

Carefree Highway Cave Creek Road to Scottsdale Road Preliminary Drainage Report



Prepared for:

**City of Scottsdale
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1.0 Introduction

1.1 Project Introduction

The City of Scottsdale aims to alleviate traffic congestion by upgrading the road along Carefree Highway that ties into Scottsdale Road (Project Number 3010.0100309.000). The proposed solution is to expand the existing two-lane road to a four-lane road, which will increase the road's capacity and improve traffic flow.

The proposed project also aims to mitigate flooding risks and control the water flow in the area. Moreover, the project will enhance the overall safety of the road by improving visibility and providing adequate space.

The purpose of this report is to identify necessary improvements that can address future development requirements, enhance drainage infrastructure to accommodate roadway improvements, and improve connectivity and access management throughout the corridor. The assessment aims to identify the specific improvements needed to make the roadway more efficient and functional, ensuring that it can meet the demands of future development and traffic flow while also enhancing safety and accessibility for all road users. The widened roadway section will tie into the existing grades. The drainage design was updated to account for increased flows resulting from increased roadway width.

1.2 Project Background

Currently, there are seven direct access points on the northside and three on the southside. This project is needed to widen Carefree Highway from one lane to two lanes in each direction between Cave Creek Road and Scottsdale Road.

1.3 Project Location

The project is located along the existing alignment of Carefree Highway beginning east of Cave Creek Road tying into the intersection of Scottsdale Road. The project length is approximately 1.8 miles. It is located in Sections 08, 09, 10 of Township 5 North, and Range 4 East of Gila and Salt River Base Line and Principal Meridian.

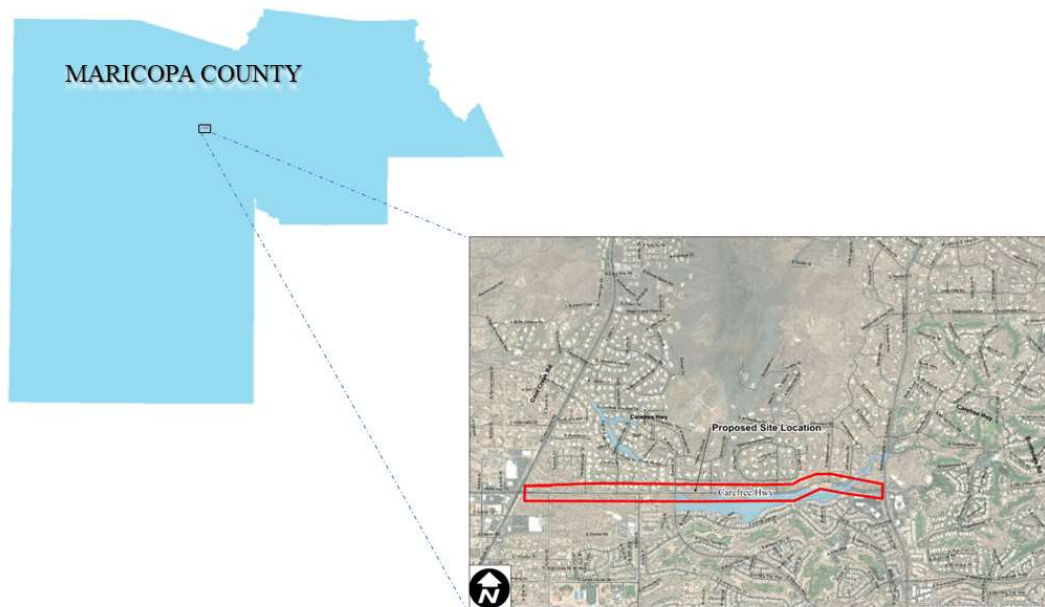


Figure 1-1 Vicinity Map

1.4 Existing Features

The existing corridor consists of a two-lane paved roadway adjacent to residential communities. The existing right-of-way (R/W) width along Carefree Highway is approximately 55 ft north of the centerline and 75 ft south of the centerline. Most of Carefree Highway does not have curb and gutter. In the City of Scottsdale Major Streets and Routes Plan, Carefree Highway and Scottsdale Road are classified as principal arterial roadways.

2.0 Overview

This report documents the drainage improvements for Carefree Highway from Crave Creek Road to Scottsdale Road (see Figure 1-1). The purpose of this study is to: (1) Provide an overview of the drainage conditions affecting the Carefree Highway project lane extension;(2) Perform site reconnaissance and compile background data; (3) Review and compare results of previous hydrologic studies; (4) Perform an up-to-date project specific hydrologic analysis referencing previous drainage studies to determine offsite storm water flows; (5) Evaluate onsite roadway storm water flows based on the proposed roadway design; (6) Determine the type and combination of drainage facilities required to handle offsite and onsite flows; and (7) Provide hydraulic calculations for the proposed design for offsite and onsite improvements.

2.1 Previous Studies

The offsite hydrology for the Cave Creek Unnamed Central Tributary located along this project was obtained from the 2003 Carefree Drainage Master Plan FDS, prepared by CH2M HILL, which is also reflected in the effective FIS for the 1-percent annual chance flood event. The effective

discharge shown in the FIS study is 2,849 cfs, located at River Station 0.9888. Cross Section A (RS 0.9888) is located approximately 300-feet upstream of Terravita Way / N. Sunset Trail.

2.2 Existing Conditions

The project extends along Carefree Highway east of Cave Creek Road and ends at Scottsdale Road. Project limits are shown graphically in **Figure 2**. Carefree Highway exists as a paved rural two-lane road without curb and gutter between Cave Creek Road and Scottsdale Road. From just east of Cave Creek Road to Scottsdale Road, vertical curb and gutter will be constructed along Carefree Highway. The road will be widened to two lanes in each direction, starting just east of the intersection of Carefree Highway and Cave Creek Rd.

Currently, there are 8 existing culverts located along Carefree Highway and all of the existing culverts are proposed to be extended or improved to match the existing drainage system. To enhance the management and regulation of stormwater flow resulting from the construction of new roads, 6 additional culverts are proposed to be constructed along Carefree Highway. These culverts will facilitate the smooth and efficient conveyance of stormwater, ensuring that the roads remain accessible and safe for public use.

The Cave Creek Unnamed Central Tributary runs primarily along the south side of Carefree Highway with crossings just east of Stagecoach Pass and west of Sunset Trail/Terravita Way. Both crossings exist as at-grade low flow crossings where traffic is impeded during high flow events. The 100-year flow at the crossing of Stagecoach pass is approximately 2,447 cfs.

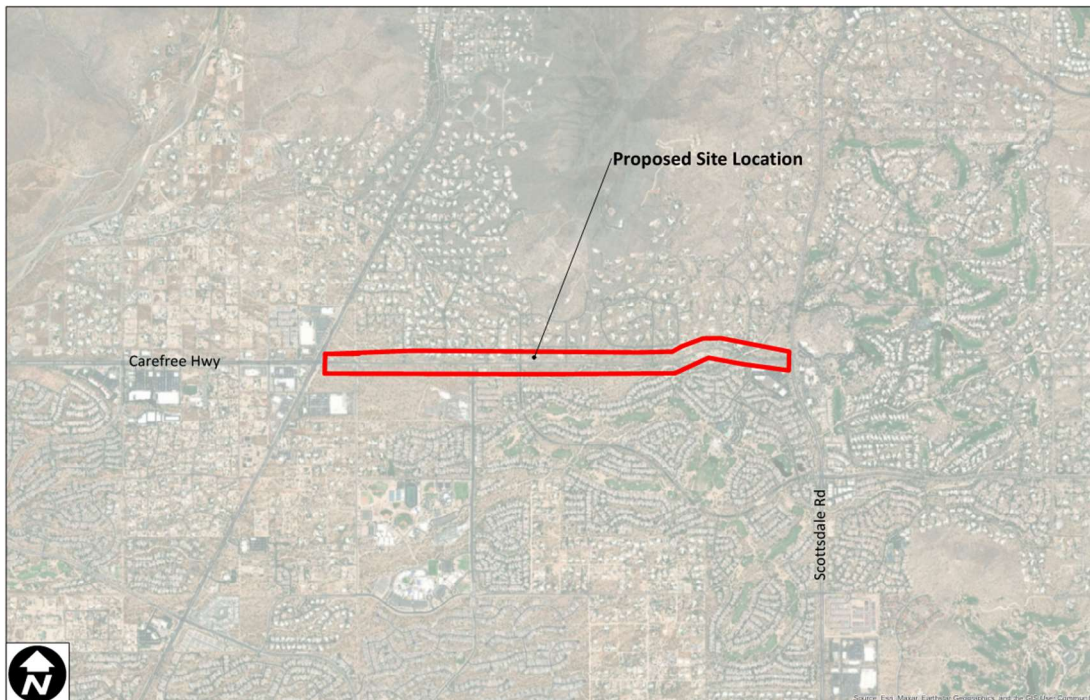


Figure 2-1 Project Limits

2.3 Federal Emergency Management Agency (FEMA) Special Flood Hazard Areas

A review of the effective Flood Insurance Rate Maps (Map No. **04013C0891M** & **04013C0890M**) indicates that the project length lies within unshaded Zone X which is described as “*Areas determined to be outside the 0.2% annual chance floodplain*”. The project length also lies within shaded Zone X which is described as “*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*”. A small portion of roadway also lies with Zone AE along Cave Creek Unnamed Central Tributary; Zone AE is described as “*Special Flood Hazard Areas with Base Flood Elevations or depths determined*”.

See **Appendix A** for the FEMA FIRMette maps and the digital appendix for the full FEMA FIRM maps.

2.4 Partnering/Stakeholders

2.4.1 City of Scottsdale

The lead agency regarding the design and construction of the proposed improvements. Carefree Highway serves as a dividing line between the City of Scottsdale and City of Carefree city limits.

2.4.2 City of Carefree

The City of Carefree is located along the northern boundary of the project limits.

2.4.3 Flood Control District of Maricopa County

The Zone AE floodplain for the Cave Creek Unnamed Central Tributary runs along the southern boundary of the project and crosses Carefree Highway in two locations. A LOMR will be required as part of the project improvements.

3.0 Drainage Design Criteria

3.1 Design Criteria

The design criteria for the referenced project are provided below. Design references are from the following:

1. City of Scottsdale. (2018). *City of Scottsdale Design Standards and Policies Manual (DSPM)*.
2. Flood Control District of Maricopa County (FCDMC). (2018). *Drainage Policies and Standards Manual for Maricopa County, Arizona (DPS)*.
3. Flood Control District of Maricopa County (FCDMC). (2018). *Drainage Design Manual for Maricopa County, Arizona, Volume I: Hydrology*.
4. Flood Control District of Maricopa County (FCDMC). (2018). *Drainage Design Manual for Maricopa County, Arizona, Volume II: Hydraulics*.
5. Flood Control District of Maricopa County (FCDMC). (2018). *Drainage Design Manual for Maricopa County, Arizona, Volume III: Erosion*.

The design of drainage improvements for Carefree Highway was prepared using the following list of specific design criteria referenced from the design manuals identified above.

Table 3-1 Drainage Design Criteria

Description of Criteria	Values for Design	Design Reference
<i>Offsite Hydrology</i>		
Rational Method	Drainage areas up to 160 acres Minimum Tc = 5 minutes	DSPM 4-1.504 FCDMC DDM Hydrology 3.6.1
Runoff Coefficients	Weighted Adjustment for Desert Areas: 0.37 and 0.45 (10-year & 100-year) Paved Street: 0.9 and 0.95 (10-yr & 100-yr)	DSPM 4-1.504 (Figure 4-1.5)
HEC-1 Flood Hydrograph Package	Drainage area greater than 160 acres	DSPM 4-1.504
Infiltration/Soil Loss	Green and Ampt	DSPM 4-1.504
Design Storm	Higher of 6-hr or 24-hr storm	DSPM 4-1.504
<i>Street Drainage (Parkways, Arterials, Collectors)</i>		
10-year storm	Flow kept between the curbs while maintaining a 12-ft dry lane in each direction.	DSPM 4 Figure 4-1.2
100-year storm	Flow kept within the right of way	DSPM 4 Figure 4-1.2
Depth	8-inches max during 100-year storm	DSPM 4
Manning's n-value	0.015 - paved	FCDMC DPS 6.5.4
<i>Pipe Culverts</i>		
Diameter	18-inches minimum diameter (Roadway) 15-inches minimum diameter (Driveway)	DSPM 4-1.206
Outlet Velocity	15 fps maximum	FCDMC DSP Table 6.7
Design Storm	Major Collector & Arterial = 50-year, no overtopping, 100-yr dmax = 6 inches Local & Minor Collector = 10-year, no overtopping, 25/50-yr dmax = 6 inches, 100-yr dmax = 12 inches	DSPM 4-1.204
Cover	18-inches minimum	MCDOT 4.7.7.1
End Treatment	Flared End Sections for pipes < 30 inches Concrete Headwall for pipes >= 30-inches	FCDMC DPS 6.7.7
Water Surface Elevation	Max WSE no greater than lowest adjacent road subgrade	FCDMC DSP Table 6.7
<i>Box Culverts</i>		
Height	4-feet minimum	FCDMC DPS 6.12.2
Cover	12-inches minimum	MCDOT 4.7.7.1
Design Storm	Major Collector & Arterial = 50-year, no overtopping, 100-yr dmax = 6 inches Local & Minor Collector = 10-year, no overtopping, 25/50-yr dmax = 6 inches, 100-yr dmax = 12 inches	DSPM 4-1.204
Water Surface Elevation	Max WSE no greater than lowest adjacent road subgrade	FCDMC DSP Table 6.7
<i>Storm Drains</i>		
Design Storm	Onsite: 10-year storm Offsite: 50-year storm	DSPM 4-1.206

Lateral and Connector	18-inches minimum	DSPM 4-1.206
Main Line	18-inches minimum	FCDMC DPS Table 6.9
Minimum Velocity	5.0 fps for Q_{design} Lesser of 3 fps for $0.5 \times Q_{\text{design}}$ or 3 fps at flow depth = 1 ft	FCDMC DPS Table 6.9
Maximum Velocity	15 fps	FCDMC DPS Table 6.9
Cover	Min cover per manufacturer's specifications	FCDMC DPS 6.6.2
Manholes	Required at all horizontal and vertical alignment changes, pipe junctions, and changes in pipe diameter	DSPM 4-1.206
Manhole Spacing	<= 30 inches: 330-ft max 33-45-inch: 440-ft max 48-84-inch: 660-ft max > 84-inch: 1320-ft max	FCDMC DPS Table 6.9
Pipe Diameter Changes	Pipe Crown Elevations Matched	FCDMC DPS Table 6.9
HGL (Q_{design})	=> 6 inches below inlet gutter flowline elev	DSPM 4-1.206
EGL (Q_{design})	< Gutter flowline elev	FCDMC DPS Table 6.9
Minimum Drainage Easement Width	Pipe outside diameter + 2 feet + 2 x depth to invert	DSPM 4-1.206
Manning's n	0.013 – Reinforced Concrete Pipe (RCP) 0.024 – Corrugated Metal Pipe (CMP) 0.013 – High-Density Polyethylene Pipe (HDPE) 0.016 – Cast-In-Place Pipe. Increase minimum size required for hydraulics by 6-inches.	FCDMC DPS Table 6.9
Utility Clearance	1 ft horizontal, 1 ft vertical 2 ft horizontal, 1 ft vertical (SRP)	FCDMC DPS 6.6.4
Open Channels		
Roadside Ditch Design Storm	50-year storm	DSPM 4-1.204
Freeboard	0 foot for roadside v-ditches	FCDMC 6.8.7
Maximum Side Slopes	2:1 soil cement 3:1 riprap 2:1 grouted riprap 4:1 earth/grass 1.5:1 concrete	FCDMC DPS Table 6.12
Required Fencing	steeper than 4:1 side-slopes depth > 3.0 feet	FCDMC DPS 6.2.7
Manning's n Values	Tables 7.6 and 7.7	FCDMC Hydraulics Manual
Storm Inlets/Catch Basins		
Clogging Factor	See Table 6.8	FCDMC DPS 6.5.12
Opening Height	6-inches maximum	FCDMC DPS 6.5.11
Spacing	12-foot dry lane each direction (10-year)	FCDMC DPS 6.5.9
Erosion Protection		
Culvert Outlet	V up to 1.3 x existing channel V, None V 1.3 to 2.5 x existing channel V, Riprap V greater than 2.5 x existing channel V, Energy Dissipator	FCDMC DPS Table 6.10
Roadside Swales	$V_{\text{max}} = 5$ fps	DSPM 4-1.204 (D)

4.0 Hydrology

4.1 Rational Method

Flow quantities for onsite and offsite hydrology were calculated using the Rational Method when areas are less than 160 acres. Criteria for the Rational Method specifically related to this project include:

- NOAA Atlas 14 rainfall and intensity data.
 - Rainfall data was gathered for the project site and found to be 0.48 inches (10-year, 5-minute rainfall depth). This rainfall depth is used for calculating rational method discharges.
- Total contributing drainage area to any individual concentration point must be less than 160 acres and must not have drainage structures or facilities that would require flood routing. For areas greater than 160 acres, the HEC-1 Flood Hydrograph Package is used.
- The maximum time of concentration is 60 minutes.
- The minimum time of concentration is 5 minutes.
- Runoff coefficients from Figure 4-1.5 in the City of Scottsdale Design Standards & Policies Manual.

The Time of Concentration (T_c) equation (equation 3.2 from the Drainage Design Manual for Maricopa County: Hydrology (FCDMC)) is used in an iterative equation with NOAA Atlas intensities to balance T_c with the correct intensity. The peak discharge is then solved directly using the appropriate intensity in Equation 3.1 (FCDMC).

4.2 HEC-1

For areas greater than 160 acres, flow quantities are calculated using the Flood Control District of Maricopa County DDMSW program and the Army Corps of Engineering Hydrologic Engineering Center's HEC-1 Flood Hydrograph Package, where rainfall excess is a function of precipitation and rainfall losses. Criteria for the Rainfall Loss Method specifically related to this project include:

- NOAA Atlas 14 rainfall and intensity data.
- Total contributing drainage area is greater than 160 acres
- The maximum time of concentration is 60 minutes.
- The minimum time of concentration is 5 minutes.
- Runoff coefficients from Figure 4-1.5 in the City of Scottsdale Design Standards & Policies Manual.

4.3 Precipitation

The National Oceanic and Atmospheric (NOAA) Atlas 14, Precipitation Frequency Atlas of the Western United States, Arizona was the source of the data used to determine the multiple rainfall depths and durations for the designed subbasins, respectively. See **Appendix B** for a summary of

the NOAA 14 data. **Table 4-1** shows a summary of the rainfall intensities for various storm frequencies that were used in the rainfall runoff calculations:

Table 4-1 NOAA Rainfall Data

Duration	Intensities					
	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr
5 min	3.56	4.81	5.77	7.04	8.02	9.01
10 min	2.71	3.66	4.39	5.36	6.12	6.84
15 min	2.24	3.03	3.63	4.44	5.04	5.68
30 min	1.51	2.04	2.44	2.98	3.4	3.82
60 min	0.93	1.26	1.51	1.85	2.1	2.36

Within the DDMSW program, a shapefile of the watershed and subbasin boundary for BA-07 was imported to delineate the boundary. The District's program spatially averaged the rainfall data within the subbasin boundary resulting in a single average rainfall depth for the HEC-1 model. Within the HEC-1 model, the point rainfall was aerielly reduced using JD records (depth/area relationship) to obtain an equivalent depth of rainfall based upon the contributing watershed.

4.3 Offsite Hydrology

The results from the 2003 Carefree Drainage Master Plan FDS and the effective FIS were used for the offsite hydrologic values of the Cave Creek Unnamed Tributary crossing Carefree Highway east of Stagecoach Pass, west of Terravita Way, and west of the intersection with Carefree Mountain Drive. Additional offsite subbasin boundaries contributing to flow reaching Carefree Highway were delineated and flows calculated using the Rational Method and HEC-1.

4.3.1 2003 Carefree Drainage Master Plan FDS Results

The Cave Creek Unnamed Tributary was analyzed by CH2M HILL as part of the Carefree Drainage Master Plan Floodplain Delineation Study (FDS). HEC-1 was used to model the hydrology of the area. The wash passes over Carefree Highway as a low flow crossing east of Stagecoach Pass. From there, the wash runs west along the south side of Carefree Highway until it reaches Terravita Way, where a flow split occurs. At Terravita Way, a portion of the flow passes under the road by means of a box culvert, and again under Carefree Highway just west of the Terravita/Sunset Trail intersection. The rest of the flow passes over the Terravita Way as a dip crossing, after which it passes through the north end of the Casa Montana subdivision, under 60th Street, and finally over Carefree Highway west of the intersection with Carefree Mountain Drive. See Appendix B for documentation of the HEC-1 results. **Table 4-2** shows a summary of the Carefree Drainage Master Plan FDS flows used in this study.

Table 4-2 Carefree Drainage Master Plan FDS Flow Summary

Location	Effective, Pre-Project, Post-Project 100-year Discharge (cfs)
At Scottsdale Rd.	1,652

At Carefree Highway, just East of Stagecoach Pass	2,447
300-feet upstream of Terravita Way (FEMA Cross Section A)	2,849
Flow Split North	2,092
Flow Split South	704

4.3.2 Pinnacle Peak ADMS FLO-2D Study

A more recent study of Pinnacle Peak West tributary was conducted by the Flood Control District of Maricopa County using FLO-2D, a two-dimensional modeling program. While the results of this study are not represented in the current FEMA FIS, they are used in the design of 3 culverts for this project. **Table 4-3** shows a comparison of the current FEMA FDS and the more recent FLO-2D study discharges. See **Appendix B** for a summary of the District's FLO-2D study results.

Table 4-3 FLO-2D vs Drainage Master Plan FDS Flows

Location	Drainage Master Plan FDS Discharge (cfs)	FLO-2D Study Discharge (cfs)
At Carefree Highway, just East of Stagecoach Pass	2,447	2362
Flow Split North	2,092	1792
Flow Split South	704	1138

4.3.3 Drainage Area Boundaries

The proposed project limits fall within Maricopa County jurisdiction and comprises two distinct watersheds, both of which have been identified for assessment. The boundaries of the watersheds are demarcated by Cave Creek Highway and East Cave Creek Road, defining the geographical scope of the study area. The drainage area contributing flow to the project area was subdivided into 13 areas. The drainage areas range in size from approximately 3.3 acres to 196 acres. All areas were less than 160 acres with the exception of area BA-07, which has an area of 196 acres. As a result, the HEC-1 flood hydrograph program was used to calculate the runoff for subbasin BA-07, while the Rational Method was used to calculate flows for the remaining 12 drainage areas. See **Exhibit 1** in **Appendix F** for the delineation of the offsite subbasin boundaries.

4.3.4 Land Use

Most of the land use in the project area was very low density/estate residential (R1-70) on slopes greater and less than 10% and mountain terrain, with smaller areas of natural desert, commercial, and medium density residential (R1-7). Runoff coefficients for these areas were obtained from the City of Scottsdale DPSM. These runoff coefficients were then area weighted to obtain a composite value to use for the 10-year, 50-year, and 100-year calculations. See **Appendix B** for a summary of the runoff coefficients used. For subbasin BA-07, a vegetative cover of 20% was estimated for mountain terrain areas. See **Exhibit 2 in Appendix F** for a map of the project area land use.

4.3.5 Surface Type

The land use for the project area was also used to determine the surface roughness for each subbasin area. Table 3.1 from the Flood Control District of Maricopa County Hydrology Design Manual was used to assign surface types to each subbasin, from which equation parameters *m* and *b* were area weighted and used to calculate the *K_b* values used in the time of concentration calculations. See **Exhibit 3 in Appendix F** for a map of the surface types in the project area.

4.3.6 Soils

The soil survey used for this project comes from the Natural Resources Conservation Service (NRCS) soil surveys contained within Book 651 titled *Maricopa County, Arizona, Central Part*. Soil data was used for BA-07 within DDMSW using the soil GIS shapefiles provided by the District and the delineated subbasin boundary. Refer to **Exhibit 4 in Appendix F** for a map of the soils data for subbasin BA-07.

4.3.7 Rainfall Losses

Rainfall infiltration losses for basin BA-07 were calculated using DDMSW Ver. 5.6. The rainfall loss method used was Green and Ampt. The DDMSW program partially bases rainfall losses on both soils and land use data.

Surface retention losses include all rainfall losses not associated with infiltration. These losses include depression storage, absorption/infiltration and evaporation. For this project, these losses are based upon land use and surface cover. These values, for the initial abstraction, were applied to the basin in the DDMSW program.

The percent impervious input data is based upon a combination of soils and land use data. In the developed areas, representative values are included in the default parameters of DDMSW program.

4.3.8 Offsite Results

The Rational Method was used to compute the 10-yr, 50-yr, and 100-yr flow values for all subbasins contributing to the project area, with the exception of BA-07. The HEC-1 program was used to compute 50-yr and 100-yr flow values for both the 6-hr and 24-hr durations for subbasin BA-07. The 6-hr storm duration resulted in the highest flows and were used in design. The FEMA Q's listed in Table 4-2 show the flow values from the most recent study of the area: the Pinnacle Peak ADMS FLO-2D study. **Table 4-4** summarizes the flow results for each subbasin. See

Appendix B for a summary of the Rational Method calculations as well as the HEC-1 model output.

Table 4-4 Offsite Subbasin Discharge Summary

Subbasin	Culvert Station	Q (cfs)		
		10-yr	50-yr	100-yr
BA-01	129+98	7.7	13	16
BA-02	139+43	38	65	85
FEMA Q	143+42	---	---	1138
BA-03	150+95	5.4	9.2	11
FEMA Q	161+75	---	---	1792
BA-04	168+50	7.3	13	15
BA-05	171+75	27	51	63
BA-06	174+05	1.5	2.8	3.1
*BA-07	177+60	---	389	471
BA-08	180+15	38	72	84
BA-09	183+00	3.7	6.8	8.1
BA-10	186+32	13	24	27
BA-11	192+10	20	38	44
BA-12	195+35	80	148	174
BA-13	203+50	151	283	352
FEMA Q	215+65	---	---	2362

*HEC-1 Discharges

4.4 Onsite Hydrology

Carefree Highway is an existing roadway being widened to accommodate growth in the area. The onsite (roadway) hydrology was performed using the Rational method. Within the project limits, drainage areas were delineated and associated with the eastbound and westbound travel lanes.

4.4.1 Onsite Drainage Area Boundaries

The study area under consideration falls within the jurisdiction of Maricopa County and consists of two separate watersheds. Both watersheds have been earmarked for assessment. The boundaries of the watershed are determined by the presence of Cave Creek Highway and East Cave Creek Road, establishing the specific geographical extent of the project. See **Exhibit 6A and Exhibit 6B** in **Appendix F** for the Onsite Hydrology.

4.4.2 Onsite Results

The Rational Method was used to compute the 10-yr, 50-yr, and 100-yr flow values for each subbasin contributing to the project area. Table 4-3 presents a summary of the discharges calculated for each subbasin using the rational calculation method for a 10-year storm event. The discharge values for the 50-year and 100-year storms have also been calculated and included in **Appendix B** for further reference.

The rational calculation method is a widely used hydrological method that estimates peak discharge by considering the area of a catchment and the rainfall intensity. Analyzing the discharge

values for different return periods enhances the comprehension of the potential flood risks in each subbasin and allows for the development of appropriate mitigation strategies to manage these risks.

Time of concentration was calculated and results shown in **Appendix B**. The minimum time of concentration used was 5 minutes, in accordance with Flood Control District of Maricopa Country. These times of concentration were input to calculate the contributing onsite flows of each subbasin. Times of concentration for the subbasins ranged from 5 minutes to 7 minutes, and contributing flows ranged from 1.3 cfs to 5.2 cfs for the 10-year storm event. See Table 4-5 for a summary of the 10-year onsite rational calculations.

Table 4-5 10-Year Onsite Rational Flows

Subbasin	Area	Q ₁₀	Subbasin	Area	Q ₁₀
---	(sqft)	(cfs)	---	(sqft)	(cfs)
DA-01	41489	4.42	DA-19	14392	1.51
DA-02	43711	4.17	DA-20	22727	2.50
DA-03	17327	1.93	DA-21	17399	1.97
DA-04	28804	3.08	DA-22	19068	1.99
DA-05	21467	2.30	DA-23	13384	1.44
DA-06	26057	2.72	DA-24	19888	2.08
DA-07	20137	2.08	DA-25	16919	1.86
DA-08	44795	4.47	DA-26	25262	2.96
DA-09	30227	3.11	DA-27	40778	4.74
DA-10	29252	3.23	DA-28	26001	2.97
DA-11	54756	5.16	DA-29	18016	1.83
DA-12	42584	4.08	DA-30	13592	1.43
DA-13	19322	2.04	DA-31	32346	3.28
DA-14	51477	4.99	DA-32	14564	1.57
DA-15	20521	2.20	DA-33	11040	1.27
DA-16	45831	3.96	DA-34	23529	2.81
DA-17	24807	2.60	DA-35	18431	2.13
DA-18	22861	2.28			

5.0 Hydraulics

5.1 Culverts

For the proposed drainage system, sixteen new culverts will be installed to control the flow of stormwater. The culverts will be designed to convey the 50-year flow without overtopping the roadway. Three culvert locations are located in a FEMA AE Flood Zone. These culverts were sized using the 100-year flows from the Pinnacle Peak ADMS FLO-2D model since no 50-year flow values were available. The design of these culverts will ensure efficient drainage and minimize the risk of flooding in the area. See **Appendix C** for HY-8 culvert design output.

5.1.1 Existing Conditions

Eight existing culverts are located within the project limits crossing under Carefree Highway, and one additional culvert crosses Mountainside Drive near the intersection with Carefree Highway. See **Appendix C.1.1** for the existing culvert HY-8 results and **Table 5-1** for a summary of the existing culvert analysis. No survey was available for the analysis of culverts 5.5 and 8.5.

Table 5-1 Existing Culvert Summary

ID	Station	Design Q 100-yr	Headwater Elev (ft)	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1	129+98	15	2068.77	2.00	1.38	2.00	2.52	4.68	2.97
Mountainside	137+32	50	20280.52	0.95	1.19	1.62	1.85	3.7	3.37
4	150+95	48	2113.24	2.37	2.16	2.16	1.52	7.69	3.96
5.5	166+80	NO	SURVEY DATA						
6	168+75	23	2160.74	1.14	1.63	1.14	2.00	10.55	2.88
7	171+81	49	2168.11	1.52	2.19	1.52	1.54	12.2	3.98
8.5	180+10	NO	SURVEY DATA						
9	186+50	50	2196.46	2.00	2.30	3.00	2.98	7.07	4.19
10	192+24	100	2206.15	2.94	2.94	2.94	2.52	9.09	4.97
11	195+53	60	2210.95	2.28	2.33	2.28	1.76	8.12	4.25

5.1.2 New Culverts

All existing culverts will be replaced with new culverts, and additional culvert crossing locations have been identified for a total of sixteen new culverts required for drainage improvements. See **Appendix C.1.2** for the new culvert HY-8 results and **Table 5-2** for a summary of the new culvert analysis.

Table 5-2 New Culvert Summary

ID	Subbasin	Station	Design Q ₅₀ (cfs)	Headwater Elev (ft)	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (fps)	Tailwater Velocity (fps)
---	---	---								
1	BA-01	130+00	13	2066.04	0.69	1.03	1.50	2.24	4.67	2.90
2	BA-02	139+50	65	2089.18	1.12	1.66	1.13	1.22	11.79	4.62
3	FLO-2D Q	143+50	1138*	2100.06	1.72	2.93	1.83	2.13	15.56	8.74
4	BA-03	151+00	9.2	2111.14	0.82	1.08	0.82	0.93	7.63	3.05
5	FLO-2D Q	161+75	1792*	2141.29	2.05	3.42	2.26	2.80	15.852	11.70
6	BA-04	168+50	13	2160.14	0.71	1.30	0.73	0.72	12.42	4.13
7	BA-05	171+75	51	2168.07	2.05	2.32	2.07	0.99	9.82	6.72
8	BA-06	174+06	2.8	2170.88	0.42	0.58	0.42	0.13	5.89	1.68
9	BA-07	177+60	389	2180.01	2.34	2.64	2.37	2.23	10.25	7.94
10	BA-08	180+15	72	2182.50	3.50	2.66	2.66	1.22	9.18	4.60
11	BA-09	183+00	6.8	2186.20	0.93	0.92	0.92	0.47	4.79	2.71

12	BA-10	186+32	24	2195.39	1.12	1.73	1.15	0.85	12.82	4.72
13	BA-11	192+10	38	2207.30	1.36	2.08	1.42	1.08	13.24	4.70
14	BA-12	195+35	148	2208.50	2.18	2.20	2.18	2.04	8.50	4.81
15	BA-13	203+84	283	2228.11	1.99	3.39	2.26	2.71	15.63	7.79
16	FLO-2D Q	215+65	2362*	2243.49	1.85	4.11	2.36	4.24	19.98	9.19

*FLO-2D 100-year flow

5.2 Channels & Ditches

5.2.1 Channels

Due to the proposed roadway encroachment into the existing Cave Creek Unnamed Central Tributary Wash, channelization of the thalweg is proposed from STA 178+75 to 184+95 along the south side of the roadway to maintain the flow area and capacity of the wash. The channel section will have a 20-foot bottom width with 4:1 side slopes. Because the proposed improvement impacts the existing wash, a CLOMR is provided separately for review and approval by City of Scottsdale and FEMA. Once construction is complete, a LOMR will be prepared for review and approval as well.

5.2.2 Roadside Ditches

The storm water drainage system is comprised of 17 roadside ditches designed to effectively manage the flow of offsite and onsite storm water resulting from the roadway improvements. These ditches have been carefully designed to ensure that they are capable of handling the 50-year peak discharge for offsite flows and 10-year onsite flows where applicable. The design also takes into consideration the slope and the elevation of the land to ensure that the flow of water is efficient and effective. The ditches are constructed using a variety of durable and reliable materials to ensure that they can withstand the harsh weather conditions and mitigate erosion. Overall, the design of the storm water drainage system aims to minimize the risk of flooding and ensure that the surrounding areas are safe and free from any potential water-related hazards.

The proposed roadside v-ditch sections vary with side slopes ranging from 2:1 to 4:1. The ditches are designed to effectively manage runoff during heavy rain events, carrying them to the nearest adjacent cross culvert and back to the natural wash. The Manning's roughness coefficient used for the development of the channel design was 0.025 for an earthen channel, 0.049 for $d_{50}=3''$ riprap, 0.069 for $d_{50}=6''$ riprap, and 0.073 for $d_{50}=9''$ riprap. See **Appendix C** for the channel and ditch design and **Table 5-3** for a summary of the results.

Table 5-3 Roadside Ditch Design Summary

Ditch ID	Length	Manning's n	Left Side Slope	Right Side Slope	Channel Slope	Channel Depth	Bottom Width	Q ₅₀	V _{max}
---	(ft)		(_:1)	(_:1)	(ft/ft)	(ft)	(ft)	(cfs)	(fps)
EB Channel 1	143	0.025; 0.073	3	3	0.0507	2.00	12.0	55.75	4.47
EB Channel 2	290	0.049	3	3	0.0299	0.50	3.0	1.21	1.9
EB Channel 3	939	0.025; 0.049	3	3	0.0304	1.30	7.8	12.52	3.88
EB Channel 4	309	0.025; 0.049	3	3	0.0362	0.40	2.4	0.70	2.2
EB Channel 5	590	0.025; 0.049	3	3	0.0432	1.10	6.6	7.68	3.46

EB Channel 6	108	0.025; 0.049; 0.069	3	3	0.0667	1.30	7.8	14.90	3.72
EB Channel 7	785	0.025; 0.049	3	3	0.0309	1.30	7.8	14.63	3.59
WB Channel 1	447	0.025; 0.049	4	3	0.0409	0.80	5.6	6.03	3.34
WB Channel 1B	200	0.049	4	3	0.0473	1.00	7.0	10.02	3.71
WB Channel 2 Westbound	197	0.025; 0.049	4	3	0.0255	0.30	2.1	0.50	1.91
WB Channel 2 Eastbound	81	0.025; 0.049	4	3	0.0287	0.20	1.4	0.22	1.22
WB Channel 3	206	0.025; 0.049	4	3	0.0096	2.10	14.7	48.09	3.02
WB Channel 4 WB to STA 180+15 Culvert	285	0.049; 0.069	4	3	0.0586	1.50	10.5	21.95	3.78
WB Channel 4 WB to STA 183+00 Culvert	300	0.025; 0.049; 0.069	4	3	0.0592	0.90	6.3	5.93; 7.71	2.87
WB Channel 4 Eastbound	34	0.025	4	3	0.0077	0.30	2.1	0.60	1.54
WB Channel 5B Westbound	369	0.025; 0.049; 0.069	3	2	0.083	0.80	4.0	3.24	2.85
WB Channel 5B Eastbound	189	0.025; 0.049	3	2	0.0218	0.50	2.5	0.73	1.54
WB Channel 6	72	0.069; 0.073	4	3	0.0939	1.40	9.8	23.11	4.39
WB Channel 7	123	0.025; 0.049	4	3	0.0566	0.30	2.1	0.23	1.54
WB Channel 8 Westbound	813	0.049; 0.069	3	2.5	0.0746	0.80	4.4	3.94	2.83
WB Channel 8 Eastbound	40	0.049	3	2.5	0.0352	0.20	1.1	0.07	1.01

6.0 Storm Drain System

StormCAD was used to model the onsite and three offsite storm drain systems. The captured flows, calculated using the rational method, from the curb and inlets were input into the StormCAD model. StormCAD was used to model the storm drain system hydraulic grade line (HGL) accounting for friction loss, junctions, bends, transitions, manholes and backwater conditions at the outfalls. The HGL is maintained at least 1-foot below the top of pavement. Tailwater at the outlet is the crown of pipe. The storm drain inlets, storm drainpipes, manholes and outlet summary tables and profiles are provided in in **Appendix D**.

6.1 Storm Drain Mainline

Three primary storm drain mainline systems were developed at the east end of the project to convey onsite runoff to the Cave Creek Unnamed Tributary. Multiple other small onsite systems were developed to convey flow to the nearest cross culvert or tributary. There are also two offsite storm drain mainline systems designed to capture and convey offsite flows to the nearest cross culverts and back to the main wash. All storm drain pipes are concrete. See **Table 6-1** for a summary of the storm drain systems conveying onsite flows. See **Table 6-2** for a summary of the storm drain systems conveying offsite flows.

Table 6-1 Onsite Storm Drain Summary

Location	Pipe ID	Start Station	Offset	End Station	Offset	Q _{max}	Diameter
(---)	(---)	(---)	(ft)	(---)	(ft)	(cfs)	(in)
East of CBC 215+65	P-01	222+57.45	-42.7	222+57.05	15.5	1.7	18
	P-02	222+57.05	54.7	222+57.05	15.5	2	18
	P-03	222+57.05	15.5	221+52.24	15.5	3.7	24
	P-04	221+52.24	15.5	220+00.55	15.5	3.7	24
	P-05	220+00.55	-40.7	220+00.55	15.5	1.4	18
	P-06	220+00.55	15.5	218+18.58	15.5	5.1	24
	P-07	218+18.58	15.5	216+42.39	15.5	5.1	24
	P-08	216+26.26	-40.7	216+42.39	6.16	1.5	18
	P-09	216+42.39	6.2	216+42.39	15.50	5.3	18
	P-10	216+42.39	15.5	215+88.59	15.49	10.4	24
West of CBC 215+65	P-11	212+77.30	-42.0	212+92.85	-6.30	154.77	48
	P-12	212+92.85	-6.30	212+91.37	0.00	156.17	48
	P-13	212+89.98	40.7	212+88.51	2.45	1.6	18
	P-14	212+91.37	0.00	213.50.21	28.7	157.77	48
	P-15	213.50.21	28.7	215+11.31	58.19	157.77	48
East CBC 203+50	P-16	209+96.91	43.9	209+96.91	12.5	3.5	18
	P-17	209+96.91	12.5	208+33.96	12.5	3.5	24
	P-18	208+33.96	12.5	206+88.90	12.5	3.5	24
	P-19	206+88.90	12.5	205+56.94	12.5	3.5	24
	P-20	205+56.94	43.9	205+56.94	12.5	4.3	18
	P-21	205+56.94	12.5	203+79.430	12.48	7.8	24
202+07	P-22	202+23.56	38.8	202+23.56	61.24	3.3	18
198+24	P-23	198+33.28	6.3	198+33.28	62.16	0.62	18
West of CBC 195+35	P-24	194+97.61	-40.7	194+90.97	-4.67	0.37	18
	P-25	194+90.97	-4.7	194+90.97	4.5	2.47	18
	P-26	194+90.97	4.5	195+22.08	19.12	2.47	18
CBC 177+60	P-27	177+95.27	40.7	177+77.57	58.36	4.8	18
East of CBC 161+75	P-28	164+51.26	-47.4	164+51.23	-40.7	6	18
	P-29	164+51.23	-40.7	164+69.24	15.5	10.6	24
	P-30	164+69.24	40.7	164+69.24	15.5	4.1	18
	P-31	164+69.24	15.5	162+47.50	15.5	14.7	24
	P-32	162+47.50	15.5	162+41.94	22.05	14.7	24
West of RCP 151+00	P-33	157+08.13	-40.7	157+08.13	15.5	3.8	18
	P-34	157+08.13	15.5	153+96.03	15.5	3.8	24
	P-35	153+96.03	40.7	153+96.03	15.5	4.9	18
	P-36	153+96.03	15.5	151+12.13	15.53	8.7	24
122+10 to 127+23	P-37	127+34.04	53.0	127+34.03	40.67	1.2	18
	P-38	127+34.03	40.7	127+34.03	15.51	7.3	18
	P-39	127+34.03	15.5	122+07.64	15.45	7.3	24

	P-40	122+07.64	15.5	122+07.63	43.07	7.3	24
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Table 6-2 Offsite Storm Drain Summary

Location	Pipe ID	Start Station	Offset	End Station	Offset	Q _{max}	Diameter
(---)	(---)	(---)	(ft)	(---)	(ft)	(cfs)	(in)
East of CBC 215+65	CO-01	223+74.94	-50.8	222+37.19	-47.7	18.02	24
	CO-02	222+37.19	-47.744	220+74.92	-49.6	23.62	24
	CO-03	220+74.92	-49.631	219+30.14	-45.8	23.62	24
	CO-04	219+30.14	-45.778	218+18.49	-50.7	32.83	24
	CO-05	218+18.49	-50.656	216+51.83	-49.9	37.63	30
	CO-06	216+51.83	-49.873	215+85.89	-53.9	37.63	30
East CBC 203+50	CO-14	209+17.34	-47.743	208+30.67	-45.5	0.40	18
	CO-15	208+30.67	-45.453	207+59.95	-48.2	76.19	42
	CO-16	207+59.95	-48.193	206+79.93	-46.2	108.99	48
	CO-17	206+79.93	-46.192	205+19.76	-49	113.63	48
	CO-18	205+19.76	-49.002	204+18.68	-43.9	114.85	48

6.2 Catch Basins and Area Drains

The Carefree Highway project improvements include the addition of 6-inch curb and gutter along the length of the project. This requires new catch basins spaced along the curb to dewater the roadway by catching and conveying runoff to the proposed storm drain systems or to roadside ditches and channels. To adequately dewater the proposed roadway, 19 catch basins were required. All catch basins are curb opening catch basins (Type I) following MAG detail 542 with one or two wings. See **Table 6-3** for a summary of the catch basin design for the project. See **Appendix C.3.2** for a more comprehensive summary of the catch basin design.

Table 6-3 Catch Basin Design Summary

Inlet	Inlet Type ¹	Station	Offset	Inlet Total Opening Length	Captured Flow	Calculated Spread
(ID)			(ft)	(ft)	(cfs)	(ft)
Inlet-101	Curb opening (M-2)	222+58	+41	23	1.7	8.6
Inlet-102	Curb opening (M-2)	222+57	+53	23	2.0	9.4
Inlet-103	Curb opening (M-2)	220+01	+39	23	1.4	7.9
Inlet-104	Curb opening (M-1)	216+37	+39	20	1.5	6.3
Inlet-105	Curb opening (M-2)	216+37	+8	37	3.8	8.8

Inlet-106	Curb opening (M-1)	212+89	+8	20	1.4	5.9
Inlet-107	Curb opening (M-2)	212+90	+39	23	1.6	5.5
Inlet-108	Curb opening (M-2)	209+92	+42	37	3.5	8.0
Inlet-109	Curb opening (M-2)	205+39	+42	37	4.3	8.5
Inlet-110	Curb opening (M-2)	202+07	+37	37	3.3	10.7
Inlet-112	Curb opening (M-2)	198+24	+8	23	1.8	6.3
Inlet-113	Curb opening (M-2)	194+91	+39	23	1.8	10.6
Inlet-114	Curb opening (M-2)	194+91	+3	23	2.1	14.5
Inlet-120	Curb opening (M-2)	177+84	+39	37	4.8	13.9
Inlet-123	Curb opening (M-2)	164+69	+39	37	4.1	11.2
Inlet-124	Curb opening (M-2)	164+51	+39	37	4.6	11.7
Inlet-125	Curb opening (M-2)	156+96	+39	37	3.8	11.2
Inlet-126	Curb opening (M-2)	153+86	+39	37	4.9	12.0
Inlet-134	Curb opening (M-2)	127+23	+39	37	6.1	13.5

1) See MAG Detail 542

Multiple offsite area drains are required to capture offsite flow and convey it in pipes to existing culvert crossings. See **Table 6-4** for a summary of the area drain inlets and **Appendix C.3.3** for additional details pertaining to the area drain design.

