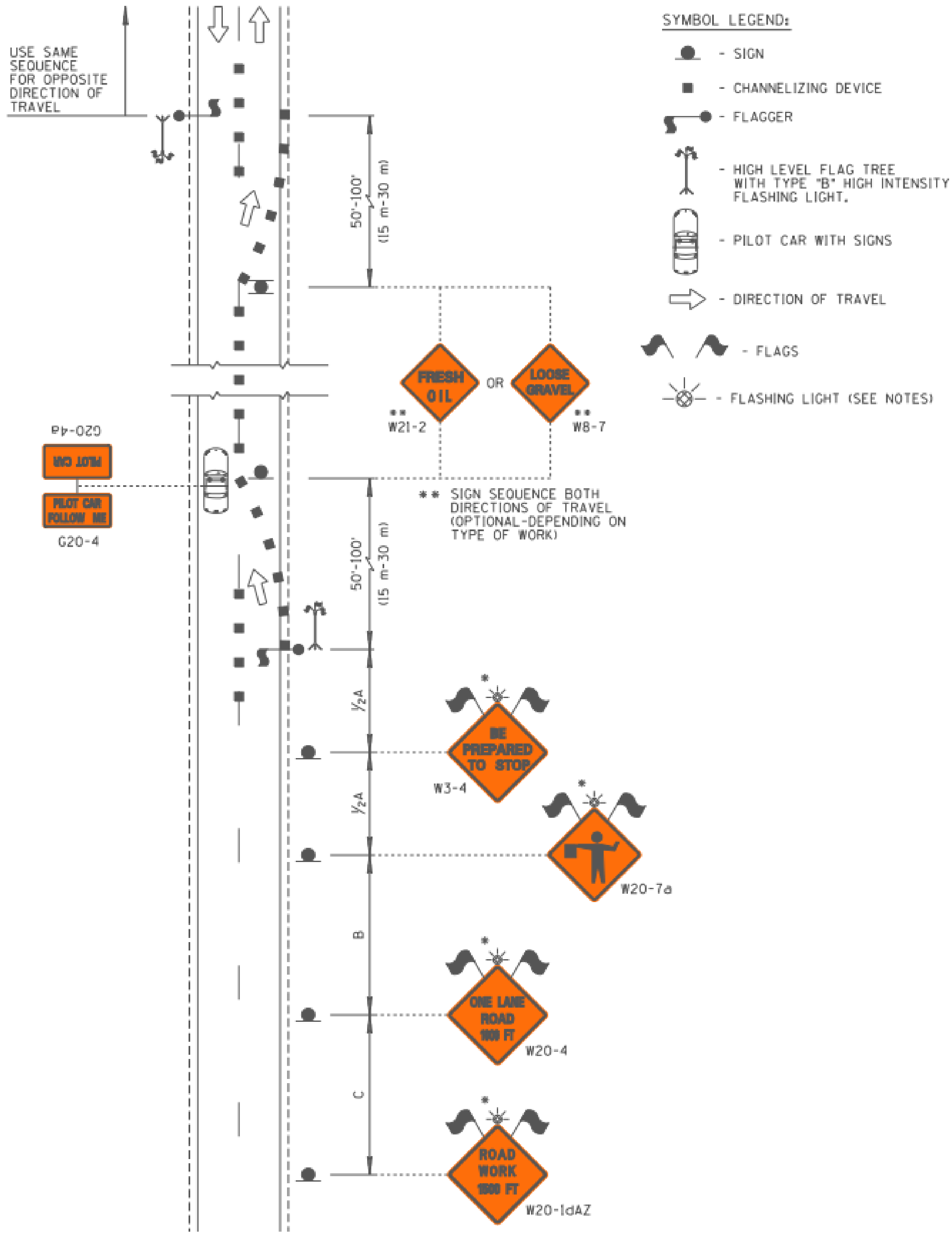
Appendix S: 1 Meter Contour Line Shape File In ArcGIS



Appendix T: 5 Foot Contour Surface and Alignment In Civil 3D



Appendix U: Traffic Control Plan



Appendix V: 2008 Unit Pricing Sheet

Estimate No. 8

Tracs No: H705601C 089-C-(201)T   Section: 1 FA 04 ROADWAY

Item No.	Item Description	Unit	Plans Qty.	Plans Amt.	Revised Qty.	Revised Amt.	Unit Price	Accum Qty.	Accum Amt.	%	Curr Qty.	Curr Amt.