Table 6-4 Area Drain Design Summary

Inlet (ID)	Inlet Type ¹	Station	Offset (ft)	Captured Flow (cfs)
OFFSITE INLET 1	Catch Basin Type G	223+75	-50.8	18.02
OFFSITE INLET 2	Catch Basin Type G	222+37	-47.8	5.60
OFFSITE INLET 3	Catch Basin Type G	219+30	-45.8	9.21
OFFSITE INLET 4	Catch Basin Type G	218+19	-50.5	4.80
OFFSITE INLET 5	ADOT SD 6.35	212+77	-44.7	-
OFFSITE INLET 6	Catch Basin Type G	209+17	-47.7	0.40
OFFSITE INLET 7	Catch Basin Type G	208+31	-45.4	75.79
OFFSITE INLET 8	Catch Basin Type G	207+60	-48.0	32.81
OFFSITE INLET 9	Catch Basin Type G	206+80	-46.2	4.64
OFFSITE INLET 10	Catch Basin Type G	205+20	-48.9	1.22

1) See MAG Detail 537

6.3 Scuppers

In addition to the catch basins, the roadway improvements also require 16 concrete scuppers located primarily along the west half of the project. Scuppers were used in place of catch basins at locations where roadway runoff could be drained directly into roadside ditches or nearby existing washes. The scupper design uses MAG detail 206 with a maximum curb opening length of 16 ft. See **Table 6-5** for a summary of the scupper design. See **Appendix C.3.2** for a more comprehensive summary of the scupper design.

Table 6-5 Scupper Design Summary

Inlet (ID)	Inlet Type ¹	Station	Offset (ft)	Inlet Total Opening Length (ft)	Captured Flow (cfs)	Calculated Spread (ft)
Inlet-111	OG Scupper	198+61	+39	16	1.1	5.5
Inlet-115	OG Scupper	190+64	+39	16	1.5	9.1
Inlet-116	OG Scupper	190+59	+39	16	1.8	10.0
Inlet-117	OG Scupper	186+95	+39	16	1.4	8.6
Inlet-118	OG Scupper	186+37	+39	16	1.8	10.1
Inlet-119	OG Scupper	180+59	+39	16	1.8	10.9
Inlet-121	OG Scupper	175+13	+39	16	2.0	9.9
Inlet-122	OG Scupper	168+58	+38	16	2.4	11.5
Inlet-127	OG Scupper	149+32	+38	16	1.9	10.2
Inlet-128	OG Scupper	146+05	+39	16	2.5	14.1
Inlet-129	OG Scupper	143+66	+39	16	2.1	13.0
Inlet-130	OG Scupper	140+92	+38	16	2.7	11.3
Inlet-131	OG Scupper	137+93	+39	16	1.8	10.3
Inlet-132	OG Scupper	135+75	+38	16	2.5	13.1
Inlet-133	OG Scupper	133+17	+39	16	2.1	10.9
Inlet-135	OG Scupper	119+38	+39	16	2.7	12.7

1) See MAG Detail 206

6.4 Spread

Spread requirements during the 10-year storm event are to provide a 12-ft dry lane in each direction. Bentley's FlowMaster CONNECT Edition was used to calculate spread at each catch basin location to verify that requirements were met. Tables 6-2 and 6-5 provide the spread width at each inlet. See Appendix C.3.5 for a summary of the FlowMaster calculations.

7.0 Erosion Protection

Erosion protection is necessary where velocities within a ditch, channel, scupper, inlets and outlets of a culvert and outlets for storm drains exceed the natural ability of the native and/or engineered soil to resist erosion. Erosion protection generally performs two functions. The first is to prevent erosion while the second is to act as an energy dissipater to reduce velocities to non-erosive levels.

7.1 Culverts

Culvert inlet and outlet velocities dictate the need for erosion protection. If the flow velocities entering and/or exiting the culverts exceed the permissible flow velocity determined by the existing conditions soil characteristics, then erosion protection is necessary to prevent scour of the up and downstream wash beds.

Erosion protection measures have been determined for the proposed condition culverts using the results of the Federal Highway Administration's HY-8 culvert models and the District's River Mechanic's module and DDMS/W software. The design of the culvert riprap aprons is summarized below in **Table 7.1**. See **Appendix D** for more extensive calculations and program results.

Table 7-1 Culvert Riprap Apron Summary

Station	Type	Material	Dimensions	Discharge (cfs)	Outlet Velocity ¹ (fps)	Calculated ² Rock D ₅₀ (ft)	Design Rock D ₅₀ (in)	Apron Thickness (ft)	Apron Width (ft)	Apron Length (ft)
130+00	Arch	concrete	28.5"x18"	15	5.38	0.77	9	1.8	7.1	12.5
139+50	Pipe	concrete	3-24"	65	11.79	3.69				
143+50	Box	concrete	4-10'x4'	1138	15.56	6.42				
151+00	Pipe	concrete	24"	9.2	7.63	1.54	18	3.0	6.0	14.0
161+75	Box	concrete	5-10'x4'	1792	15.82	6.64				
168+50	Pipe	concrete	24"	13	12.42	4.09				
171+75	Pipe	concrete	36"	51	9.82	2.56				
174+06	Pipe	concrete	24"	2.8	5.89	0.92	12	2.2	6.0	12.0
177+60	Box	concrete	2-8'x4'	389	10.25	2.79				
180+15	Pipe	concrete	42"	72	9.18	2.23				
183+00	Pipe	concrete	24"	6.8	4.79	0.61	9	1.8	6.0	10.0
186+32	Pipe	concrete	24"	24	12.82	4.36				
192+10	Pipe	concrete	30"	38	13.24	4.65				
195+35	Box	concrete	1-8'x3'	148	8.50	1.92	24	4.0	12.0	16.0
203+84	Box	concrete	1-8'x4'	283	15.63	6.48				
215+65	Box	concrete	5-10'x6'	2362	19.98	10.59				

- 1) Culvert output from HY-8 models
- 2) Calculations from FCDMC's DDMSW-River Mechanics - Riprap
- 3) Riprap Apron Dimensions from FCDMC Manual, Volume II, Chapter 8

As presented above, there are locations identified in Table 7.1 showing high flow velocities which are not suited to the design of riprap erosion protection as indicated by the need for very large rock (D50). In these locations other measures could be employed including:

- Concrete aprons (with or without energy dissipators)
- Grouted Rock
- Gabions
- other channel liners (multiple products exist), and
- a combination of solution types

7.2 Ditches and Channels

Velocities along the wash range from 6-10 fps and the thalweg runs right along the southern roadway embankment between STA 178+75 to 184+95. Erosion protection is proposed along the

right bank of the wash and south embankment of the roadway from STA 177+35 to 204+59, with both d50=12" and 18" sizes depending on the velocities in the wash. A summary of the riprap proposed along the wash is provided in Appendix C.2.1.

For ditches where velocities exceed 5 fps, per City of Scottsdale DSPM, or if the flows are supercritical, loose riprap erosion protection is proposed. Riprap sizes range from d50=3" to 9", depending on the slope and velocities of the ditch. A summary of the ditch design, including riprap for each ditch, is provided in Appendix C.2.2.

8.0 Flood Hazard Mitigation Measures

The widening of Carefree Highway and the addition of a multi-use path on the south side of the roadway encroaches on the Cave Creek Unnamed Central Tributary. The Tributary is a FEMA Zone AE floodplain. A Conditional Letter of Map Revision (CLOMR) will be provided in the preliminary drainage report at 60% to ensure no rise in the floodwater elevations.

9.0 Utility Conflicts

No potholes were obtained for this project. No utility conflicts are expected.

10.0 Conclusion

Onsite and offsite hydrology was analyzed to determine the impact of the Carefree Highway project improvements.

- Sixteen new culverts will be installed to control the flow of stormwater, replacing all existing culverts and improving the efficiency of the drainage system.
- Roadside and median ditches will be placed to convey runoff to roadway culverts.
- The roadway improvements include the addition of roll curbs requiring curb and median catch basins along the length of the project. All runoff collected in the catch basins will be conveyed to roadside ditches and channels and downstream culvert crossings.
- Two storm drain mainline systems at the east end of the project will collect onsite runoff and convey it to the Cave Creek Unnamed Tributary. Three offsite storm drain mainline systems capture and convey offsite flows to the nearest cross culverts.
- The widening of Carefree Highway encroaches on the Zone AE floodplain of the tributary and a LOMR will be provided in the preliminary drainage report at 60% to ensure no rise in floodplain elevations.

11.0 References

1. Bentley Systems, Inc., FlowMaster, V10.03, 2020.
2. Bentley Systems, Inc., StormCAD V10.03, 2021.
3. Carefree Highway (Cave Creek Road to Scottsdale Road) FLO-2D Results. Flood Control District of Maricopa County.
4. City of Scottsdale Design Standards and Manual, December 2018.
5. Drainage Policies and Standards for Maricopa County, Arizona. Flood Control District of Maricopa County. August 22, 2018.

6. Drainage Design Manual for Maricopa County, Arizona, Volume I – Hydrology, Flood Control District of Maricopa County. December 2018.
7. Drainage Design Manual for Maricopa County, Arizona, Volume II – Hydraulics, Flood Control District of Maricopa County. December 2018.
8. Flood Insurance Study 04013CV002F, Maricopa County, Arizona and Incorporated Areas. Federal Emergency Management Agency. February 8, 2024.
9. Precipitation-Frequency Atlas of the United States, NOAA Atlas 14, Volume 1, Version 5, G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley, NOAA, National Weather Service, Silver Spring, Maryland, 2006.
10. FEMA FIRM Panel **04013C0891M & 04013C0890M**. FEMA Map Service Center.
<https://msc.fema.gov>

APPENDIX A

FEMA Special Flood Hazard Areas

National Flood Hazard Layer FIRMMette



111°57'50"W 33°48'15"N



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

1:6,000

111°57'12"W 33°47'45"N

Basemap Imagery Source: USGS National Map 2023

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 Zone AE, AO, AH, VE, AR
		Regulatory Floodway
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
GENERAL STRUCTURES		Area of Undetermined Flood Hazard Zone D
		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
MAP PANELS		Digital Data Available
		No Digital Data Available
		Unmapped



The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

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

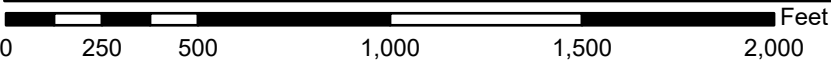
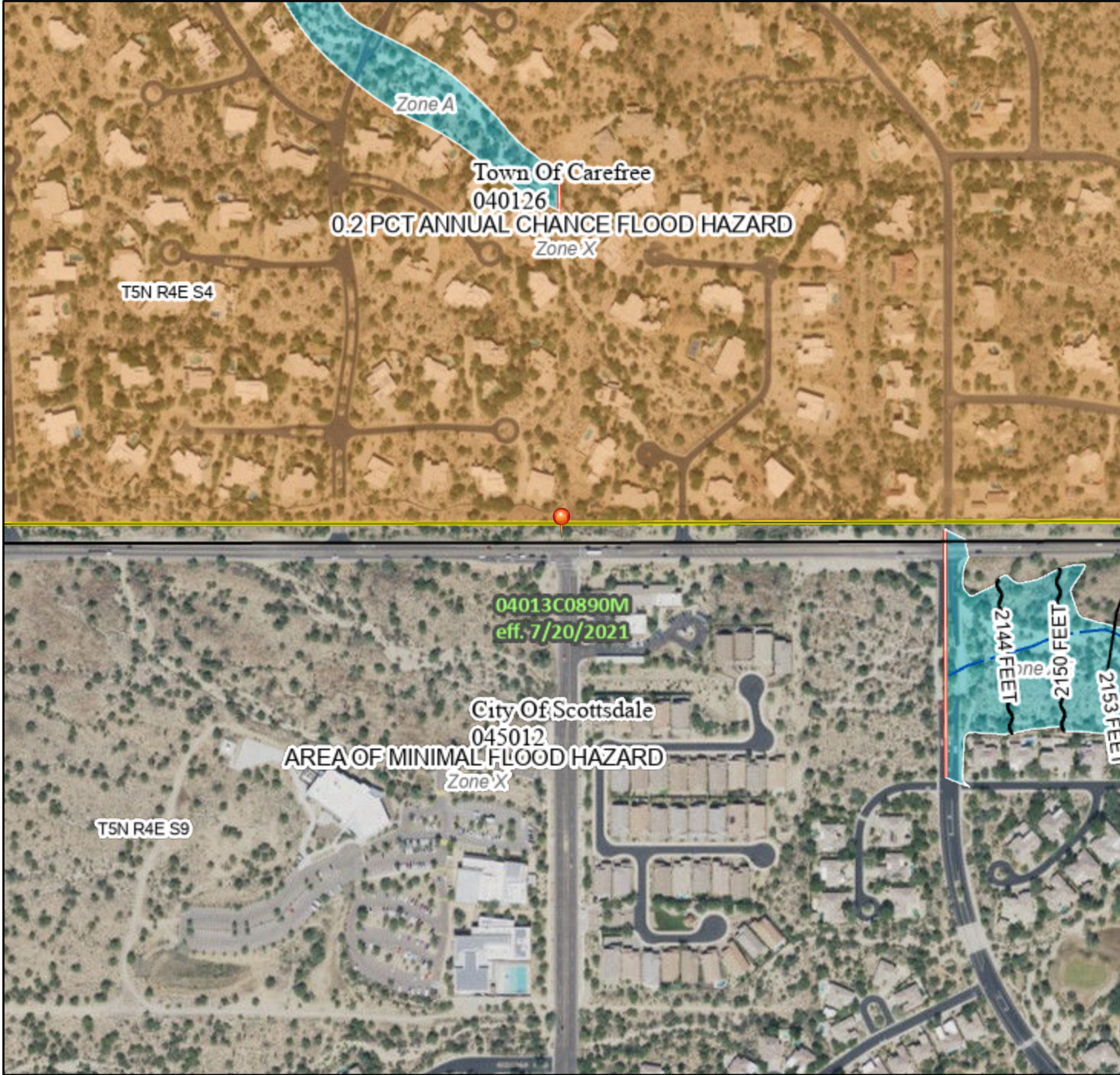
The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 6/14/2023 at 2:29 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap 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.

National Flood Hazard Layer FIRMMette



111°57'26"W 33°48'12"N



1:6,000

111°56'49"W 33°47'42"N

Basemap Imagery Source: USGS National Map 2023

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 Zone AE, AO, AH, VE, AR
		Regulatory Floodway
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
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		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
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		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
MAP PANELS		Coastal Transect Baseline
		Profile Baseline
		Hydrographic Feature
		Digital Data Available
		No Digital Data Available
		Unmapped



The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

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

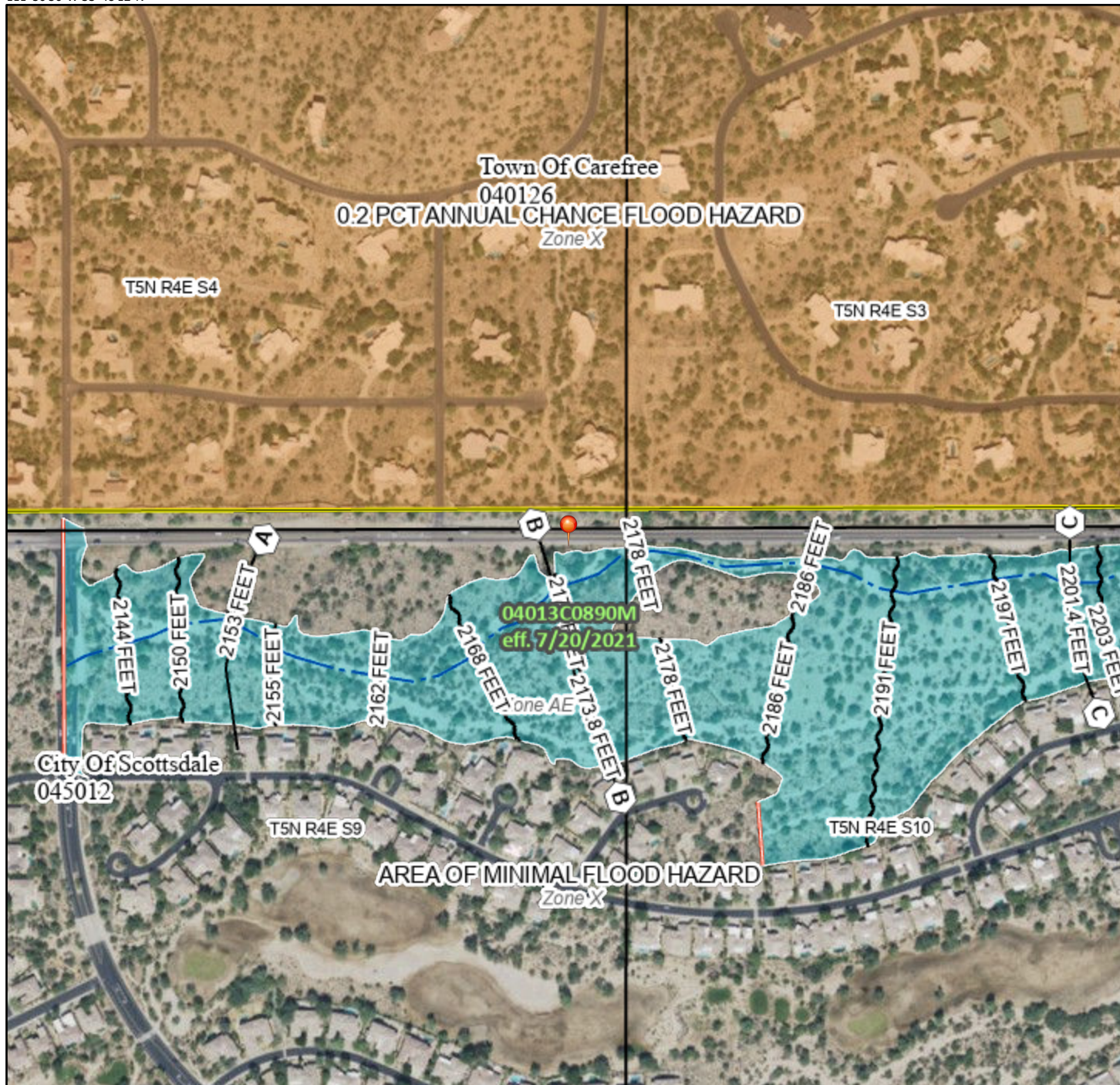
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National Flood Hazard Layer FIRMMette



111°56'56"W 33°48'12"N



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

1:6,000

111°56'19"W 33°47'42"N

Basemap Imagery Source: USGS National Map 2023

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 Zone AE, AO, AH, VE, AR
		Regulatory Floodway
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
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		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
MAP PANELS		Coastal Transect Baseline
		Profile Baseline
		Hydrographic Feature
		Digital Data Available
		No Digital Data Available
		Unmapped



The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

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

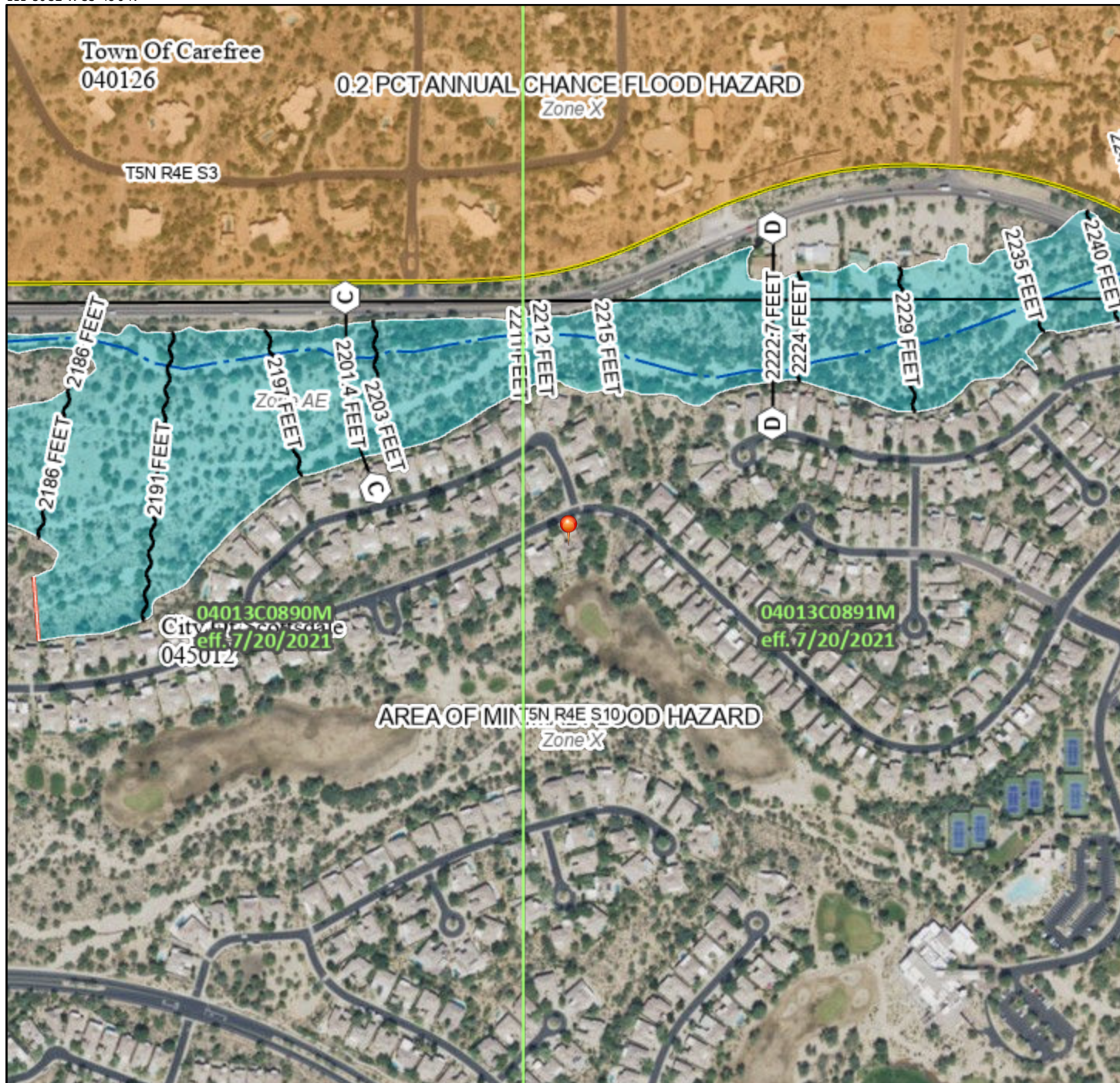
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National Flood Hazard Layer FIRMette



111°56'32"W 33°48'6"N



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

1:6,000

111°55'55"W 33°47'36"N

Basemap Imagery Source: USGS National Map 2023

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 Zone AE, AO, AH, VE, AR
		Regulatory Floodway
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
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		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
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		Effective LOMRs
GENERAL STRUCTURES		Area of Undetermined Flood Hazard Zone D
		Channel, Culvert, or Storm Sewer
OTHER FEATURES		Levee, Dike, or Floodwall
		Cross Sections with 1% Annual Chance Water Surface Elevation
MAP PANELS		Coastal Transect
		Base Flood Elevation Line (BFE)
OTHER FEATURES		Limit of Study
		Jurisdiction Boundary
OTHER FEATURES		Coastal Transect Baseline
		Profile Baseline
OTHER FEATURES		Hydrographic Feature
		Digital Data Available
MAP PANELS		No Digital Data Available
		Unmapped



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

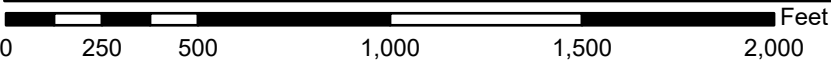
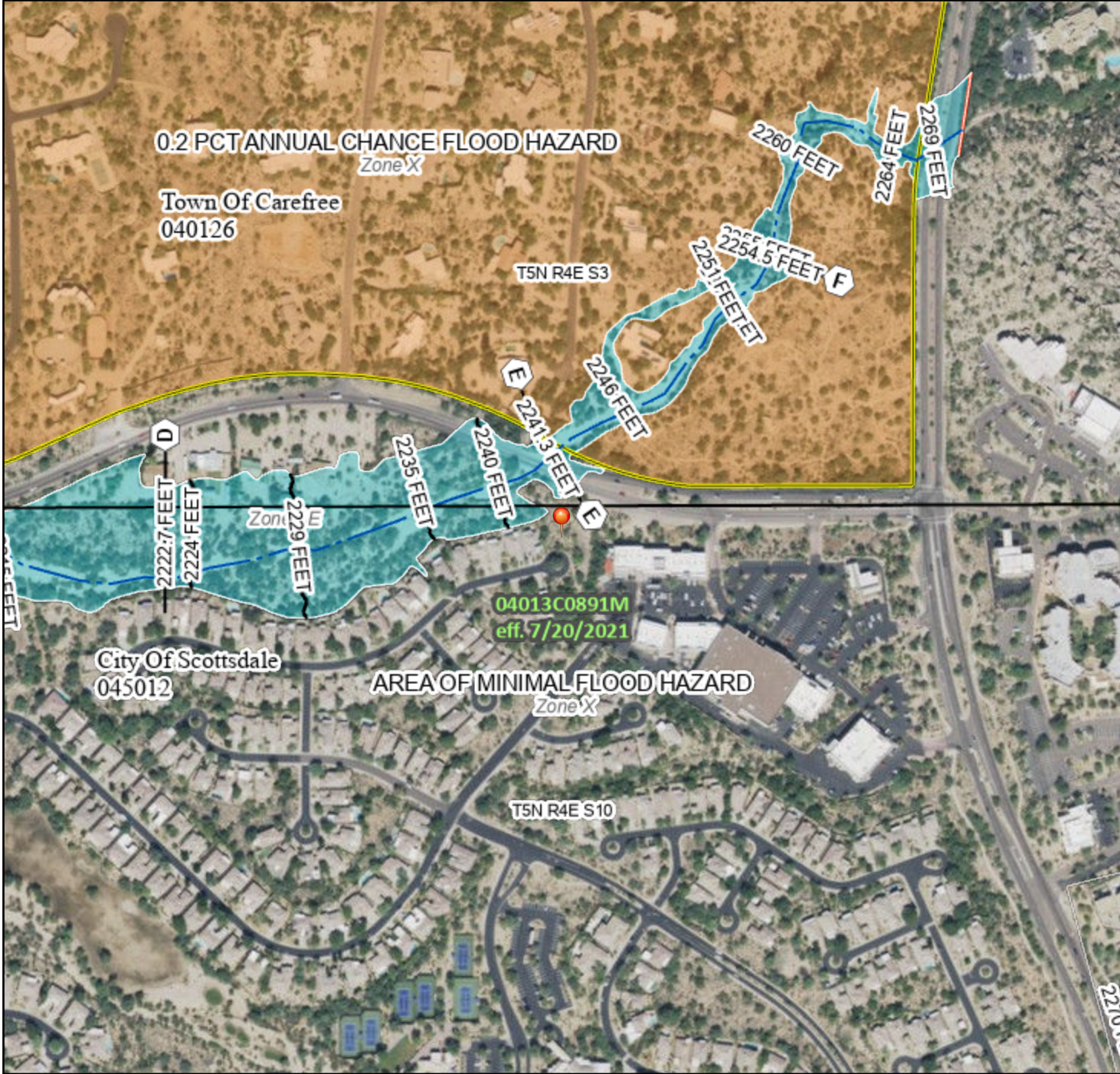
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National Flood Hazard Layer FIRMette



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1:6,000

111°55'35"W 33°47'42"N

Basemap Imagery Source: USGS National Map 2023

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 Zone AE, AO, AH, VE, AR
		Regulatory Floodway
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
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OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
MAP PANELS		Coastal Transect Baseline
		Profile Baseline
		Hydrographic Feature
		Digital Data Available
		No Digital Data Available
		Unmapped



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APPENDIX B

Hydrology

B.1 Previous Hydrology Studies

FLOOD INSURANCE STUDY

VOLUME 2 OF 58



MARICOPA COUNTY, ARIZONA AND INCORPORATED AREAS

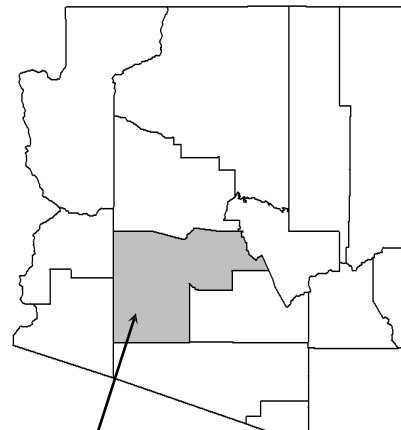
COMMUNITY NAME

AVONDALE, CITY OF
BUCKEYE, CITY OF
CAREFREE, TOWN OF CAVE
CREEK, TOWN OF
CHANDLER, CITY OF
EL MIRAGE, CITY OF
FOUNTAIN HILLS, TOWN OF
GILA BEND, TOWN OF
GILBERT, TOWN OF
GLENDALE, CITY OF
GOODYEAR, CITY OF
GUADALUPE, TOWN OF
LITCHFIELD PARK, CITY OF
MARICOPA COUNTY
(UNINCORPORATED AREAS)
MESA, CITY OF
PARADISE VALLEY, TOWN OF
PEORIA, CITY OF
PHOENIX, CITY OF
QUEEN CREEK, TOWN OF
SCOTTSDALE, CITY OF
SURPRISE, CITY OF
TEMPE, CITY OF
TOLLESON, CITY OF
WICKENBURG, TOWN OF
YOUNGTOWN, TOWN OF

COMMUNITY NUMBER

040038
040039
040126
040129
040040
040041
040135
040043
040044
040045
040046
040111
040128

040037
040048
040049
040050
040051
040132
045012
040053
040054
040055
040056
040057



Maricopa County

REVISED
February 8, 2024



Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
04013CV002F

Table 3. Summary of Discharges

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (Sq. Miles)	PEAK DISCHARGES (cfs)			
		10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
Cave Creek Tributary 1C					
At the confluence with Cave Creek Tributary 1	0.36	-- ¹	-- ¹	933	-- ¹
At the confluence with Cave Creek Tributary 1D	0.26	-- ¹	-- ¹	650	-- ¹
Cave Creek Tributary 1D					
At the confluence with Cave Creek Tributary 1C	0.1	-- ¹	-- ¹	283	-- ¹
Cave Creek Unnamed Central Tributary					
Approximately 300 feet upstream of Terravita Sunset Trail	2.44	-- ¹	-- ¹	2,849	-- ¹
Cave Creek Wash					
At confluence with Arizona Canal Diversion Channel ²	34.7	10,300	16,100	18,500	-- ¹
Downstream of confluence with Moon Valley Wash ²	33.1	10,100	15,300	17,500	-- ¹
Downstream of confluence with East Fork of Cave Creek ²	22.5	3,100	8,700	11,000	25,000
Downstream of Loop 101 ²	5	-- ¹	-- ¹	5,500	-- ¹
Upstream of Loop 101 ²	4.97	-- ¹	-- ¹	3,300	-- ¹
Upstream of Deer Valley Road ²	4.5	-- ¹	-- ¹	3,090	-- ¹
Downstream of CAP Canal ²	4.11	-- ¹	-- ¹	2,880	-- ¹
Upstream of CAP Canal ²	-- ¹	-- ¹	-- ¹	4,900	-- ¹
Upstream of Cave Buttes Dam Ponding Area	142.5	-- ¹	-- ¹	38,200	-- ¹
Upstream of confluence with Minor Tributary	137.9	-- ¹	-- ¹	36,800	-- ¹
At Carefree Highway	124.4	-- ¹	-- ¹	33,800	-- ¹
Downstream of New River Road	118.1	-- ¹	-- ¹	31,400	-- ¹
Near Andora Hills Wash Drive	115	-- ¹	-- ¹	31,200	-- ¹
Downstream of confluence with Andora Hills Wash	112.2	-- ¹	-- ¹	30,900	-- ¹
Downstream of confluence with Galloway Wash	91.4	-- ¹	-- ¹	24,700	-- ¹
Downstream of confluence with Willow Springs Wash	86	-- ¹	-- ¹	24,700	-- ¹

--¹ Data Not Computed--² Data Not Available

FLOOD INSURANCE STUDY

VOLUME 20 OF 58



MARICOPA COUNTY, ARIZONA AND INCORPORATED AREAS

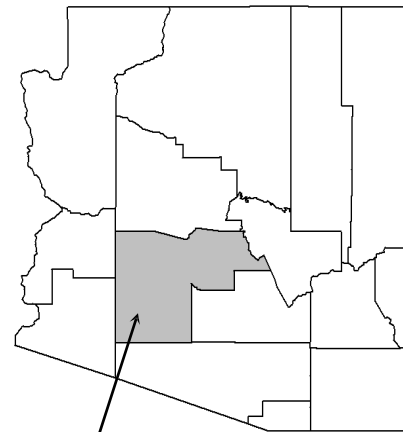
COMMUNITY NAME

AVONDALE, CITY OF
BUCKEYE, CITY OF
CAREFREE, TOWN OF CAVE
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FOUNTAIN HILLS, TOWN OF
GILA BEND, TOWN OF
GILBERT, TOWN OF
GLENDALE, CITY OF
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MESA, CITY OF
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QUEEN CREEK, TOWN OF
SCOTTSDALE, CITY OF
SURPRISE, CITY OF
TEMPE, CITY OF
TOLLESON, CITY OF
WICKENBURG, TOWN OF
YOUNGTOWN, TOWN OF

COMMUNITY NUMBER

040038
040039
040126
040129
040040
040041
040135
040043
040044
040045
040046
040111
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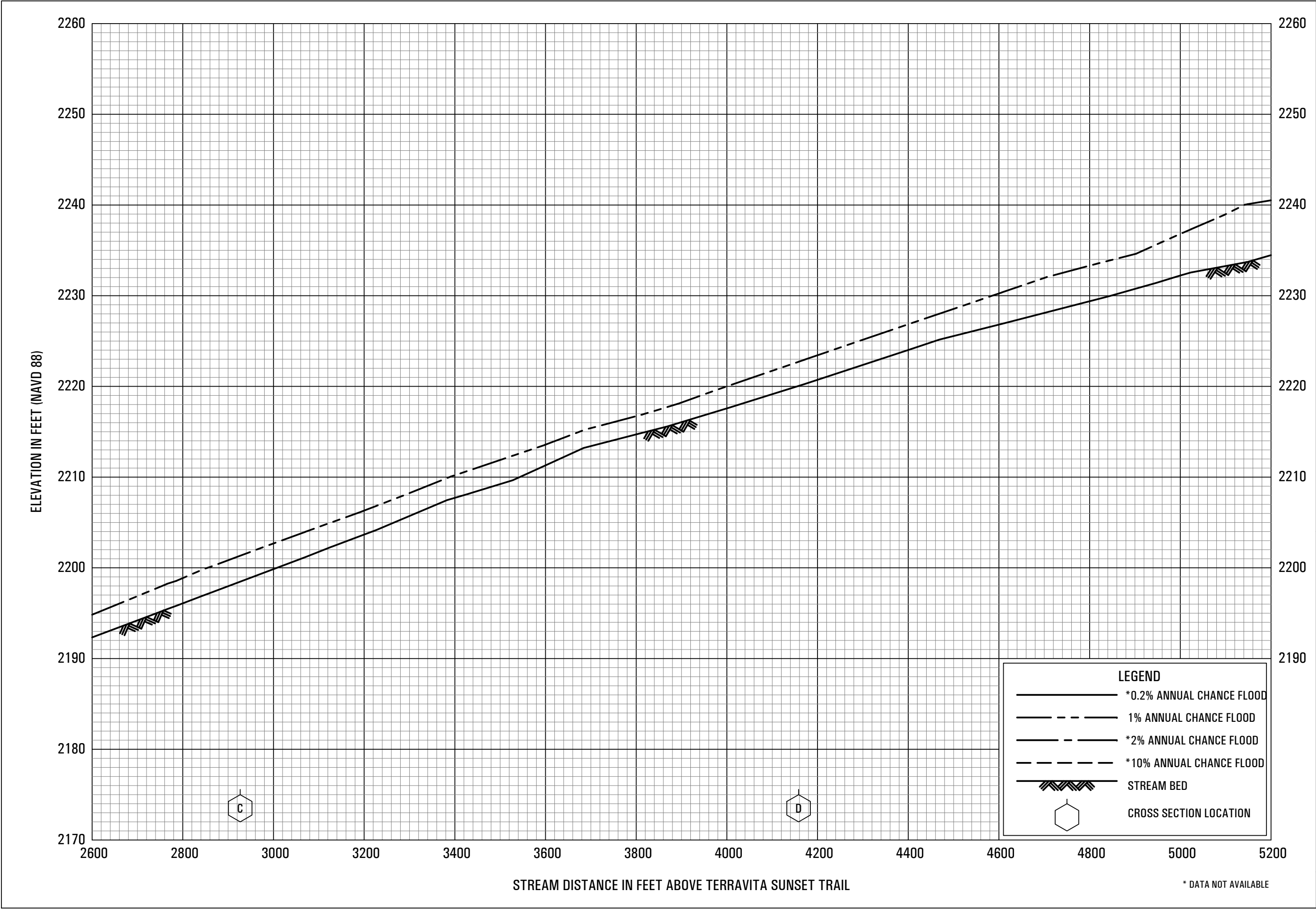
Maricopa County

REVISED
February 8, 2024



Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
04013CV020F



Project: Carefree Highway (Cave Creek Road to Scottsdale Road)

Project Length: 2.1 miles

FLO-2D Results: FCDMC studies

- Pinnacle Peak West - Whisper Rock
- Pinnacle Peak West - Tatum Ranch

FLO-2D zone AE floodplain. Cross Section located 50-ft upstream of Terravita Way. Box culvert (north) and dip crossing (south) convey flow across Terravita Way (constitutes flow split) northwest and west of concentration point.

- Cross Section Number: 2
- Direction: west(4)
- Start Grid: 34,079
- End Grid: 26,060
- Length: 440.0 ft
- Maximum Discharge (cfs): 2,648.4
- Time of max. Discharge (hrs): 12.17
- Split flow (measured from FLO-2D results) NW: 1,792 cfs W: 1,138 cfs

FLO-2D zone AE floodplain. Cross section located 350-ft downstream of Carefree Highway (1,100-ft west of Scottsdale Road). Existing crossing of Carefree Hwy is dip crossing.

- Cross Section Number: 37
- Direction: southwest (7)
- Start Grid: 65,850
- End Grid: 59,242
- Length: 282.8 ft
- Maximum Discharge (cfs): 2,362.0
- Time of max. Discharge (hrs): 12.14

Carefree Highway Grid Summation (taken along roadway alignment)

- Length: 316.8 ft
- Maximum Discharge (cfs): 1,570.1

B.2 Precipitation Data



POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps_&_aerials](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	2.75 (2.28-3.35)	3.56 (2.99-4.37)	4.81 (3.98-5.87)	5.77 (4.75-7.01)	7.04 (5.71-8.52)	8.02 (6.43-9.65)	9.01 (7.12-10.8)	10.0 (7.81-12.0)	11.4 (8.66-13.7)	12.4 (9.28-15.0)
10-min	2.09 (1.73-2.55)	2.71 (2.27-3.32)	3.66 (3.03-4.47)	4.39 (3.61-5.33)	5.36 (4.35-6.49)	6.10 (4.89-7.34)	6.86 (5.41-8.23)	7.63 (5.94-9.15)	8.65 (6.59-10.4)	9.47 (7.06-11.4)
15-min	1.72 (1.44-2.11)	2.24 (1.88-2.74)	3.03 (2.50-3.69)	3.63 (2.98-4.40)	4.43 (3.59-5.36)	5.04 (4.04-6.07)	5.67 (4.47-6.80)	6.30 (4.91-7.56)	7.15 (5.44-8.60)	7.82 (5.84-9.44)
30-min	1.16 (0.966-1.42)	1.51 (1.26-1.85)	2.04 (1.69-2.49)	2.44 (2.01-2.97)	2.98 (2.42-3.61)	3.40 (2.72-4.08)	3.82 (3.01-4.58)	4.24 (3.31-5.09)	4.82 (3.67-5.79)	5.27 (3.93-6.36)
60-min	0.719 (0.598-0.878)	0.934 (0.781-1.14)	1.26 (1.04-1.54)	1.51 (1.24-1.84)	1.85 (1.50-2.23)	2.10 (1.69-2.53)	2.36 (1.86-2.83)	2.63 (2.05-3.15)	2.98 (2.27-3.58)	3.26 (2.43-3.94)
2-hr	0.420 (0.354-0.502)	0.540 (0.456-0.650)	0.718 (0.604-0.860)	0.856 (0.712-1.02)	1.04 (0.857-1.24)	1.18 (0.962-1.41)	1.33 (1.07-1.58)	1.48 (1.17-1.75)	1.68 (1.30-1.99)	1.84 (1.40-2.19)
3-hr	0.300 (0.253-0.363)	0.383 (0.325-0.464)	0.499 (0.422-0.604)	0.592 (0.496-0.713)	0.721 (0.595-0.863)	0.824 (0.672-0.982)	0.931 (0.747-1.11)	1.04 (0.824-1.24)	1.20 (0.922-1.43)	1.33 (0.996-1.58)
6-hr	0.178 (0.155-0.209)	0.224 (0.195-0.264)	0.285 (0.247-0.333)	0.333 (0.286-0.389)	0.400 (0.339-0.465)	0.453 (0.379-0.524)	0.508 (0.418-0.587)	0.564 (0.456-0.653)	0.640 (0.505-0.741)	0.699 (0.540-0.811)
12-hr	0.104 (0.091-0.121)	0.131 (0.115-0.153)	0.165 (0.143-0.191)	0.192 (0.165-0.221)	0.228 (0.194-0.262)	0.256 (0.216-0.294)	0.284 (0.237-0.327)	0.313 (0.258-0.360)	0.352 (0.283-0.406)	0.381 (0.301-0.443)
24-hr	0.059 (0.052-0.068)	0.075 (0.067-0.086)	0.098 (0.087-0.112)	0.117 (0.102-0.133)	0.143 (0.124-0.164)	0.165 (0.141-0.189)	0.188 (0.158-0.217)	0.212 (0.175-0.248)	0.247 (0.199-0.293)	0.276 (0.217-0.332)
2-day	0.034 (0.029-0.039)	0.043 (0.037-0.049)	0.056 (0.049-0.064)	0.067 (0.058-0.077)	0.082 (0.071-0.094)	0.095 (0.080-0.109)	0.108 (0.090-0.125)	0.122 (0.100-0.143)	0.141 (0.113-0.168)	0.157 (0.123-0.190)
3-day	0.024 (0.021-0.027)	0.030 (0.026-0.035)	0.040 (0.035-0.045)	0.048 (0.042-0.054)	0.059 (0.051-0.067)	0.068 (0.058-0.079)	0.079 (0.066-0.091)	0.089 (0.074-0.105)	0.105 (0.084-0.125)	0.117 (0.092-0.142)
4-day	0.019 (0.016-0.021)	0.024 (0.021-0.027)	0.032 (0.028-0.036)	0.038 (0.033-0.043)	0.048 (0.041-0.054)	0.055 (0.047-0.063)	0.064 (0.054-0.074)	0.073 (0.060-0.086)	0.086 (0.070-0.103)	0.098 (0.077-0.118)
7-day	0.012 (0.011-0.014)	0.016 (0.014-0.018)	0.021 (0.018-0.024)	0.025 (0.022-0.028)	0.031 (0.027-0.036)	0.037 (0.031-0.042)	0.042 (0.035-0.049)	0.048 (0.040-0.057)	0.058 (0.046-0.069)	0.065 (0.051-0.080)
10-day	0.009 (0.008-0.011)	0.012 (0.011-0.014)	0.016 (0.014-0.018)	0.019 (0.017-0.022)	0.024 (0.021-0.027)	0.028 (0.024-0.032)	0.032 (0.027-0.037)	0.037 (0.030-0.043)	0.043 (0.035-0.052)	0.049 (0.038-0.060)
20-day	0.006 (0.005-0.007)	0.008 (0.007-0.009)	0.010 (0.009-0.011)	0.012 (0.010-0.014)	0.015 (0.013-0.017)	0.017 (0.014-0.019)	0.019 (0.016-0.022)	0.022 (0.018-0.025)	0.025 (0.020-0.030)	0.028 (0.022-0.033)
30-day	0.005 (0.004-0.005)	0.006 (0.005-0.007)	0.008 (0.007-0.009)	0.009 (0.008-0.011)	0.012 (0.010-0.013)	0.013 (0.011-0.015)	0.015 (0.013-0.017)	0.017 (0.014-0.019)	0.019 (0.016-0.023)	0.021 (0.017-0.025)
45-day	0.004 (0.003-0.004)	0.005 (0.004-0.005)	0.006 (0.006-0.007)	0.007 (0.007-0.008)	0.009 (0.008-0.010)	0.010 (0.009-0.012)	0.012 (0.010-0.013)	0.013 (0.011-0.015)	0.015 (0.012-0.018)	0.016 (0.013-0.020)
60-day	0.003 (0.003-0.004)	0.004 (0.004-0.005)	0.005 (0.005-0.006)	0.006 (0.005-0.007)	0.007 (0.007-0.008)	0.008 (0.007-0.010)	0.009 (0.008-0.011)	0.010 (0.009-0.012)	0.012 (0.010-0.014)	0.013 (0.011-0.015)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

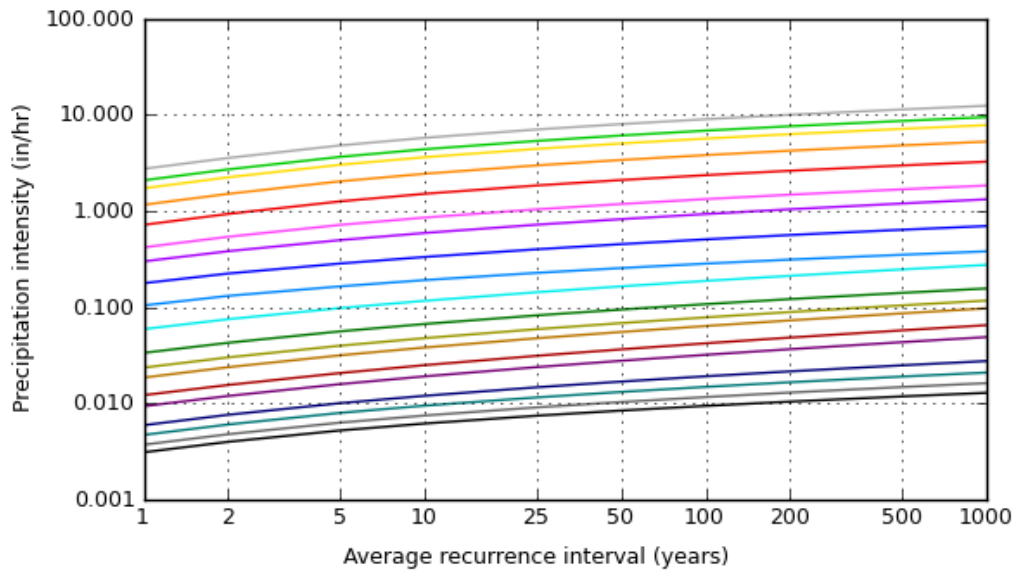
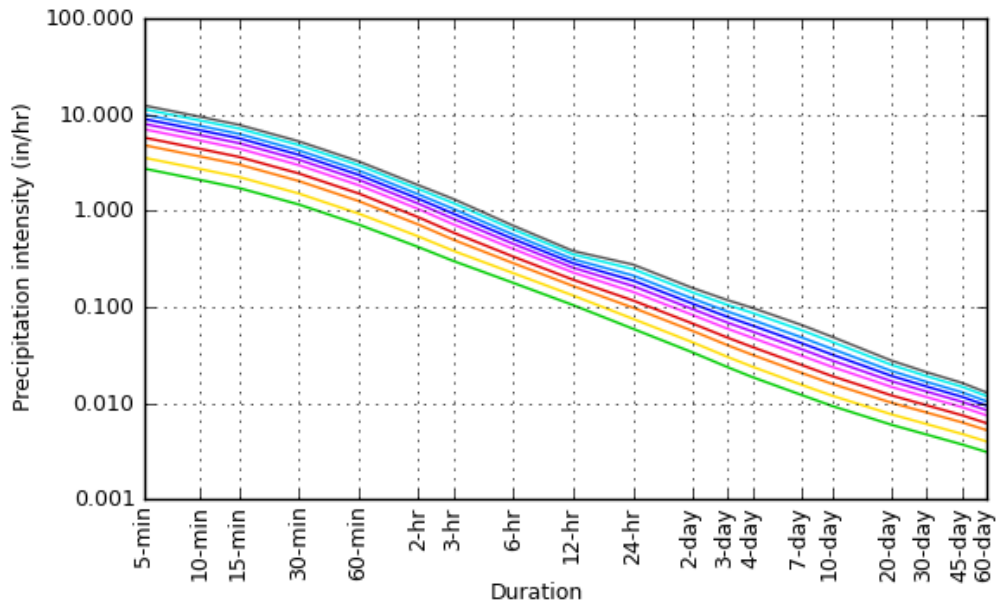
Please refer to NOAA Atlas 14 document for more information.

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PF graphical

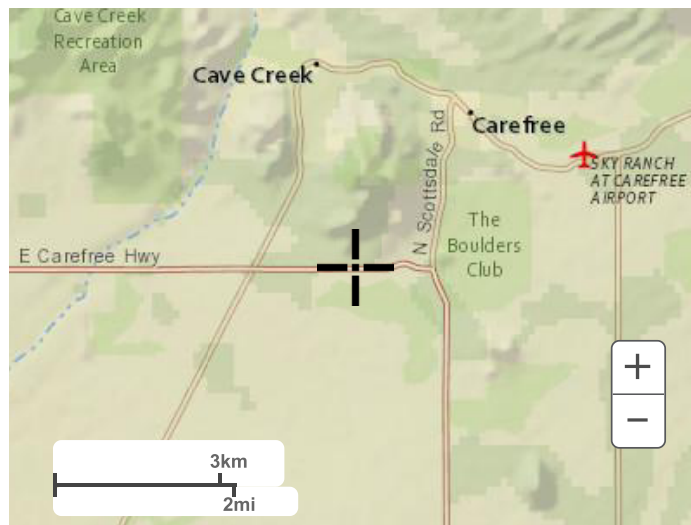
PDS-based intensity-duration-frequency (IDF) curves

Latitude: 33.7993°, Longitude: -111.9434°



Maps & aerials

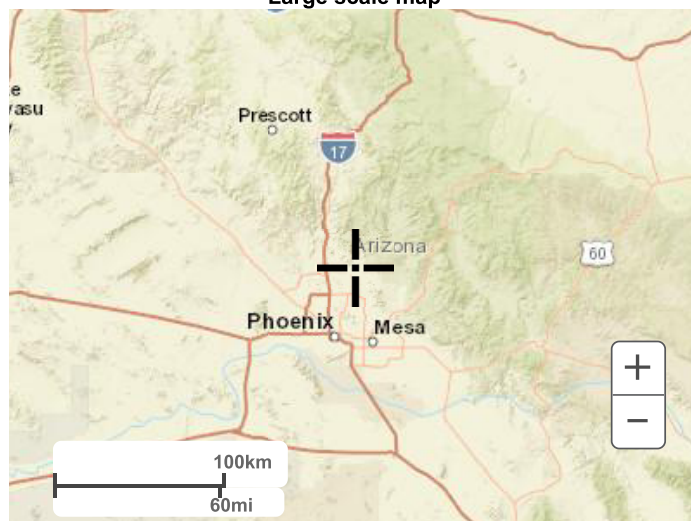
Small scale terrain



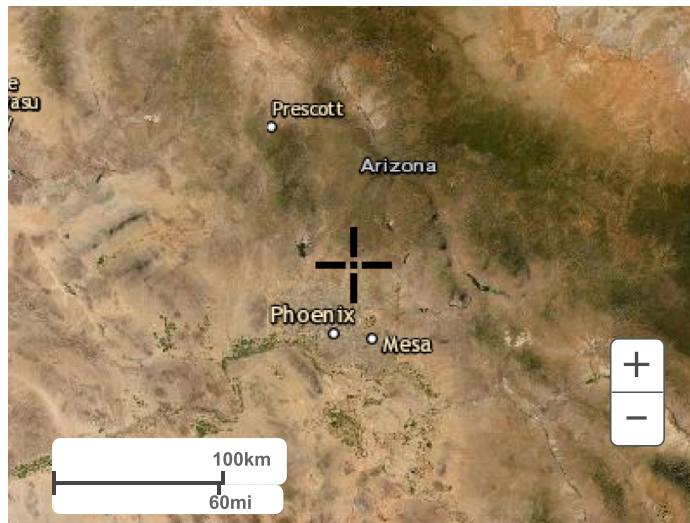
Large scale terrain



Large scale map



Large scale aerial



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B.3 Offsite Rational Method Calculations

Project: Carefree Hwy - Cave Creek Rd to Scottsdale Rd
Location: Carefree, Arizona
Date: May 7, 2024
Subject: 10-Year Rational Flow Calculations

Proj. Number: 3010.0100309
Proj. Engineer: L. Thiele
Checker: L. Vick

Source: Effective Maricopa County Drainage Policies and Standards Manual, 2018

Subbasin	Culvert Station	C	Tc	L	m	b	Kb	Elev	Elev	S	i	Tc (Calc)	Tc (Calc)	A	Q	Slope
			(min)	(mi)				Start	End	(ft/mi)	(in/hr)	(hrs)	(min)	(ac)	(cfs)	(ft/ft)
Carefree Highway																
BA-01	129+98	0.37	10	0.207	-0.01375	0.080	0.071	2094.00	2068.00	125.5	4.39	0.167	10	4.75	7.7	0.0238
BA-02	139+43	0.50	12	0.433	-0.00979	0.059	0.046	2136.00	2086.00	115.4	4.01	0.206	12	19.19	38.5	0.0219
BA-03	150+95	0.40	11	0.244	-0.01325	0.077	0.071	2143.00	2112.00	127.1	4.18	0.183	11	3.26	5.4	0.0241
BA-04	168+50	0.42	8	0.116	-0.02500	0.150	0.136	2188.00	2161.00	232.5	4.74	0.141	8	3.65	7.3	0.0440
BA-05	171+75	0.48	13	0.393	-0.02677	0.168	0.136	2370.00	2166.00	519.4	3.86	0.218	13	14.70	27.5	0.0984
BA-06	174+05	0.42	7	0.064	-0.02500	0.150	0.154	2185.00	2175.00	155.3	4.98	0.124	7	0.71	1.5	0.0294
BA-08	180+15	0.42	16	0.488	-0.02500	0.150	0.115	2330.00	2178.00	311.6	3.48	0.271	16	26.13	38.2	0.0590
BA-09	183+00	0.42	9	0.145	-0.02500	0.150	0.143	2232.00	2186.00	317.8	4.55	0.149	9	1.96	3.7	0.0602
BA-10	186+32	0.42	10	0.208	-0.02500	0.150	0.129	2266.50	2192.00	358.2	4.39	0.165	10	6.78	12.5	0.0678
BA-11	192+10	0.42	16	0.502	-0.02500	0.150	0.122	2378.00	2204.00	346.4	3.48	0.275	16	13.65	19.9	0.0656
BA-12	195+35	0.43	15	0.676	-0.02525	0.152	0.109	2599.00	2208.00	578.8	3.63	0.253	15	51.21	79.7	0.1096
BA-13	203+50	0.43	18	1.016	-0.02596	0.160	0.107	2892.00	2226.00	655.3	3.23	0.308	18	107.72	150.8	0.1241

Project: Carefree Hwy - Cave Creek Rd to Scottsdale Rd
Location: Carefree, Arizona
Date: May 7, 2024
Subject: 50-Year Rational Flow Calculations

Proj. Number: 3010.0100309
Proj. Engineer: L. Thiele
Checker: L. Vick

Source: Effective Maricopa County Drainage Policies and Standards Manual, 2018

Subbasin	Culvert Station	C	Tc	L	L	m	b	Kb	Elev	Elev	S	i	Tc (Calc)	Tc (Calc)	A	A	Q	Slope
			(min)	(ft)	(mi)				Start	End	(ft/mi)	(in/hr)	(hrs)	(min)	(ft)	(ac)	(cfs)	(ft/ft)
Carefree Hwy																		
BA-01	129+98	0.42	9	1094.0	0.207	-0.01375	0.080	0.071	2094.00	2068.00	125.5	6.33	0.145	9	206892	4.75	12.6	0.0238
BA-02	139+43	0.58	11	2287.4	0.433	-0.00979	0.059	0.046	2136.00	2086.00	115.4	5.83	0.178	11	835979	19.19	64.8	0.0219
BA-03	150+95	0.45	9	1288.3	0.244	-0.01325	0.077	0.071	2143.00	2112.00	127.1	6.33	0.157	9	141861	3.26	9.2	0.0241
BA-04	168+50	0.53	7	613.3	0.116	-0.02500	0.150	0.136	2188.00	2161.00	232.5	6.93	0.122	7	159064	3.65	13.4	0.0440
BA-05	171+75	0.59	11	2073.8	0.393	-0.02677	0.168	0.136	2370.00	2166.00	519.4	5.83	0.187	11	640329	14.70	50.5	0.0984
BA-06	174+05	0.53	6	340.0	0.064	-0.02500	0.150	0.154	2185.00	2175.00	155.3	7.38	0.107	6	30812	0.71	2.8	0.0294
BA-08	180+15	0.53	14	2575.2	0.488	-0.02500	0.150	0.115	2330.00	2178.00	311.6	5.19	0.233	14	1138140	26.13	71.9	0.0590
BA-09	183+00	0.53	8	764.4	0.145	-0.02500	0.150	0.143	2232.00	2186.00	317.8	6.59	0.129	8	85331	1.96	6.8	0.0602
BA-10	186+32	0.53	8	1098.3	0.208	-0.02500	0.150	0.129	2266.50	2192.00	358.2	6.59	0.142	8	295301	6.78	23.7	0.0678
BA-11	192+10	0.53	14	2652.5	0.502	-0.02500	0.150	0.122	2378.00	2204.00	346.4	5.19	0.236	14	594519	13.65	37.6	0.0656
BA-12	195+35	0.54	13	3566.8	0.676	-0.02525	0.152	0.109	2599.00	2208.00	578.8	5.37	0.218	13	2230664	51.21	148.1	0.1096
BA-13	203+50	0.54	16	5366.3	1.016	-0.02596	0.160	0.107	2892.00	2226.00	655.3	4.84	0.264	16	4692121	107.72	282.9	0.1241

Project: Carefree Hwy - Cave Creek Rd to Scottsdale Rd
Location: Carefree, Arizona
Date: May 7, 2024
Subject: 100-Year Rational Flow Calculations

Source: Effective Maricopa County Drainage Policies and Standards Manual, 2018

Proj. Number: 3010.0100309
Proj. Engineer: L. Thiele
Checker: L. Vick

Subbasin	Culvert Station	C	Tc	L	L	m	b	Kb	Elev	Elev	S	i	Tc (Calc)	Tc (Calc)	A	A	Q	Slope
			(min)	(ft)	(mi)				Start	End	(ft/mi)	(in/hr)	(hrs)	(min)	(sf)	(ac)	(cfs)	(ft/ft)
Carefree Hwy																		
BA-01	129+98	0.45	8	1094.015	0.207	-0.01375	0.080	0.071	2094.00	2068.00	125.483	7.383	0.137	8	206892	4.7	15.8	0.024
BA-02	139+43	0.65	10	2287.426	0.433	-0.00979	0.059	0.046	2136.00	2086.00	115.414	6.840	0.168	10	835979	19.2	84.9	0.022
BA-03	150+95	0.48	9	1288.295	0.244	-0.01325	0.077	0.071	2143.00	2112.00	127.052	7.081	0.150	9	141861	3.3	11.0	0.024
BA-04	168+50	0.53	7	613.291	0.116	-0.02500	0.150	0.136	2188.00	2161.00	232.451	7.771	0.117	7	159064	3.7	15.0	0.044
BA-05	171+75	0.63	11	2073.774	0.393	-0.02677	0.168	0.136	2370.00	2166.00	519.401	6.524	0.179	11	640329	14.7	60.0	0.098
BA-06	174+05	0.53	6	340.047	0.064	-0.02500	0.150	0.154	2185.00	2175.00	155.273	8.288	0.102	6	30812	0.7	3.1	0.029
BA-08	180+15	0.53	13	2575.249	0.488	-0.02500	0.150	0.115	2330.00	2178.00	311.644	6.037	0.220	13	1138140	26.1	83.6	0.059
BA-09	183+00	0.53	7	764.365	0.145	-0.02500	0.150	0.143	2232.00	2186.00	317.754	7.771	0.121	7	85331	2.0	8.1	0.060
BA-10	186+32	0.53	8	1098.261	0.208	-0.02500	0.150	0.129	2266.50	2192.00	358.166	7.383	0.136	8	295301	6.8	26.5	0.068
BA-11	192+10	0.53	13	2652.493	0.502	-0.02500	0.150	0.122	2378.00	2204.00	346.361	6.037	0.223	13	594519	13.6	43.7	0.066
BA-12	195+35	0.54	12	3566.771	0.676	-0.02525	0.152	0.109	2599.00	2208.00	578.809	6.260	0.205	12	2230664	51.2	174.2	0.110
BA-13	203+50	0.58	15	5366.300	1.016	-0.02596	0.160	0.107	2892.00	2226.00	655.290	5.680	0.249	15	4692121	107.7	352.2	0.124

Project: Carefree Hwy - Cave Creek Rd to Scottsdale Rd
Location: Surprise, Arizona
Date: May 7, 2024
Subject: Rational C-Value Calculations

Proj. Number: 3010.0100309
Proj. Engineer: L. Thiele
Checker: L. Vick

Source: Effective Maricopa County Drainage Policies and Standards Manual, 2018

Subbasin	Culvert Station	Total Area (sf)	Length (ft)	Residential Area R1-70, <10% (sf)	10-year C-Value (---)	50-year C-Value (---)	100-year C-Value (---)	Residential Area R1-70, >10% (sf)	10-year C-Value (---)	50-year C-Value (---)	100-year C-Value (---)	Natural Desert (sf)	10-year C-Value (---)	50-year C-Value (---)	100-year C-Value (---)	Mountain Terrain (sf)	10-year C-Value (---)	50-year C-Value (---)	100-year C-Value (---)	Residential Area R1-7, <10% (sf)	10-year C-Value (---)	50-year C-Value (---)	100-year C-Value (---)	Commercial (sf)	10-year C-Value (---)	50-year C-Value (---)	100-year C-Value (---)	10-Year Weighted C-Value (---)	50-Year Weighted C-Value (---)	100-Year Weighted C-Value (---)	
Carefree Highway																															
BA-01	129+98	206,892	1,094	0	0.37	0.52	0.60	0	0.69	0.77	0.85	206,892	0.37	0.42	0.45	0	0.60	0.70	0.80	0	0.51	0.66	0.80	0	0.80	0.83	0.86	0.37	0.42	0.45	
BA-02	139+43	835,979	2,287	0	0.42	0.53	0.53	0	0.37	0.52	0.60	394,491	0.37	0.42	0.45	0	0.60	0.70	0.80	279,958	0.51	0.66	0.80	161,530	0.80	0.83	0.86	0.50	0.58	0.65	
FEMA Q	143+42	---	---	---	0.42	0.53	0.53	0	0.37	0.52	0.60	0	0.37	0.42	0.45	0	0.60	0.70	0.80	0	0.51	0.66	0.80	0	0.80	0.83	0.86	---	---	---	
BA-03	150+95	141,861	1,288	0	0.42	0.53	0.53	0	0.37	0.52	0.60	132,466	0.37	0.42	0.45	0	0.60	0.70	0.80	0	0.51	0.66	0.80	9,395	0.80	0.83	0.86	0.40	0.45	0.48	
FEMA Q	161+75	---	---	---	0.42	0.53	0.53	0	0.37	0.52	0.60	0	0.37	0.42	0.45	0	0.60	0.70	0.80	0	0.51	0.66	0.80	0	0.80	0.83	0.86	---	---	---	
BA-04	168+50	159,064	613	159,064	0.42	0.53	0.53	0	0.37	0.52	0.60	0	0.37	0.42	0.45	0	0.60	0.70	0.80	0	0.51	0.66	0.80	0	0.80	0.83	0.86	0.42	0.53	0.53	
BA-05	171+75	640,329	2,074	414,174	0.42	0.53	0.53	0	0.37	0.52	0.60	0	0.37	0.42	0.45	226,155	0.60	0.70	0.80	0	0.51	0.66	0.80	0	0.80	0.83	0.86	0.48	0.59	0.63	
BA-06	174+05	30,812	340	30,812	0.42	0.53	0.53	0	0.37	0.52	0.60	0	0.37	0.42	0.45	0	0.60	0.70	0.80	0	0.51	0.66	0.80	0	0.80	0.83	0.86	0.42	0.53	0.53	
BA-08	180+15	1,138,140	2,575	1,138,140	0.42	0.53	0.53	0	0.37	0.52	0.60	0	0.37	0.42	0.45	0	0.60	0.70	0.80	0	0.51	0.66	0.80	0	0.80	0.83	0.86	0.42	0.53	0.53	
BA-09	183+00	85,331	764	85,331	0.42	0.53	0.53	0	0.37	0.52	0.60	0	0.37	0.42	0.45	0	0.60	0.70	0.80	0	0.51	0.66	0.80	0	0.80	0.83	0.86	0.42	0.53	0.53	
BA-10	186+32	295,301	1,098	295,301	0.42	0.53	0.53	0	0.37	0.52	0.60	0	0.37	0.42	0.45	0	0.60	0.70	0.80	0	0.51	0.66	0.80	0	0.80	0.83	0.86	0.42	0.53	0.53	
BA-11	192+10	594,519	2,652	594,519	0.42	0.53	0.53	0	0.37	0.52	0.60	0	0.37	0.42	0.45	0	0.60	0.70	0.80	0	0.51	0.66	0.80	0	0.80	0.83	0.86	0.42	0.53	0.53	
BA-12	195+35	2,230,664	3,567	2,120,866	0.42	0.53	0.53	0	0.37	0.52	0.60	0	0.37	0.42	0.45	109,798	0.60	0.70	0.80	0	0.51	0.66	0.80	0	0.80	0.83	0.86	0.43	0.54	0.54	
BA-13	203+50	4,692,121	5,366	2,861,244	0.42	0.53	0.53	723,457	0.37	0.52	0.60	0	0.37	0.42	0.45	937,654	0.60	0.70	0.80	0	0.51	0.66	0.80	0	0.80	0.83	0.86	0.43	0.54	0.58	
FEMA Q	215+65	---	---	---	0.42	0.53	0.53	0	0.37	0.52	0.60	0	0.37	0.42	0.45	0	0.60	0.70	0.80	0	0.51	0.66	0.80	0	0.80	0.83	0.86	---	---	---	

Project: Carefree Highway - Cave Creek Rd to Scottsdale Widening
Location: Scottsdale AZ
Date: 5/28/2024
Subject: 10-Year Rational Flow Calculations
Source: Design Standards & Policies Manual, City of Scottsdale, 2018

Project Number: 3010.0100309.000
Project Engineer: M. Jacobsen
Checker: L. Vick

$$Q = C i A$$
$$T_c = 11.4 L^{0.5} K_b^{0.525} S^{-0.31} i^{-0.38}$$

Type A	Type C	Type B
m	-0.00625 m	-0.025 m
b	0.04 b	0.15 b
		-0.01375
		0.08

Subbasin	Area sqft	C	Tc min	L ft	L mi	US Elev ft	DS Elev ft	Weighted m	Weighted b	Kb	S ft/mi	i in/hr	Tc (calc) hrs min	Area acre	Q cfs	Roadside Ditch
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OFF-1A	79,878	0.68	5	623	0.118	2417.6	2280			0.09089	1165.881	5.772	0.06	4	1.83	7.22
OFF-1B	203,786	0.72	6	1,168	0.221	2417.6	2260.9			0.08453	708.504	5.312	0.10	6	4.68	17.88
OFF-1C	432,874	0.63	8	1,476	0.280	2525.8	2260.9			0.12507	947.702	4.737	0.14	8	9.94	29.53
OFF-1 TOTAL	716,538	0.66	7	1,476	0.280	2525.8	2260.9			0.10016	947.702	4.983	0.12	7	16.45	54.08
OFF-2A	111,035	0.46	10	797	0.151	2269	2252.2			0.07441	111.299	4.392	0.15	9	2.55	5.11
OFF-2B	36,198	0.37	5	338	0.064	2264	2251.4			0.08111	196.757	5.772	0.08	5	0.83	1.77
OFF-2B CUMULATIVE	147,233	0.44	9	912	0.173	2269	2249.3			0.07273	114.092	4.545	0.16	9	3.38	6.69
OFF-2C	140,261	0.37	8	955	0.181	2274	2243.5			0.07302	168.614	4.737	0.14	8	3.22	5.64
OFF-2C CUMULATIVE	287,494	0.40	12	1,422	0.269	2269	2241.8			0.06873	100.961	4.010	0.21	12	6.60	10.68
OFF-2D	60,921	0.37	6	561	0.106	2265	2243			0.07800	207.055	5.312	0.10	6	1.40	2.75
OFF-2 TOTAL	348,415	0.37	8	955	0.181	2274	2243			0.06758	171.378	4.737	0.13	8	8.00	14.02
OFF-1 + OFF-2	1,064,954	0.56	10	2,365	0.448	2525.8	2243			0.08387	631.427	4.392	0.16	10	24.45	60.66
OFF-3A	45,905	0.42	7	414	0.078	2247.4	2240.5			0.07969	87.923	4.983	0.12	7	1.05	2.20
OFF-3B	2,024,938	0.38	11	4,719	0.894	2892.8	2239.4			0.05707	731.002	4.184	0.18	11	46.49	73.42
OFF-3E	50,412	0.37	7	479	0.091	2247.8	2238.8			0.07913	99.206	4.983	0.12	7	1.16	2.13
OFF-3B + OFF-3E (STAGECOACH PASS)	2,075,350	0.38	11	4,981	0.943	2892.8	2238.8			0.05693	693.191	4.184	0.19	11	47.64	75.22
OFF-3C	32,262	0.37	5	309	0.058	2247.8	2238			0.08179	167.522	5.772	0.08	5	0.74	1.58
OFF-3D	1,396,250	0.40	11	3,889	0.737	2655.8	2225.8			0.05929	583.805	4.184	0.18	11	32.05	54.21
OFF-3D1	1,049,154	0.42	10	3,498	0.663	2655.8	2225.8			0.06100	649.000	4.392	0.17	10	24.09	43.96
OFF-3C + OFF-3D1	1,081,417	0.41	10	3,498	0.663	2655.8	2225.8			0.06082	649.000	4.392	0.17	10	24.83	45.16
OFF-3C + OFF-3D	1,428,513	0.40	11	3,889	0.737	2655.8	2225.8			0.05916	583.805	4.184	0.18	11	32.79	55.35
OFF-3 TOTAL REV (DITCH TO CULVERT STA 204+00)	3,471,600	0.39	12	5,596	1.060	2892.8	2225.8			0.05386	629.364	4.010	0.21	12	79.70	124.05
OFF-4A1	6,686	0.37	5	282	0.053	2232.4	2222			0.09119	194.787	5.772	0.08	5	0.15	0.33
OFF-4A	34,062	0.37	5	357	0.068	2235	2221.9			0.08147	193.563	5.772	0.08	5	0.78	1.67
OFF-4B	13,593	0.37	6	380	0.072	2224	2214			0.08695	139.008	5.312	0.10	6	0.31	0.61
OFF-4 TOTAL	47,654	0.37	8	737	0.140	2235	2214			0.07946	150.412	4.737	0.13	8	1.09	1.92
OFF-4E	897	0.37	5	57	0.011	2231.5	2226.2			0.10319	487.131	5.772	0.03	2	0.02	0.04
OFF-5	2,927	0.37	5	58	0.011	2210.4	2207			0.09612	308.651	5.772	0.03	2	0.07	0.14
OFF-6	262,228	0.37	7	1,096	0.208	2268	2202.9			0.06928	313.650	4.983	0.12	7	6.02	11.10
OFF-7E	9,398	0.37	5	262	0.050	2223	2208			0.08916	302.422	5.772	0.06	4	0.22	0.46
OFF-7W	33,584	0.37	5	486	0.092	2225	2199.2			0.08155	280.053	5.772	0.08	5	0.77	1.65
OFF-8E	6,306	0.37	5	187	0.035	2212.1	2192.1			0.09154	563.884	5.772	0.04	3	0.14	0.31
OFF-8W1	61,921	0.37	5	575	0.109	2232.7	2187.7			0.07790	413.088	5.772	0.08	5	1.42	3.04
OFF-8W2	18,620	0.37	5	538	0.102	2220.6	2186.9			0.08508	330.623	5.772	0.09	5	0.43	0.91
OFF-8W TOTAL	80,540	0.37	5	693	0.131	2232.7	2186.9			0.07633	348.751	5.772	0.09	5	1.85	3.95
OFF-8B1	2,986	0.37	5	213	0.040	2201	2186.2			0.09600	367.340	5.772	0.06	3	0.07	0.15
OFF-8B	265,173	0.37	9	1,444	0.274	2258	2178.4			0.06921	291.013	4.545	0.14	9	6.09	10.24
OFF-9A	833,133	0.37	19	2,879	0.545	2231	2178.9			0.06238	95.562	3.128	0.31	19	19.13	22.13
OFF-9B	3,649	0.37	5	99	0.019	2179.9	2176.9			0.09481	159.878	5.772	0.05	3	0.08	0.18
OFF-9 TOTAL	836,782	0.37	20	3,067	0.581	2231	2176.9			0.06235	93.147	3.034	0.33	20	19.21	21.56
OFF-10E	2,820	0.37	5	90	0.017	2180	2177			0.09635	175.765	5.772	0.05	3	0.06	0.14
OFF-10W	6,473	0.37	5	201	0.038	2180	2174.8			0.09138	136.838	5.772	0.07	4	0.15	0.32
OFF-11	121,063	0.37	8	961	0.182	2203	2166			0.07390	203.213	4.737	0.13	8	2.78	4.87
OFF-10W + OFF-11	127,537	0.37	8	961	0.182	2203	2166			0.07358	203.213	4.737	0.13	8	2.93	5.13
OFF-11A	8,298	0.37	5	261	0.049	2169.2	2161.4			0.08990	158.051	5.772	0.08	5	0.19	0.41
OFF-12	68,459	0.37	7	761	0.144	2176	2146.2			0.07730	206.653	4.983	0.12	7	1.57	2.90
OFF-13A	160,864	0.58	10	1,088	0.206	2143	2119.6			0.07220	113.517	4.392	0.17	10	3.69	9.47
OFF-13 TOTAL	173,572	0.57	12	1,269	0.240	2143	2119.2			0.07174	99.001	4.010	0.20	12	3.98	9.08
OFF-14	111,572	0.38	9	876	0.166	2120.1	2097			0.07438	139.297	4.545	0.15	9	2.56	4.46
OFF-14A	5,402	0.37	5	194	0.037	2115	2109.1			0.09246	160.909	5.772	0.07	4	0.12	0.26
OFF-14B	6,154	0.37	9	216	0.041	2109.1	2108.4			0.09169	17.112	4.545	0.16	9	0.14	0.24
OFF-15	9,115	0.37	6	363	0.069	2098	2087.7			0.08934	149.656	5.312	0.10	6	0.21	0.41
OFF-16	205,043	0.37	10	1,128	0.214	2094	2067.9			0.07075	122.143	4.392	0.17	10	4.71	7.65
OFF-16A	46,763	0.37	7	529	0.100	2093	2079.5			0.07958	134.790	4.983	0.11	7	1.07	1.98
OFF-17	57,843	0.37	8	654	0.124	2076.3	2061			0.07831	123.561	4.737	0.13	8	1.33	2.33
OFF-17A	6,671	0.37	6	371	0.070	2070	2061			0.09120	128.116	5.312	0.10	6	0.15	0.30
M-01	6,573	0.63	5	408	0.077	2076.4	2068.2			0.04513	105.998	5.772	0.08	5	0.15	0.55
M-01 + OFF-17A	13,244	0.50	8	779	0.148	2076.4	2061	-0.010027924	0.060148926	0.06533	104.329	4.737	0.14	8	0.30	0.72
M-01 + OFF-17	64,416	0.40	9	779	0.148	2076.4	2061	-0.012984735	0.075918585	0.07371	104.329	4.545	0.15	9	1.48	2.67
OFF-18	842,566	0.38	18	3,009	0.570	2110	2046			0.06231	112.292	3.232	0.30	18	19.34	23.95
RD-08	79,933	0.82	9	1,605	0.304	2100.953	2062.024			0.03836	128.026	4.545	0.14	9	1.83	6.87
M-01 + OFF-17 + OFF-18 + RD-08	935,643	0.42	17	3,009	0.570	2110	2046	-0.013093297	0.076497581	0.05906	112.292	3.348	0.29	17	21.48	30.38
M-01+OFF-17+OFF-18+RD-08+DA-01	964,576	0.44	17	3,009	0.570	2110	2046	-0.012807833	0.074975107	0.05775	112.292	3.348	0.29	17	22.14	32.39
DA-01	28,933	0.90	5	610	0.116	2062	2048.6			0.04111	115.936	5.772	0.09	5	0.66	3.45
OFF-2A (OFFSITE INLETS)	107,596	0.46	9	727	0.138	2269	2254.8			0.07460	103.154	4.545	0.15	9	2.47	5.16
OFF-2B (OFFSITE INLETS)	38,391	0.37	5	293	0.056	2264	2252.9			0.08075	199.977	5.772	0.07	4	0.88	1.88
OFF-2C (OFFSITE INLETS)	139,767	0.37	8	883	0.167	2274	2246.9			0.07304	162.046	4.737	0.14	8	3.21	5.62
OFF-2D (OFFSITE INLETS)	52,575	0.37	6	561	0.106	2265	2243			0.07888	207.055	5.312	0.10	6	1.21	2.37
OFF-3D0 (OFFSITE INLETS)	4,184	0.37	5	172	0.033	2240.9	2234			0.09399	211.433	5.772	0.06	4	0.10	0.21
OFF-3D1 (OFFSITE INLETS)	1,044,575	0.42	10	3,448	0.653	2655.8	2233.5			0.06103	646.660	4.392	0.16	10	23.98	43.79
OFF-3D2 (OFFSITE INLETS)	321,608	0.37	11	1,951	0.370	2318	2232.5			0.06806	231.343	4.184	0.18	11	7.38	11.43
OFF-3D3 (OFFSITE INLETS)	11,820	0.37	5	186	0.035	2240	2230.2			0.08779	278.181	5.772	0.05	3	0.27	0.58
OFF-3D4 (OFFSITE INLETS)	11,920	0.37	5	215	0.041	2236	2227.3			0.08774	213.622	5.772	0.06	4	0.27	0.58

Project: Carefree Highway - Cave Creek Rd to Scottsdale Widening
Location: Scottsdale AZ
Date: 5/28/2024
Subject: 50-Year Rational Flow Calculations
Source: Design Standards & Policies Manual, City of Scottsdale, 2018

Project Number: 3010.0100309.000
Project Engineer: M. Jacobsen
Checker: L. Vick

$$Q = C i A$$
$$T_c = 11.4 L^{0.5} K_b^{0.52} S^{-0.314} 0.38$$

Type A		Type C		Type B	
m	-0.00625	m	-0.025	m	-0.01375
b	0.04	b	0.15	b	0.08

Subbasin	Area sgft	C ---	Tc min	L ft	L mi	US Elev ft	DS Elev ft	Weighted m	Weighted b	Kb	S ft/mi	i in/hr	Tc (calc)		Area acre	Q cfs	Roadside Ditch
													hrs	min			
OFF-1A	79,878	0.76	5	623	0.118	2417.6	2280			0.09089	1165.881	8.016	0.06	3	1.83	11.23	
OFF-1B	203,786	0.78	5	1,168	0.221	2417.6	2260.9			0.08453	708.504	8.016	0.09	5	4.68	29.24	
OFF-1C	432,874	0.71	7	1,476	0.280	2525.8	2260.9			0.12507	947.702	6.933	0.12	7	9.94	48.88	
OFF-1 TOTAL	716,538	0.74	6	1,476	0.280	2525.8	2260.9			0.10016	947.702	7.384	0.10	6	16.45	89.34	
OFF-2A	111,035	0.51	8	797	0.151	2269	2252.2			0.07441	111.299	6.594	0.13	8	2.55	8.52	
OFF-2B	36,198	0.42	5	338	0.064	2264	2251.4			0.08111	196.757	8.016	0.07	4	0.83	2.80	
OFF-2B CUMULATIVE	147,233	0.49	8	912	0.173	2269	2249.3			0.07273	114.092	6.594	0.14	8	3.38	10.82	
OFF-2C	140,261	0.42	7	955	0.181	2274	2243.5			0.07302	168.614	6.933	0.12	7	3.22	9.38	
OFF-2C CUMULATIVE	287,494	0.45	11	1,422	0.269	2269	2241.8			0.06873	100.961	5.825	0.18	11	6.60	17.44	
OFF-2D	60,921	0.42	5	561	0.106	2265	2243			0.07800	207.055	8.016	0.09	5	1.40	4.71	
OFF-2 TOTAL	348,415	0.42	7	955	0.181	2274	2243			0.06758	171.378	6.933	0.12	7	8.00	23.29	
OFF-1 + OFF-2	1,064,954	0.63	8	2,365	0.448	2525.8	2243			0.08387	631.427	6.594	0.14	8	24.45	101.93	
OFF-3A	45,905	0.47	6	414	0.078	2247.4	2240.5			0.07969	87.923	7.384	0.10	6	1.05	3.63	
OFF-3B	2,024,938	0.53	9	4,719	0.894	2892.8	2239.4			0.05707	731.002	6.331	0.16	9	46.49	154.77	
OFF-3E	50,412	0.42	6	479	0.091	2247.8	2238.8			0.07913	99.206	7.384	0.10	6	1.16	3.59	
OFF-3B + OFF-3E (STAGECOACH PASS)	2,075,350	0.52	10	4,981	0.943	2892.8	2238.8			0.05693	693.191	6.120	0.16	10	47.64	152.59	
OFF-3C	32,262	0.52	5	309	0.058	2247.8	2238			0.08179	167.522	8.016	0.07	4	0.74	3.09	
OFF-3D	1,396,250	0.55	9	3,889	0.737	2655.8	2225.8			0.05929	583.805	6.331	0.16	9	32.05	110.95	
OFF-3D1	1,049,154	0.56	9	3,498	0.663	2655.8	2225.8			0.06100	649.000	6.331	0.14	9	24.09	84.72	
OFF-3C + OFF-3D1	1,081,417	0.55	9	3,498	0.663	2655.8	2225.8			0.06082	649.000	6.331	0.14	9	24.83	87.16	
OFF-3C + OFF-3D	1,428,513	0.55	9	3,889	0.737	2655.8	2225.8			0.05916	583.805	6.331	0.15	9	32.79	113.39	WB Channel 9
OFF-3 TOTAL REV (DITCH TO CULVERT STA 204+00)	3,471,600	0.53	11	5,596	1.060	2892.8	2225.8			0.05386	629.364	5.825	0.18	11	79.70	247.34	
OFF-4A1	6,686	0.52	5	282	0.053	2232.4	2222			0.09119	194.787	8.016	0.07	4	0.15	0.64	
OFF-4A	34,062	0.52	5	357	0.068	2235	2221.9			0.08147	193.563	8.016	0.07	4	0.78	3.26	
OFF-4B	13,593	0.52	5	380	0.072	2224	2214			0.08695	139.008	8.016	0.08	5	0.31	1.30	
OFF-4 TOTAL	47,654	0.52	7	737	0.140	2235	2214			0.07946	150.412	6.933	0.12	7	1.09	3.94	WB Channel 8
OFF-4E	897	0.42	5	57	0.011	2231.5	2226.2			0.10319	487.131	8.016	0.02	1	0.02	0.07	
OFF-5	2,927	0.42	5	58	0.011	2210.4	2207			0.09612	308.651	8.016	0.03	2	0.07	0.23	WB Channel 7
OFF-6	262,228	0.52	6	1,096	0.208	2268	2202.9			0.06928	313.650	7.384	0.10	6	6.02	23.11	WB Channel 6
OFF-7E	9,398	0.42	5	262	0.050	2223	2208			0.08916	302.422	8.016	0.06	3	0.22	0.73	WB Channel 5 Eastbound
OFF-7W	33,584	0.52	5	486	0.092	2225	2199.2			0.08155	280.053	8.016	0.07	4	0.77	3.21	WB Channel 5 Westbound
OFF-8E	6,306	0.52	5	187	0.035	2212.1	2192.1			0.09154	563.884	8.016	0.04	2	0.14	0.60	WB Channel 4 Eastbound
OFF-8W1	61,921	0.52	5	575	0.109	2232.7	2187.7			0.07790	413.088	8.016	0.07	4	1.42	5.93	
OFF-8W2	18,620	0.52	5	538	0.102	2220.6	2186.9			0.08508	330.623	8.016	0.08	5	0.43	1.78	
OFF-8W TOTAL	80,540	0.52	5	693	0.131	2232.7	2186.9			0.07633	348.751	8.016	0.08	5	1.85	7.71	WB Channel 4 Westbound
OFF-8B1	2,986	0.52	5	213	0.040	2201	2186.2			0.09600	367.340	8.016	0.05	3	0.07	0.29	
OFF-8B	265,173	0.52	7	1,444	0.274	2258	2178.4			0.06921	291.013	6.933	0.12	7	6.09	21.95	
OFF-9A	833,133	0.52	16	2,879	0.545	2231	2178.9			0.06238	95.562	4.835	0.27	16	19.13	48.09	
OFF-9B	3,649	0.42	5	99	0.019	2179.9	2176.9			0.09481	159.878	8.016	0.04	3	0.08	0.28	
OFF-9 TOTAL	836,782	0.52	17	3,067	0.581	2231	2176.9			0.06235	93.147	4.654	0.28	17	19.21	46.45	WB Channel 3
OFF-10E	2,820	0.42	5	90	0.017	2180	2177			0.09635	175.765	8.016	0.04	2	0.06	0.22	WB Channel 2 Eastbound
OFF-10W	6,473	0.42	5	201	0.038	2180	2174.8			0.09138	136.838	8.016	0.06	4	0.15	0.50	WB Channel 2 Westbound
OFF-11	121,063	0.52	7	961	0.182	2203	2166			0.07390	203.213	6.933	0.12	7	2.78	10.02	WB Channel 1B
OFF-10W + OFF-11	127,537	0.52	7	961	0.182	2203	2166			0.07358	203.213	6.933	0.12	7	2.93	10.55	
OFF-11A	8,298	0.42	5	261	0.049	2169.2	2161.4			0.08990	158.051	8.016	0.07	4	0.19	0.64	
OFF-12	68,459	0.52	6	761	0.144	2176	2146.2			0.07730	206.653	7.384	0.10	6	1.57	6.03	WB Channel 1
OFF-13A	160,864	0.63	9	1,088	0.206	2143	2119.6			0.07220	113.517	6.331	0.15	9	3.69	14.63	EB Channel 7
OFF-13 TOTAL	173,572	0.61	10	1,269	0.240	2143	2119.2			0.07174	99.001	6.120	0.17	10	3.98	14.90	EB Channel 6
OFF-14	111,572	0.43	7	876	0.166	2120.1	2097			0.07438	139.297	6.933	0.12	7	2.56	7.68	EB Channel 5
OFF-14A	5,402	0.42	5	194	0.037	2115	2109.1			0.09246	160.909	8.016	0.06	4	0.12	0.42	
OFF-14B	6,154	0.42	8	216	0.041	2109.1	2108.4			0.09169	17.112	6.594	0.13	8	0.14	0.39	
OFF-15	9,115	0.42	5	363	0.069	2098	2087.7			0.08934	149.656	8.016	0.08	5	0.21	0.70	EB Channel 4
OFF-16	205,043	0.42	9	1,128	0.214	2094	2067.9			0.07075	122.143	6.331	0.15	9	4.71	12.52	EB Channel 3
OFF-16A	46,763	0.42	6	529	0.100	2093	2079.5			0.07958	134.790	7.384	0.10	6	1.07	3.33	
OFF-17	57,843	0.42	7	654	0.124	2076.3	2061			0.07831	123.561	6.933	0.11	7	1.33	3.87	EB Channel 2
OFF-17A	6,671	0.42	5	371	0.070	2070	2061			0.09120	128.116	8.016	0.09	5	0.15	0.52	
M-01	6,573	0.73	5	408	0.077	2076.4	2068.2			0.04513	105.998	8.016	0.07	4	0.15	0.88	
M-01 + OFF-17A	13,244	0.57	7	779	0.148	2076.4	2061	-0.010027924	0.060148926	0.06533	104.329	6.933	0.12	7	0.30	1.21	
M-01 + OFF-17	64,416	0.45	8	779	0.148	2076.4	2061	-0.012984735	0.075918585	0.07371	104.329	6.594	0.13	8	1.48	4.40	
OFF-18	842,566	0.43	15	3,009	0.570	2110	2046			0.06231	112.292	5.040	0.25	15	19.34	42.18	EB Channel 1
RD-08	79,833	0.86	7	1,605	0.304	2100.953	2062.024			0.03836	128.026	6.933	0.12	7	1.83	10.89	
M-01 + OFF-17 + OFF-18 + RD-08	935,643	0.47	15	3,009	0.570	2110	2046	-0.013093297	0.076497581	0.05906	112.292	5.040	0.25	15	21.48	50.98	
M-01+OFF-17+OFF-18+RD-08+DA-01	964,576	0.48	15	3,009	0.570	2110	2046	-0.012807833	0.074975107	0.05775	112.292	5.040	0.24	15	22.14	54.09	
DA-01	28,933	0.93	5	610	0.116	2062	2048.6			0.04111	115.936	8.016	0.08	5	0.66	4.95	
OFF-2A (OFF																	