1090010	ASPHALTIC CONCRETE PAVEMENT	L.SUM	0	$0.00	0	$0.00	$1.00	23,639.05	$23,639.05	#VALUE!	0.000	$.00
1090011	ASPHALTIC CONCRETE PAVEMENT QUALITY	L.SUM	0	$0.00	0	$0.00	$1.00	9,773.93	$9,773.93	#VALUE!	0.000	$.00
1090020	PORTLAND CEMENT CONCRETE PAVEMENT	L.SUM	0	$0.00	0	$0.00	$1.00	0	$0.00	#VALUE!	0.000	$.00
1090030	PAYROLL SUBMITTAL RETENTION	L.SUM	0	$0.00	0	$0.00	$1.00	0	$0.00	#VALUE!	0.000	$.00
1090035	MISCELLANEOUS INCENTIVES	L.SUM	0	$0.00	0	$0.00	$1.00	-92.85	($92.85)	#VALUE!	0.000	$.00
1090040	MISCELLANEOUS ADJUSTMENTS	L.SUM	0	$0.00	0	$0.00	$1.00	-400	($400.00)	#VALUE!	0.000	$.00
2010011	CLEARING AND GRUBBING	ACRE	20	$32,000.00	20	$32,000.00	$1,600.00	16.9	$27,040.00	85	0.000	$.00
2020009	REMOVAL OF STRUCTURAL CONCRETE	CU.YD.	2	$5,000.00	2	$5,000.00	$2,500.00	2	$5,000.00	100	0.000	$.00
2020038	REMOVAL OF ASPHALTIC CONCRETE	SQ.YD.	5,000.00	$20,000.00	5,000.00	$20,000.00	$4.00	1,991.80	$7,967.20	40	0.000	$.00
2020053	REMOVE ((Recessed Pavement Markers))	EACH	0	$0.00	324	$764.64	$2.36	324	$764.64	100	0.000	$.00
2020083	REMOVE BITUMINOUS PAVEMENT (MILLING)	SQ.YD.	11,400.00	$22,800.00	11,400.00	$22,800.00	$2.00	11,379.66	$22,759.32	100	0.000	$.00
2020101	REMOVE FENCE	L.FT.	155	$930.00	155	$930.00	$6.00	152	$912.00	98	0.000	$.00
2020162	REMOVE (MILLING) (0" TO 3/4")	SQ.YD.	300	$2,100.00	300	$2,100.00	$7.00	357.5	$2,502.50	119	0.000	$.00
2030301	ROADWAY EXCAVATION	CU.YD.	7,385.00	$110,775.00	7,385.00	$110,775.00	$15.00	7,385.00	$110,775.00	100	0.000	$.00
2030501	STRUCTURAL EXCAVATION	CU.YD.	41	$4,510.00	41	$4,510.00	$110.00	41	$4,510.00	100	0.000	$.00
2030506	STRUCTURE BACKFILL	CU.YD.	72	$10,800.00	91.5	$13,725.00	$150.00	91.5	$13,725.00	100	0.000	$.00
3030022	AGGREGATE BASE, CLASS 2	CU.YD.	8,000.00	$360,000.00	8,000.00	$360,000.00	$45.00	8,556.74	$385,053.31	107	0.000	$.00
4040000	BITUMINOUS PRICE ADJUSTMENT	L.SUM	0	$0.00	0	$0.00	$1.00	3,871.57	$3,871.57	#VALUE!	0.000	$.00
4040111	BITUMINOUS TACK COAT	TON	40	$18,000.00	40	$15,640.20	$450.00	43.13	$17,048.70	95	0.000	$.00
4040116	APPLY BITUMINOUS TACK COAT	HOUR	100	$14,000.00	100	$14,000.00	$140.00	88	$12,320.00	88	0.000	$.00
4040264	ASPHALT BINDER (PG 64-22)	TON	615	$338,250.00	615	$338,250.00	$550.00	662.45	$364,347.50	108	0.000	$.00
4040288	ASPHALT BINDER (PG 70-22 TR+)	TON	241	$180,750.00	241	$180,750.00	$750.00	231.25	$173,437.50	96	0.000	$.00
4070002	ASPHALTIC CONCRETE FRICTION COURSE (SPECIAL WITH PG 70-22 TR+))	TON	3,700.00	$181,300.00	3,700.00	$181,300.00	$49.00	3,552.52	$174,073.48	96	0.000	$.00
4070021	MINERAL ADMIXTURE (FOR ACFC))	TON	35	$3,150.00	35	$3,150.00	$90.00	34.26	$3,083.40	98	0.000	$.00
4090003	ASPHALTIC CONCRETE (MISCELLANEOUS STRUCTURAL)	TON	870	$104,400.00	870	$104,400.00	$120.00	375.57	$45,068.40	43	0.000	$.00
4160004	ASPHALTIC CONCRETE (3/4" MIX) (END PRODUCT) (SPECIAL MIX)	TON	12,300.00	$528,900.00	12,300.00	$528,900.00	$43.00	14,007.80	$602,335.41	114	0.000	$.00
4160031	MINERAL ADMIXTURE	TON	117	$10,530.00	117	$10,530.00	$90.00	134.33	$12,089.70	115	0.000	$.00
5010011	PIPE, CORRUGATED METAL, 24"	L.FT.	66	$4,950.00	66	$4,950.00	$75.00	72	$5,400.00	109	0.000	$.00
5010017	PIPE, CORRUGATED METAL, 30"	L.FT.	22	$1,870.00	22	$1,870.00	$85.00	22	$1,870.00	100	0.000	$.00
5014024	FLARED END SECTION, 24" (C-13.25)	EACH	2	$1,500.00	2	$1,500.00	$750.00	3	$2,250.00	150	0.000	$.00
5014030	FLARED END SECTION, 30" (C-13.25)	EACH	2	$1,700.00	2	$1,700.00	$850.00	2	$1,700.00	100	0.000	$.00
6010002	STRUCTURAL CONCRETE (CLASS S) (F'C =	CU.YD.	52	$33,800.00	52	$33,800.00	$650.00	52	$33,800.00	100	0.000	$.00
6010724	PORTLAND CEMENT CONCRETE SLAB (CLASS	CU.YD.	8	$5,200.00	8	$5,200.00	$650.00	22.61	$14,696.50	283	0.000	$.00
6050002	REINFORCING STEEL	LB.	5,233.00	$10,466.00	5,233.00	$10,466.00	$2.00	5,233.00	$10,466.00	100	0.000	$.00
6050003	REINFORCING STEEL (PROTECTIVE CONCRETE	LB.	480	$960.00	480	$960.00	$2.00	866	$1,732.00	180	0.000	$.00
6050101	PLACE DOWELS	EACH	8	$800.00	35	$3,500.00	$100.00	35	$3,500.00	100	0.000	$.00
6070038	SLIP BASE ( )	EACH	4	$500.00	4	$500.00	$125.00	4	$500.00	100	0.000	$.00
6070054	SIGN POST (PERFORATED) (2 S)	L.FT.	100	$800.00	100	$800.00	$8.00	103	$824.00	103	0.000	$.00
6070055	SIGN POST (PERFORATED) (2 1/2 S)	L.FT.	55	$495.00	55	$495.00	$9.00	48	$432.00	87	0.000	$.00
6070060	FOUNDATION FOR SIGN POST (CONCRETE)	EACH	12	$1,680.00	12	$1,680.00	$140.00	12	$1,680.00	100	0.000	$.00
6080005	WARNING, MARKER, OR REGULATORY SIGN	SQ.FT.	70	$1,400.00	70	$1,400.00	$20.00	70	$1,400.00	100	0.000	$.00

Appendix V: 2008 Unit Pricing Sheet (Continued)

6070060	FOUNDATION FOR SIGN POST (CONCRETE)	EACH	12	$1,680.00	12	$1,680.00	$140.00	12	$1,680.00	100	0.000	$.00
6080005	WARNING, MARKER, OR REGULATORY SIGN	SQ.FT.	70	$1,400.00	70	$1,400.00	$20.00	70	$1,400.00	100	0.000	$.00
7015010	TEMPORARY CONCRETE BARRIER	L.FT.	1,360.00	$31,280.00	1,360.00	$31,280.00	$23.00	1,380.00	$31,740.00	101	0.000	$.00