Project: Carefree Highway - Cave Creek Rd to Scottsdale Widening
Location: Scottsdale AZ
Date: 5/28/2024
Subject: 100-Year Rational Flow Calculations
Source: Design Standards & Policies Manual, City of Scottsdale, 2018

Project Number: 3010.0100309.000
Project Engineer: M. Jacobsen
Checker: L. Vick

$Q = C/A$
 $T_c = 11.41(A^{0.385})^{0.77} S^{-0.1038}$

Type A	Type C	Type B
m	-0.00625 m	-0.025 m
b	0.04 b	0.15 b
		-0.01375
		0.08

Subbasin	Area	C	Tc	L	L	US Elev	DS Elev	Weighted m	Weighted b	Kb	S	i	Tc (calc)	Area	Q	Flowby Q	Total Q (Q+Flowby)	Roadside Ditch	
---	sqft	---	min	ft	mi	ft	ft				ft/mi	in/hr	hrs	min	acre	cfs	cfs	cfs	
OFF-1A	79,878	0.84	5	623	0.118	2417.6	2280			0.09089	1165.881	9.012	0.05	3	1.834	13.93		13.93	
OFF-1B	203,786	0.84	5	1,168	0.221	2417.6	2260.9			0.08453	708.504	9.012	0.08	5	4.678	35.38		35.38	
OFF-1C	432,874	0.79	7	1,476	0.280	2525.8	2260.9			0.12507	947.702	7.771	0.11	7	9.937	60.97		60.97	
OFF-1 TOTAL	716,538	0.81	6	1,476	0.280	2525.8	2260.9			0.10016	947.702	8.288	0.10	6	16.449	110.37		110.37	
OFF-2A	111,035	0.54	8	797	0.151	2269	2252.2			0.07441	111.299	7.383	0.12	7	2.549	10.15		10.15	
OFF-2B	36,198	0.45	5	338	0.064	2264	2251.4			0.08111	196.757	9.012	0.07	4	0.831	3.37		3.37	
OFF-2B CUMULATIVE	147,233	0.52	8	912	0.173	2269	2249.3			0.07273	114.092	7.383	0.13	8	3.380	12.91		12.91	
OFF-2C	140,261	0.45	7	955	0.181	2274	2243.5			0.07302	168.614	7.771	0.12	7	3.220	11.26		11.26	
OFF-2C CUMULATIVE	287,494	0.48	10	1,422	0.269	2269	2241.8			0.06873	100.961	6.840	0.17	10	6.600	21.87		21.87	
OFF-2D	60,921	0.45	5	561	0.106	2265	2243			0.07800	207.055	9.012	0.08	5	1.399	5.67		5.67	
OFF-2 TOTAL	348,415	0.45	7	955	0.181	2274	2243			0.06758	171.378	7.771	0.11	7	7.999	27.97		27.97	
OFF-1 + OFF-2	1,064,954	0.69	8	2,365	0.448	2525.8	2243			0.08387	631.427	7.383	0.13	8	24.448	124.89		124.89	
OFF-3A	45,905	0.50	6	414	0.078	2247.4	2240.5			0.07969	87.923	8.288	0.10	6	1.054	4.33		4.33	
OFF-3B	2,024,938	0.61	9	4,719	0.894	2892.8	2239.4			0.05707	731.002	7.081	0.15	9	46.486	199.67		199.67	
OFF-3E	50,412	0.45	6	479	0.091	2247.8	2238.8			0.07913	99.206	8.288	0.10	6	1.157	4.32		4.32	
OFF-3B + OFF-3E (STAGECOACH PASS)	2,075,350	0.60	9	4,981	0.943	2892.8	2238.8			0.05693	693.191	7.081	0.16	9	47.643	203.36		203.36	
OFF-3C	32,262	0.60	5	309	0.058	2247.8	2238			0.08179	167.522	9.012	0.07	4	0.741	4.00		4.00	
OFF-3D	1,396,250	0.63	9	3,889	0.737	2655.8	2225.8			0.05929	583.805	7.081	0.15	9	32.053	142.94		142.94	
OFF-3D1	1,049,154	0.64	8	3,498	0.663	2655.8	2225.8			0.06100	649.000	7.383	0.14	8	24.085	113.73		113.73	
OFF-3C + OFF-3D1	1,081,417	0.64	8	3,498	0.663	2655.8	2225.8			0.06082	649.000	7.383	0.14	8	24.826	117.01		117.01	
OFF-3C + OFF-3D	1,428,513	0.63	9	3,889	0.737	2655.8	2225.8			0.05916	583.805	7.081	0.15	9	32.794	146.09		146.09	WB Channel 9
OFF-3 TOTAL REV (DITCH TO CULVERT STA 204+00)	3,471,600	0.61	10	5,596	1.060	2892.8	2225.8			0.05386	629.364	6.840	0.17	10	79.697	334.50		334.50	
OFF-4A1	6,686	0.60	5	282	0.053	2232.4	2222			0.09119	194.787	9.012	0.06	4	0.153	0.83		0.83	
OFF-4A	34,062	0.60	5	357	0.068	2235	2221.9			0.08147	193.563	9.012	0.07	4	0.782	4.23		4.23	
OFF-4B	13,593	0.60	5	380	0.072	2224	2214			0.08695	139.008	9.012	0.08	5	0.312	1.69		1.69	
OFF-4 TOTAL	47,554	0.60	6	737	0.140	2235	2214			0.07946	150.412	8.288	0.11	6	1.094	5.44		5.44	WB Channel 8
OFF-4E	897	0.45	5	57	0.011	2231.5	2226.2			0.10319	487.131	9.012	0.02	1	0.021	0.08		0.08	
OFF-5	2,927	0.45	5	58	0.011	2210.4	2207			0.09612	308.651	9.012	0.03	2	0.067	0.27		0.27	WB Channel 7
OFF-6	262,228	0.60	6	1,096	0.208	2268	2202.9			0.06928	313.650	8.288	0.10	6	6.020	29.94		29.94	WB Channel 6
OFF-7E	9,398	0.45	5	262	0.050	2223	2208			0.08916	302.422	9.012	0.05	3	0.216	0.87		0.87	WB Channel 5 Eastbound
OFF-7W	33,584	0.60	5	486	0.092	2225	2199.2			0.08155	280.053	9.012	0.07	4	0.771	4.17		4.17	WB Channel 5 Westbound
OFF-8E	6,306	0.60	5	187	0.035	2212.1	2192.1			0.09154	563.884	9.012	0.04	2	0.145	0.78		0.78	WB Channel 4 Eastbound
OFF-8W1	61,921	0.60	5	575	0.109	2232.7	2187.7			0.07790	413.088	9.012	0.07	4	1.422	7.69		7.69	
OFF-8W2	18,620	0.60	5	538	0.102	2220.6	2186.9			0.08508	330.623	9.012	0.07	4	0.427	2.31		2.31	
OFF-8W TOTAL	80,540	0.60	5	693	0.131	2232.7	2186.9			0.07633	348.751	9.012	0.08	5	1.849	10.00		10.00	WB Channel 4 Westbound
OFF-8B1	2,986	0.60	5	213	0.040	2220.6	2186.9			0.09600	836.443	9.012	0.04	2	0.069	0.37		0.37	
OFF-8B	265,173	0.60	9	1,444	0.274	2232.7	2186.9			0.06921	167.442	7.081	0.14	9	6.088	25.86		25.86	
OFF-9A	833,133	0.60	15	2,879	0.545	2231	2178.9			0.06238	95.562	5.680	0.25	15	19.126	65.18		65.18	
OFF-9B	3,649	0.45	5	99	0.019	2179.9	2176.9			0.09481	159.878	9.012	0.04	2	0.084	0.34		0.34	
OFF-9 TOTAL	836,782	0.60	16	3,067	0.581	2231	2176.9			0.06235	93.147	5.448	0.26	16	19.210	62.72		62.72	WB Channel 3
OFF-10E	2,820	0.45	5	90	0.017	2180	2177			0.09635	175.765	9.012	0.04	2	0.065	0.26		0.26	WB Channel 2 Eastbound
OFF-10W	6,473	0.45	5	201	0.038	2180	2174.8			0.09138	136.838	9.012	0.06	4	0.149	0.60		0.60	WB Channel 2 Westbound
OFF-11	121,063	0.60	6	961	0.182	2203	2166			0.07390	203.213	8.288	0.11	6	2.779	13.82		13.82	WB Channel 1B
OFF-10W + OFF-11	127,537	0.60	6	961	0.182	2203	2166			0.07358	203.213	8.288	0.11	6	2.928	14.56		14.56	
OFF-11A	8,298	0.45	5	261	0.049	2169.2	2161.4			0.08990	158.051	9.012	0.07	4	0.191	0.77		0.77	
OFF-12	68,459	0.60	6	761	0.144	2176	2146.2			0.07730	206.653	8.288	0.10	6	1.572	7.82		7.82	WB Channel 1
OFF-13A	160,864	0.65	9	1,088	0.206	2143	2119.6			0.07220	113.517	7.081	0.14	9	3.693	17.05		17.05	WB Channel 7
OFF-13 TOTAL	173,572	0.64	10	1,269	0.240	2143	2119.2			0.07174	99.001	6.840	0.16	10	3.985	17.36		17.36	EB Channel 6
OFF-14	111,572	0.46	7	876	0.166	2120.1	2097			0.07438	139.297	7.771	0.12	7	2.561	9.20		9.20	EB Channel 5
OFF-14A	5,402	0.45	5	194	0.037	2115	2109.1			0.09246	160.909	9.012	0.06	3	0.124	0.50		0.50	
OFF-14B	6,154	0.45	8	216	0.041	2109.1	2108.4			0.09169	17.112	7.383	0.13	8	0.141	0.47		0.47	
OFF-15	9,115	0.45	5	363	0.069	2098	2087.7			0.08934	149.656	9.012	0.08	5	0.209	0.85		0.85	EB Channel 4
OFF-16	205,043	0.45	8	1,128	0.214	2094	2067.9			0.07075	122.143	7.383	0.14	8	4.707	15.64		15.64	EB Channel 3
OFF-16A	46,763	0.45	6	529	0.100	2093	2079.5			0.07958	134.790	8.288	0.09	6	1.074	4.00		4.00	
OFF-17	57,843	0.45	6	654	0.124	2076.3	2061			0.07831	123.561	8.288	0.11	6	1.328	4.95		4.95	EB Channel 2
OFF-17A	6,671	0.45	5	371	0.070	2070	2061			0.09120	128.116	9.012	0.08	5	0.153	0.62		0.62	
M-01	6,573	0.83	5	408	0.077	2076.4	2068.2			0.04513	105.998	9.012	0.06	4	0.151	1.13		1.13	
M-01 + OFF-17A	13,244	0.64	7	779	0.148	2076.4	2061	-0.010027924	0.060148926	0.06533	104.329	7.771	0.12	7	0.304	1.51		1.51	
M-01 + OFF-17	64,416	0.49	7	779	0.148	2076.4	2061	-0.012984735	0.075918585	0.07371	104.329	7.771	0.12	7	1.479	5.62		5.62	
OFF-1B	842,566	0.46	14	3,009	0.570	2110	2046			0.06321	112.292	5.846</							

Project: Carefree Highway - Cave Creek Rd to Scottsdale Widening
Location: Scottsdale AZ
Date: 5/28/2024
Subject: Runoff Coefficient Values
Source: Design Standards & Policies Manual, City of Scottsdale, 2018

Project Number: 3010.0100309.000
Project Engineer: M. Jacobsen
Project Checker: L. Vics

Subbasin	Roadside Ditch	Area sf ft	Residential Area R1-70, <10%	C 2-25 yr	C 50 yr	C 100 yr	Pavement Area	C 2-25 yr	C 50 yr	C 100 yr	Commercial & Industrial Area	C 2-25 yr	C 50 yr	C 100 yr	Mountain Terrain - Slopes > 10%	C 2-25 yr	C 50 yr	C 100 yr	Desert Landscaping	C 2-25 yr	C 50 yr	C 100 yr	Natural Desert	C 2-25 yr	C 50 yr	C 100 yr	2.25 Year Weighted C-Value	50 Year Weighted C-Value	100 Year Weighted C-Value	
OFF-1A		79877.5474	623.1578	0	0.37	0.52	0.6	21158.16	0.9	0.93	0.95	0	0.8	0.83	0.86	50403.09	0.6	0.7	0.8	8316.297	0.63	0.73	0.83	0	0.37	0.42	0.45	0.68	0.76	0.84
OFF-1B		203786.389	1167.779	0	0.37	0.52	0.6	9432.7	0.9	0.93	0.95	106845.37	0.8	0.83	0.86	82174.53	0.6	0.7	0.8	5333.8	0.63	0.73	0.83	0	0.37	0.42	0.45	0.72	0.78	0.84
OFF-1C		432874.324	1475.856	0	0.37	0.52	0.6	24157.61	0.9	0.93	0.95	61937.31	0.8	0.83	0.86	310257.61	0.6	0.7	0.8	2335.5	0.63	0.73	0.83	34186.25	0.37	0.42	0.45	0.63	0.71	0.79
OFF-1 TOTAL		716538.26	1475.856	0	0.37	0.52	0.6	54748.47	0.9	0.93	0.95	168793	0.8	0.83	0.86	442435.23	0.6	0.7	0.8	15985.597	0.63	0.73	0.83	34186	0.37	0.42	0.45	0.66	0.74	0.81
OFF-2A		111034.7	796.9878	0	0.37	0.52	0.6	15067.61	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	6305.5	0.63	0.73	0.83	89661.57	0.37	0.42	0.45	0.43	0.51	0.54
OFF-2B		36198.2946	338.1222	0	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	36198.2946	0.37	0.42	0.45	0.37	0.42	0.45
OFF-2B CUMULATIVE		147232.994	911.6878	0	0.37	0.52	0.6	15067.61	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	6305.5	0.63	0.73	0.83	125859.8646	0.37	0.42	0.45	0.44	0.49	0.52
OFF-2C		142061.328	955.0819	0	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	142061.328	0.37	0.42	0.45	0.42	0.45	0.45
OFF-2C CUMULATIVE		287494.322	1472.491	0	0.37	0.52	0.6	15067.61	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	6305.5	0.63	0.73	0.83	266121.1926	0.37	0.42	0.45	0.40	0.45	0.48
OFF-2D		60921.0827	561.0097	0	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	60921.0827	0.37	0.42	0.45	0.37	0.42	0.45
OFF-2 TOTAL		348415.405	955.0819	0	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	348415.405	0.37	0.42	0.45	0.37	0.42	0.45
OFF-1 + OFF-2		1064953.67	2364.778	0	0.37	0.52	0.6	54748.47	0.9	0.93	0.95	168793	0.8	0.83	0.86	442435	0.6	0.7	0.8	15986	0.63	0.73	0.83	382607	0.37	0.42	0.45	0.56	0.63	0.68
OFF-3A		45904.5345	414.3621	0	0.37	0.52	0.6	4180.094	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	4174.4405	0.37	0.42	0.45	0.42	0.47	0.50
OFF-3B		2024938.05	4719.483	1,958.546	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	66,392.32	0.6	0.7	0.8	0	0.63	0.73	0.83	0	0.37	0.42	0.45	0.38	0.53	0.61
OFF-3E		50411.6834	479.0056	0	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	50,412	0.37	0.42	0.45	0.37	0.42	0.45
OFF-3B + OFF-3E (STAGE/COACH PASS)		2075349.73	4981.483	1,958.546	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	66,392	0.6	0.7	0.8	0	0.63	0.73	0.83	50,412	0.37	0.42	0.45	0.38	0.52	0.60
OFF-3C		32262.4161	308.8783	32.262	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0.00	0.6	0.7	0.8	0	0.63	0.73	0.83	0	0.37	0.42	0.45	0.37	0.52	0.60
OFF-3D		1396295.11	3688.967	1,188.548	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	207,702.55	0.6	0.7	0.8	0	0.63	0.73	0.83	0	0.37	0.42	0.45	0.40	0.55	0.60
OFF-3D1		1049154.42	3408.305	873.714	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	207,702.55	0.6	0.7	0.8	0	0.63	0.73	0.83	0	0.37	0.42	0.45	0.42	0.56	0.64
OFF-3C + OFF-3D1		1081416.83	3408.305	873.714	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	207,703	0.6	0.7	0.8	0	0.63	0.73	0.83	0	0.37	0.42	0.45	0.41	0.55	0.64
OFF-3C + OFF-3D		1428512.52	3888.967	1,220.810	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	207,703	0.6	0.7	0.8	0	0.63	0.73	0.83	0	0.37	0.42	0.45	0.40	0.55	0.63
OFF-3 TOTAL REV (DITCH TO CULVERT STA 204+00)	WB Channel 9	3471599.84	5595.743	3147093.284	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	274094.87	0.6	0.7	0.8	0	0.63	0.73	0.83	50411.6834	0.37	0.42	0.45	0.39	0.53	0.61
OFF-4A1		6685.6574	281.9081	6685.6574	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	0	0.37	0.42	0.45	0.37	0.52	0.60
OFF-4A		34061.8099	357.3416	34061.8099	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	0	0.37	0.42	0.45	0.37	0.52	0.60
OFF-4B		13592.4459	127.8383	13592.4459	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	0	0.37	0.42	0.45	0.37	0.52	0.60
OFF-4A TOTAL	WB Channel 8	47654.4558	737.1755	47654.4558	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	0	0.37	0.42	0.45	0.37	0.52	0.60
OFF-4E		896.7672	57.4466	0	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	896.7672	0.37	0.42	0.45	0.37	0.42	0.45
OFF-5	WB Channel 7	2927.362	58.1627	0	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	2927.362	0.37	0.42	0.45	0.37	0.42	0.45
OFF-6	WB Channel 6	262228.301	1955.898	262228.3005	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	0	0.37	0.42	0.45	0.37	0.52	0.60
OFF-7E	WB Channel 5 Eastbound	9397.6972	261.8858	0	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	9397.6972	0.37	0.42	0.45	0.37	0.42	0.45
OFF-7W	WB Channel 5 Westbound	33583.8629	486.423	33583.8629	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	0	0.37	0.42	0.45	0.37	0.52	0.60
OFF-8E	WB Channel 4 Eastbound	6306.1526	187.2727	6306.1526	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	0	0.37	0.42	0.45	0.37	0.52	0.60
OFF-8W1		61920.664	575.1804	61920.664	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	0	0.37	0.42	0.45	0.37	0.52	0.60
OFF-8W2		18619.6631	138.1817	18619.6631	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	0	0.37	0.42	0.45	0.37	0.52	0.60
OFF-8W TOTAL	WB Channel 4 Westbound	80540.3271	693.4	80540.3271	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	0	0.37	0.42	0.45	0.37	0.52	0.60
OFF-8B1		2986.0418	212.7295	2986.0418	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	0	0.37	0.42	0.45	0.37	0.52	0.60
OFF-8B		205173.261	1444.223	205173.2609	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	0	0.37	0.42	0.45	0.37	0.52	0.60
OFF-9A		833132.866	2878.633	833132.866	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	0	0.37	0.42	0.45	0.37	0.52	0.60
OFF-9B		3648.7892	99.0757	0	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	3648.7892	0.37	0.42	0.45	0.37	0.42	0.45
OFF-9 TOTAL	WB Channel 3	836781.655	3066.633	833132.866	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	3648.7892	0.37	0.42	0.45	0.37	0.52	0.60
OFF-10E	WB Channel 2 Eastbound	2820.1839	90.1203	0	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	2820.1839	0.37	0.42	0.45	0.37	0.42	0.45
OFF-10W	WB Channel 2 Westbound	6473.2282	200.6464	0	0.37	0.52	0.6	0	0.9	0.93	0.95	0	0.8	0.83	0.86	0	0.6	0.7	0.8	0	0.63	0.73	0.83	6473.2282	0.37	0.42	0.45	0.37	0.42	0.45
OFF-11	WB Channel 1B	121063.404	961.3552	121063.4037	0.37	0.52																								

B.4 HEC-1 Output

```

1*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* JUN 1998
* VERSION 4.1
*
* RUN DATE 01MAY24 TIME 08:51:26
*
*****

```

```

*****
*
* U.S. ARMY CORPS OF ENGINEERS
* HYDROLOGIC ENGINEERING CENTER
* 609 SECOND STREET
* DAVIS, CALIFORNIA 95616
* (916) 756-1104
*
*****

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X X XXXXXX XXXX X
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X X X X X
XXXXXX XXXX X XXXXX
X X X X X
X X X X X
X X XXXXXX XXXX XXX

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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE. THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
 NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
 DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
 KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1 HEC-1 INPUT PAGE 1

```

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
1 ID Flood Control District of Maricopa County
2 ID CAREFREE HWY - Carefree Highway
3 ID 50 YEAR
4 ID 6 Hour Storm
5 ID Unit Hydrograph: Clark
6 ID Storm: Multiple
7 ID 05/01/2024
  *DIAGRAM
8 IT 5 1JAN99 0 2000
9 IO 5
10 IN 15
  *
11 JD 2.740 0.0001
12 PC 0.000 0.008 0.016 0.025 0.033 0.041 0.050 0.058 0.066 0.074
13 PC 0.087 0.099 0.118 0.138 0.216 0.377 0.834 0.911 0.931 0.950
14 PC 0.962 0.972 0.983 0.991 1.000
15 JD 2.724 0.5000
16 PC 0.000 0.008 0.016 0.025 0.033 0.041 0.050 0.058 0.066 0.074
17 PC 0.087 0.099 0.118 0.138 0.216 0.377 0.834 0.911 0.931 0.950
18 PC 0.962 0.972 0.983 0.991 1.000
  *
19 KK 01 BASIN
20 BA 0.306
21 LG 0.27 0.27 6.76 0.13 27
22 UC 0.483 0.414
23 UA 0 5.0 16.0 30.0 65.0 77.0 84.0 90.0 94.0 97.0
24 UA 100
  *
25 ZZ

```

1 SCHEMATIC DIAGRAM OF STREAM NETWORK

```

INPUT LINE (V) ROUTING (--->) DIVERSION OR PUMP FLOW
NO. (.) CONNECTOR (<---) RETURN OF DIVERTED OR PUMPED FLOW
19 01

```

(**) RUNOFF ALSO COMPUTED AT THIS LOCATION

```

1*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* JUN 1998
* VERSION 4.1
*
* RUN DATE 01MAY24 TIME 08:51:26
*
*****

```

```

*****
*
* U.S. ARMY CORPS OF ENGINEERS
* HYDROLOGIC ENGINEERING CENTER
* 609 SECOND STREET
* DAVIS, CALIFORNIA 95616
* (916) 756-1104
*
*****

```

Flood Control District of Maricopa County
 CAREFREE HWY - Carefree Highway
 50 YEAR
 6 Hour Storm

Unit Hydrograph: Clark
Storm: Multiple
05/01/2024

9 IO OUTPUT CONTROL VARIABLES
 IPRNT 5 PRINT CONTROL
 IPLOT 0 PLOT CONTROL
 QSCAL 0. HYDROGRAPH PLOT SCALE

IT HYDROGRAPH TIME DATA
 NMIN 5 MINUTES IN COMPUTATION INTERVAL
 IDATE 1JAN99 STARTING DATE
 ITIME 0000 STARTING TIME
 NQ 2000 NUMBER OF HYDROGRAPH ORDINATES
 NDDATE 7JAN99 ENDING DATE
 NDTIME 2235 ENDING TIME
 ICENT 19 CENTURY MARK

 COMPUTATION INTERVAL 0.08 HOURS
 TOTAL TIME BASE 166.58 HOURS

ENGLISH UNITS
DRAINAGE AREA SQUARE MILES
PRECIPITATION DEPTH INCHES
LENGTH, ELEVATION FEET
FLOW CUBIC FEET PER SECOND
STORAGE VOLUME ACRE-FEET
SURFACE AREA ACRES
TEMPERATURE DEGREES FAHRENHEIT

11 JD INDEX STORM NO. 1
 STRM 2.74 PRECIPITATION DEPTH
 TRDA 0.00 TRANSPOSITION DRAINAGE AREA

12 PI PRECIPITATION PATTERN
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.01 0.01 0.03
 0.03 0.03 0.05 0.05 0.05 0.15 0.15 0.15 0.03 0.03
 0.03 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.00 0.00
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 0.00 0.00

15 JD INDEX STORM NO. 2
 STRM 2.72 PRECIPITATION DEPTH
 TRDA 0.50 TRANSPOSITION DRAINAGE AREA

16 PI PRECIPITATION PATTERN
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.01 0.01 0.03
 0.03 0.03 0.05 0.05 0.05 0.15 0.15 0.15 0.03 0.03
 0.03 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.00 0.00
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 0.00 0.00

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
				6-HOUR	24-HOUR	72-HOUR			
+	HYDROGRAPH AT								
+	01	389.	4.25	59.	15.	5.	0.31		

*** NORMAL END OF HEC-1 ***


```

1*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* JUN 1998
* VERSION 4.1
*
* RUN DATE 01MAY24 TIME 09:58:48
*
*****

```

```

*****
*
* U.S. ARMY CORPS OF ENGINEERS
* HYDROLOGIC ENGINEERING CENTER
* 609 SECOND STREET
* DAVIS, CALIFORNIA 95616
* (916) 756-1104
*
*****

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X X XXXXXX XXXX X
X X X X X XX
X X X X X
XXXXXXX XXXX X XXXXX X
X X X X X
X X X X X
X X XXXXXX XXXX XXX

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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
 THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
 NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
 DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
 KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1 HEC-1 INPUT PAGE 1

```

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
1 ID Flood Control District of Maricopa County
2 ID CAREFREE HWY - Carefree Highway
3 ID 50 YEAR
4 ID 24 Hour Storm
5 ID Unit Hydrograph: Clark
6 ID Storm: Multiple
7 ID 04/30/2024
*DIAGRAM
8 IT 5 1JAN99 0 2000
9 IO 5
10 IN 15
*
11 JD 4.218 0.0001
12 PC 0.000 0.002 0.005 0.008 0.011 0.014 0.017 0.020 0.023 0.026
13 PC 0.029 0.032 0.035 0.038 0.041 0.044 0.048 0.052 0.056 0.060
14 PC 0.064 0.068 0.072 0.076 0.080 0.085 0.090 0.095 0.100 0.105
15 PC 0.110 0.115 0.120 0.126 0.133 0.140 0.147 0.155 0.163 0.172
16 PC 0.181 0.191 0.203 0.218 0.236 0.257 0.283 0.387 0.663 0.707
17 PC 0.735 0.758 0.776 0.791 0.804 0.815 0.825 0.834 0.842 0.849
18 PC 0.856 0.863 0.869 0.875 0.881 0.887 0.893 0.898 0.903 0.908
19 PC 0.913 0.918 0.922 0.926 0.930 0.934 0.938 0.942 0.946 0.950
20 PC 0.953 0.956 0.959 0.962 0.965 0.968 0.971 0.974 0.977 0.980
21 PC 0.983 0.986 0.989 0.992 0.995 0.998 1.000
22 JD 4.007 10.0
*
23 KK 01 BASIN
24 BA 0.306
25 LG 0.27 0.27 6.76 0.13 27
26 UC 0.483 0.414
27 UA 0 5.0 16.0 30.0 65.0 77.0 84.0 90.0 94.0 97.0
28 UA 100
*
29 ZZ

```

1 SCHEMATIC DIAGRAM OF STREAM NETWORK

```

INPUT
LINE (V) ROUTING (--->) DIVERSION OR PUMP FLOW

NO. (.) CONNECTOR (<---) RETURN OF DIVERTED OR PUMPED FLOW

23 01

```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```

1*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* JUN 1998
* VERSION 4.1
*
* RUN DATE 01MAY24 TIME 09:58:48
*
*****

```

```

*****
*
* U.S. ARMY CORPS OF ENGINEERS
* HYDROLOGIC ENGINEERING CENTER
* 609 SECOND STREET
* DAVIS, CALIFORNIA 95616
* (916) 756-1104
*
*****

```

```

9 IO      OUTPUT CONTROL VARIABLES
          IPRNT      5   PRINT CONTROL
          IPLOT      0   PLOT CONTROL
          QSCAL     0.   HYDROGRAPH PLOT SCALE

IT        HYDROGRAPH TIME DATA
          NMIN      5   MINUTES IN COMPUTATION INTERVAL
          IDATE     17AN99 STARTING DATE
          ITIME     0000 STARTING TIME
          NQ       2000 NUMBER OF HYDROGRAPH ORDINATES
          NDDATE    77AN99 ENDING DATE
          NDTIME    2235 ENDING TIME
          ICENT     19   CENTURY MARK

          COMPUTATION INTERVAL  0.08 HOURS
          TOTAL TIME BASE      166.58 HOURS

ENGLISH UNITS
          DRAINAGE AREA      SQUARE MILES
          PRECIPITATION DEPTH INCHES
          LENGTH, ELEVATION  FEET
          FLOW               CUBIC FEET PER SECOND
          STORAGE VOLUME     ACRE-FEET
          SURFACE AREA        ACRES
          TEMPERATURE         DEGREES FAHRENHEIT

```

11 JD	INDEX STORM NO. 1		
	STRM	4.22	PRECIPITATION DEPTH
	TRDA	0.00	TRANSPPOSITION DRAINAGE AREA

[illegible]

```

22 JD          INDEX STORM NO. 2
                STRM      4.01 PRECIPITATION DEPTH
                TRDA     10.00 TRANSPOSITION DRAINAGE AREA

```

[illegible]

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
					6-HOUR	24-HOUR	72-HOUR			
+										
+	HYDROGRAPH AT	01	372.	12.17	61.	18.	6.	0.31		

*** NORMAL END OF HEC-1 ***

```

1*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* JUN 1998
* VERSION 4.1
*
* RUN DATE 01MAY24 TIME 09:57:48
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*
* U.S. ARMY CORPS OF ENGINEERS
* HYDROLOGIC ENGINEERING CENTER
* 609 SECOND STREET
* DAVIS, CALIFORNIA 95616
* (916) 756-1104
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X X XXXXXX XXXX XXX

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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
 THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
 NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
 DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
 KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1 HEC-1 INPUT PAGE 1

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LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
1 ID Flood Control District of Maricopa County
2 ID CAREFREE HWY - Carefree Highway
3 ID 100 YEAR
4 ID 6 Hour Storm
5 ID Unit Hydrograph: Clark
6 ID Storm: Multiple
7 ID 05/01/2024
  *DIAGRAM
8 IT 5 1JAN99 0 2000
9 IO 5
10 IN 15
  *
11 JD 3.069 0.0001
12 PC 0.000 0.008 0.016 0.025 0.033 0.041 0.050 0.058 0.066 0.074
13 PC 0.087 0.099 0.118 0.138 0.216 0.377 0.834 0.911 0.931 0.950
14 PC 0.962 0.972 0.983 0.991 1.000
15 JD 3.051 0.5000
16 PC 0.000 0.008 0.016 0.025 0.033 0.041 0.050 0.058 0.066 0.074
17 PC 0.087 0.099 0.118 0.138 0.216 0.377 0.834 0.911 0.931 0.950
18 PC 0.962 0.972 0.983 0.991 1.000
  *
19 KK 01 BASIN
20 BA 0.306
21 LG 0.27 0.27 6.76 0.13 27
22 UC 0.456 0.389
23 UA 0 5.0 16.0 30.0 65.0 77.0 84.0 90.0 94.0 97.0
24 UA 100
  *
25 ZZ

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1 SCHEMATIC DIAGRAM OF STREAM NETWORK

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INPUT LINE (V) ROUTING (--->) DIVERSION OR PUMP FLOW
NO. (.) CONNECTOR (<---) RETURN OF DIVERTED OR PUMPED FLOW
19 01

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(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

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1*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* JUN 1998
* VERSION 4.1
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* RUN DATE 01MAY24 TIME 09:57:48
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Flood Control District of Maricopa County
 CAREFREE HWY - Carefree Highway
 100 YEAR
 6 Hour Storm

Unit Hydrograph: Clark
Storm: Multiple
05/01/2024

9 IO OUTPUT CONTROL VARIABLES
 IPRNT 5 PRINT CONTROL
 IPLOT 0 PLOT CONTROL
 QSCAL 0. HYDROGRAPH PLOT SCALE

IT HYDROGRAPH TIME DATA
 NMIN 5 MINUTES IN COMPUTATION INTERVAL
 IDATE 1JAN99 STARTING DATE
 ITIME 0000 STARTING TIME
 NQ 2000 NUMBER OF HYDROGRAPH ORDINATES
 NDDATE 7JAN99 ENDING DATE
 NDTIME 2235 ENDING TIME
 ICENT 19 CENTURY MARK

COMPUTATION INTERVAL 0.08 HOURS
TOTAL TIME BASE 166.58 HOURS

ENGLISH UNITS
DRAINAGE AREA SQUARE MILES
PRECIPITATION DEPTH INCHES
LENGTH, ELEVATION FEET
FLOW CUBIC FEET PER SECOND
STORAGE VOLUME ACRES-FEET
SURFACE AREA ACRES
TEMPERATURE DEGREES FAHRENHEIT

11 JD INDEX STORM NO. 1
 STRM 3.07 PRECIPITATION DEPTH
 TRDA 0.00 TRANSPOSITION DRAINAGE AREA

12 PI PRECIPITATION PATTERN
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.01 0.01 0.03
 0.03 0.03 0.05 0.05 0.05 0.15 0.15 0.15 0.03 0.03
 0.03 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.00 0.00
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 0.00 0.00

15 JD INDEX STORM NO. 2
 STRM 3.05 PRECIPITATION DEPTH
 TRDA 0.50 TRANSPOSITION DRAINAGE AREA

16 PI PRECIPITATION PATTERN
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
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 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.01 0.01 0.03
 0.03 0.03 0.05 0.05 0.05 0.15 0.15 0.15 0.03 0.03
 0.03 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.00 0.00
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 0.00 0.00

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
				6-HOUR	24-HOUR	72-HOUR			
+									
+	HYDROGRAPH AT								
	01	471.	4.17	68.	17.	6.	0.31		

*** NORMAL END OF HEC-1 ***


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1*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* JUN 1998
* VERSION 4.1
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* RUN DATE 01MAY24 TIME 09:59:53
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X X XXXXXX XXXX X
X X X X X XX
X X X X X
XXXXXXX XXXX X XXXXX X
X X X X X
X X X X X
X X XXXXXX XXXX XXX

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 DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
 KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1 HEC-1 INPUT PAGE 1

```

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
1 ID Flood Control District of Maricopa County
2 ID CAREFREE HWY - Carefree Highway
3 ID 100 YEAR
4 ID 24 Hour Storm
5 ID Unit Hydrograph: Clark
6 ID Storm: Multiple
7 ID 04/30/2024
*DIAGRAM
8 IT 5 1JAN99 0 2000
9 IO 5
10 IN 15
*
11 JD 4.804 0.0001
12 PC 0.000 0.002 0.005 0.008 0.011 0.014 0.017 0.020 0.023 0.026
13 PC 0.029 0.032 0.035 0.038 0.041 0.044 0.048 0.052 0.056 0.060
14 PC 0.064 0.068 0.072 0.076 0.080 0.085 0.090 0.095 0.100 0.105
15 PC 0.110 0.115 0.120 0.126 0.133 0.140 0.147 0.155 0.163 0.172
16 PC 0.181 0.191 0.203 0.218 0.236 0.257 0.283 0.387 0.663 0.707
17 PC 0.735 0.758 0.776 0.791 0.804 0.815 0.825 0.834 0.842 0.849
18 PC 0.856 0.863 0.869 0.875 0.881 0.887 0.893 0.898 0.903 0.908
19 PC 0.913 0.918 0.922 0.926 0.930 0.934 0.938 0.942 0.946 0.950
20 PC 0.953 0.956 0.959 0.962 0.965 0.968 0.971 0.974 0.977 0.980
21 PC 0.983 0.986 0.989 0.992 0.995 0.998 1.000
22 JD 4.564 10.0
*
23 KK 01 BASIN
24 BA 0.306
25 LG 0.27 0.27 6.76 0.13 27
26 UC 0.456 0.389
27 UA 0 5.0 16.0 30.0 65.0 77.0 84.0 90.0 94.0 97.0
28 UA 100
*
29 ZZ

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1 SCHEMATIC DIAGRAM OF STREAM NETWORK

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NO. (.) CONNECTOR (<---) RETURN OF DIVERTED OR PUMPED FLOW

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[illegible]

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
					6-HOUR	24-HOUR	72-HOUR			
+										
+	HYDROGRAPH AT	01	455.	12.17	73.	21.	7.	0.31		

*** NORMAL END OF HEC-1 ***

B.5 Onsite Rational Method Calculations

Duration	2-year		5-year		10-year		25-year		50-year		100-year	
	Depth	Intensity	Depth	Intensity	Depth	Intensity	Depth	Intensity	Depth	Intensity	Depth	Intensity
5	0.297	3.564	0.401	4.812	0.481	5.772	0.587	7.044	0.668	8.016	0.751	9.012
6	0.328	3.280	0.443	4.428	0.531	5.312	0.648	6.482	0.738	7.384	0.829	8.288
7	0.359	3.077	0.485	4.154	0.581	4.983	0.709	6.081	0.809	6.933	0.907	7.771
8	0.390	2.925	0.526	3.948	0.632	4.737	0.771	5.780	0.879	6.594	0.984	7.383
9	0.421	2.807	0.568	3.788	0.682	4.545	0.832	5.545	0.950	6.331	1.062	7.081
10	0.452	2.712	0.61	3.660	0.732	3.770	0.893	5.358	1.02	6.120	1.14	6.840
11	0.474	2.584	0.639	3.488	0.767	4.184	0.936	5.108	1.068	5.825	1.196	6.524
12	0.496	2.478	0.669	3.344	0.802	4.010	0.980	4.899	1.116	5.580	1.252	6.260
13	0.517	2.388	0.698	3.222	0.837	3.863	1.023	4.722	1.164	5.372	1.308	6.037
14	0.539	2.311	0.728	3.118	0.872	3.737	1.067	4.571	1.212	5.194	1.364	5.846
15	0.561	2.244	0.757	3.028	0.907	3.628	1.11	4.440	1.26	5.040	1.42	5.680
16	0.574	2.152	0.775	2.905	0.928	3.480	1.135	4.258	1.289	4.835	1.453	5.448
17	0.587	2.071	0.792	2.796	0.949	3.348	1.161	4.096	1.319	4.654	1.485	5.242
18	0.600	1.999	0.810	2.699	0.970	3.232	1.186	3.953	1.348	4.493	1.518	5.060
19	0.613	1.935	0.827	2.612	0.990	3.128	1.211	3.825	1.377	4.349	1.551	4.897
20	0.626	1.877	0.845	2.534	1.011	3.034	1.237	3.710	1.407	4.220	1.583	4.750
21	0.639	1.825	0.862	2.463	1.032	2.949	1.262	3.606	1.436	4.103	1.616	4.617
22	0.652	1.777	0.880	2.399	1.053	2.872	1.287	3.511	1.465	3.996	1.649	4.496
23	0.664	1.733	0.897	2.341	1.074	2.802	1.313	3.424	1.495	3.899	1.681	4.386
24	0.677	1.694	0.915	2.287	1.095	2.737	1.338	3.345	1.524	3.810	1.714	4.285
25	0.690	1.657	0.932	2.238	1.116	2.678	1.363	3.272	1.553	3.728	1.747	4.192
26	0.703	1.623	0.950	2.192	1.137	2.623	1.389	3.205	1.583	3.652	1.779	4.106
27	0.716	1.592	0.967	2.150	1.157	2.572	1.414	3.142	1.612	3.582	1.812	4.027
28	0.729	1.562	0.985	2.111	1.178	2.525	1.439	3.084	1.641	3.517	1.845	3.953
29	0.742	1.535	1.002	2.074	1.199	2.481	1.465	3.030	1.671	3.457	1.877	3.884
30	0.755	1.510	1.02	2.040	1.22	2.440	1.49	2.980	1.7	3.400	1.91	3.820
31	0.761	1.473	1.028	1.990	1.230	2.380	1.502	2.907	1.713	3.316	1.925	3.726
32	0.767	1.438	1.036	1.943	1.239	2.324	1.514	2.839	1.727	3.238	1.940	3.638
33	0.773	1.405	1.044	1.898	1.249	2.271	1.526	2.775	1.740	3.164	1.955	3.555
34	0.779	1.374	1.052	1.856	1.259	2.221	1.538	2.714	1.753	3.094	1.970	3.476
35	0.785	1.345	1.060	1.817	1.268	2.174	1.550	2.657	1.767	3.029	1.985	3.403
36	0.791	1.318	1.068	1.780	1.278	2.130	1.562	2.603	1.780	2.967	2.000	3.333
37	0.797	1.292	1.076	1.745	1.288	2.088	1.574	2.552	1.793	2.908	2.015	3.268
38	0.803	1.267	1.084	1.712	1.297	2.048	1.586	2.504	1.807	2.853	2.030	3.205
39	0.809	1.244	1.092	1.680	1.307	2.011	1.598	2.458	1.820	2.800	2.045	3.146
40	0.815	1.222	1.100	1.650	1.317	1.975	1.610	2.415	1.833	2.750	2.060	3.090
41	0.821	1.201	1.108	1.621	1.326	1.941	1.622	2.374	1.847	2.702	2.075	3.037
42	0.827	1.181	1.116	1.594	1.336	1.909	1.634	2.334	1.860	2.657	2.090	2.986
43	0.833	1.162	1.124	1.568	1.346	1.878	1.646	2.297	1.873	2.614	2.105	2.937
44	0.839	1.143	1.132	1.544	1.355	1.848	1.658	2.261	1.887	2.573	2.120	2.891
45	0.845	1.126	1.140	1.520	1.365	1.820	1.670	2.227	1.900	2.533	2.135	2.847
46	0.850	1.109	1.148	1.497	1.375	1.793	1.682	2.194	1.913	2.496	2.150	2.804
47	0.856	1.093	1.156	1.476	1.384	1.767	1.694	2.163	1.927	2.460	2.165	2.764
48	0.862	1.078	1.164	1.455	1.394	1.743	1.706	2.133	1.940	2.425	2.180	2.725
49	0.868	1.063	1.172	1.435	1.404	1.719	1.718	2.104	1.953	2.392	2.195	2.688
50	0.874	1.049	1.180	1.416	1.413	1.696	1.730	2.076	1.967	2.360	2.210	2.652
51	0.880	1.036	1.188	1.398	1.423	1.674	1.742	2.049	1.980	2.329	2.225	2.618
52	0.886	1.023	1.196	1.380	1.433	1.653	1.754	2.024	1.993	2.300	2.240	2.585
53	0.892	1.010	1.204	1.363	1.442	1.633	1.766	1.999	2.007	2.272	2.255	2.553
54	0.898	0.998	1.212	1.347	1.452	1.613	1.778	1.976	2.020	2.244	2.270	2.522
55	0.904	0.986	1.220	1.331	1.462	1.595	1.790	1.953	2.033	2.218	2.285	2.493
56	0.910	0.975	1.228	1.316	1.471	1.576	1.802	1.931	2.047	2.193	2.300	2.464
57	0.916	0.964	1.236	1.301	1.481	1.559	1.814	1.909	2.060	2.168	2.315	2.437
58	0.922	0.954	1.244	1.287	1.491	1.542	1.826	1.889	2.073	2.145	2.330	2.410
59	0.928	0.944	1.252	1.273	1.500	1.526	1.838	1.869	2.087	2.122	2.345	2.385
60	0.934	0.934	1.26	1.260	1.51	1.510	1.85	1.850	2.1	2.100	2.36	2.360

Project: Carefree Highway
Location: Town of Queen Creek, AZ
Date: June 7, 2024
Subject: 10-Year Rational Flow Calculations

Source: Drainage Design Manual for Maricopa County, Arizona : Hydrology, 2013

Subbasin	C	Est. Tc (min)	L (ft)	L (mi)	m	b	Kb	US Elev	DS Elev [ft]	S (ft/mi)	i (in/hr)	Tc (Calc) (hrs)	Tc (Calc) (min)	A (ac)	Discharge (cfs)	Slope (ft/ft)
CAREFREE HIGHWAY																
DA-01	0.87	6	893	0.169	-0.00625	0.04	0.040	2061.914	2042.82	112.9	5.31	0.108	6	0.952	4.4	0.0214
DA-02	0.78	6	839	0.159	-0.00625	0.04	0.040	2079.678	2061.88	112.0	5.31	0.105	6	1.003	4.2	0.0212
DA-03	0.84	5	475	0.090	-0.00625	0.04	0.043	2083.880	2074.05	109.1	5.77	0.079	5	0.398	1.9	0.0207
DA-04	0.81	5	513	0.097	-0.00625	0.04	0.041	2094.045	2079.41	150.7	5.77	0.073	4	0.661	3.1	0.0285
DA-05	0.81	5	578	0.109	-0.00625	0.04	0.042	2101.389	2084.16	157.4	5.77	0.078	5	0.493	2.3	0.0298
DA-06	0.79	5	525	0.099	-0.00625	0.04	0.041	2103.087	2094.05	91.0	5.77	0.087	5	0.598	2.7	0.0172
DA-07	0.85	6	569	0.108	-0.00625	0.04	0.042	2109.609	2100.90	80.8	5.31	0.098	6	0.462	2.1	0.0153
DA-08	0.82	6	776	0.147	-0.00625	0.04	0.040	2119.384	2102.62	114.1	5.31	0.100	6	1.028	4.5	0.0216
DA-09	0.84	6	757	0.143	-0.00625	0.04	0.041	2127.302	2109.34	125.3	5.31	0.097	6	0.694	3.1	0.0237
DA-10	0.83	5	742	0.141	-0.00625	0.04	0.041	2147.735	2127.39	144.7	5.77	0.089	5	0.672	3.2	0.0274
DA-11	0.82	7	1060	0.201	-0.00625	0.04	0.039	2147.735	2119.88	138.8	4.98	0.112	7	1.257	5.2	0.0263
DA-12	0.84	7	1043	0.198	-0.00625	0.04	0.040	2175.736	2147.73	141.8	4.98	0.111	7	0.978	4.1	0.0269
DA-13	0.80	5	376	0.071	-0.00625	0.04	0.042	2161.808	2148.22	190.8	5.77	0.059	4	0.444	2.0	0.0361
DA-14	0.79	6	932	0.177	-0.00625	0.04	0.040	2182.862	2161.67	120.0	5.31	0.107	6	1.182	5.0	0.0227
DA-15	0.81	5	546	0.103	-0.00625	0.04	0.042	2185.227	2175.41	94.9	5.77	0.088	5	0.471	2.2	0.0180
DA-16	0.75	7	855	0.162	-0.00625	0.04	0.040	2197.395	2182.36	92.9	4.98	0.114	7	1.052	4.0	0.0176
DA-17	0.79	5	612	0.116	-0.00625	0.04	0.042	2198.557	2185.00	117.1	5.77	0.087	5	0.569	2.6	0.0222
DA-18	0.75	5	421	0.080	-0.00625	0.04	0.042	2205.829	2197.54	103.9	5.77	0.075	5	0.525	2.3	0.0197
DA-19	0.79	5	368	0.070	-0.00625	0.04	0.043	2205.928	2198.31	109.4	5.77	0.070	4	0.330	1.5	0.0207
DA-20	0.83	5	440	0.083	-0.00625	0.04	0.042	2211.089	2205.36	68.8	5.77	0.087	5	0.522	2.5	0.0130
DA-21	0.85	5	426	0.081	-0.00625	0.04	0.042	2211.165	2205.64	68.4	5.77	0.087	5	0.399	2.0	0.0130
DA-22	0.79	5	352	0.067	-0.00625	0.04	0.042	2216.817	2211.466	80.2	5.77	0.075	4	0.438	2.0	0.0152
DA-23	0.81	5	364	0.069	-0.00625	0.04	0.043	2215.956	2210.671	76.6	5.77	0.078	5	0.307	1.4	0.0145
DA-24	0.79	5	383	0.073	-0.00625	0.04	0.042	2224	2215.466	117.6	5.77	0.069	4	0.457	2.1	0.0223
DA-25	0.83	5	441	0.083	-0.00625	0.04	0.043	2226.026	2215.129	130.5	5.77	0.072	4	0.388	1.9	0.0247
DA-26	0.88	5	366	0.069	-0.00625	0.04	0.041	2231.036	2223.67	106.4	5.77	0.069	4	0.580	3.0	0.0201
DA-27	0.88	5	478	0.091	-0.00625	0.04	0.040	2237.287	2228.425	97.9	5.77	0.080	5	0.936	4.7	0.0185
DA-28	0.86	5	308	0.058	-0.00625	0.04	0.041	2241.202	2235.814	92.3	5.77	0.066	4	0.597	3.0	0.0175
DA-29	0.76	5	353	0.067	-0.00625	0.04	0.042	2247.25	2239.20	120.2	5.77	0.066	4	0.414	1.8	0.0228
DA-30	0.79	5	353	0.067	-0.00625	0.04	0.043	2245.82	2240.23	83.6	5.77	0.075	4	0.312	1.4	0.0158
DA-31	0.83	6	630	0.119	-0.00625	0.04	0.041	2254.55	2245.81	73.3	5.31	0.104	6	0.743	3.3	0.0139
DA-32	0.82	5	366	0.069	-0.00625	0.04	0.043	2250.12	2244.77	77.2	5.77	0.078	5	0.334	1.6	0.0146
DA-33	0.87	5	258	0.049	-0.00625	0.04	0.044	2254.89	2249.23	115.8	5.77	0.058	3	0.253	1.3	0.0219
DA-34	0.90	5	432	0.082	-0.00625	0.04	0.042	2263.29	2254.23	110.8	5.77	0.075	4	0.540	2.8	0.0210
DA-35	0.87	5	449	0.085	-0.00625	0.04	0.042	2263.56	2254.46	107.0	5.77	0.078	5	0.423	2.1	0.0203

Notes:

Project: Carefree Highway
Location: Town of Queen Creek, AZ
Date: June 7, 2024
Subject: 50-Year Rational Flow Calculations

Source: Drainage Design Manual for Maricopa County, Arizona : Hydrology, 2013

Subbasin	C	Tc (min)	L (mi)	m	b	Kb	S (ft/mi)	i (in/hr)	Tc (Calc) (hrs)	Tc (Calc) (min)	A (ac)	Q (cfs)
CAREFREE HIGHWAY												
DA-01	0.90	6	0.169	-0.00625	0.04	0.040	112.9	7.38	0.095	6	0.952	6.4
DA-02	0.82	6	0.159	-0.00625	0.04	0.040	112.0	7.38	0.092	6	1.003	6.1
DA-03	0.87	5	0.090	-0.00625	0.04	0.043	109.1	8.02	0.070	4	0.398	2.8
DA-04	0.84	5	0.097	-0.00625	0.04	0.041	150.7	8.02	0.065	4	0.661	4.5
DA-05	0.84	5	0.109	-0.00625	0.04	0.042	157.4	8.02	0.068	4	0.493	3.3
DA-06	0.82	5	0.099	-0.00625	0.04	0.041	91.0	8.02	0.077	5	0.598	3.9
DA-07	0.88	5	0.108	-0.00625	0.04	0.042	80.8	8.02	0.084	5	0.462	3.3
DA-08	0.85	5	0.147	-0.00625	0.04	0.040	114.1	8.02	0.085	5	1.028	7.0
DA-09	0.88	5	0.143	-0.00625	0.04	0.041	125.3	8.02	0.083	5	0.694	4.9
DA-10	0.87	5	0.141	-0.00625	0.04	0.041	144.7	8.02	0.079	5	0.672	4.7
DA-11	0.86	6	0.201	-0.00625	0.04	0.039	138.8	7.38	0.096	6	1.257	8.0
DA-12	0.87	6	0.198	-0.00625	0.04	0.040	141.8	7.38	0.096	6	0.978	6.3
DA-13	0.83	5	0.071	-0.00625	0.04	0.042	190.8	8.02	0.052	3	0.444	3.0
DA-14	0.83	6	0.177	-0.00625	0.04	0.040	120.0	7.38	0.095	6	1.182	7.2
DA-15	0.84	5	0.103	-0.00625	0.04	0.042	94.9	8.02	0.078	5	0.471	3.2
DA-16	0.79	6	0.162	-0.00625	0.04	0.040	92.9	7.38	0.099	6	1.052	6.1
DA-17	0.83	5	0.116	-0.00625	0.04	0.042	117.1	8.02	0.077	5	0.569	3.8
DA-18	0.79	5	0.080	-0.00625	0.04	0.042	103.9	8.02	0.066	4	0.525	3.3
DA-19	0.83	5	0.070	-0.00625	0.04	0.043	109.4	8.02	0.062	4	0.330	2.2
DA-20	0.86	5	0.083	-0.00625	0.04	0.042	68.8	8.02	0.077	5	0.522	3.6
DA-21	0.89	5	0.081	-0.00625	0.04	0.042	68.4	8.02	0.077	5	0.399	2.8
DA-22	0.82	5	0.067	-0.00625	0.04	0.042	80.2	8.02	0.066	4	0.438	2.9
DA-23	0.84	5	0.069	-0.00625	0.04	0.043	76.6	8.02	0.069	4	0.307	2.1
DA-24	0.82	5	0.073	-0.00625	0.04	0.042	117.6	8.02	0.061	4	0.457	3.0
DA-25	0.86	5	0.083	-0.00625	0.04	0.043	130.5	8.02	0.064	4	0.388	2.7
DA-26	0.91	5	0.069	-0.00625	0.04	0.041	106.4	8.02	0.061	4	0.580	4.3
DA-27	0.91	5	0.091	-0.00625	0.04	0.040	97.9	8.02	0.071	4	0.936	6.8
DA-28	0.89	5	0.058	-0.00625	0.04	0.041	92.3	8.02	0.059	4	0.597	4.3
DA-29	0.80	5	0.067	-0.00625	0.04	0.042	120.2	8.02	0.059	4	0.414	2.7
DA-30	0.83	5	0.067	-0.00625	0.04	0.043	83.6	8.02	0.066	4	0.312	2.1
DA-31	0.86	5	0.119	-0.00625	0.04	0.041	73.3	8.02	0.089	5	0.743	5.1
DA-32	0.85	5	0.069	-0.00625	0.04	0.043	77.2	8.02	0.069	4	0.334	2.3
DA-33	0.90	5	0.049	-0.00625	0.04	0.044	115.8	8.02	0.051	3	0.253	1.8
DA-34	0.93	5	0.082	-0.00625	0.04	0.042	110.8	8.02	0.066	4	0.540	4.0
DA-35	0.90	5	0.085	-0.00625	0.04	0.042	107.0	8.02	0.068	4	0.423	3.1

Notes:

Project: Carefree Highway
Location: Town of Queen Creek, AZ
Date: June 7, 2024
Subject: 100-Year Rational Flow Calculations

Source: Drainage Design Manual for Maricopa County, Arizona : Hydrology, 2013

Subbasin	C	Tc (min)	L (mi)	m	b	Kb	S (ft/mi)	i (in/hr)	Tc (Calc) (hrs)	Tc (Calc) (min)	A (ac)	Q (cfs)
CAREFREE HIGHWAY												
DA-01	0.92	5	0.169	-0.00625	0.04	0.040	112.9	9.01	0.088	5	0.952	7.9
DA-02	0.84	5	0.159	-0.00625	0.04	0.040	112.0	9.01	0.086	5	1.003	7.6
DA-03	0.89	5	0.090	-0.00625	0.04	0.043	109.1	9.01	0.067	4	0.398	3.2
DA-04	0.86	5	0.097	-0.00625	0.04	0.041	150.7	9.01	0.062	4	0.661	5.1
DA-05	0.86	5	0.109	-0.00625	0.04	0.042	157.4	9.01	0.065	4	0.493	3.8
DA-06	0.85	5	0.099	-0.00625	0.04	0.041	91.0	9.01	0.074	4	0.598	4.6
DA-07	0.90	5	0.108	-0.00625	0.04	0.042	80.8	9.01	0.080	5	0.462	3.7
DA-08	0.87	5	0.147	-0.00625	0.04	0.040	114.1	9.01	0.082	5	1.028	8.1
DA-09	0.90	5	0.143	-0.00625	0.04	0.041	125.3	9.01	0.080	5	0.694	5.6
DA-10	0.89	5	0.141	-0.00625	0.04	0.041	144.7	9.01	0.075	5	0.672	5.4
DA-11	0.88	5	0.201	-0.00625	0.04	0.039	138.8	9.01	0.089	5	1.257	10.0
DA-12	0.89	5	0.198	-0.00625	0.04	0.040	141.8	9.01	0.089	5	0.978	7.8
DA-13	0.85	5	0.071	-0.00625	0.04	0.042	190.8	9.01	0.050	3	0.444	3.4
DA-14	0.85	5	0.177	-0.00625	0.04	0.040	120.0	9.01	0.088	5	1.182	9.1
DA-15	0.86	5	0.103	-0.00625	0.04	0.042	94.9	9.01	0.075	4	0.471	3.7
DA-16	0.81	5	0.162	-0.00625	0.04	0.040	92.9	9.01	0.091	5	1.052	7.7
DA-17	0.85	5	0.116	-0.00625	0.04	0.042	117.1	9.01	0.074	4	0.569	4.3
DA-18	0.81	5	0.080	-0.00625	0.04	0.042	103.9	9.01	0.063	4	0.525	3.8
DA-19	0.85	5	0.070	-0.00625	0.04	0.043	109.4	9.01	0.059	4	0.330	2.5
DA-20	0.88	5	0.083	-0.00625	0.04	0.042	68.8	9.01	0.074	4	0.522	4.2
DA-21	0.91	5	0.081	-0.00625	0.04	0.042	68.4	9.01	0.073	4	0.399	3.3
DA-22	0.84	5	0.067	-0.00625	0.04	0.042	80.2	9.01	0.063	4	0.438	3.3
DA-23	0.87	5	0.069	-0.00625	0.04	0.043	76.6	9.01	0.066	4	0.307	2.4
DA-24	0.85	5	0.073	-0.00625	0.04	0.042	117.6	9.01	0.059	4	0.457	3.5
DA-25	0.89	5	0.083	-0.00625	0.04	0.043	130.5	9.01	0.061	4	0.388	3.1
DA-26	0.94	5	0.069	-0.00625	0.04	0.041	106.4	9.01	0.059	4	0.580	4.9
DA-27	0.93	5	0.091	-0.00625	0.04	0.040	97.9	9.01	0.068	4	0.936	7.8
DA-28	0.91	5	0.058	-0.00625	0.04	0.041	92.3	9.01	0.056	3	0.597	4.9
DA-29	0.82	5	0.067	-0.00625	0.04	0.042	120.2	9.01	0.056	3	0.414	3.1
DA-30	0.85	5	0.067	-0.00625	0.04	0.043	83.6	9.01	0.063	4	0.312	2.4
DA-31	0.88	5	0.119	-0.00625	0.04	0.041	73.3	9.01	0.085	5	0.743	5.9
DA-32	0.87	5	0.069	-0.00625	0.04	0.043	77.2	9.01	0.066	4	0.334	2.6
DA-33	0.92	5	0.049	-0.00625	0.04	0.044	115.8	9.01	0.049	3	0.253	2.1
DA-34	0.95	5	0.082	-0.00625	0.04	0.042	110.8	9.01	0.063	4	0.540	4.6
DA-35	0.93	5	0.085	-0.00625	0.04	0.042	107.0	9.01	0.065	4	0.423	3.5

Notes:

APPENDIX C

Hydraulics

C.1 Culvert Calculations

C.1.1 Existing Conditions Culvert HY-8 Calculations

HY-8 Culvert Analysis Report 129+98

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.00 cfs

Design Flow: 15.00 cfs

Maximum Flow: 40.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: EX. 129+98

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2064.77	0.00	0.00	0.00	1
2065.84	4.00	4.00	0.00	1
2066.90	8.00	8.00	0.00	1
2068.55	12.00	12.00	0.00	1
2068.81	15.00	11.48	3.38	23
2068.87	20.00	9.15	10.73	9
2068.91	24.00	6.72	17.12	7
2068.95	28.00	2.66	25.23	7
2069.41	32.00	0.48	31.52	13
2069.96	36.00	0.44	35.56	21
2070.50	40.00	0.40	39.60	4
2068.76	12.45	12.45	0.00	Overtopping

Culvert Data: Culvert 1

Table 1 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2064.77	0.00	0.000	0-NF	0.00	0.00	2.00	0.00	0.00	0.00
4.00	4.00	2065.84	0.96	1.072	1-S1f	0.68	0.70	2.00	0.89	1.27	2.25
8.00	8.00	2066.90	1.44	2.129	1-S1f	0.99	1.01	2.00	1.51	2.55	2.65
12.00	12.00	2068.55	1.88	3.778	4-FFf	1.28	1.24	2.00	2.10	3.82	2.86
15.00	11.48	2068.81	1.82	4.042	4-FFf	1.24	1.22	2.00	2.52	3.65	2.97
20.00	9.15	2068.87	1.57	4.101	4-FFf	1.07	1.08	2.00	3.22	2.91	3.10
24.00	6.72	2068.91	1.29	4.140	4-FFf	0.89	0.92	2.00	3.78	2.14	3.18
28.00	2.66	2068.95	0.77	4.183	4-FFf	0.55	0.57	2.00	4.33	0.85	3.23
32.00	0.48	2069.41	0.32	4.640	4-FFf	0.23	0.24	2.00	4.88	0.15	3.28
36.00	0.44	2069.96	0.30	5.186	4-	0.22	0.23	2.00	5.42	0.14	3.32

40.00	0.40	2070.50	0.29	5.731	FFf 4- FFf	0.22	0.22	2.00	5.97	0.13	3.35
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Culvert Barrel Data

Culvert Barrel Type Straight Culvert

Inlet Elevation (invert): 2064.77 ft,

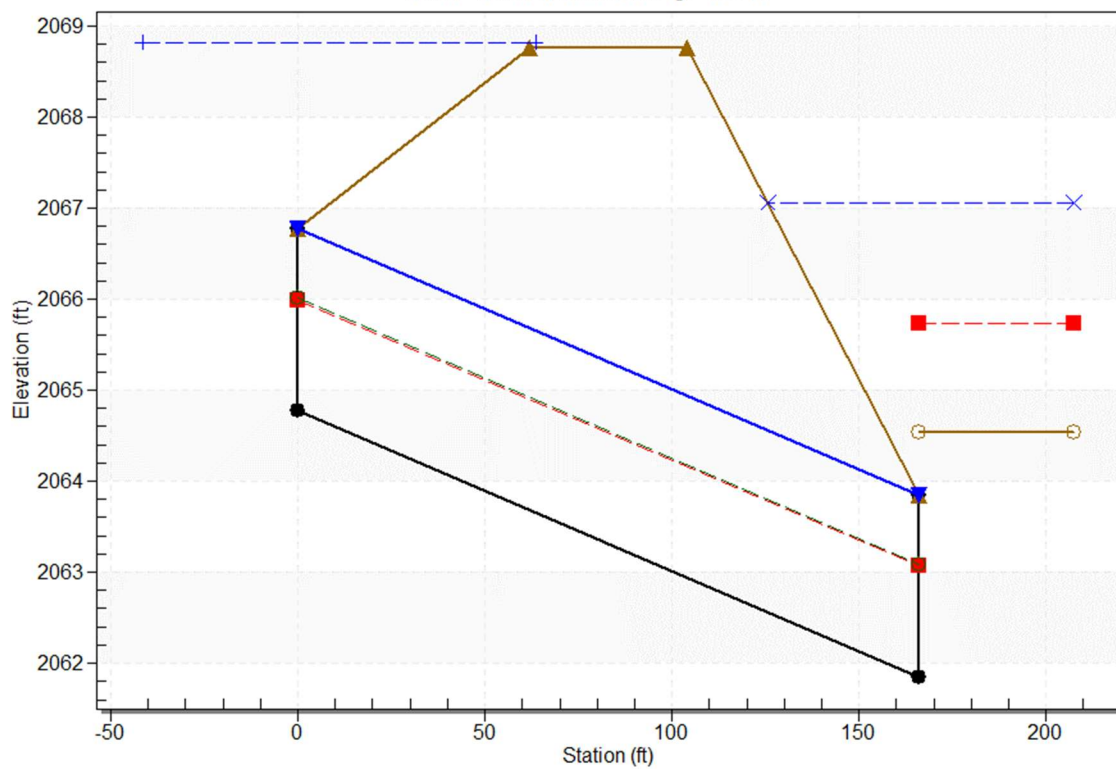
Outlet Elevation (invert): 2061.85 ft

Culvert Length: 166.04 ft,

Culvert Slope: 0.0176

Water Surface Profile Plot for Culvert: Culvert 1

Crossing - EX. 129+98, Design Discharge - 15.0 cfs
Culvert - Culvert 1, Culvert Discharge - 11.5 cfs



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2064.77 ft

Outlet Station: 166.01 ft

Outlet Elevation: 2061.85 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Corrugated Steel
 Embedment: 0.00 in
 Barrel Manning's n: 0.0240
 Culvert Type: Straight
 Inlet Configuration: Square Edge with Headwall (Ke=0.5)
 Inlet Depression: None

Tailwater Data for Crossing: EX. 129+98

Table 2 - Downstream Channel Rating Curve (Crossing: EX. 129+98)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	2064.53	0.00	0.00	0.00	0.00
4.00	2065.42	0.89	2.25	0.56	0.42
8.00	2066.04	1.51	2.65	0.94	0.38
12.00	2066.63	2.10	2.86	1.31	0.35
15.00	2067.05	2.52	2.97	1.57	0.33
20.00	2067.75	3.22	3.10	2.01	0.30
24.00	2068.31	3.78	3.18	2.36	0.29
28.00	2068.86	4.33	3.23	2.70	0.27
32.00	2069.41	4.88	3.28	3.04	0.26
36.00	2069.95	5.42	3.32	3.38	0.25
40.00	2070.50	5.97	3.35	3.72	0.24

Tailwater Channel Data - EX. 129+98

Tailwater Channel Option: Rectangular Channel
 Bottom Width: 2.00 ft
 Channel Slope: 0.0100
 Channel Manning's n: 0.0400
 Channel Invert Elevation: 2064.53 ft

Roadway Data for Crossing: EX. 129+98

Roadway Profile Shape: Constant Roadway Elevation
 Crest Length: 100.00 ft
 Crest Elevation: 2068.76 ft
 Roadway Surface: Paved
 Roadway Top Width: 42.00 ft

HY-8 Culvert Analysis Report 137+32

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.00 cfs

Design Flow: 50.00 cfs

Maximum Flow: 100.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: EX. 137+32

Headwater Elevation (ft)	Total Discharge (cfs)	Mountainside Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2078.79	0.00	0.00	0.00	1
2079.49	10.00	10.00	0.00	1
2079.80	20.00	20.00	0.00	1
2080.04	30.00	30.00	0.00	1
2080.29	40.00	40.00	0.00	1
2080.52	50.00	50.00	0.00	1
2080.72	60.00	60.00	0.00	1
2080.91	70.00	70.00	0.00	1
2081.23	80.00	80.00	0.00	1
2081.49	90.00	90.00	0.00	1
2081.84	100.00	100.00	0.00	1
2082.00	104.23	104.23	0.00	Overtopping

Culvert Data: Mountainside

Table 1 - Culvert Summary Table: Mountainside

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2078.79	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
10.00	10.00	2079.49	0.70	0.0*	1-S2n	0.42	0.52	0.42	0.64	4.62	1.94
20.00	20.00	2079.80	1.01	0.248	1-S2n	0.59	0.74	0.59	1.01	5.59	2.49
30.00	30.00	2080.04	1.25	0.596	1-S2n	0.72	0.91	0.73	1.31	6.23	2.86
40.00	40.00	2080.29	1.50	0.933	1-S2n	0.84	1.06	0.86	1.59	6.72	3.14
50.00	50.00	2080.52	1.73	1.268	1-JS1t	0.95	1.19	1.62	1.85	3.70	3.37
60.00	60.00	2080.72	1.93	1.607	1-JS1t	1.05	1.31	1.87	2.10	3.80	3.56
70.00	70.00	2080.91	2.12	1.952	1-JS1t	1.14	1.42	2.11	2.34	3.95	3.73
80.00	80.00	2081.23	2.32	2.439	1-S1t	1.23	1.52	2.35	2.58	4.18	3.88
90.00	90.00	2081.49	2.51	2.701	1-	1.32	1.61	2.50	2.80	4.58	4.01

					S1f							
100.00	100.00	2081.84	2.71	3.049	1-S1f	1.41	1.70	2.50	3.02	5.09	4.13	
					S1f							

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

Inlet Elevation (invert): 2078.79 ft,

Outlet Elevation (invert): 2078.23 ft

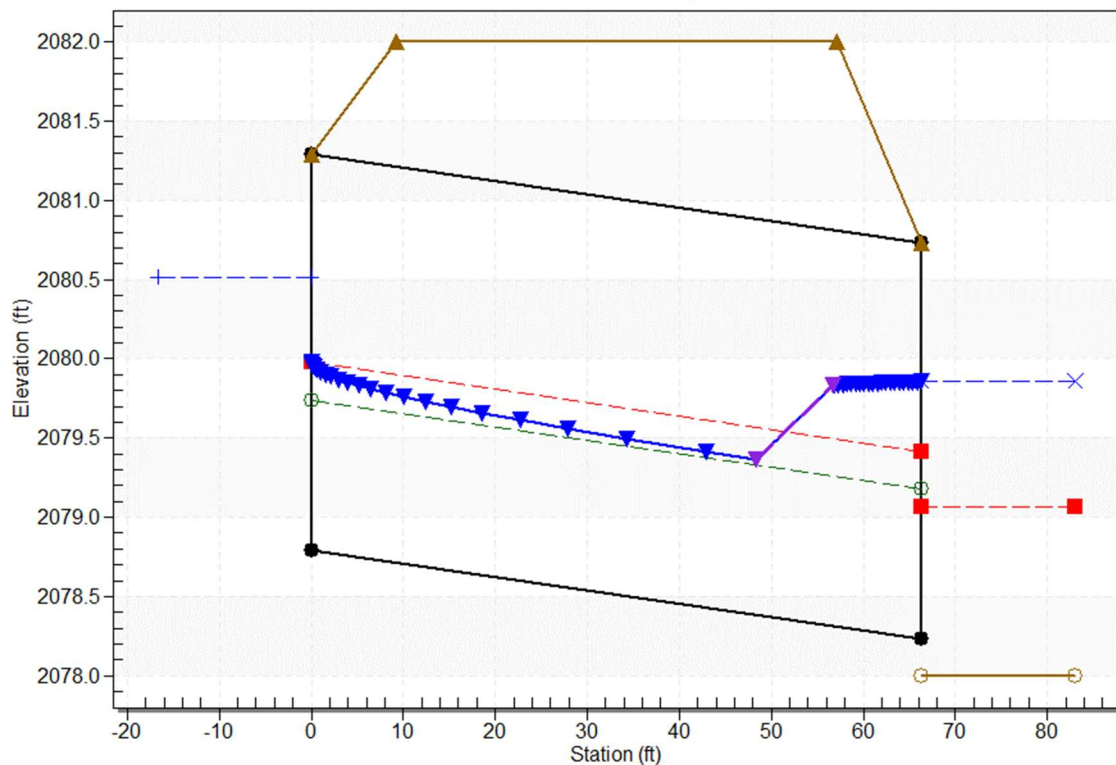
Culvert Length: 66.40 ft,

Culvert Slope: 0.0084

Water Surface Profile Plot for Culvert: Mountainside

Crossing - EX. 137+32, Design Discharge - 50.0 cfs

Culvert - Mountainside, Culvert Discharge - 50.0 cfs



Site Data - Mountainside

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2078.79 ft

Outlet Station: 66.40 ft

Outlet Elevation: 2078.23 ft

Number of Barrels: 4

Culvert Data Summary - Mountainside

Barrel Shape: Circular

Barrel Diameter: 2.50 ft
 Barrel Material: Concrete
 Embedment: 0.00 in
 Barrel Manning's n: 0.0120
 Culvert Type: Straight
 Inlet Configuration: Square Edge with Headwall (Ke=0.5)
 Inlet Depression: None

Tailwater Data for Crossing: EX. 137+32

Table 2 - Downstream Channel Rating Curve (Crossing: EX. 137+32)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	2078.00	0.00	0.00	0.00	0.00
10.00	2078.64	0.64	1.94	0.24	0.43
20.00	2079.01	1.01	2.49	0.38	0.44
30.00	2079.31	1.31	2.86	0.49	0.44
40.00	2079.59	1.59	3.14	0.60	0.44
50.00	2079.85	1.85	3.37	0.69	0.44
60.00	2080.10	2.10	3.56	0.79	0.43
70.00	2080.34	2.34	3.73	0.88	0.43
80.00	2080.58	2.58	3.88	0.96	0.43
90.00	2080.80	2.80	4.01	1.05	0.42
100.00	2081.02	3.02	4.13	1.13	0.42

Tailwater Channel Data - EX. 137+32

Tailwater Channel Option: Rectangular Channel
 Bottom Width: 8.00 ft
 Channel Slope: 0.0060
 Channel Manning's n: 0.0400
 Channel Invert Elevation: 2078.00 ft

Roadway Data for Crossing: EX. 137+32

Roadway Profile Shape: Constant Roadway Elevation
 Crest Length: 100.00 ft
 Crest Elevation: 2082.00 ft
 Roadway Surface: Paved
 Roadway Top Width: 48.00 ft

HY-8 Culvert Analysis Report 150+95

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.00 cfs

Design Flow: 48.00 cfs

Maximum Flow: 100.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: EX. 150+95

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 4 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2109.75	0.00	0.00	0.00	1
2111.21	10.00	10.00	0.00	1
2111.87	20.00	20.00	0.00	1
2112.41	30.00	30.00	0.00	1
2112.88	40.00	40.00	0.00	1
2113.24	48.00	48.00	0.00	1
2113.68	60.00	57.70	2.18	18
2113.75	70.00	59.21	10.70	6
2113.80	80.00	60.33	19.61	5
2113.85	90.00	61.28	28.70	5
2113.89	100.00	62.11	37.84	4
2113.64	56.87	56.87	0.00	Overtopping

Culvert Data: Culvert 4

Table 1 - Culvert Summary Table: Culvert 4

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2109.75	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
10.00	10.00	2111.21	1.30	1.464	2-M2c	0.97	0.96	0.96	0.55	4.69	2.28
20.00	20.00	2111.87	1.90	2.124	2-M2c	1.39	1.37	1.37	0.85	5.73	2.93
30.00	30.00	2112.41	2.41	2.655	2-M2c	1.75	1.69	1.69	1.11	6.51	3.38
40.00	40.00	2112.88	2.89	3.128	2-M2c	2.09	1.97	1.97	1.34	7.18	3.73
48.00	48.00	2113.24	3.26	3.487	2-M2c	2.37	2.16	2.16	1.52	7.69	3.96
60.00	57.70	2113.68	3.74	3.928	7-M2c	2.77	2.38	2.38	1.76	8.29	4.25
70.00	59.21	2113.75	3.82	4.000	7-M2c	2.84	2.41	2.41	1.96	8.38	4.46
80.00	60.33	2113.80	3.88	4.054	7-M2c	2.90	2.43	2.43	2.15	8.45	4.65