7015020	TEMPORARY IMPACT ATTENUATORS	EACH	8	$6,800.00	8	$6,800.00	$850.00	8	$6,800.00	100	0.000	$.00
7016020	TEMPORARY CONCRETE BARRIER (IN USE)	L.FT./DAY	36,720.00	$7,344.00	36,720.00	$7,344.00	$0.20	44,960.00	$8,992.00	122	0.000	$.00
7016021	TEMPORARY IMPACT ATTENUATORS (IN USE)	EACH-	216	$6,480.00	216	$6,480.00	$30.00	260	$7,800.00	120	0.000	$.00
7016030	BARRICADE (TYPE II, VERT. PANEL, TUBULAR	EACH-	25,435.00	$12,717.50	25,435.00	$12,717.50	$0.50	17,349.00	$8,674.50	68	0.000	$.00
7016031	BARRICADE (TYPE III, HIGH LEVEL FLAG TREES)	EACH-	10	$10.00	10	$10.00	$1.00	0	$0.00	0	0.000	$.00
7016032	PORTABLE SIGN STANDS (RIGID)	EACH-	380	$380.00	380	$380.00	$1.00	529	$529.00	139	0.000	$.00
7016033	PORTABLE SIGN STANDS (SPRING TYPE)	EACH-	430	$430.00	430	$430.00	$1.00	2,073.00	$2,073.00	482	0.000	$.00
7016035	WARNING LIGHTS (TYPE A)	EACH-	3,100.00	$775.00	3,100.00	$775.00	$0.25	3,525.00	$881.25	114	0.000	$.00
7016037	WARNING LIGHTS (TYPE C)	EACH-	20,740.00	$5,185.00	20,740.00	$5,185.00	$0.25	17,423.00	$4,355.75	84	0.000	$.00
7016039	EMBEDDED SIGN POST	EACH-	7,440.00	$1,116.00	7,440.00	$1,116.00	$0.15	3,420.00	$513.00	46	0.000	$.00
7016050	TRUCK MOUNTED ATTENUATOR	EACH-	3	$450.00	3	$450.00	$150.00	0	$0.00	0	0.000	$.00
7016051	TEMPORARY SIGN (LESS THAN 10 S.F.)	EACH-	1,620.00	$1,053.00	1,620.00	$1,053.00	$0.65	704	$457.60	43	0.000	$.00
7016052	TEMPORARY SIGN (10 S.F. OR MORE)	EACH-	2,910.00	$2,182.50	2,910.00	$2,182.50	$0.75	3,737.00	$2,802.75	128	0.000	$.00
7016067	CHANGEABLE MESSAGE BOARD	EACH-	320	$8,000.00	320	$8,000.00	$25.00	174	$4,350.00	54	0.000	$.00
7016071	PILOT VEHICLE WITH DRIVER	HOUR	360	$14,400.00	360	$14,400.00	$40.00	315	$12,600.00	88	0.000	$.00
7016075	FLAGGING SERVICES (CIVILIAN)	HOUR	820	$18,040.00	820	$18,040.00	$22.00	983.5	$21,637.00	120	0.000	$.00
7016080	FLAGGING SERVICES (DPS)	HOUR	445	$29,040.70	445	$29,040.70	$65.26	756	$49,336.56	170	0.000	$.00
7030025	DELINEATOR ASSEMBLY (FLEXIBLE) (DRIVEN	EACH	168	$10,920.00	168	$10,920.00	$65.00	168	$10,920.00	100	0.000	$.00
7060101	PAVEMENT MARKER, RECESSED, TYPE D	EACH	380	$1,900.00	380	$1,900.00	$5.00	445	$2,225.00	117	0.000	$.00
7060111	PAVEMENT MARKER, RECESSED, TYPE G	EACH	260	$1,300.00	260	$1,300.00	$5.00	316	$1,580.00	122	0.000	$.00
7080001	PERMANENT PAVEMENT MARKING (PAINTED)	L.FT.	60,760.00	$9,114.00	60,760.00	$9,114.00	$0.15	29,477.00	$4,421.55	49	0.000	$.00
7080011	PERMANENT PAVEMENT MARKING (PAINTED)	L.FT.	57,430.00	$8,614.50	57,430.00	$8,614.50	$0.15	29,243.00	$4,386.45	51	0.000	$.00