90.00	61.28	2113.85	3.93	4.100	7-	2.96	2.45	2.45	2.34	8.51	4.81

100.00	62.11 cfs	2113.89	3.97	4.142	M2c 7- M2c	3.01	2.47	2.47	2.52	8.56	4.97
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Culvert Barrel Data

Culvert Barrel Type Straight Culvert

Inlet Elevation (invert): 2109.75 ft,

Outlet Elevation (invert): 2108.79 ft

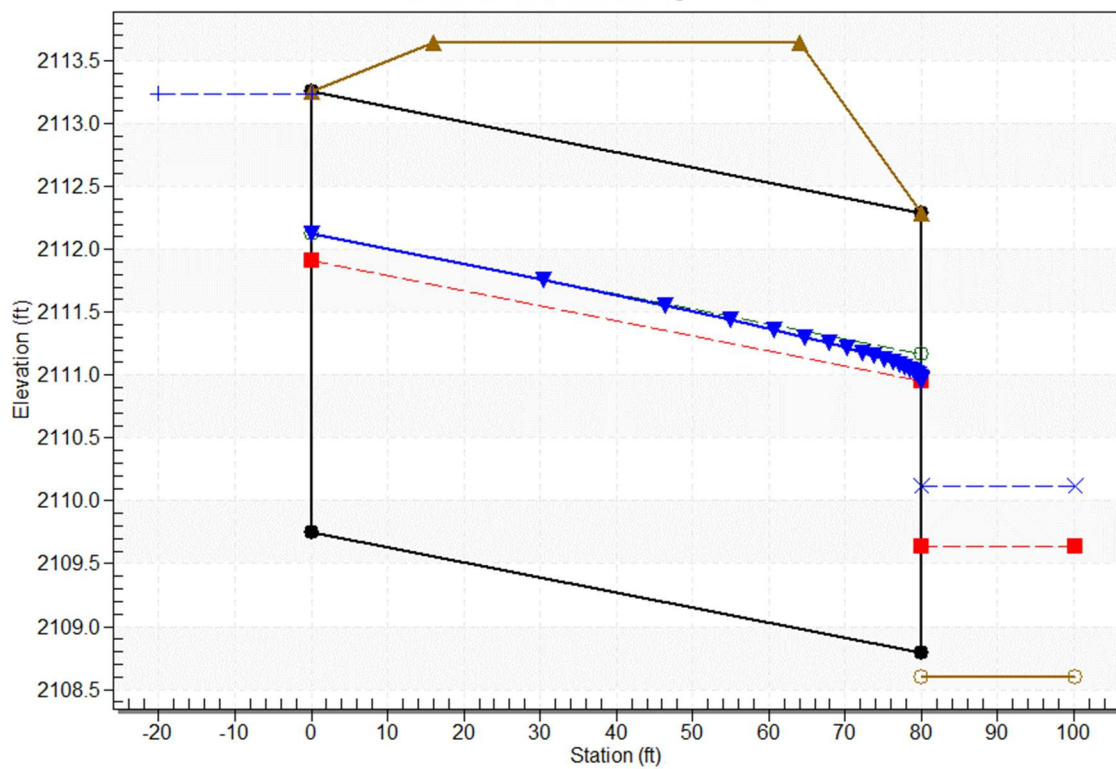
Culvert Length: 80.11 ft,

Culvert Slope: 0.0120

Water Surface Profile Plot for Culvert: Culvert 4

Crossing - EX. 150+95, Design Discharge - 48.0 cfs

Culvert - Culvert 4, Culvert Discharge - 48.0 cfs



Site Data - Culvert 4

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2109.75 ft

Outlet Station: 80.10 ft

Outlet Elevation: 2108.79 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 4

Barrel Shape: Circular

Barrel Diameter: 3.50 ft

Barrel Material: Corrugated Steel
 Embedment: 0.00 in
 Barrel Manning's n: 0.0240
 Culvert Type: Straight
 Inlet Configuration: Square Edge with Headwall
 Inlet Depression: None

Tailwater Data for Crossing: EX. 150+95

Table 2 - Downstream Channel Rating Curve (Crossing: EX. 150+95)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	2108.60	0.00	0.00	0.00	0.00
10.00	2109.15	0.55	2.28	0.34	0.54
20.00	2109.45	0.85	2.93	0.53	0.56
30.00	2109.71	1.11	3.38	0.69	0.57
40.00	2109.94	1.34	3.73	0.84	0.57
48.00	2110.12	1.52	3.96	0.95	0.57
60.00	2110.36	1.76	4.25	1.10	0.56
70.00	2110.56	1.96	4.46	1.22	0.56
80.00	2110.75	2.15	4.65	1.34	0.56
90.00	2110.94	2.34	4.81	1.46	0.55
100.00	2111.12	2.52	4.97	1.57	0.55

Tailwater Channel Data - EX. 150+95

Tailwater Channel Option: Rectangular Channel
 Bottom Width: 8.00 ft
 Channel Slope: 0.0100
 Channel Manning's n: 0.0400
 Channel Invert Elevation: 2108.60 ft

Roadway Data for Crossing: EX. 150+95

Roadway Profile Shape: Constant Roadway Elevation
 Crest Length: 100.00 ft
 Crest Elevation: 2113.64 ft
 Roadway Surface: Paved
 Roadway Top Width: 48.00 ft

HY-8 Culvert Analysis Report 168+50

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.00 cfs

Design Flow: 23.00 cfs

Maximum Flow: 50.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: EX. 168+50

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 6 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2157.60	0.00	0.00	0.00	1
2161.63	5.00	5.00	0.00	1
2161.79	10.00	10.00	0.00	1
2161.93	15.00	15.00	0.00	1
2162.05	20.00	20.00	0.00	1
2162.12	23.00	23.00	0.00	1
2162.27	30.00	30.00	0.00	1
2162.37	35.00	35.00	0.00	1
2162.47	40.00	40.00	0.00	1
2162.56	45.00	45.00	0.00	1
2162.65	50.00	50.00	0.00	1
2162.76	56.72	56.72	0.00	Overtopping

Culvert Data: Culvert 6

Table 1 - Culvert Summary Table: Culvert 6

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2157.60	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
5.00	5.00	2161.63	4.03	0.0*	5-S2n	0.32	0.52	0.32	0.68	6.79	1.83
10.00	10.00	2161.79	4.19	0.0*	5-S2n	0.45	0.74	0.45	1.09	8.31	2.28
15.00	15.00	2161.93	4.33	0.0*	5-S2n	0.55	0.91	0.55	1.46	9.35	2.57
20.00	20.00	2162.05	4.45	0.0*	5-S2n	0.64	1.06	0.64	1.80	10.14	2.78
23.00	23.00	2162.12	4.52	0.0*	5-S2n	0.69	1.14	0.68	2.00	10.56	2.88
30.00	30.00	2162.27	4.67	0.0*	5-JS1t	0.79	1.31	2.44	2.45	3.07	3.07
35.00	35.00	2162.37	4.77	0.0*	5-JS1t	0.85	1.42	2.50	2.76	3.57	3.17
40.00	40.00	2162.47	4.87	0.0*	5-JS1t	0.92	1.52	2.50	3.06	4.07	3.27
45.00	45.00	2162.56	4.96	0.327	5-	0.98	1.61	2.50	3.36	4.58	3.35

50.00 cfs	50.00 cfs	2162.65	5.05	0.835	JS1t 5- JS1t	1.03	1.70	2.50	3.66	5.09	3.42
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* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

Inlet Elevation (invert): 2157.60 ft,

Outlet Elevation (invert): 2153.67 ft

Culvert Length: 160.56 ft,

Culvert Slope: 0.0245

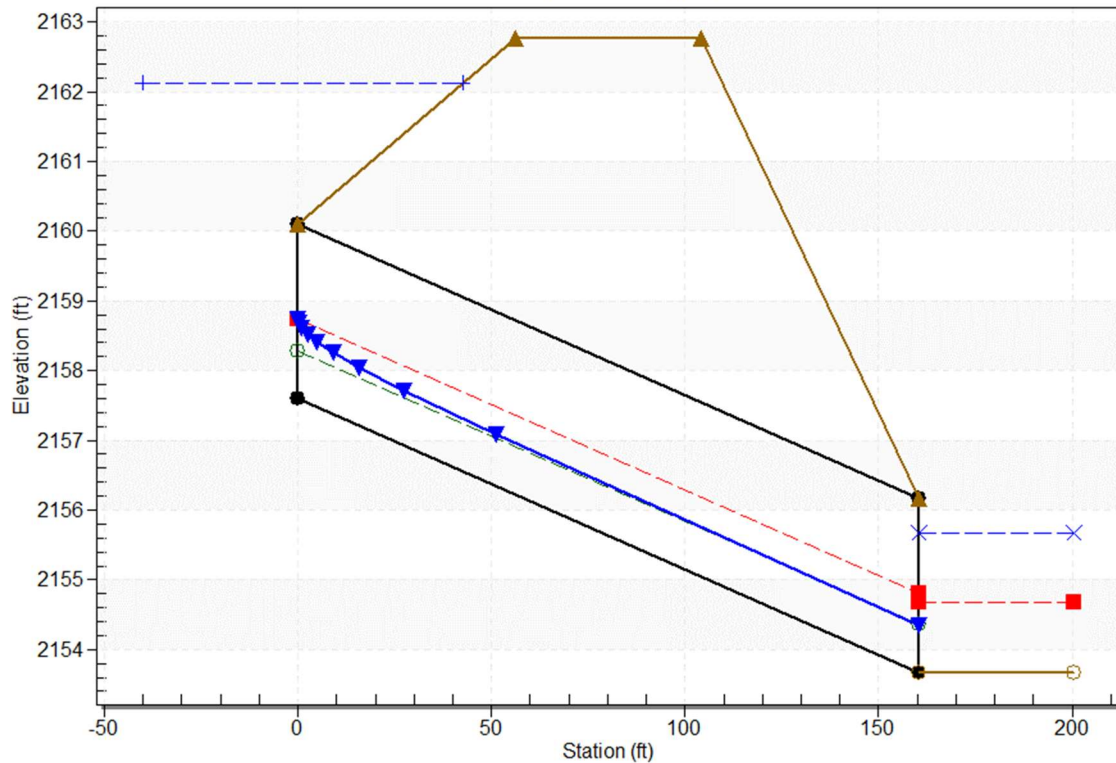
Inlet Throat Elevation: 2157.60 ft,

Inlet Crest Elevation: 2161.35 ft

Water Surface Profile Plot for Culvert: Culvert 6

Crossing - EX. 168+50, Design Discharge - 23.0 cfs

Culvert - Culvert 6, Culvert Discharge - 23.0 cfs



Site Data - Culvert 6

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2160.80 ft

Outlet Station: 160.40 ft

Outlet Elevation: 2153.67 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 6

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: Yes

Tailwater Data for Crossing: EX. 168+50

Table 2 - Downstream Channel Rating Curve (Crossing: EX. 168+50)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	2153.67	0.00	0.00	0.00	0.00
5.00	2154.35	0.68	1.83	0.26	0.39
10.00	2154.76	1.09	2.28	0.41	0.38
15.00	2155.13	1.46	2.57	0.55	0.37
20.00	2155.47	1.80	2.78	0.67	0.36
23.00	2155.67	2.00	2.88	0.75	0.36
30.00	2156.12	2.45	3.07	0.92	0.35
35.00	2156.43	2.76	3.17	1.03	0.34
40.00	2156.73	3.06	3.27	1.15	0.33
45.00	2157.03	3.36	3.35	1.26	0.32
50.00	2157.33	3.66	3.42	1.37	0.31

Tailwater Channel Data - EX. 168+50

Tailwater Channel Option: Rectangular Channel

Bottom Width: 4.00 ft

Channel Slope: 0.0060

Channel Manning's n: 0.0400

Channel Invert Elevation: 2153.67 ft

Roadway Data for Crossing: EX. 168+50

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 2162.76 ft

Roadway Surface: Paved

Roadway Top Width: 48.00 ft

HY-8 Culvert Analysis Report 171+75

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.00 cfs

Design Flow: 49.00 cfs

Maximum Flow: 80.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: EX. 171+75

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 7 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2164.87	0.00	0.00	0.00	1
2166.05	8.00	8.00	0.00	1
2166.62	16.00	16.00	0.00	1
2167.14	24.00	24.00	0.00	1
2167.61	32.00	32.00	0.00	1
2168.09	40.00	40.00	0.00	1
2168.72	49.00	49.00	0.00	1
2169.28	56.00	56.00	0.00	1
2170.03	64.00	64.00	0.00	1
2170.90	72.00	72.00	0.00	1
2171.35	80.00	75.81	4.13	17
2171.29	75.33	75.33	0.00	Overtopping

Culvert Data: Culvert 7

Table 1 - Culvert Summary Table: Culvert 7

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2164.87	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
8.00	8.00	2166.05	1.18	0.0*	1-S2n	0.45	0.89	0.47	0.48	11.30	2.10
16.00	16.00	2166.62	1.75	0.0*	1-S2n	0.63	1.28	0.67	0.74	13.54	2.71
24.00	24.00	2167.14	2.27	0.0*	1-S2n	0.77	1.58	0.84	0.96	14.84	3.13
32.00	32.00	2167.61	2.74	0.0*	1-S2n	0.89	1.83	0.99	1.16	15.68	3.46
40.00	40.00	2168.09	3.22	0.0*	5-S2n	1.00	2.06	1.14	1.34	16.30	3.73
49.00	49.00	2168.72	3.85	0.181	5-S2n	1.12	2.28	1.28	1.54	16.96	3.98
56.00	56.00	2169.28	4.41	0.702	5-S2n	1.20	2.43	1.40	1.68	17.37	4.16
64.00	64.00	2170.03	5.16	1.358	5-S2n	1.29	2.57	1.52	1.84	17.86	4.34
72.00	72.00	2170.90	6.03	2.078	5-	1.38	2.68	1.63	2.00	18.31	4.50

80.00	75.81	2171.35	6.48	2.443	S2n 5- S2n	1.42	2.73	1.69	2.15	18.52	4.65
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* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

Inlet Elevation (invert): 2164.87 ft,

Outlet Elevation (invert): 2160.95 ft

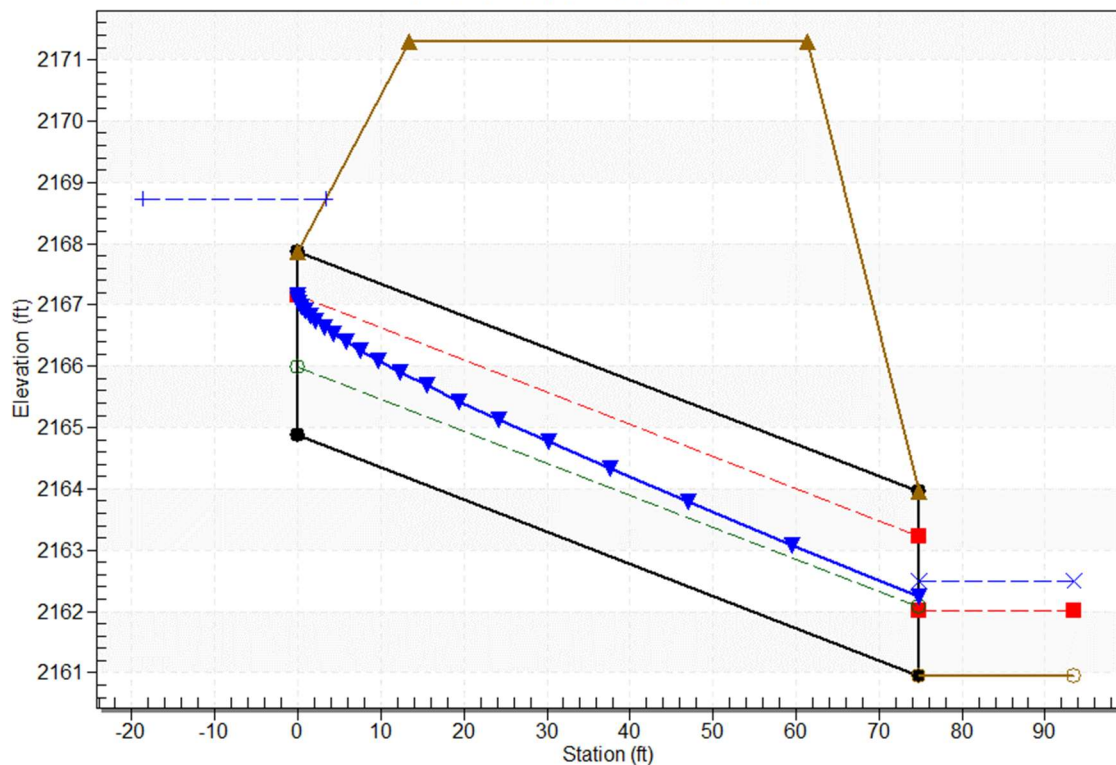
Culvert Length: 74.90 ft,

Culvert Slope: 0.0524

Water Surface Profile Plot for Culvert: Culvert 7

Crossing - EX. 171+75, Design Discharge - 49.0 cfs

Culvert - Culvert 7, Culvert Discharge - 49.0 cfs



Site Data - Culvert 7

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2164.87 ft

Outlet Station: 74.80 ft

Outlet Elevation: 2160.95 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 7

Barrel Shape: Circular

Barrel Diameter: 3.00 ft
 Barrel Material: Concrete
 Embedment: 0.00 in
 Barrel Manning's n: 0.0120
 Culvert Type: Straight
 Inlet Configuration: Square Edge with Headwall
 Inlet Depression: None

Tailwater Data for Crossing: EX. 171+75

Table 2 - Downstream Channel Rating Curve (Crossing: EX. 171+75)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	2160.95	0.00	0.00	0.00	0.00
8.00	2161.43	0.48	2.10	0.30	0.54
16.00	2161.69	0.74	2.71	0.46	0.56
24.00	2161.91	0.96	3.13	0.60	0.56
32.00	2162.11	1.16	3.46	0.72	0.57
40.00	2162.29	1.34	3.73	0.84	0.57
49.00	2162.49	1.54	3.98	0.96	0.57
56.00	2162.63	1.68	4.16	1.05	0.56
64.00	2162.79	1.84	4.34	1.15	0.56
72.00	2162.95	2.00	4.50	1.25	0.56
80.00	2163.10	2.15	4.65	1.34	0.56

Tailwater Channel Data - EX. 171+75

Tailwater Channel Option: Rectangular Channel
 Bottom Width: 8.00 ft
 Channel Slope: 0.0100
 Channel Manning's n: 0.0400
 Channel Invert Elevation: 2160.95 ft

Roadway Data for Crossing: EX. 171+75

Roadway Profile Shape: Constant Roadway Elevation
 Crest Length: 100.00 ft
 Crest Elevation: 2171.29 ft
 Roadway Surface: Paved
 Roadway Top Width: 48.00 ft

HY-8 Culvert Analysis Report 186+50

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.00 cfs

Design Flow: 50.00 cfs

Maximum Flow: 100.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: EX. 186+50

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 9 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2192.53	0.00	0.00	0.00	1
2193.88	10.00	10.00	0.00	1
2194.54	20.00	20.00	0.00	1
2195.14	30.00	30.00	0.00	1
2195.76	40.00	40.00	0.00	1
2196.46	50.00	50.00	0.00	1
2197.29	60.00	60.00	0.00	1
2198.86	70.00	66.11	3.82	24
2198.94	80.00	64.46	15.52	7
2199.00	90.00	62.68	27.26	5
2199.06	100.00	60.82	39.16	5
2198.80	66.55	66.55	0.00	Overtopping

Culvert Data: Culvert 9

Table 1 - Culvert Summary Table: Culvert 9

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00 cfs	0.00 cfs	2192.53	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
10.00 cfs	10.00 cfs	2193.88	1.35	0.0*	1-S2n	0.80	1.00	0.80	0.92	6.57	2.73
20.00 cfs	20.00 cfs	2194.54	2.01	0.0*	1-S2n	1.15	1.43	1.15	1.49	7.98	3.35
30.00 cfs	30.00 cfs	2195.14	2.61	0.0*	1-S2n	1.45	1.77	1.45	2.01	8.88	3.72
40.00 cfs	40.00 cfs	2195.76	3.23	0.198	5-S2n	1.72	2.06	1.72	2.51	9.52	3.99
50.00 cfs	50.00 cfs	2196.46	3.93	2.211	5-JS1t	2.00	2.30	3.00	2.98	7.07	4.19
60.00 cfs	60.00 cfs	2197.29	4.76	4.571	5-S1f	2.32	2.50	3.00	3.45	8.49	4.35
70.00 cfs	66.11 cfs	2198.86	5.35	6.326	4-FFf	2.58	2.60	3.00	3.91	9.35	4.48
80.00	64.46 cfs	2198.94	5.18	6.411	4-	2.49	2.58	3.00	4.36	9.12	4.59

cfs					FFf						
90.00	62.68 cfs	2199.00	5.01	6.475	4-	2.42	2.55	3.00	4.81	8.87	4.68
cfs					FFf						
100.00	60.82 cfs	2199.06	4.84	6.529	4-	2.35	2.52	3.00	5.26	8.60	4.76
cfs					FFf						

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

Inlet Elevation (invert): 2192.53 ft,

Outlet Elevation (invert): 2187.49 ft

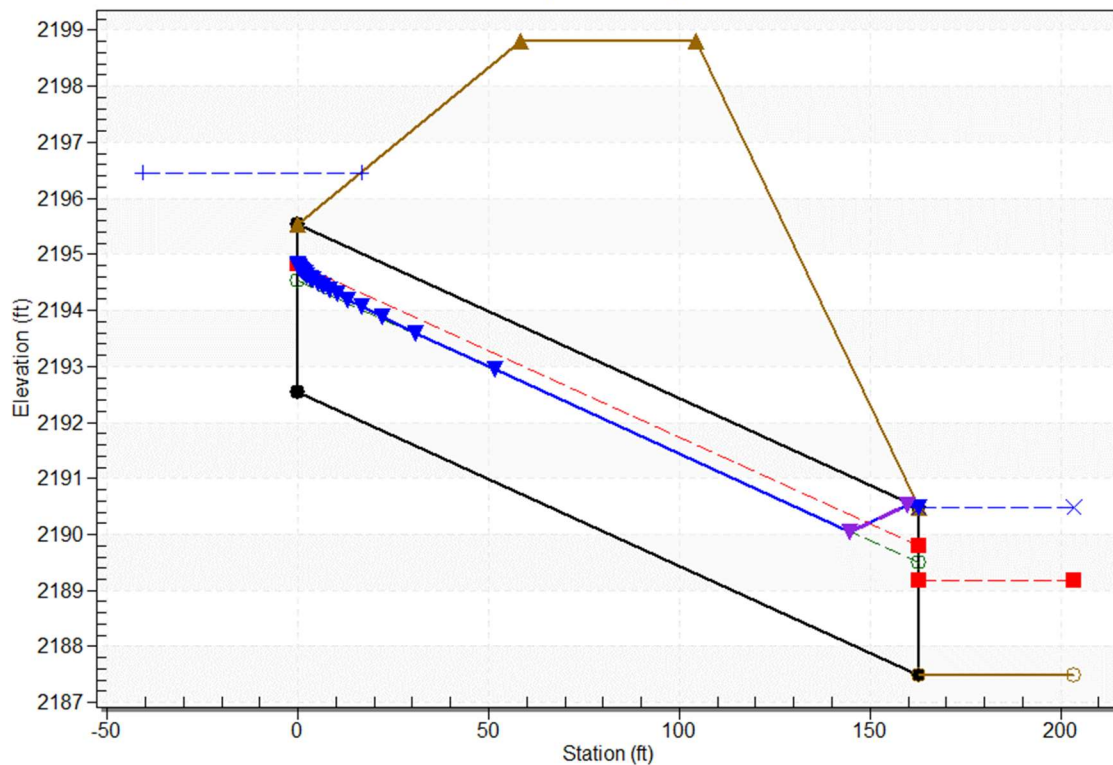
Culvert Length: 162.88 ft,

Culvert Slope: 0.0310

Water Surface Profile Plot for Culvert: Culvert 9

Crossing - EX. 186+50, Design Discharge - 50.0 cfs

Culvert - Culvert 9, Culvert Discharge - 50.0 cfs



Site Data - Culvert 9

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2192.53 ft

Outlet Station: 162.80 ft

Outlet Elevation: 2187.49 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 9

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Corrugated Steel
 Embedment: 0.00 in
 Barrel Manning's n: 0.0240
 Culvert Type: Straight
 Inlet Configuration: Square Edge with Headwall (Ke=0.5)
 Inlet Depression: None

Tailwater Data for Crossing: EX. 186+50

Table 2 - Downstream Channel Rating Curve (Crossing: EX. 186+50)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	2187.49	0.00	0.00	0.00	0.00
10.00	2188.41	0.92	2.73	0.57	0.50
20.00	2188.98	1.49	3.35	0.93	0.48
30.00	2189.50	2.01	3.72	1.26	0.46
40.00	2190.00	2.51	3.99	1.56	0.44
50.00	2190.47	2.98	4.19	1.86	0.43
60.00	2190.94	3.45	4.35	2.15	0.41
70.00	2191.40	3.91	4.48	2.44	0.40
80.00	2191.85	4.36	4.59	2.72	0.39
90.00	2192.30	4.81	4.68	3.00	0.38
100.00	2192.75	5.26	4.76	3.28	0.37

Tailwater Channel Data - EX. 186+50

Tailwater Channel Option: Rectangular Channel
 Bottom Width: 4.00 ft
 Channel Slope: 0.0100
 Channel Manning's n: 0.0400
 Channel Invert Elevation: 2187.49 ft

Roadway Data for Crossing: EX. 186+50

Roadway Profile Shape: Constant Roadway Elevation
 Crest Length: 100.00 ft
 Crest Elevation: 2198.80 ft
 Roadway Surface: Paved
 Roadway Top Width: 46.00 ft

HY-8 Culvert Analysis Report 192+24

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.00 cfs

Design Flow: 100.00 cfs

Maximum Flow: 160.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: EX. 192+24

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 10 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2201.29	0.00	0.00	0.00	1
2202.83	16.00	16.00	0.00	1
2203.51	32.00	32.00	0.00	1
2204.10	48.00	48.00	0.00	1
2204.64	64.00	64.00	0.00	1
2205.16	80.00	80.00	0.00	1
2206.15	100.00	100.00	0.00	1
2206.32	112.00	105.78	6.12	10
2206.40	128.00	108.82	19.09	6
2206.47	144.00	111.32	32.61	5
2206.53	160.00	113.51	46.47	5
2206.24	103.04	103.04	0.00	Overtopping

Culvert Data: Culvert 10

Table 1 - Culvert Summary Table: Culvert 10

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2201.29	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
16.00	16.00	2202.83	1.54	0.093	1-S2n	1.06	1.13	1.06	0.74	5.60	2.71
32.00	32.00	2203.51	2.22	0.700	1-S2n	1.51	1.62	1.51	1.16	6.82	3.46
48.00	48.00	2204.10	2.81	1.278	1-S2n	1.88	2.00	1.88	1.52	7.62	3.96
64.00	64.00	2204.64	3.35	1.881	1-S2n	2.22	2.33	2.22	1.84	8.21	4.34
80.00	80.00	2205.16	3.87	2.525	1-S2n	2.54	2.62	2.54	2.15	8.66	4.65
100.00	100.00	2206.15	4.52	4.865	7-M2c	2.94	2.94	2.94	2.52	9.09	4.97
112.00	105.78	2206.32	4.72	5.027	7-M2c	3.06	3.02	3.02	2.73	9.31	5.13
128.00	108.82	2206.40	4.83	5.112	7-M2c	3.12	3.07	3.07	3.00	9.42	5.32
144.00	111.32	2206.47	4.92	5.179	7-	3.18	3.10	3.27	3.27	8.98	5.50

					M1t							
160.00	113.51	2206.53	4.99	5.239	7-M1t	3.23	3.14	3.54	3.54	8.46	5.65	
					M1t							

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

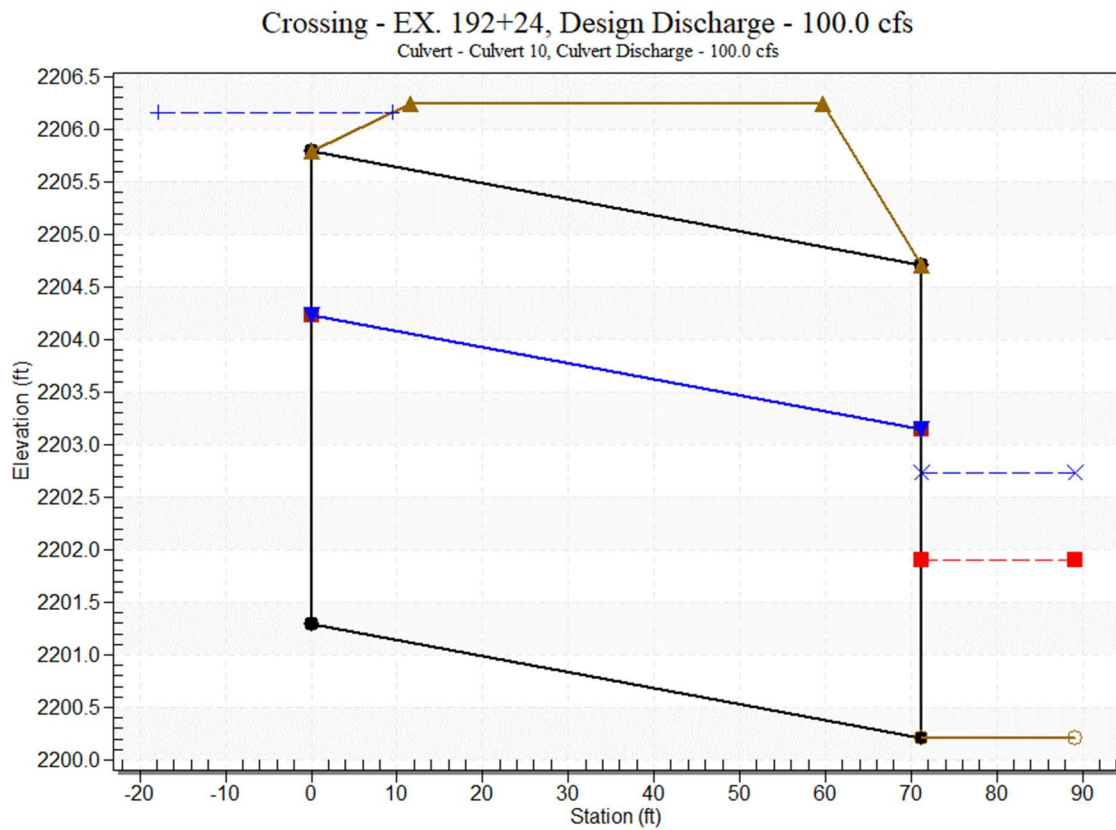
Inlet Elevation (invert): 2201.29 ft,

Outlet Elevation (invert): 2200.21 ft

Culvert Length: 71.31 ft,

Culvert Slope: 0.0151

Water Surface Profile Plot for Culvert: Culvert 10



Site Data - Culvert 10

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2201.29 ft

Outlet Station: 71.30 ft

Outlet Elevation: 2200.21 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 10

Barrel Shape: Circular

Barrel Diameter: 4.50 ft

Barrel Material: Corrugated Steel
 Embedment: 0.00 in
 Barrel Manning's n: 0.0240
 Culvert Type: Straight
 Inlet Configuration: Square Edge with Headwall
 Inlet Depression: None

Tailwater Data for Crossing: EX. 192+24

Table 2 - Downstream Channel Rating Curve (Crossing: EX. 192+24)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	2200.21	0.00	0.00	0.00	0.00
16.00	2200.95	0.74	2.71	0.46	0.56
32.00	2201.37	1.16	3.46	0.72	0.57
48.00	2201.73	1.52	3.96	0.95	0.57
64.00	2202.05	1.84	4.34	1.15	0.56
80.00	2202.36	2.15	4.65	1.34	0.56
100.00	2202.73	2.52	4.97	1.57	0.55
112.00	2202.94	2.73	5.13	1.70	0.55
128.00	2203.21	3.00	5.32	1.88	0.54
144.00	2203.48	3.27	5.50	2.04	0.54
160.00	2203.75	3.54	5.65	2.21	0.53

Tailwater Channel Data - EX. 192+24

Tailwater Channel Option: Rectangular Channel
 Bottom Width: 8.00 ft
 Channel Slope: 0.0100
 Channel Manning's n: 0.0400
 Channel Invert Elevation: 2200.21 ft

Roadway Data for Crossing: EX. 192+24

Roadway Profile Shape: Constant Roadway Elevation
 Crest Length: 100.00 ft
 Crest Elevation: 2206.24 ft
 Roadway Surface: Paved
 Roadway Top Width: 48.00 ft

HY-8 Culvert Analysis Report 195+53

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.00 cfs

Design Flow: 60.00 cfs

Maximum Flow: 80.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: EX. 195+53

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 11 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2207.50	0.00	0.00	0.00	1
2208.61	8.00	8.00	0.00	1
2209.10	16.00	16.00	0.00	1
2209.48	24.00	24.00	0.00	1
2209.84	32.00	32.00	0.00	1
2210.17	40.00	40.00	0.00	1
2210.49	48.00	48.00	0.00	1
2210.80	56.00	56.00	0.00	1
2210.95	60.00	60.00	0.00	1
2211.09	72.00	63.67	8.30	8
2211.14	80.00	64.83	15.12	5
2211.00	61.28	61.28	0.00	Overtopping

Culvert Data: Culvert 11

Table 1 - Culvert Summary Table: Culvert 11

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2207.50	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
8.00	8.00	2208.61	1.11	0.0*	1-S2n	0.78	0.82	0.78	0.48	4.67	2.10
16.00	16.00	2209.10	1.60	0.0*	1-S2n	1.10	1.17	1.10	0.74	5.71	2.71
24.00	24.00	2209.48	1.98	0.0*	1-S2n	1.36	1.45	1.36	0.96	6.40	3.13
32.00	32.00	2209.84	2.34	0.0*	1-S2n	1.58	1.68	1.58	1.16	6.92	3.46
40.00	40.00	2210.17	2.67	0.381	1-S2n	1.79	1.89	1.79	1.34	7.34	3.73
48.00	48.00	2210.49	2.99	0.831	1-S2n	1.99	2.08	1.99	1.52	7.69	3.96
56.00	56.00	2210.80	3.30	1.314	1-S2n	2.18	2.25	2.18	1.68	7.99	4.16
60.00	60.00	2210.95	3.45	1.568	1-S2n	2.28	2.33	2.28	1.76	8.12	4.25
72.00	63.67	2211.09	3.59	1.810	1-	2.37	2.41	2.37	2.00	8.23	4.50

80.00	64.83	2211.14	3.64	1.888	S2n 1- S2n	2.39	2.43	2.39	2.15	8.26	4.65
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* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

Inlet Elevation (invert): 2207.50 ft,

Outlet Elevation (invert): 2205.40 ft

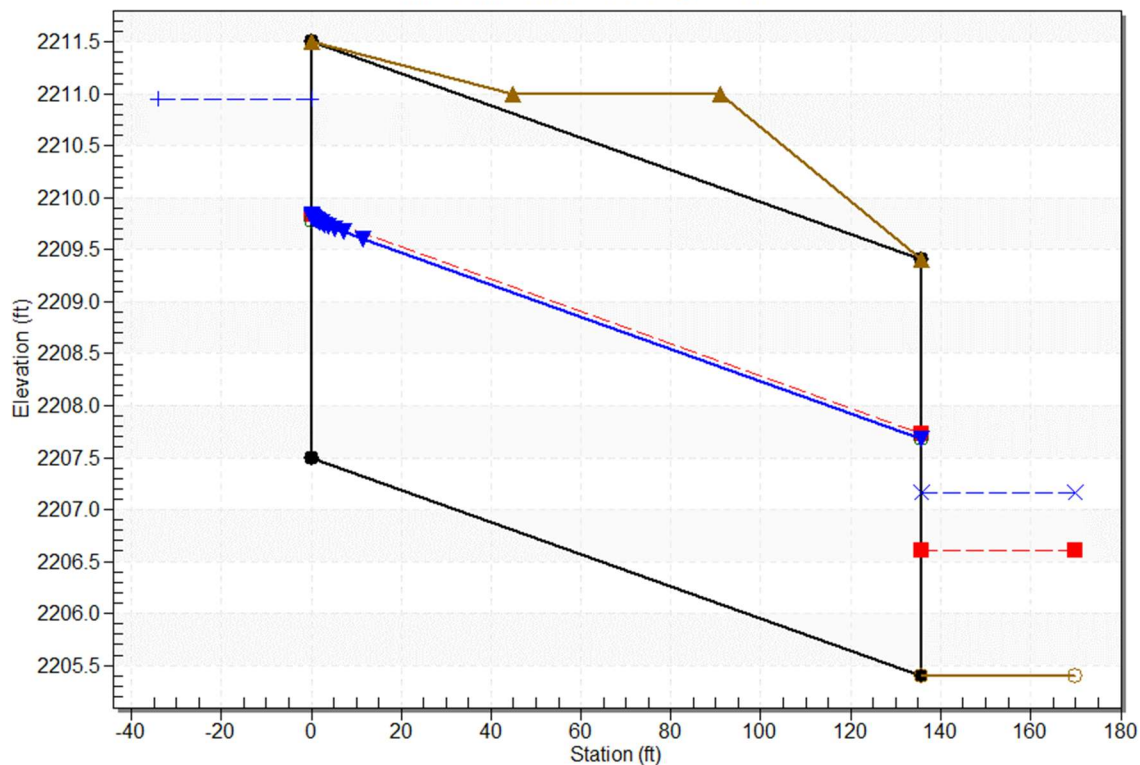
Culvert Length: 135.92 ft,

Culvert Slope: 0.0155

Water Surface Profile Plot for Culvert: Culvert 11

Crossing - EX. 195+53, Design Discharge - 60.0 cfs

Culvert - Culvert 11, Culvert Discharge - 60.0 cfs



Site Data - Culvert 11

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2207.50 ft

Outlet Station: 135.90 ft

Outlet Elevation: 2205.40 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 11

Barrel Shape: Circular

Barrel Diameter: 4.00 ft
 Barrel Material: Corrugated Steel
 Embedment: 0.00 in
 Barrel Manning's n: 0.0240
 Culvert Type: Straight
 Inlet Configuration: Square Edge with Headwall
 Inlet Depression: None

Tailwater Data for Crossing: EX. 195+53

Table 2 - Downstream Channel Rating Curve (Crossing: EX. 195+53)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	2205.40	0.00	0.00	0.00	0.00
8.00	2205.88	0.48	2.10	0.30	0.54
16.00	2206.14	0.74	2.71	0.46	0.56
24.00	2206.36	0.96	3.13	0.60	0.56
32.00	2206.56	1.16	3.46	0.72	0.57
40.00	2206.74	1.34	3.73	0.84	0.57
48.00	2206.92	1.52	3.96	0.95	0.57
56.00	2207.08	1.68	4.16	1.05	0.56
60.00	2207.16	1.76	4.25	1.10	0.56
72.00	2207.40	2.00	4.50	1.25	0.56
80.00	2207.55	2.15	4.65	1.34	0.56

Tailwater Channel Data - EX. 195+53

Tailwater Channel Option: Rectangular Channel
 Bottom Width: 8.00 ft
 Channel Slope: 0.0100
 Channel Manning's n: 0.0400
 Channel Invert Elevation: 2205.40 ft

Roadway Data for Crossing: EX. 195+53

Roadway Profile Shape: Constant Roadway Elevation
 Crest Length: 100.00 ft
 Crest Elevation: 2211.00 ft
 Roadway Surface: Paved
 Roadway Top Width: 46.00 ft

C.1.2 New Culvert HY-8 Calculations

HY-8 Culvert Analysis Report 130+00

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.00 cfs

Design Flow: 13.00 cfs

Maximum Flow: 16.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Pipe 130+00

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2064.16	0.00	0.00	0.00	1
2064.60	1.60	1.60	0.00	1
2064.81	3.20	3.20	0.00	1
2065.00	4.80	4.80	0.00	1
2065.19	6.40	6.40	0.00	1
2065.38	8.00	8.00	0.00	1
2065.58	9.60	9.60	0.00	1
2065.79	11.20	11.20	0.00	1
2066.04	13.00	13.00	0.00	1
2066.25	14.40	14.40	0.00	1
2066.50	16.00	16.00	0.00	1
2068.76	26.55	26.55	0.00	Overtopping

Culvert Data: Culvert 1

Table 1 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00 cfs	0.00 cfs	2064.16	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
1.60 cfs	1.60 cfs	2064.60	0.44	0.0*	1-S2n	0.22	0.32	0.22	0.46	4.54	1.73
3.20 cfs	3.20 cfs	2064.81	0.65	0.0*	1-JS1t	0.32	0.47	0.76	0.76	2.02	2.12
4.80 cfs	4.80 cfs	2065.00	0.84	0.0*	1-JS1t	0.39	0.58	1.02	1.02	2.25	2.35
6.40 cfs	6.40 cfs	2065.19	1.03	0.0*	1-JS1t	0.45	0.69	1.27	1.27	2.50	2.52
8.00 cfs	8.00 cfs	2065.38	1.22	0.0*	1-JS1f	0.52	0.78	1.50	1.51	2.87	2.65
9.60 cfs	9.60 cfs	2065.58	1.42	0.0*	1-JS1f	0.57	0.87	1.50	1.75	3.45	2.75
11.20 cfs	11.20 cfs	2065.79	1.63	0.136	5-JS1f	0.63	0.95	1.50	1.98	4.02	2.83
13.00 cfs	13.00 cfs	2066.04	1.88	0.713	5-JS1f	0.69	1.03	1.50	2.24	4.67	2.90

14.40 cfs	14.40 cfs	2066.25	2.09	1.193	5- JS1f	0.74	1.09	1.50	2.44	5.17	2.95
16.00 cfs	16.00 cfs	2066.50	2.34	1.774	5- JS1f	0.80	1.15	1.50	2.66	5.74	3.00

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

Inlet Elevation (invert): 2064.16 ft,

Outlet Elevation (invert): 2061.40 ft

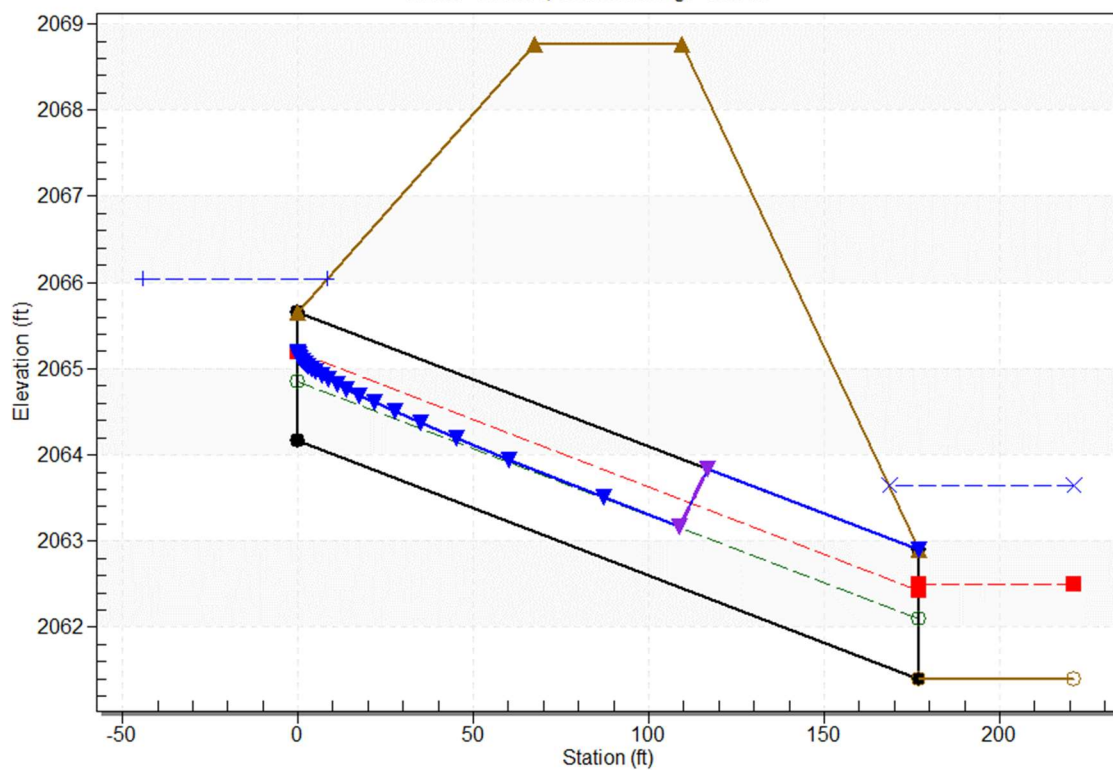
Culvert Length: 177.02 ft,

Culvert Slope: 0.0156

Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Pipe 130+00, Design Discharge - 13.0 cfs

Culvert - Culvert 1, Culvert Discharge - 13.0 cfs



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2064.16 ft

Outlet Station: 177.00 ft

Outlet Elevation: 2061.40 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Pipe Arch

Barrel Span: 28.50 in

Barrel Rise: 18.00 in

Barrel Material: Concrete
 Embedment: 0.00 in
 Barrel Manning's n: 0.0120
 Culvert Type: Straight
 Inlet Configuration: Square Edge with Headwall (Ke=0.5)
 Inlet Depression: None

Tailwater Data for Crossing: Pipe 130+00

Table 2 - Downstream Channel Rating Curve (Crossing: Pipe 130+00)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	2061.40	0.00	0.00	0.00	0.00
1.60	2061.86	0.46	1.73	0.29	0.45
3.20	2062.16	0.76	2.12	0.47	0.43
4.80	2062.42	1.02	2.35	0.64	0.41
6.40	2062.67	1.27	2.52	0.79	0.39
8.00	2062.91	1.51	2.65	0.94	0.38
9.60	2063.15	1.75	2.75	1.09	0.37
11.20	2063.38	1.98	2.83	1.24	0.35
13.00	2063.64	2.24	2.90	1.40	0.34
14.40	2063.84	2.44	2.95	1.52	0.33
16.00	2064.06	2.66	3.00	1.66	0.32

Tailwater Channel Data - Pipe 130+00

Tailwater Channel Option: Rectangular Channel
 Bottom Width: 2.00 ft
 Channel Slope: 0.0100
 Channel Manning's n: 0.0400
 Channel Invert Elevation: 2061.40 ft

Roadway Data for Crossing: Pipe 130+00

Roadway Profile Shape: Constant Roadway Elevation
 Crest Length: 100.00 ft
 Crest Elevation: 2068.76 ft
 Roadway Surface: Paved
 Roadway Top Width: 42.00 ft

HY-8 Culvert Analysis Report 139+50

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.00 cfs

Design Flow: 65.00 cfs

Maximum Flow: 85.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Pipe 139+50

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 2 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2085.99	0.00	0.00	0.00	1
2086.78	8.50	8.50	0.00	1
2087.17	17.00	17.00	0.00	1
2087.51	25.50	25.50	0.00	1
2087.81	34.00	34.00	0.00	1
2088.13	42.50	42.50	0.00	1
2088.48	51.00	51.00	0.00	1
2088.88	59.50	59.50	0.00	1
2089.18	65.00	65.00	0.00	1
2089.90	76.50	76.50	0.00	1
2090.52	85.00	85.00	0.00	1
2092.33	105.79	105.79	0.00	Overtopping

Culvert Data: Culvert 2

Table 1 - Culvert Summary Table: Culvert 2

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2085.99	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
8.50	8.50	2086.78	0.79	0.0*	1-S2n	0.38	0.59	0.38	0.40	6.82	2.49
17.00	17.00	2087.17	1.18	0.0*	1-S2n	0.54	0.84	0.54	0.59	8.33	3.11
25.50	25.50	2087.51	1.52	0.0*	1-S2n	0.66	1.04	0.66	0.74	9.34	3.52
34.00	34.00	2087.81	1.82	0.0*	1-S2n	0.77	1.21	0.78	0.86	9.96	3.83
42.50	42.50	2088.13	2.14	0.0*	5-S2n	0.87	1.36	0.89	0.97	10.41	4.09
51.00	51.00	2088.48	2.49	0.0*	5-S2n	0.97	1.49	0.97	1.07	11.25	4.31
59.50	59.50	2088.88	2.89	0.0*	5-S2n	1.06	1.60	1.08	1.16	11.46	4.51
65.00	65.00	2089.18	3.19	0.0*	5-S2n	1.12	1.66	1.13	1.22	11.79	4.62
76.50	76.50	2089.90	3.91	0.984	5-S2n	1.25	1.77	1.25	1.32	12.38	4.83
85.00	85.00	2090.52	4.53	1.961	5-	1.34	1.83	1.36	1.39	12.45	4.98

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

Inlet Elevation (invert): 2085.99 ft,

Outlet Elevation (invert): 2081.05 ft

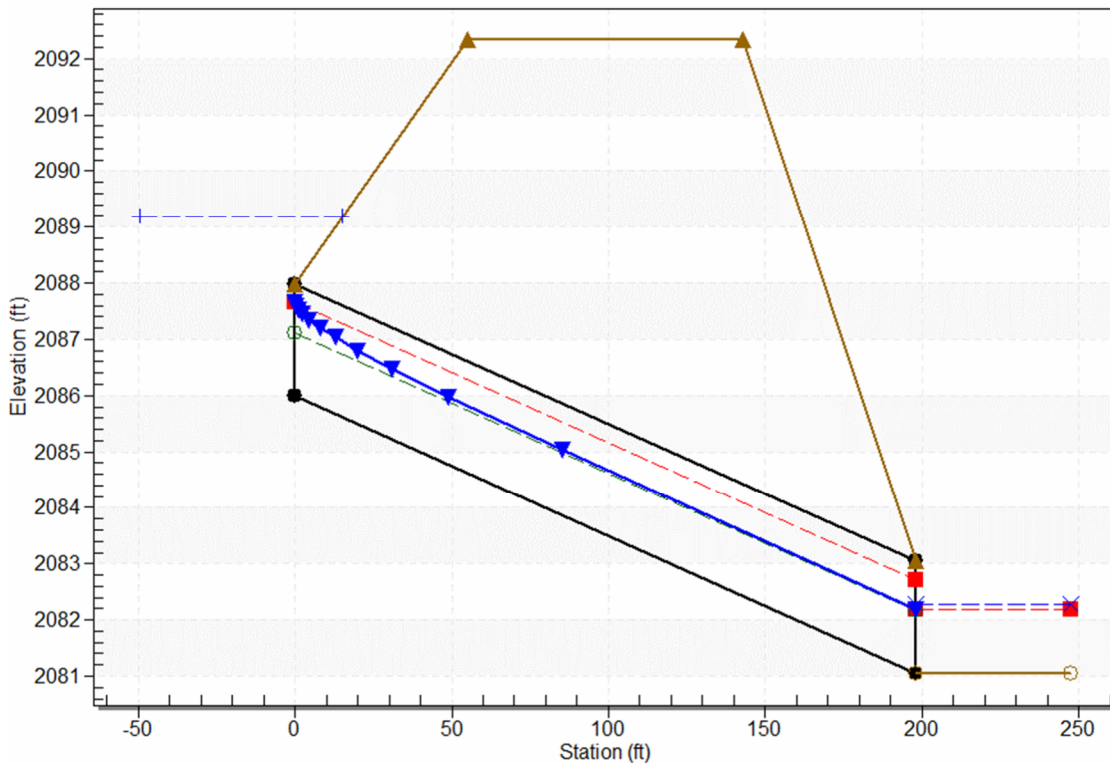
Culvert Length: 198.06 ft,

Culvert Slope: 0.0249

Water Surface Profile Plot for Culvert: Culvert 2

Crossing - Pipe 139+50, Design Discharge - 65.0 cfs

Culvert - Culvert 2, Culvert Discharge - 65.0 cfs



Site Data - Culvert 2

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2085.99 ft

Outlet Station: 198.00 ft

Outlet Elevation: 2081.05 ft

Number of Barrels: 3

Culvert Data Summary - Culvert 2

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130
 Culvert Type: Straight
 Inlet Configuration: Square Edge with Headwall
 Inlet Depression: None

Tailwater Data for Crossing: Pipe 139+50

Table 2 - Downstream Channel Rating Curve (Crossing: Pipe 139+50)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	2081.05	0.00	0.00	0.00	0.00
8.50	2081.45	0.40	2.49	0.48	0.75
17.00	2081.64	0.59	3.11	0.71	0.79
25.50	2081.79	0.74	3.52	0.89	0.82
34.00	2081.91	0.86	3.83	1.04	0.83
42.50	2082.02	0.97	4.09	1.17	0.85
51.00	2082.12	1.07	4.31	1.28	0.86
59.50	2082.21	1.16	4.51	1.39	0.87
65.00	2082.27	1.22	4.62	1.46	0.87
76.50	2082.37	1.32	4.83	1.58	0.88
85.00	2082.44	1.39	4.98	1.67	0.89

Tailwater Channel Data - Pipe 139+50

Tailwater Channel Option: Irregular Channel
 Channel Slope: Irregular Channel

User Defined Channel Cross-Section

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	2084.24	0.0400
2	18.00	2081.05	0.0400
3	25.00	2081.05	0.0400
4	31.00	2084.24	0.0000

Roadway Data for Crossing: Pipe 139+50

Roadway Profile Shape: Constant Roadway Elevation
 Crest Length: 100.00 ft
 Crest Elevation: 2092.33 ft
 Roadway Surface: Paved
 Roadway Top Width: 88.00 ft

HY-8 Culvert Analysis Report 143+50

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 500.00 cfs

Design Flow: 1138.00 cfs

Maximum Flow: 2000.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Box 143+50

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2097.80	500.00	500.00	0.00	1
2098.34	650.00	650.00	0.00	1
2098.86	800.00	800.00	0.00	1
2099.38	950.00	950.00	0.00	1
2100.06	1138.00	1138.00	0.00	1
2100.50	1250.00	1250.00	0.00	1
2101.13	1400.00	1400.00	0.00	1
2101.83	1550.00	1550.00	0.00	1
2102.48	1700.00	1677.95	21.98	6
2102.81	1850.00	1739.78	110.21	6
2103.09	2000.00	1789.07	210.89	5
2102.30	1644.17	1644.17	0.00	Overtopping

Culvert Data: Culvert 1

Table 1 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
500.00	500.00	2097.80	2.84	0.0*	1-S2n	1.00	1.69	1.03	1.30	12.11	6.39
650.00	650.00	2098.34	3.38	0.0*	1-S2n	1.19	2.02	1.22	1.52	13.27	7.07
800.00	800.00	2098.86	3.90	0.0*	1-S2n	1.36	2.32	1.42	1.72	14.13	7.65
950.00	950.00	2099.38	4.42	0.563	5-S2n	1.52	2.60	1.60	1.91	14.81	8.17
1138.00	1138.00	2100.06	5.10	1.407	5-S2n	1.72	2.93	1.83	2.13	15.56	8.74
1250.00	1250.00	2100.50	5.54	2.386	5-S2n	1.83	3.12	1.96	2.25	15.93	9.06
1400.00	1400.00	2101.13	6.17	3.026	5-S2n	1.97	3.36	2.13	2.41	16.40	9.45
1550.00	1550.00	2101.83	6.87	3.721	5-S2n	2.12	3.60	2.30	2.57	16.84	9.82
1700.00	1677.95	2102.48	7.52	4.357	5-S2n	2.23	3.79	2.44	2.71	17.17	10.16
1850.00	1739.78	2102.81	7.85	4.679	5-	2.29	3.89	2.51	2.85	17.31	10.48

					S2n							
2000.00	1789.07	2103.09	8.13	4.942	5-S2n	2.33	3.96	2.56	2.99	17.44	10.79	

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

Inlet Elevation (invert): 2094.96 ft,

Outlet Elevation (invert): 2091.75 ft

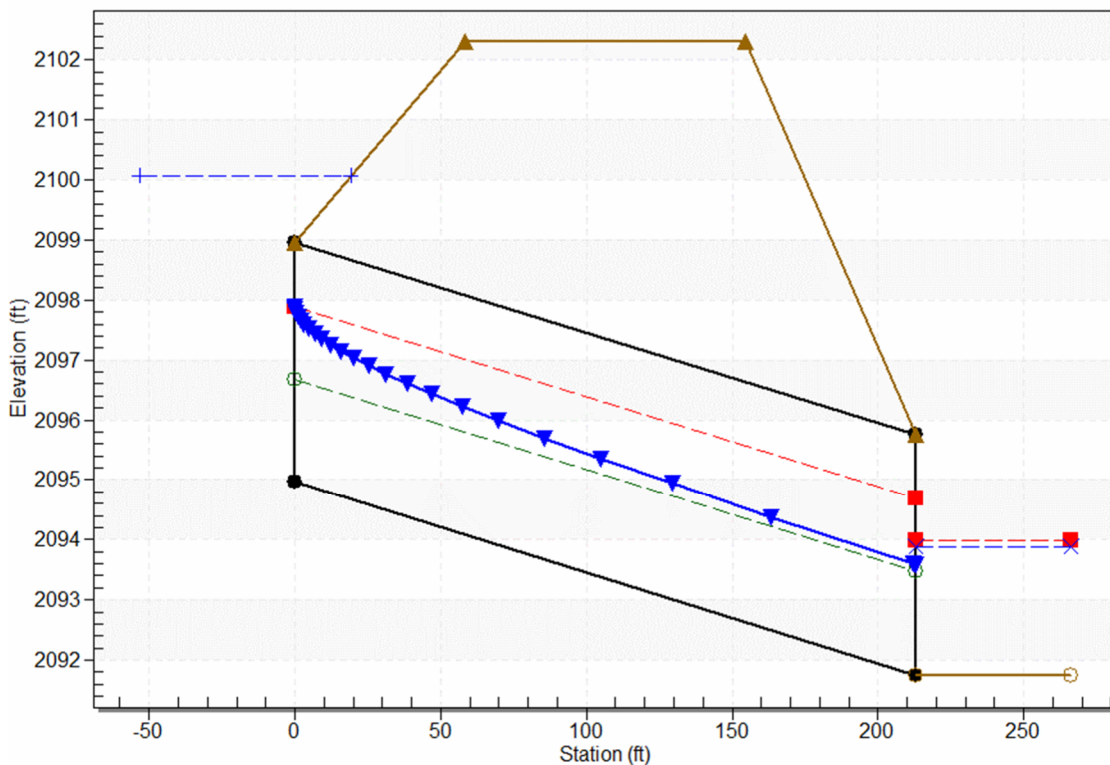
Culvert Length: 213.02 ft,

Culvert Slope: 0.0151

Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Box 143+50, Design Discharge - 1138.0 cfs

Culvert - Culvert 1, Culvert Discharge - 1138.0 cfs



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2094.96 ft

Outlet Station: 213.00 ft

Outlet Elevation: 2091.75 ft

Number of Barrels: 4

Culvert Data Summary - Culvert 1

Barrel Shape: Concrete Box

Barrel Span: 10.00 ft
 Barrel Rise: 4.00 ft
 Barrel Material: Concrete
 Embedment: 0.00 in
 Barrel Manning's n: 0.0130
 Culvert Type: Straight
 Inlet Configuration: Square Edge (90°) Headwall
 Inlet Depression: None

Tailwater Data for Crossing: Box 143+50

Table 2 - Downstream Channel Rating Curve (Crossing: Box 143+50)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
500.00	2093.05	1.30	6.39	1.78	1.00
650.00	2093.27	1.52	7.07	2.09	1.02
800.00	2093.47	1.72	7.65	2.37	1.04
950.00	2093.66	1.91	8.17	2.62	1.06
1138.00	2093.88	2.13	8.74	2.93	1.07
1250.00	2094.00	2.25	9.06	3.10	1.08
1400.00	2094.16	2.41	9.45	3.31	1.09
1550.00	2094.32	2.57	9.82	3.52	1.10
1700.00	2094.46	2.71	10.16	3.72	1.11
1850.00	2094.60	2.85	10.48	3.92	1.12
2000.00	2094.74	2.99	10.79	4.11	1.13

Tailwater Channel Data - Box 143+50

Tailwater Channel Option: Irregular Channel
 Channel Slope: Irregular Channel

User Defined Channel Cross-Section

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	2102.21	0.0400
2	6.31	2091.75	0.0400
3	65.23	2091.75	0.0400
4	80.15	2102.21	0.0000

Roadway Data for Crossing: Box 143+50

Roadway Profile Shape: Constant Roadway Elevation
 Crest Length: 100.00 ft
 Crest Elevation: 2102.30 ft
 Roadway Surface: Paved
 Roadway Top Width: 96.00 ft

HY-8 Culvert Analysis Report 151+00

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.00 cfs

Design Flow: 9.20 cfs

Maximum Flow: 11.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Pipe 151+00

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2109.53	0.00	0.00	0.00	1
2110.02	1.10	1.10	0.00	1
2110.23	2.20	2.20	0.00	1
2110.40	3.30	3.30	0.00	1
2110.54	4.40	4.40	0.00	1
2110.70	5.50	5.50	0.00	1
2110.84	6.60	6.60	0.00	1
2110.97	7.70	7.70	0.00	1
2111.14	9.20	9.20	0.00	1
2111.21	9.90	9.90	0.00	1
2111.33	11.00	11.00	0.00	1
2114.70	30.92	30.92	0.00	Overtopping

Culvert Data: Culvert 1

Table 1 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2109.53	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
1.10	1.10	2110.02	0.49	0.0*	1-S2n	0.28	0.36	0.28	0.42	4.15	1.79
2.20	2.20	2110.23	0.70	0.0*	1-S2n	0.39	0.52	0.39	0.54	5.09	2.13
3.30	3.30	2110.40	0.87	0.0*	1-S2n	0.48	0.63	0.48	0.63	5.73	2.36
4.40	4.40	2110.54	1.01	0.0*	1-S2n	0.55	0.74	0.55	0.70	6.22	2.53
5.50	5.50	2110.70	1.17	0.0*	1-S2n	0.62	0.83	0.62	0.77	6.63	2.68
6.60	6.60	2110.84	1.31	0.0*	1-S2n	0.68	0.91	0.68	0.82	6.97	2.80
7.70	7.70	2110.97	1.44	0.0*	1-S2n	0.74	0.99	0.74	0.87	7.28	2.91
9.20	9.20	2111.14	1.61	0.0*	1-S2n	0.82	1.08	0.82	0.93	7.63	3.05
9.90	9.90	2111.21	1.68	0.0*	1-S2n	0.85	1.13	0.85	0.95	7.79	3.10

11.00	11.00	2111.33	1.80	0.0*	1- S2n	0.90	1.19	0.91	0.99	7.96	3.19
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* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

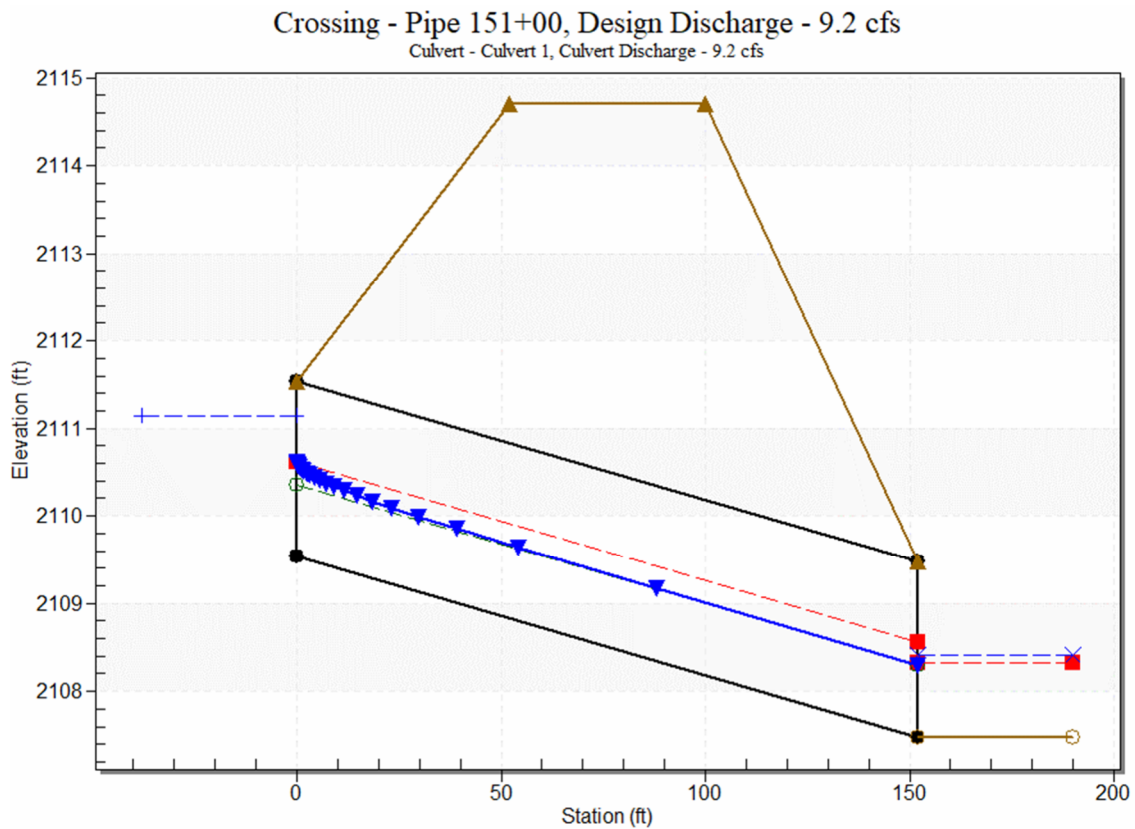
Inlet Elevation (invert): 2109.53 ft,

Outlet Elevation (invert): 2107.48 ft

Culvert Length: 152.01 ft,

Culvert Slope: 0.0135

Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2109.53 ft

Outlet Station: 152.00 ft

Outlet Elevation: 2107.48 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 2.00 ft
 Barrel Material: Concrete
 Embedment: 0.00 in
 Barrel Manning's n: 0.0130
 Culvert Type: Straight
 Inlet Configuration: Square Edge with Headwall
 Inlet Depression: None

Tailwater Data for Crossing: Pipe 151+00

Table 2 - Downstream Channel Rating Curve (Crossing: Pipe 151+00)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	2107.48	0.00	0.00	0.00	0.00
1.10	2107.90	0.42	1.79	0.20	0.69
2.20	2108.02	0.54	2.13	0.26	0.72
3.30	2108.11	0.63	2.36	0.30	0.74
4.40	2108.18	0.70	2.53	0.34	0.75
5.50	2108.25	0.77	2.68	0.37	0.76
6.60	2108.30	0.82	2.80	0.39	0.77
7.70	2108.35	0.87	2.91	0.42	0.78
9.20	2108.41	0.93	3.05	0.45	0.79
9.90	2108.43	0.95	3.10	0.46	0.79
11.00	2108.47	0.99	3.19	0.48	0.80

Tailwater Channel Data - Pipe 151+00

Tailwater Channel Option: Irregular Channel
 Channel Slope: Irregular Channel

User Defined Channel Cross-Section

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	2109.48	0.0250
2	6.00	2107.48	0.0250
3	14.00	2109.48	0.0000

Roadway Data for Crossing: Pipe 151+00

Roadway Profile Shape: Constant Roadway Elevation
 Crest Length: 100.00 ft
 Crest Elevation: 2114.70 ft
 Roadway Surface: Paved
 Roadway Top Width: 48.00 ft

HY-8 Culvert Analysis Report 161+75

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 800.00 cfs

Design Flow: 1792.00 cfs

Maximum Flow: 2400.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Box 161+75

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2138.32	800.00	800.00	0.00	1
2138.76	960.00	960.00	0.00	1
2139.20	1120.00	1120.00	0.00	1
2139.65	1280.00	1280.00	0.00	1
2140.12	1440.00	1440.00	0.00	1
2140.63	1600.00	1600.00	0.00	1
2141.29	1792.00	1792.00	0.00	1
2141.77	1920.00	1920.00	0.00	1
2142.42	2080.00	2080.00	0.00	1
2143.11	2240.00	2240.00	0.00	1
2143.49	2400.00	2321.87	78.06	8
2143.27	2274.12	2274.12	0.00	Overtopping

Culvert Data: Culvert 1

Table 1 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
800.00	800.00	2138.32	3.35	0.079	1-S2n	1.20	2.00	1.26	1.73	12.73	8.72
960.00	960.00	2138.76	3.79	0.558	1-S2n	1.35	2.25	1.43	1.93	13.39	9.33
1120.00	1120.00	2139.20	4.23	1.063	5-S2n	1.50	2.50	1.60	2.12	14.01	9.87
1280.00	1280.00	2139.65	4.68	1.598	5-S2n	1.64	2.73	1.77	2.29	14.50	10.36
1440.00	1440.00	2140.12	5.15	2.163	5-S2n	1.77	2.95	1.93	2.46	14.95	10.81
1600.00	1600.00	2140.63	5.66	3.176	5-S2n	1.90	3.17	2.08	2.61	15.37	11.23
1792.00	1792.00	2141.29	6.32	3.812	5-S2n	2.05	3.42	2.26	2.80	15.82	11.70
1920.00	1920.00	2141.77	6.80	4.265	5-S2n	2.15	3.58	2.39	2.91	16.09	11.99
2080.00	2080.00	2142.42	7.45	4.866	5-S2n	2.27	3.77	2.53	3.05	16.41	12.33
2240.00	2240.00	2143.11	8.14	5.505	5-	2.39	3.96	2.68	3.19	16.71	12.66

					S2n							
2400.00	2321.87	2143.49	8.52	5.816	5-S2n	2.45	4.00	2.75	3.32	16.86	12.97	

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

Inlet Elevation (invert): 2134.97 ft,

Outlet Elevation (invert): 2132.55 ft

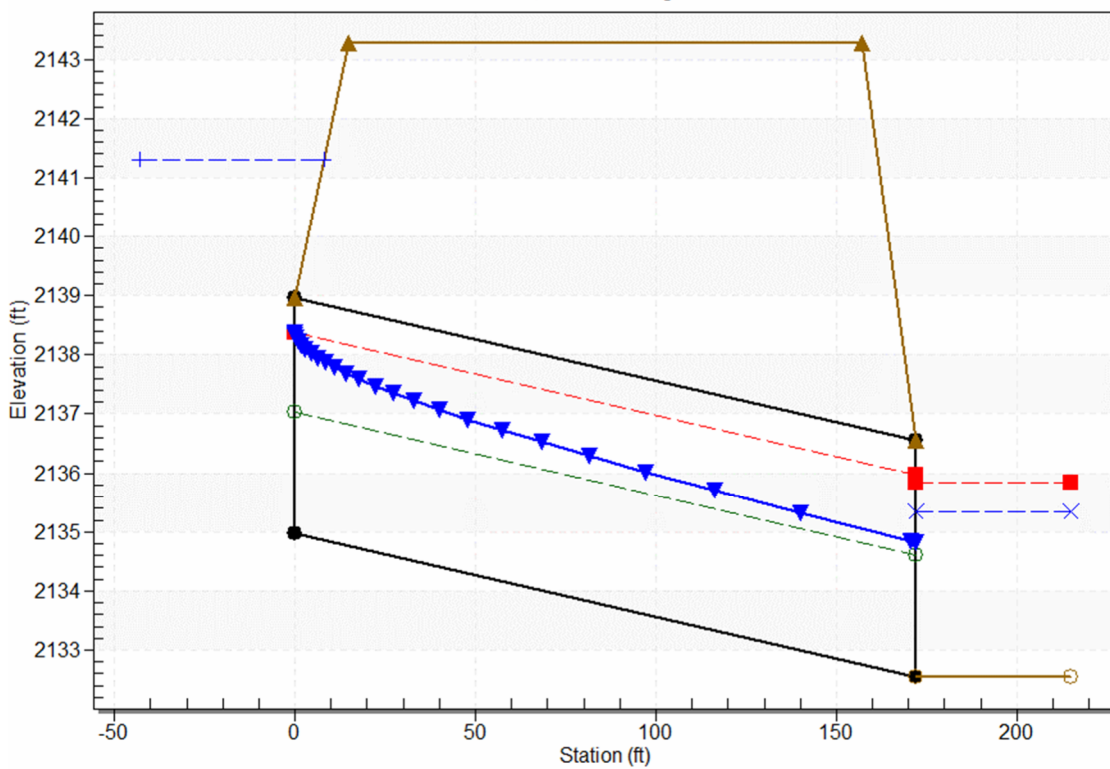
Culvert Length: 172.02 ft,

Culvert Slope: 0.0141

Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Box 161+75, Design Discharge - 1792.0 cfs

Culvert - Culvert 1, Culvert Discharge - 1792.0 cfs



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2134.97 ft

Outlet Station: 172.00 ft

Outlet Elevation: 2132.55 ft

Number of Barrels: 5

Culvert Data Summary - Culvert 1

Barrel Shape: Concrete Box

Barrel Span: 10.00 ft

Barrel Rise: 4.00 ft
 Barrel Material: Concrete
 Embedment: 0.00 in
 Barrel Manning's n: 0.0130
 Culvert Type: Straight
 Inlet Configuration: Square Edge (90°) Headwall
 Inlet Depression: None

Tailwater Data for Crossing: Box 161+75

Table 2 - Downstream Channel Rating Curve (Crossing: Box 161+75)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
800.00	2134.28	1.73	8.72	3.15	1.20
960.00	2134.48	1.93	9.33	3.51	1.22
1120.00	2134.67	2.12	9.87	3.84	1.24
1280.00	2134.84	2.29	10.36	4.16	1.25
1440.00	2135.01	2.46	10.81	4.46	1.26
1600.00	2135.16	2.61	11.23	4.75	1.27
1792.00	2135.35	2.80	11.70	5.08	1.29
1920.00	2135.46	2.91	11.99	5.29	1.29
2080.00	2135.60	3.05	12.33	5.54	1.30
2240.00	2135.74	3.19	12.66	5.79	1.31
2400.00	2135.87	3.32	12.97	6.03	1.32

Tailwater Channel Data - Box 161+75

Tailwater Channel Option: Irregular Channel
 Channel Slope: Irregular Channel

User Defined Channel Cross-Section

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	2139.55	0.0400
2	12.00	2132.55	0.0400
3	62.00	2132.55	0.0400
4	74.00	2139.55	0.0000

Roadway Data for Crossing: Box 161+75

Roadway Profile Shape: Constant Roadway Elevation
 Crest Length: 250.00 ft
 Crest Elevation: 2143.27 ft
 Roadway Surface: Paved
 Roadway Top Width: 142.00 ft

HY-8 Culvert Analysis Report 168+50

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.00 cfs

Design Flow: 13.00 cfs

Maximum Flow: 15.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Pipe 168+50

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2158.15	0.00	0.00	0.00	1
2158.71	1.50	1.50	0.00	1
2158.95	3.00	3.00	0.00	1
2159.15	4.50	4.50	0.00	1
2159.35	6.00	6.00	0.00	1
2159.54	7.50	7.50	0.00	1
2159.70	9.00	9.00	0.00	1
2159.87	10.50	10.50	0.00	1
2160.03	12.00	12.00	0.00	1
2160.14	13.00	13.00	0.00	1
2160.36	15.00	15.00	0.00	1
2162.79	28.88	28.88	0.00	Overtopping

Culvert Data: Culvert 1

Table 1 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2158.15	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
1.50	1.50	2158.71	0.56	0.0*	1-S2n	0.24	0.42	0.24	0.19	6.90	1.91
3.00	3.00	2158.95	0.80	0.0*	1-S2n	0.34	0.60	0.34	0.29	8.47	2.48
4.50	4.50	2159.15	1.00	0.0*	1-S2n	0.42	0.75	0.42	0.37	9.53	2.87
6.00	6.00	2159.35	1.20	0.0*	1-S2n	0.48	0.87	0.48	0.45	10.37	3.17
7.50	7.50	2159.54	1.39	0.0*	1-S2n	0.54	0.97	0.54	0.51	11.10	3.43
9.00	9.00	2159.70	1.55	0.0*	1-S2n	0.59	1.07	0.61	0.57	11.11	3.65
10.50	10.50	2159.87	1.72	0.0*	1-S2n	0.64	1.16	0.64	0.63	12.16	3.84
12.00	12.00	2160.03	1.88	0.0*	1-S2n	0.68	1.24	0.68	0.69	12.62	4.02
13.00	13.00	2160.14	1.99	0.0*	1-S2n	0.71	1.30	0.73	0.72	12.42	4.13

15.00	15.00	2160.36	2.21	0.0*	5-S2n	0.77	1.40	0.77	0.79	13.41	4.32
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* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

Inlet Elevation (invert): 2158.15 ft,

Outlet Elevation (invert): 2150.80 ft

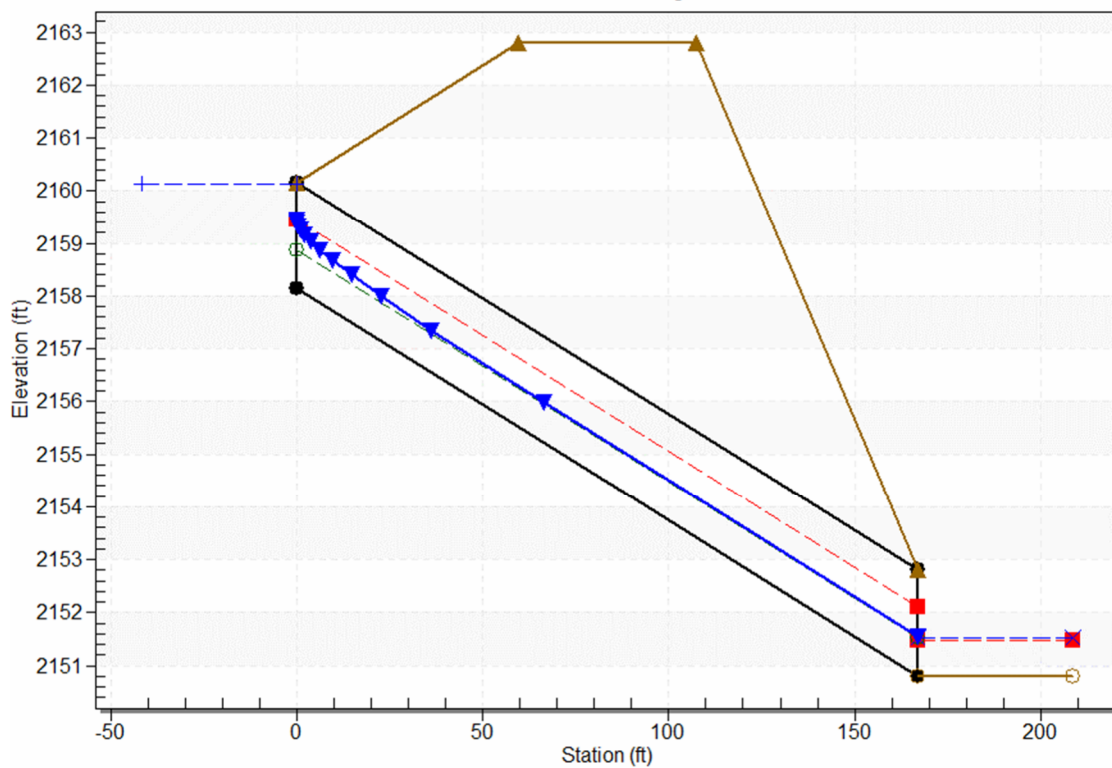
Culvert Length: 167.16 ft,

Culvert Slope: 0.0440

Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Pipe 168+50, Design Discharge - 13.0 cfs

Culvert - Culvert 1, Culvert Discharge - 13.0 cfs



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2158.15 ft

Outlet Station: 167.00 ft

Outlet Elevation: 2150.80 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 2.00 ft
 Barrel Material: Concrete
 Embedment: 0.00 in
 Barrel Manning's n: 0.0130
 Culvert Type: Straight
 Inlet Configuration: Square Edge with Headwall
 Inlet Depression: None

Tailwater Data for Crossing: Pipe 168+50

Table 2 - Downstream Channel Rating Curve (Crossing: Pipe 168+50)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	2150.80	0.00	0.00	0.00	0.00
1.50	2150.99	0.19	1.91	0.32	0.78
3.00	2151.09	0.29	2.48	0.49	0.82
4.50	2151.17	0.37	2.87	0.62	0.84
6.00	2151.25	0.45	3.17	0.75	0.86
7.50	2151.31	0.51	3.43	0.86	0.87
9.00	2151.37	0.57	3.65	0.96	0.88
10.50	2151.43	0.63	3.84	1.05	0.88
12.00	2151.49	0.69	4.02	1.14	0.89
13.00	2151.52	0.72	4.13	1.20	0.89
15.00	2151.59	0.79	4.32	1.31	0.90

Tailwater Channel Data - Pipe 168+50

Tailwater Channel Option: Irregular Channel
 Channel Slope: Irregular Channel

User Defined Channel Cross-Section

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	2158.67	0.0400
2	4.00	2150.80	0.0400
3	8.00	2150.80	0.0400
4	12.00	2158.67	0.0000

Roadway Data for Crossing: Pipe 168+50

Roadway Profile Shape: Constant Roadway Elevation
 Crest Length: 100.00 ft
 Crest Elevation: 2162.79 ft
 Roadway Surface: Paved
 Roadway Top Width: 48.00 ft

HY-8 Culvert Analysis Report 171+75

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.00 cfs

Design Flow: 51.00 cfs

Maximum Flow: 60.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Pipe 171+75

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2164.00	0.00	0.00	0.00	1
2165.05	6.00	6.00	0.00	1
2165.52	12.00	12.00	0.00	1
2165.96	18.00	18.00	0.00	1
2166.34	24.00	24.00	0.00	1
2166.69	30.00	30.00	0.00	1
2167.04	36.00	36.00	0.00	1
2167.42	42.00	42.00	0.00	1
2167.84	48.00	48.00	0.00	1
2168.07	51.00	51.00	0.00	1
2168.84	60.00	60.00	0.00	1
2170.01	71.28	71.28	0.00	Overtopping

Culvert Data: Culvert 1

Table 1 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2164.00	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
6.00	6.00	2165.05	1.05	0.0*	1-S2n	0.62	0.77	0.62	0.28	5.63	3.26
12.00	12.00	2165.52	1.52	0.309	1-S2n	0.89	1.10	0.89	0.43	6.87	4.17
18.00	18.00	2165.96	1.96	0.691	1-S2n	1.10	1.36	1.11	0.54	7.59	4.79
24.00	24.00	2166.34	2.34	1.086	1-S2n	1.28	1.58	1.30	0.64	8.18	5.27
30.00	30.00	2166.69	2.69	1.505	1-S2n	1.46	1.77	1.48	0.73	8.65	5.67
36.00	36.00	2167.04	3.04	1.954	5-S2n	1.62	1.95	1.65	0.81	9.05	6.02
42.00	42.00	2167.42	3.42	2.437	5-S2n	1.79	2.11	1.82	0.88	9.39	6.32
48.00	48.00	2167.84	3.84	3.327	5-S2n	1.96	2.26	1.98	0.95	9.68	6.59
51.00	51.00	2168.07	4.07	3.565	5-S2n	2.05	2.32	2.07	0.99	9.82	6.72

60.00	60.00	2168.84	4.84	4.344	5-S2n	2.34	2.50	2.35	1.08	10.11	7.06
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* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

Inlet Elevation (invert): 2164.00 ft,

Outlet Elevation (invert): 2163.11 ft

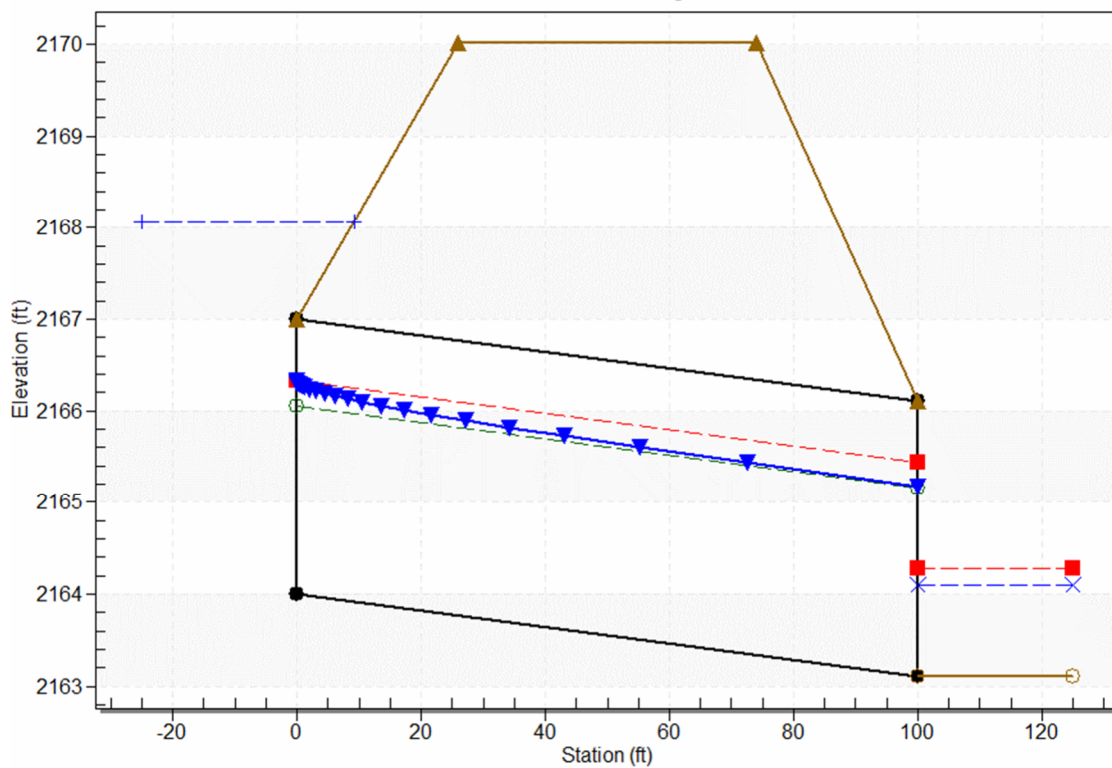
Culvert Length: 100.00 ft,

Culvert Slope: 0.0089

Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Pipe 171+75, Design Discharge - 51.0 cfs

Culvert - Culvert 1, Culvert Discharge - 51.0 cfs



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2164.00 ft

Outlet Station: 100.00 ft

Outlet Elevation: 2163.11 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 3.00 ft
 Barrel Material: Concrete
 Embedment: 0.00 in
 Barrel Manning's n: 0.0130
 Culvert Type: Straight
 Inlet Configuration: Square Edge with Headwall
 Inlet Depression: None

Tailwater Data for Crossing: Pipe 171+75

Table 2 - Downstream Channel Rating Curve (Crossing: Pipe 171+75)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	2163.11	0.00	0.00	0.00	0.00
6.00	2163.39	0.28	3.26	0.83	1.12
12.00	2163.54	0.43	4.17	1.25	1.18
18.00	2163.65	0.54	4.79	1.58	1.22
24.00	2163.75	0.64	5.27	1.87	1.25
30.00	2163.84	0.73	5.67	2.13	1.27
36.00	2163.92	0.81	6.02	2.36	1.29
42.00	2163.99	0.88	6.32	2.58	1.30
48.00	2164.06	0.95	6.59	2.78	1.31
51.00	2164.10	0.99	6.72	2.88	1.32
60.00	2164.19	1.08	7.06	3.15	1.33

Tailwater Channel Data - Pipe 171+75

Tailwater Channel Option: Irregular Channel
 Channel Slope: Irregular Channel

User Defined Channel Cross-Section

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	2166.58	0.0400
2	6.00	2163.11	0.0400
3	12.00	2163.11	0.0400
4	18.00	2166.58	0.0000

Roadway Data for Crossing: Pipe 171+75

Roadway Profile Shape: Constant Roadway Elevation
 Crest Length: 100.00 ft
 Crest Elevation: 2170.01 ft
 Roadway Surface: Paved
 Roadway Top Width: 48.00 ft

HY-8 Culvert Analysis Report 174+06

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.00 cfs

Design Flow: 2.80 cfs

Maximum Flow: 3.10 cfs

Table 1 - Summary of Culvert Flows at Crossing: Pipe 174+06

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2170.09	0.00	0.00	0.00	1
2170.34	0.31	0.31	0.00	1
2170.45	0.62	0.62	0.00	1
2170.54	0.93	0.93	0.00	1
2170.61	1.24	1.24	0.00	1
2170.67	1.55	1.55	0.00	1
2170.73	1.86	1.86	0.00	1
2170.78	2.17	2.17	0.00	1
2170.83	2.48	2.48	0.00	1
2170.88	2.80	2.80	0.00	1
2170.93	3.10	3.10	0.00	1
2176.62	35.85	35.85	0.00	Overtopping

Culvert Data: Culvert 1

Table 1 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2170.09	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
0.31	0.31	2170.34	0.25	0.0*	1-S2n	0.14	0.19	0.14	0.04	3.08	0.76
0.62	0.62	2170.45	0.36	0.0*	1-S2n	0.20	0.27	0.20	0.06	3.77	0.99
0.93	0.93	2170.54	0.45	0.0*	1-S2n	0.24	0.33	0.24	0.07	4.26	1.14
1.24	1.24	2170.61	0.52	0.0*	1-S2n	0.28	0.38	0.28	0.08	4.64	1.27
1.55	1.55	2170.67	0.58	0.0*	1-S2n	0.31	0.43	0.31	0.09	4.95	1.37
1.86	1.86	2170.73	0.64	0.0*	1-S2n	0.34	0.47	0.34	0.10	5.23	1.46
2.17	2.17	2170.78	0.69	0.0*	1-S2n	0.37	0.51	0.37	0.11	5.47	1.54
2.48	2.48	2170.83	0.74	0.0*	1-S2n	0.39	0.55	0.39	0.12	5.69	1.61
2.80	2.80	2170.88	0.79	0.0*	1-S2n	0.42	0.58	0.42	0.13	5.89	1.68

3.10	3.10	2170.93	0.84	0.0*	1- S2n	0.44	0.61	0.44	0.14	6.07	1.73
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* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

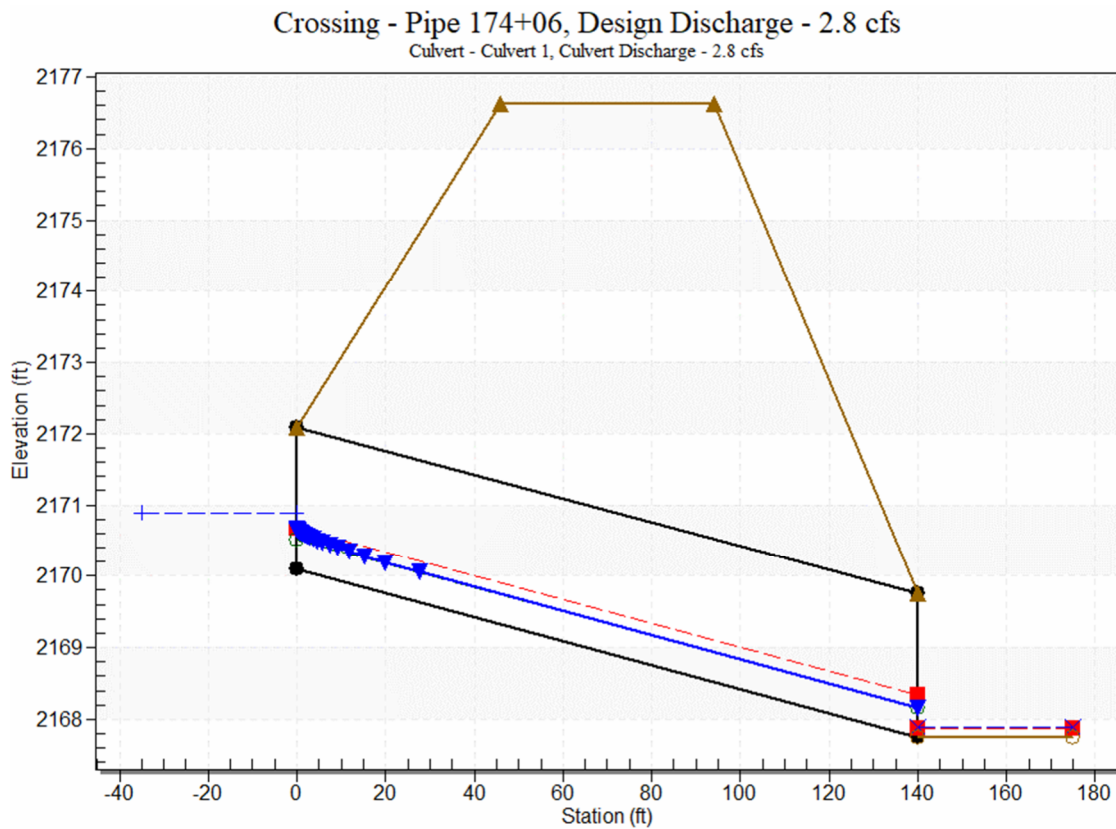
Inlet Elevation (invert): 2170.09 ft,

Outlet Elevation (invert): 2167.75 ft

Culvert Length: 140.02 ft,

Culvert Slope: 0.0167

Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2170.09 ft

Outlet Station: 140.00 ft

Outlet Elevation: 2167.75 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 2.00 ft
 Barrel Material: Concrete
 Embedment: 0.00 in
 Barrel Manning's n: 0.0130
 Culvert Type: Straight
 Inlet Configuration: Square Edge with Headwall
 Inlet Depression: None

Tailwater Data for Crossing: Pipe 174+06

Table 2 - Downstream Channel Rating Curve (Crossing: Pipe 174+06)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	2167.75	0.00	0.00	0.00	0.00
0.31	2167.79	0.04	0.76	0.08	0.72
0.62	2167.81	0.06	0.99	0.13	0.77
0.93	2167.82	0.07	1.14	0.16	0.80
1.24	2167.83	0.08	1.27	0.19	0.82
1.55	2167.84	0.09	1.37	0.22	0.83
1.86	2167.85	0.10	1.46	0.24	0.85
2.17	2167.86	0.11	1.54	0.27	0.86
2.48	2167.87	0.12	1.61	0.29	0.87
2.80	2167.88	0.13	1.68	0.31	0.88
3.10	2167.89	0.14	1.73	0.32	0.88

Tailwater Channel Data - Pipe 174+06

Tailwater Channel Option: Irregular Channel
 Channel Slope: Irregular Channel

User Defined Channel Cross-Section

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	2168.73	0.0400
2	12.50	2167.75	0.0400
3	23.00	2167.75	0.0400
4	41.60	2168.73	0.0000

Roadway Data for Crossing: Pipe 174+06

Roadway Profile Shape: Constant Roadway Elevation
 Crest Length: 100.00 ft
 Crest Elevation: 2176.62 ft
 Roadway Surface: Paved
 Roadway Top Width: 48.00 ft

HY-8 Culvert Analysis Report 177+60

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.00 cfs

Design Flow: 389.00 cfs

Maximum Flow: 471.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Box 177+60

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2175.50	0.00	0.00	0.00	1
2176.60	47.10	47.10	0.00	1
2177.25	94.20	94.20	0.00	1
2177.79	141.30	141.30	0.00	1
2178.25	188.40	188.40	0.00	1
2178.69	235.50	235.50	0.00	1
2179.10	282.60	282.60	0.00	1
2179.50	329.70	329.70	0.00	1
2180.01	389.00	389.00	0.00	1
2180.33	423.90	423.90	0.00	1
2180.77	471.00	471.00	0.00	1
2182.37	618.57	618.57	0.00	Overtopping

Culvert Data: Culvert 1

Table 1 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2175.50	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
47.10	47.10	2176.60	1.10	0.194	1-S2n	0.58	0.65	0.58	0.67	5.10	3.96
94.20	94.20	2177.25	1.75	0.597	1-S2n	0.90	1.02	0.90	1.00	6.54	5.03
141.30	141.30	2177.79	2.29	0.992	1-S2n	1.17	1.34	1.18	1.26	7.47	5.76
188.40	188.40	2178.25	2.75	1.384	1-S2n	1.42	1.63	1.43	1.49	8.21	6.33
235.50	235.50	2178.69	3.19	1.783	1-S2n	1.65	1.89	1.67	1.69	8.81	6.80
282.60	282.60	2179.10	3.60	2.197	1-S2n	1.87	2.13	1.90	1.87	9.32	7.19
329.70	329.70	2179.50	4.00	2.628	5-S2n	2.08	2.36	2.11	2.04	9.76	7.55
389.00	389.00	2180.01	4.51	3.200	5-S2n	2.34	2.64	2.37	2.23	10.25	7.94
423.90	423.90	2180.33	4.83	3.553	5-S2n	2.49	2.79	2.52	2.34	10.51	8.14

471.00	471.00	2180.77	5.27	4.049	5-S2n	2.68	3.00	2.72	2.48	10.83	8.41
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Culvert Barrel Data

Culvert Barrel Type Straight Culvert

Inlet Elevation (invert): 2175.50 ft,

Outlet Elevation (invert): 2175.01 ft

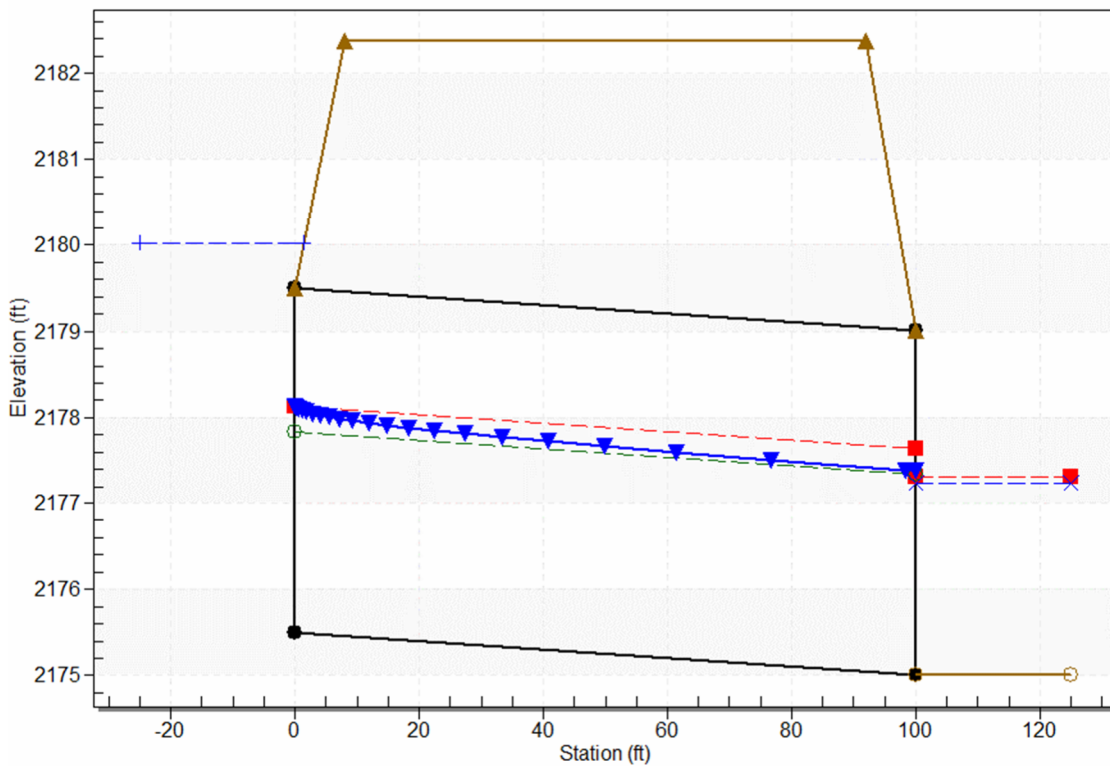
Culvert Length: 100.00 ft,

Culvert Slope: 0.0049

Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Box 177+60, Design Discharge - 389.0 cfs

Culvert - Culvert 1, Culvert Discharge - 389.0 cfs



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2175.50 ft

Outlet Station: 100.00 ft

Outlet Elevation: 2175.01 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 1

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 4.00 ft
 Barrel Material: Concrete
 Embedment: 0.00 in
 Barrel Manning's n: 0.0130
 Culvert Type: Straight
 Inlet Configuration: Square Edge (90°) Headwall
 Inlet Depression: None

Tailwater Data for Crossing: Box 177+60

Table 2 - Downstream Channel Rating Curve (Crossing: Box 177+60)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	2175.01	0.00	0.00	0.00	0.00
47.10	2175.68	0.67	3.96	0.94	0.89
94.20	2176.01	1.00	5.03	1.40	0.95