7080101	PERMANENT PAVEMENT MARKING (PAINTED	EACH	8	$800.00	8	$800.00	$100.00	8	$800.00	100	0.000	$.00
7080221	PERMANENT PAVEMENT MARKING (PAINTED	EACH	2	$120.00	2	$120.00	$60.00	2	$120.00	100	0.000	$.00
7090001	DUAL COMPONENT PAVEMENT MARKING	L.FT.	45,570.00	$11,392.50	45,570.00	$11,392.50	$0.25	48,219.00	$12,054.75	106	0.000	$.00
7090002	DUAL COMPONENT PAVEMENT MARKING	L.FT.	43,070.00	$10,767.50	43,070.00	$10,767.50	$0.25	45,352.00	$11,338.00	105	0.000	$.00
7090010	DUAL COMPONENT PAVEMENT LEGEND	EACH	2	$450.00	2	$450.00	$225.00	2	$450.00	100	0.000	$.00
7090012	DUAL COMPONENT PAVEMENT SYMBOL	EACH	8	$2,800.00	8	$2,800.00	$350.00	8	$2,800.00	100	0.000	$.00
8050003	SEEDING (CLASS II)	ACRE	10	$30,000.00	10	$30,000.00	$3,000.00	13	$39,000.00	130	0.000	$.00
8101005	EROSION CONTROL (CHECK DAM)	CU.YD.	415	$35,275.00	415	$35,275.00	$85.00	207.88	$17,669.80	50	0.000	$.00
8101014	EROSION CONTROL (SEDIMENT	L.FT.	8,700.00	$30,450.00	8,700.00	$30,450.00	$3.50	8,980.00	$31,430.00	103	0.000	$.00
8101021	EROSION CONTROL (WATTLES) (9")	L.FT.	350	$1,050.00	350	$1,050.00	$3.00	0	$0.00	0	0.000	$.00
8101029	EROSION CONTROL (ROCK MULCH)	CU.YD.	75	$6,375.00	75	$6,375.00	$85.00	180.06	$15,305.10	240	0.000	$.00
8101046	EROSION CONTROL (SEDIMENT CONTROL	L.FT.	0	$0.00	6,450.00	$7,288.50	$1.13	6,450.00	$7,288.50	100	0.000	$.00
9010001	MOBILIZATION	L.SUM	1	$333,127.00	1	$333,127.00	$333,127.00	1	$333,127.00	100	0.000	$.00
9030011	BARBED WIRE FENCE, TYPE 1	L.FT.	80	$800.00	80	$800.00	$10.00	386	$3,860.00	483	0.000	$.00
9240050	MISCELLANEOUS WORK (oversaturated subgrade)	L.SUM	0	$0.00	1	$69,600.00	$69,600.00	1	$69,600.00	100	0.000	$.00
9240101	MISCELLANEOUS WORK (RESIDENT ENGINEER	L.SUM	0	$0.00	0	$1,709.95	$1.00	1,709.95	$1,709.95	#VALUE!	0.000	$.00
9240170	CONTRACTOR QUALITY CONTROL	L.SUM	1	$49,000.00	1	$49,000.00	$49,000.00	1	$49,000.00	100	0.000	$.00
9240183	MISCELLANEOUS WORK (SEAL CRACKS LESS	LB.	1,300.00	$3,250.00	1,300.00	$3,250.00	$2.50	1,950.00	$4,875.00	150	0.000	$.00
9250001	CONSTRUCTION SURVEYING AND LAYOUT	L.SUM	1	$34,000.00	1	$34,000.00	$34,000.00	1	$34,000.00	100	0.000	$.00
9280036	GROUND-IN RUMBLE STRIP (8 INCH)	L.FT.	33,000.00	$6,600.00	33,000.00	$6,600.00	$0.20	32,634.00	$6,526.80	99	0.000	$.00
9999903	LUMP SUM STRUCTURE (TOTAL OF	L.SUM	1	$0.00	1	$0.00	$0.00	0	$0.00	#VALUE!	0.000	$.00
		Totals	**410416.00**	**$2,748,105.20**	**417237.50**	**$2,830,733.49**	**$501,136.50**	**396115.11**	**$2,929,885.57**		**0.00**	**0.00**