141.30	2176.27	1.26	5.76	1.77	0.98
188.40	2176.50	1.49	6.33	2.08	1.00
235.50	2176.70	1.69	6.80	2.36	1.02
282.60	2176.88	1.87	7.19	2.61	1.03
329.70	2177.05	2.04	7.55	2.85	1.04
389.00	2177.24	2.23	7.94	3.12	1.06
423.90	2177.35	2.34	8.14	3.27	1.06
471.00	2177.49	2.48	8.41	3.46	1.07

Tailwater Channel Data - Box 177+60

Tailwater Channel Option: Irregular Channel
 Channel Slope: Irregular Channel

User Defined Channel Cross-Section

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	2178.00	0.0400
2	8.00	2175.01	0.0400
3	24.00	2175.01	0.0400
4	32.00	2178.00	0.0000

Roadway Data for Crossing: Box 177+60

Roadway Profile Shape: Constant Roadway Elevation
 Crest Length: 100.00 ft
 Crest Elevation: 2182.37 ft
 Roadway Surface: Paved
 Roadway Top Width: 84.00 ft

HY-8 Culvert Analysis Report 180+15

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.00 cfs

Design Flow: 72.00 cfs

Maximum Flow: 84.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Pipe 180+15

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2177.93	0.00	0.00	0.00	1
2179.12	8.40	8.40	0.00	1
2179.66	16.80	16.80	0.00	1
2180.15	25.20	25.20	0.00	1
2180.58	33.60	33.60	0.00	1
2180.98	42.00	42.00	0.00	1
2181.56	50.40	50.40	0.00	1
2181.91	58.80	58.80	0.00	1
2182.28	67.20	67.20	0.00	1
2182.50	72.00	72.00	0.00	1
2183.28	84.00	84.00	0.00	1
2184.72	102.21	102.21	0.00	Overtopping

Culvert Data: Culvert 1

Table 1 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2177.93	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
8.40	8.40	2179.12	1.19	0.420	1-S2n	0.84	0.87	0.84	0.37	4.74	2.37
16.80	16.80	2179.66	1.73	0.872	1-S2n	1.20	1.25	1.20	0.55	5.77	2.97
25.20	25.20	2180.15	2.22	1.293	1-S2n	1.49	1.54	1.49	0.69	6.44	3.37
33.60	33.60	2180.58	2.65	1.721	1-S2n	1.76	1.80	1.76	0.81	6.94	3.68
42.00	42.00	2180.98	3.05	2.172	1-S2n	2.02	2.02	2.02	0.92	7.32	3.93
50.40	50.40	2181.56	3.44	3.626	7-M2c	2.28	2.22	2.22	1.01	7.84	4.15
58.80	58.80	2181.91	3.84	3.978	7-M2c	2.56	2.40	2.40	1.09	8.35	4.34
67.20	67.20	2182.28	4.29	4.345	7-M2c	2.90	2.57	2.57	1.17	8.88	4.51
72.00	72.00	2182.50	4.57	4.568	7-M2c	3.50	2.66	2.66	1.22	9.18	4.60

84.00	84.00	2183.28	5.35	5.206	7- M2c	3.50	2.86	2.86	1.32	9.99	4.80
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Culvert Barrel Data

Culvert Barrel Type Straight Culvert

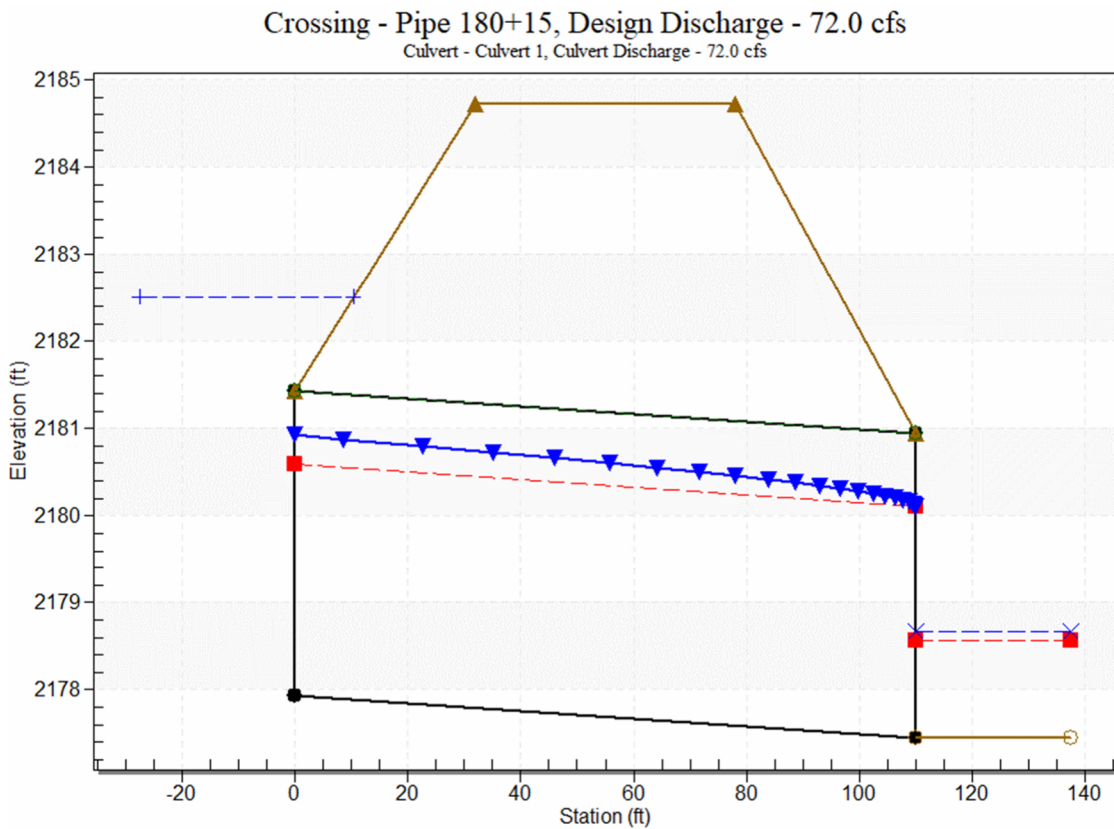
Inlet Elevation (invert): 2177.93 ft,

Outlet Elevation (invert): 2177.45 ft

Culvert Length: 110.00 ft,

Culvert Slope: 0.0044

Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2177.93 ft

Outlet Station: 110.00 ft

Outlet Elevation: 2177.45 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 3.50 ft

Barrel Material: Concrete
 Embedment: 0.00 in
 Barrel Manning's n: 0.0130
 Culvert Type: Straight
 Inlet Configuration: Square Edge with Headwall
 Inlet Depression: None

Tailwater Data for Crossing: Pipe 180+15

Table 2 - Downstream Channel Rating Curve (Crossing: Pipe 180+15)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	2177.45	0.00	0.00	0.00	0.00
8.40	2177.82	0.37	2.37	0.43	0.73
16.80	2178.00	0.55	2.97	0.64	0.78
25.20	2178.14	0.69	3.37	0.80	0.80
33.60	2178.26	0.81	3.68	0.94	0.82
42.00	2178.37	0.92	3.93	1.06	0.83
50.40	2178.46	1.01	4.15	1.16	0.84
58.80	2178.54	1.09	4.34	1.26	0.85
67.20	2178.62	1.17	4.51	1.36	0.86
72.00	2178.67	1.22	4.60	1.40	0.86
84.00	2178.77	1.32	4.80	1.52	0.87

Tailwater Channel Data - Pipe 180+15

Tailwater Channel Option: Trapezoidal Channel
 Bottom Width: 8.00 ft
 Side Slope (H:V): 4.00 (.:1)
 Channel Slope: 0.0185
 Channel Manning's n: 0.0400
 Channel Invert Elevation: 2177.45 ft

Roadway Data for Crossing: Pipe 180+15

Roadway Profile Shape: Constant Roadway Elevation
 Crest Length: 100.00 ft
 Crest Elevation: 2184.72 ft
 Roadway Surface: Paved
 Roadway Top Width: 46.00 ft

HY-8 Culvert Analysis Report 183+00

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.00 cfs

Design Flow: 6.80 cfs

Maximum Flow: 8.10 cfs

Table 1 - Summary of Culvert Flows at Crossing: Pipe 183+00

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2184.75	0.00	0.00	0.00	1
2185.22	0.81	0.81	0.00	1
2185.35	1.62	1.62	0.00	1
2185.49	2.43	2.43	0.00	1
2185.61	3.24	3.24	0.00	1
2185.72	4.05	4.05	0.00	1
2185.84	4.86	4.86	0.00	1
2186.07	5.67	5.67	0.00	1
2186.20	6.80	6.80	0.00	1
2186.26	7.29	7.29	0.00	1
2186.35	8.10	8.10	0.00	1
2189.65	27.70	27.70	0.00	Overtopping

Culvert Data: Culvert 1

Table 1 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2184.75	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
0.81	0.81	2185.22	0.42	0.468	2-M2c	0.31	0.31	0.31	0.14	2.62	1.33
1.62	1.62	2185.35	0.60	0.0*	1-S2n	0.44	0.44	0.44	0.21	3.17	1.70
2.43	2.43	2185.49	0.74	0.059	1-S2n	0.54	0.54	0.54	0.26	3.56	1.95
3.24	3.24	2185.61	0.86	0.166	1-S2n	0.62	0.63	0.62	0.31	3.87	2.14
4.05	4.05	2185.72	0.97	0.270	1-S2n	0.70	0.71	0.70	0.35	4.11	2.30
4.86	4.86	2185.84	1.09	0.373	1-S2n	0.77	0.78	0.77	0.39	4.32	2.44
5.67	5.67	2186.07	1.20	1.317	2-M2c	0.84	0.84	0.84	0.43	4.52	2.56
6.80	6.80	2186.20	1.34	1.455	2-M2c	0.93	0.92	0.92	0.47	4.79	2.71
7.29	7.29	2186.26	1.40	1.512	2-M2c	0.97	0.96	0.96	0.49	4.90	2.77

8.10	8.10	2186.35	1.49	1.603	2- M2c	1.03	1.01	1.01	0.52	5.07	2.86
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* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

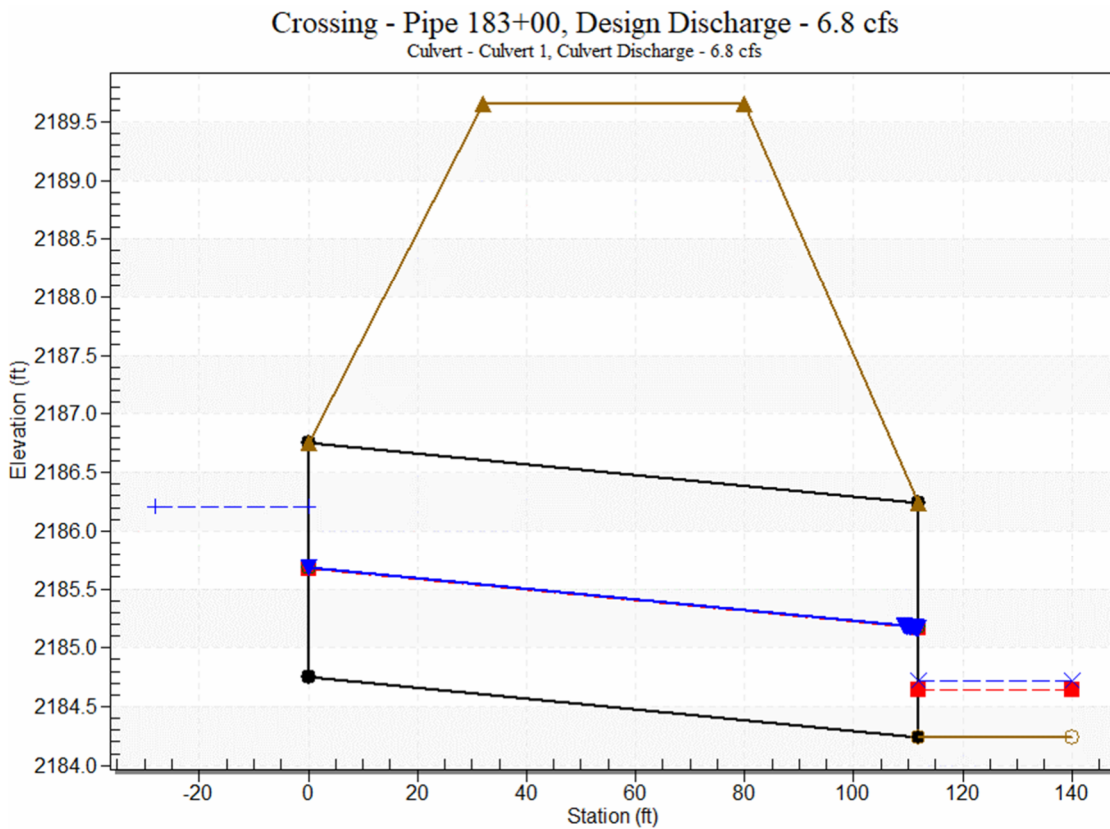
Inlet Elevation (invert): 2184.75 ft,

Outlet Elevation (invert): 2184.24 ft

Culvert Length: 112.00 ft,

Culvert Slope: 0.0046

Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2184.75 ft

Outlet Station: 112.00 ft

Outlet Elevation: 2184.24 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 2.00 ft
 Barrel Material: Concrete
 Embedment: 0.00 in
 Barrel Manning's n: 0.0130
 Culvert Type: Straight
 Inlet Configuration: Square Edge with Headwall
 Inlet Depression: None

Tailwater Data for Crossing: Pipe 183+00

Table 2 - Downstream Channel Rating Curve (Crossing: Pipe 183+00)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	2184.24	0.00	0.00	0.00	0.00
0.81	2184.38	0.14	1.33	0.17	0.65
1.62	2184.45	0.21	1.70	0.26	0.69
2.43	2184.50	0.26	1.95	0.33	0.72
3.24	2184.55	0.31	2.14	0.39	0.73
4.05	2184.59	0.35	2.30	0.44	0.75
4.86	2184.63	0.39	2.44	0.49	0.76
5.67	2184.67	0.43	2.56	0.53	0.76
6.80	2184.71	0.47	2.71	0.59	0.78
7.29	2184.73	0.49	2.77	0.61	0.78
8.10	2184.76	0.52	2.86	0.65	0.78

Tailwater Channel Data - Pipe 183+00

Tailwater Channel Option: Irregular Channel
 Channel Slope: Irregular Channel

User Defined Channel Cross-Section

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	2185.71	0.0400
2	4.00	2184.24	0.0400
3	8.00	2184.24	0.0400
4	12.00	2185.71	0.0000

Roadway Data for Crossing: Pipe 183+00

Roadway Profile Shape: Constant Roadway Elevation
 Crest Length: 100.00 ft
 Crest Elevation: 2189.65 ft
 Roadway Surface: Paved
 Roadway Top Width: 48.00 ft

HY-8 Culvert Analysis Report 186+32

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.00 cfs

Design Flow: 24.00 cfs

Maximum Flow: 27.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Pipe 186+32

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 9 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2191.78	0.00	0.00	0.00	1
2192.55	2.70	2.70	0.00	1
2192.92	5.40	5.40	0.00	1
2193.25	8.10	8.10	0.00	1
2193.54	10.80	10.80	0.00	1
2193.83	13.50	13.50	0.00	1
2194.16	16.20	16.20	0.00	1
2194.53	18.90	18.90	0.00	1
2194.95	21.60	21.60	0.00	1
2195.39	24.00	24.00	0.00	1
2196.01	27.00	27.00	0.00	1
2197.84	34.34	34.34	0.00	Overtopping

Culvert Data: Culvert 9

Table 1 - Culvert Summary Table: Culvert 9

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2191.78	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
2.70	2.70	2192.55	0.77	0.0*	1-S2n	0.35	0.57	0.35	0.25	7.23	2.36
5.40	5.40	2192.92	1.14	0.0*	1-S2n	0.50	0.82	0.50	0.37	8.85	2.98
8.10	8.10	2193.25	1.47	0.0*	1-S2n	0.61	1.01	0.61	0.47	9.93	3.40
10.80	10.80	2193.54	1.76	0.0*	1-S2n	0.71	1.18	0.71	0.55	10.76	3.71
13.50	13.50	2193.83	2.05	0.0*	5-S2n	0.80	1.32	0.80	0.62	11.44	3.98
16.20	16.20	2194.16	2.38	0.0*	5-S2n	0.89	1.45	0.89	0.69	12.01	4.20
18.90	18.90	2194.53	2.75	0.0*	5-S2n	0.97	1.56	1.00	0.75	12.03	4.40
21.60	21.60	2194.95	3.17	0.268	5-S2n	1.05	1.66	1.08	0.81	12.53	4.57
24.00	24.00	2195.39	3.61	0.824	5-S2n	1.12	1.73	1.15	0.85	12.82	4.72

27.00	27.00	2196.01	4.23	1.588	5-S2n	1.21	1.81	1.25	0.91	13.11	4.88
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* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

Inlet Elevation (invert): 2191.78 ft,

Outlet Elevation (invert): 2188.00 ft

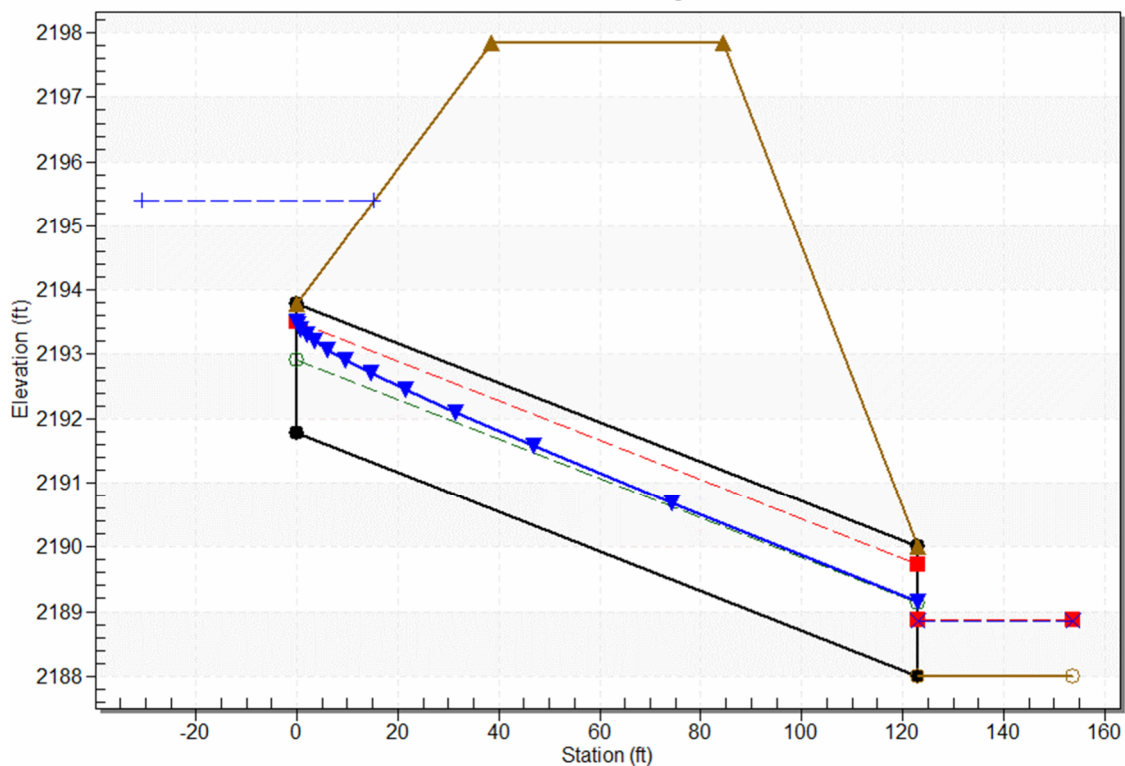
Culvert Length: 123.06 ft,

Culvert Slope: 0.0307

Water Surface Profile Plot for Culvert: Culvert 9

Crossing - Pipe 186+32, Design Discharge - 24.0 cfs

Culvert - Culvert 9, Culvert Discharge - 24.0 cfs



Site Data - Culvert 9

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2191.78 ft

Outlet Station: 123.00 ft

Outlet Elevation: 2188.00 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 9

Barrel Shape: Circular

Barrel Diameter: 2.00 ft
 Barrel Material: Concrete
 Embedment: 0.00 in
 Barrel Manning's n: 0.0130
 Culvert Type: Straight
 Inlet Configuration: Square Edge with Headwall
 Inlet Depression: None

Tailwater Data for Crossing: Pipe 186+32

Table 2 - Downstream Channel Rating Curve (Crossing: Pipe 186+32)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	2188.00	0.00	0.00	0.00	0.00
2.70	2188.25	0.25	2.36	0.48	0.88
5.40	2188.37	0.37	2.98	0.72	0.93
8.10	2188.47	0.47	3.40	0.90	0.96
10.80	2188.55	0.55	3.71	1.06	0.98
13.50	2188.62	0.62	3.98	1.20	1.00
16.20	2188.69	0.69	4.20	1.33	1.01
18.90	2188.75	0.75	4.40	1.45	1.02
21.60	2188.81	0.81	4.57	1.55	1.03
24.00	2188.85	0.85	4.72	1.64	1.04
27.00	2188.91	0.91	4.88	1.75	1.05

Tailwater Channel Data - Pipe 186+32

Tailwater Channel Option: Irregular Channel
 Channel Slope: Irregular Channel

User Defined Channel Cross-Section

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	2189.73	0.0400
2	4.00	2188.00	0.0400
3	8.00	2188.00	0.0400
4	12.00	2189.73	0.0000

Roadway Data for Crossing: Pipe 186+32

Roadway Profile Shape: Constant Roadway Elevation
 Crest Length: 100.00 ft
 Crest Elevation: 2197.84 ft
 Roadway Surface: Paved
 Roadway Top Width: 46.00 ft

HY-8 Culvert Analysis Report 192+10

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.00 cfs

Design Flow: 38.00 cfs

Maximum Flow: 44.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Pipe 192+10

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 9 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2203.29	0.00	0.00	0.00	1
2204.22	4.40	4.40	0.00	1
2204.65	8.80	8.80	0.00	1
2205.05	13.20	13.20	0.00	1
2205.40	17.60	17.60	0.00	1
2205.74	22.00	22.00	0.00	1
2206.10	26.40	26.40	0.00	1
2206.50	30.80	30.80	0.00	1
2206.97	35.20	35.20	0.00	1
2207.30	38.00	38.00	0.00	1
2208.10	44.00	44.00	0.00	1
2208.12	44.12	44.12	0.00	Overtopping

Culvert Data: Culvert 9

Table 1 - Culvert Summary Table: Culvert 9

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2203.29	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
4.40	4.40	2204.22	0.93	0.0*	1-S2n	0.44	0.69	0.44	0.32	7.66	2.38
8.80	8.80	2204.65	1.36	0.0*	1-S2n	0.61	0.99	0.61	0.48	9.38	3.00
13.20	13.20	2205.05	1.76	0.0*	1-S2n	0.76	1.22	0.76	0.61	10.53	3.42
17.60	17.60	2205.40	2.11	0.0*	1-S2n	0.88	1.42	0.91	0.71	10.93	3.74
22.00	22.00	2205.74	2.45	0.0*	1-S2n	0.99	1.59	1.02	0.80	11.62	4.00
26.40	26.40	2206.10	2.81	0.0*	5-S2n	1.10	1.75	1.14	0.89	12.15	4.22
30.80	30.80	2206.50	3.21	0.729	5-S2n	1.20	1.89	1.24	0.97	12.68	4.42
35.20	35.20	2206.97	3.68	1.272	5-S2n	1.30	2.01	1.35	1.04	13.01	4.60
38.00	38.00	2207.30	4.01	1.647	5-S2n	1.36	2.08	1.42	1.08	13.24	4.70

44.00	44.00	2208.10	4.81	2.525	5-S2n	1.49	2.21	1.55	1.17	13.72	4.90
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* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

Inlet Elevation (invert): 2203.29 ft,

Outlet Elevation (invert): 2200.25 ft

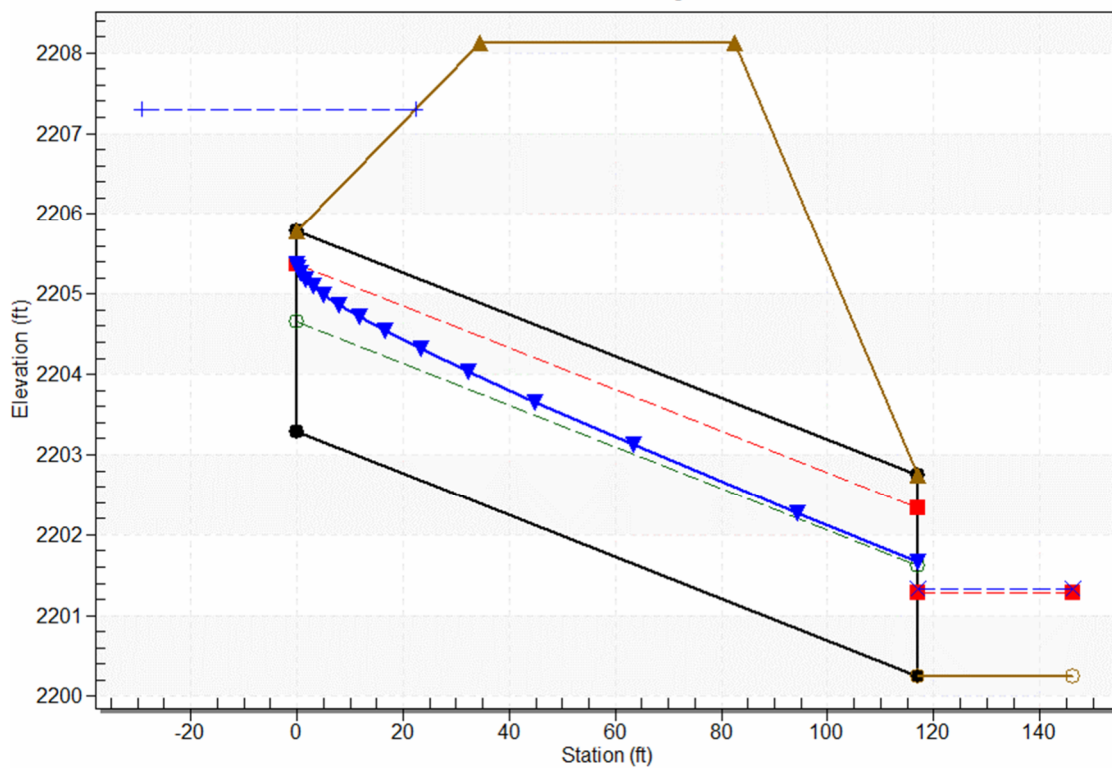
Culvert Length: 117.04 ft,

Culvert Slope: 0.0260

Water Surface Profile Plot for Culvert: Culvert 9

Crossing - Pipe 192+10, Design Discharge - 38.0 cfs

Culvert - Culvert 9, Culvert Discharge - 38.0 cfs



Site Data - Culvert 9

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2203.29 ft

Outlet Station: 117.00 ft

Outlet Elevation: 2200.25 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 9

Barrel Shape: Circular

Barrel Diameter: 2.50 ft
 Barrel Material: Concrete
 Embedment: 0.00 in
 Barrel Manning's n: 0.0130
 Culvert Type: Straight
 Inlet Configuration: Square Edge with Headwall
 Inlet Depression: None

Tailwater Data for Crossing: Pipe 192+10

Table 2 - Downstream Channel Rating Curve (Crossing: Pipe 192+10)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	2200.25	0.00	0.00	0.00	0.00
4.40	2200.57	0.32	2.38	0.45	0.78
8.80	2200.73	0.48	3.00	0.67	0.83
13.20	2200.86	0.61	3.42	0.85	0.85
17.60	2200.96	0.71	3.74	0.99	0.87
22.00	2201.05	0.80	4.00	1.12	0.89
26.40	2201.14	0.89	4.22	1.24	0.90
30.80	2201.22	0.97	4.42	1.35	0.91
35.20	2201.29	1.04	4.60	1.45	0.91
38.00	2201.33	1.08	4.70	1.51	0.92
44.00	2201.42	1.17	4.90	1.63	0.93

Tailwater Channel Data - Pipe 192+10

Tailwater Channel Option: Irregular Channel
 Channel Slope: Irregular Channel

User Defined Channel Cross-Section

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	2202.00	0.0400
2	4.00	2200.25	0.0400
3	9.00	2200.25	0.0400
4	13.00	2202.00	0.0000

Roadway Data for Crossing: Pipe 192+10

Roadway Profile Shape: Constant Roadway Elevation
 Crest Length: 100.00 ft
 Crest Elevation: 2208.12 ft
 Roadway Surface: Paved
 Roadway Top Width: 48.00 ft

HY-8 Culvert Analysis Report 195+35

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.00 cfs

Design Flow: 148.00 cfs

Maximum Flow: 174.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Box 195+35

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 9 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2204.65	0.00	0.00	0.00	1
2205.57	17.40	17.40	0.00	1
2206.08	34.80	34.80	0.00	1
2206.52	52.20	52.20	0.00	1
2206.90	69.60	69.60	0.00	1
2207.26	87.00	87.00	0.00	1
2207.60	104.40	104.40	0.00	1
2207.95	121.80	121.80	0.00	1
2208.31	139.20	139.20	0.00	1
2208.50	148.00	148.00	0.00	1
2209.10	174.00	174.00	0.00	1
2211.38	250.55	250.55	0.00	Overtopping

Culvert Data: Culvert 9

Table 1 - Culvert Summary Table: Culvert 9

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2204.65	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
17.40	17.40	2205.57	0.90	0.922	3-M1t	0.53	0.53	0.62	0.62	3.53	2.45
34.80	34.80	2206.08	1.43	0.652	1-S2n	0.83	0.84	0.83	0.92	5.26	3.09
52.20	52.20	2206.52	1.87	0.966	1-JS1t	1.08	1.10	1.16	1.16	5.64	3.51
69.60	69.60	2206.90	2.25	1.277	1-S2n	1.30	1.33	1.30	1.36	6.68	3.84
87.00	87.00	2207.26	2.61	1.603	1-S2n	1.51	1.54	1.51	1.53	7.20	4.11
104.40	104.40	2207.60	2.95	1.974	1-S2n	1.71	1.74	1.71	1.70	7.63	4.34
121.80	121.80	2207.95	3.30	2.366	5-S2n	1.90	1.93	1.90	1.84	8.01	4.54
139.20	139.20	2208.31	3.66	2.780	5-S2n	2.08	2.11	2.08	1.98	8.35	4.72
148.00	148.00	2208.50	3.85	2.998	5-S2n	2.18	2.20	2.18	2.04	8.50	4.81

174.00	174.00	2209.10	4.45	3.956	5-S2n	2.44	2.45	2.44	2.23	8.92	5.04
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Culvert Barrel Data

Culvert Barrel Type Straight Culvert

Inlet Elevation (invert): 2204.65 ft,

Outlet Elevation (invert): 2204.32 ft

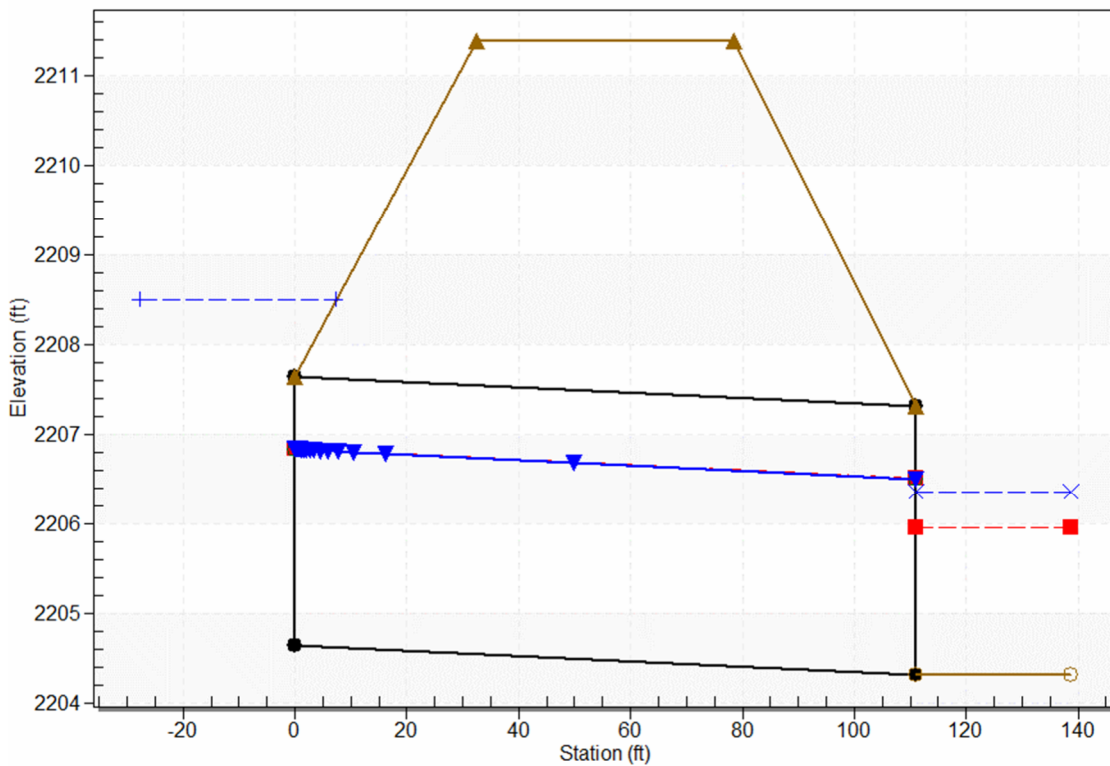
Culvert Length: 111.00 ft,

Culvert Slope: 0.0030

Water Surface Profile Plot for Culvert: Culvert 9

Crossing - Box 195+35, Design Discharge - 148.0 cfs

Culvert - Culvert 9, Culvert Discharge - 148.0 cfs



Site Data - Culvert 9

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2204.65 ft

Outlet Station: 111.00 ft

Outlet Elevation: 2204.32 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 9

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 3.00 ft
 Barrel Material: Concrete
 Embedment: 0.00 in
 Barrel Manning's n: 0.0120
 Culvert Type: Straight
 Inlet Configuration: Square Edge (90°) Headwall
 Inlet Depression: None

Tailwater Data for Crossing: Box 195+35

Table 2 - Downstream Channel Rating Curve (Crossing: Box 195+35)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	2204.32	0.00	0.00	0.00	0.00
17.40	2204.94	0.62	2.45	0.38	0.58
34.80	2205.24	0.92	3.09	0.57	0.62
52.20	2205.48	1.16	3.51	0.72	0.64
69.60	2205.68	1.36	3.84	0.85	0.65
87.00	2205.85	1.53	4.11	0.96	0.66
104.40	2206.02	1.70	4.34	1.06	0.67
121.80	2206.16	1.84	4.54	1.15	0.68
139.20	2206.30	1.98	4.72	1.24	0.68
148.00	2206.36	2.04	4.81	1.28	0.68
174.00	2206.55	2.23	5.04	1.39	0.69

Tailwater Channel Data - Box 195+35

Tailwater Channel Option: Irregular Channel
 Channel Slope: Irregular Channel

User Defined Channel Cross-Section

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	2206.75	0.0400
2	6.00	2204.32	0.0400
3	16.00	2204.32	0.0400
4	22.00	2206.75	0.0000

Roadway Data for Crossing: Box 195+35

Roadway Profile Shape: Constant Roadway Elevation
 Crest Length: 100.00 ft
 Crest Elevation: 2211.38 ft
 Roadway Surface: Paved
 Roadway Top Width: 46.00 ft

HY-8 Culvert Analysis Report 203+84

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.00 cfs

Design Flow: 283.00 cfs

Maximum Flow: 352.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Box 203+84

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 9 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2221.88	0.00	0.00	0.00	1
2223.31	35.20	35.20	0.00	1
2224.14	70.40	70.40	0.00	1
2224.82	105.60	105.60	0.00	1
2225.45	140.80	140.80	0.00	1
2226.05	176.00	176.00	0.00	1
2226.67	211.20	211.20	0.00	1
2227.34	246.40	246.40	0.00	1
2228.11	283.00	283.00	0.00	1
2228.91	316.80	316.80	0.00	1
2229.52	352.00	340.50	11.43	10
2229.41	336.20	336.20	0.00	Overtopping

Culvert Data: Culvert 9

Table 1 - Culvert Summary Table: Culvert 9

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2221.88	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
35.20	35.20	2223.31	1.43	0.0*	1-S2n	0.51	0.84	0.52	0.87	8.51	4.18
70.40	70.40	2224.14	2.26	0.0*	1-S2n	0.79	1.34	0.82	1.28	10.69	5.20
105.60	105.60	2224.82	2.94	0.000	1-S2n	1.03	1.76	1.09	1.60	12.12	5.88
140.80	140.80	2225.45	3.57	0.624	1-S2n	1.24	2.13	1.34	1.87	13.14	6.40
176.00	176.00	2226.05	4.17	1.290	5-S2n	1.44	2.47	1.58	2.11	13.92	6.82
211.20	211.20	2226.67	4.79	2.006	5-S2n	1.63	2.79	1.81	2.32	14.56	7.18
246.40	246.40	2227.34	5.46	3.233	5-S2n	1.81	3.09	2.04	2.52	15.13	7.50
283.00	283.00	2228.11	6.23	3.946	5-S2n	1.99	3.39	2.26	2.71	15.63	7.79
316.80	316.80	2228.91	7.03	4.669	5-S2n	2.15	3.65	2.47	2.87	16.06	8.04

352.00	340.50	2229.52	7.64	5.213	5-S2n	2.26	3.83	2.61	3.03	16.33	8.27
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* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

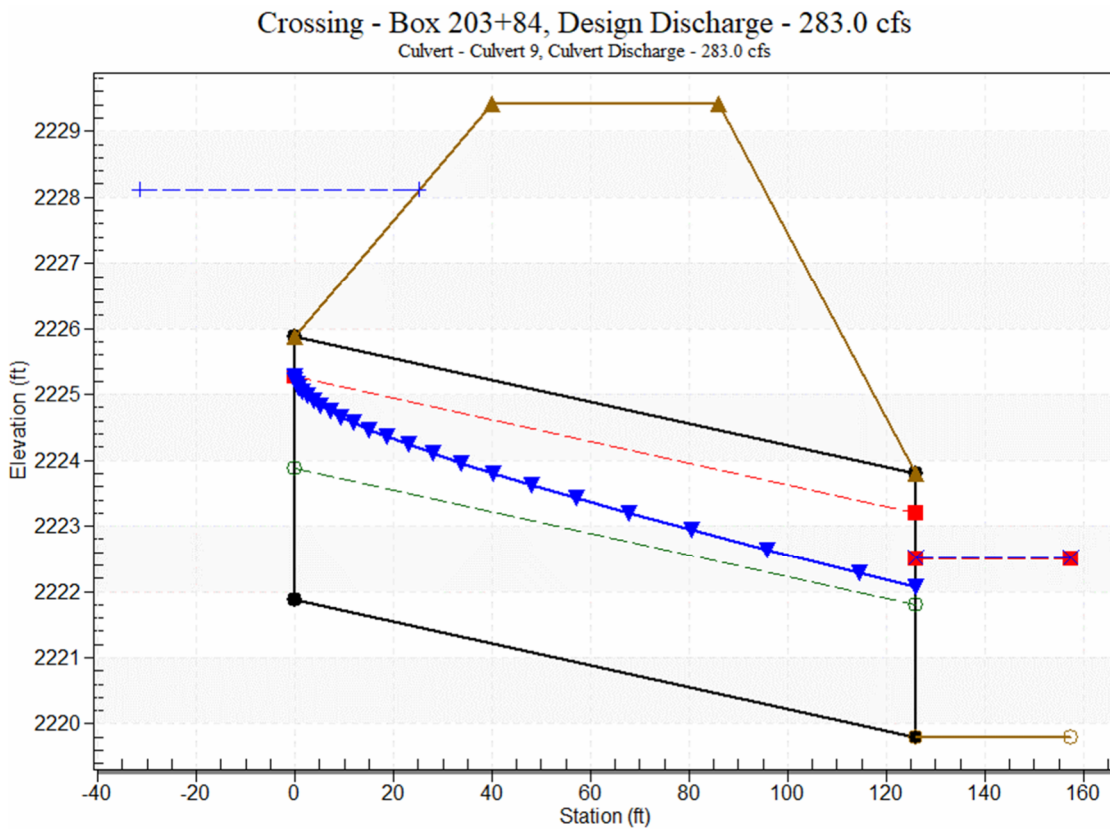
Inlet Elevation (invert): 2221.88 ft,

Outlet Elevation (invert): 2219.80 ft

Culvert Length: 126.02 ft,

Culvert Slope: 0.0165

Water Surface Profile Plot for Culvert: Culvert 9



Site Data - Culvert 9

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2221.88 ft

Outlet Station: 126.00 ft

Outlet Elevation: 2219.80 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 9

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft
 Barrel Rise: 4.00 ft
 Barrel Material: Concrete
 Embedment: 0.00 in
 Barrel Manning's n: 0.0130
 Culvert Type: Straight
 Inlet Configuration: Square Edge (90°) Headwall
 Inlet Depression: None

Tailwater Data for Crossing: Box 203+84

Table 2 - Downstream Channel Rating Curve (Crossing: Box 203+84)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	2219.80	0.00	0.00	0.00	0.00
35.20	2220.67	0.87	4.18	1.08	0.86
70.40	2221.08	1.28	5.20	1.60	0.90
105.60	2221.40	1.60	5.88	2.00	0.93
140.80	2221.67	1.87	6.40	2.34	0.95
176.00	2221.91	2.11	6.82	2.63	0.96
211.20	2222.12	2.32	7.18	2.90	0.97
246.40	2222.32	2.52	7.50	3.14	0.98
283.00	2222.51	2.71	7.79	3.38	0.99
316.80	2222.67	2.87	8.04	3.58	1.00
352.00	2222.83	3.03	8.27	3.78	1.00

Tailwater Channel Data - Box 203+84

Tailwater Channel Option: Irregular Channel
 Channel Slope: Irregular Channel

User Defined Channel Cross-Section

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	2223.80	0.0400
2	8.00	2219.80	0.0400
3	16.00	2219.80	0.0400
4	24.00	2223.80	0.0000

Roadway Data for Crossing: Box 203+84

Roadway Profile Shape: Constant Roadway Elevation
 Crest Length: 100.00 ft
 Crest Elevation: 2229.41 ft
 Roadway Surface: Paved
 Roadway Top Width: 46.00 ft

HY-8 Culvert Analysis Report 215+65

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 1000.00 cfs

Design Flow: 2362.00 cfs

Maximum Flow: 2800.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Box 215+65

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2240.34	1000.00	1000.00	0.00	1
2240.79	1180.00	1180.00	0.00	1
2241.21	1360.00	1360.00	0.00	1
2241.62	1540.00	1540.00	0.00	1
2242.03	1720.00	1720.00	0.00	1
2242.43	1900.00	1900.00	0.00	1
2242.84	2080.00	2080.00	0.00	1
2243.25	2260.00	2260.00	0.00	1
2243.49	2362.00	2362.00	0.00	1
2244.11	2620.00	2620.00	0.00	1
2244.57	2800.00	2800.00	0.00	1
2244.80	2889.70	2889.70	0.00	Overtopping

Culvert Data: Culvert 1

Table 1 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1000.00	1000.00	2240.34	3.84	0.0*	1-S2n	1.05	2.32	1.20	2.58	16.62	6.87
1180.00	1180.00	2240.79	4.29	0.0*	1-S2n	1.17	2.59	1.37	2.84	17.26	7.28
1360.00	1360.00	2241.21	4.71	0.046	1-S2n	1.28	2.84	1.53	3.08	17.81	7.64
1540.00	1540.00	2241.62	5.12	0.432	1-S2n	1.39	3.09	1.68	3.32	18.29	7.97
1720.00	1720.00	2242.03	5.53	0.825	1-S2n	1.49	3.32	1.84	3.53	18.72	8.27
1900.00	1900.00	2242.43	5.93	1.228	1-S2n	1.59	3.55	1.99	3.74	19.11	8.55
2080.00	2080.00	2242.84	6.34	1.641	5-S2n	1.69	3.77	2.14	3.94	19.47	8.81
2260.00	2260.00	2243.25	6.75	2.066	5-S2n	1.79	3.99	2.28	4.13	19.80	9.06
2362.00	2362.00	2243.49	6.99	2.312	5-S2n	1.85	4.11	2.36	4.24	19.98	9.19
2620.00	2620.00	2244.11	7.61	2.954	5-	1.98	4.40	2.57	4.50	20.40	9.51

2800.00	2800.00	2244.57	8.07	3.418	S2n 5- S2n	2.07	4.60	2.71	4.67	20.68	9.72
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* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

Inlet Elevation (invert): 2236.50 ft,

Outlet Elevation (invert): 2232.91 ft

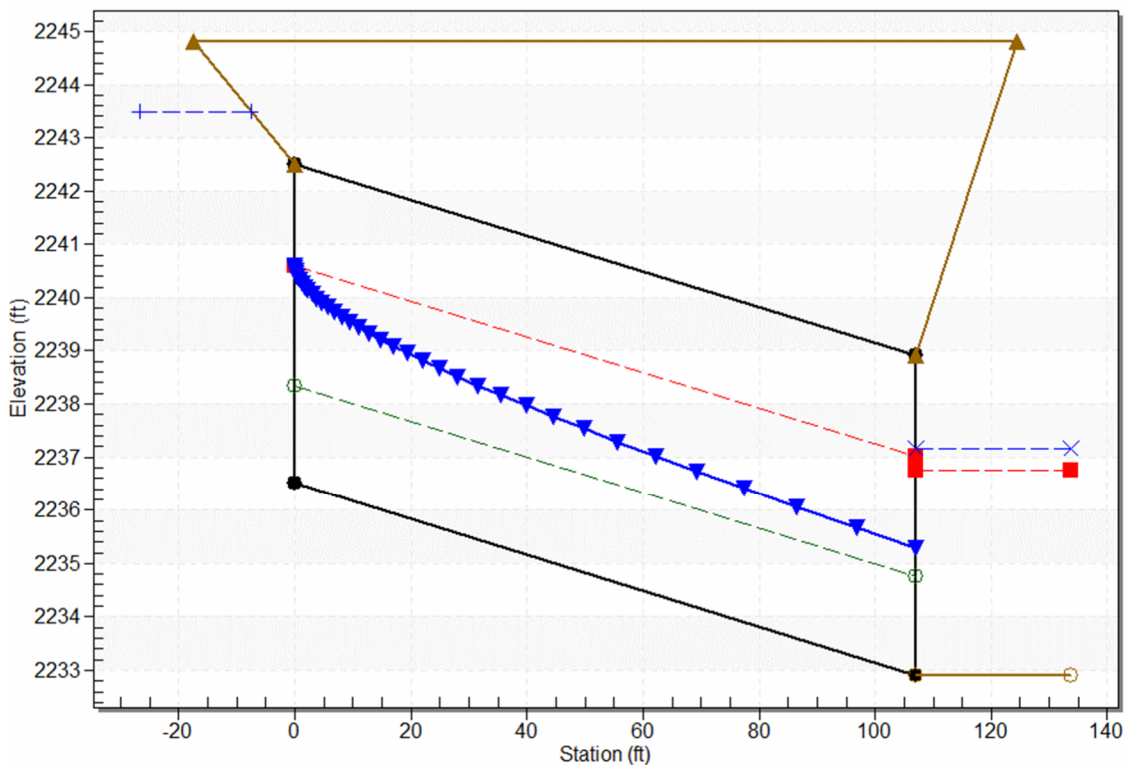
Culvert Length: 107.06 ft,

Culvert Slope: 0.0336

Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Box 215+65, Design Discharge - 2362.0 cfs

Culvert - Culvert 1, Culvert Discharge - 2362.0 cfs



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 2236.50 ft

Outlet Station: 107.00 ft

Outlet Elevation: 2232.91 ft

Number of Barrels: 5

Culvert Data Summary - Culvert 1

Barrel Shape: Concrete Box

Barrel Span: 10.00 ft
 Barrel Rise: 6.00 ft
 Barrel Material: Concrete
 Embedment: 0.00 in
 Barrel Manning's n: 0.0130
 Culvert Type: Straight
 Inlet Configuration: Square Edge (90°) Headwall
 Inlet Depression: None

Tailwater Data for Crossing: Box 215+65

Table 2 - Downstream Channel Rating Curve (Crossing: Box 215+65)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
1000.00	2235.49	2.58	6.87	1.83	0.80
1180.00	2235.75	2.84	7.28	2.02	0.81
1360.00	2235.99	3.08	7.64	2.19	0.82
1540.00	2236.23	3.32	7.97	2.36	0.82
1720.00	2236.44	3.53	8.27	2.51	0.83
1900.00	2236.65	3.74	8.55	2.66	0.84
2080.00	2236.85	3.94	8.81	2.80	0.84
2260.00	2237.04	4.13	9.06	2.94	0.85
2362.00	2237.15	4.24	9.19	3.02	0.85
2620.00	2237.41	4.50	9.51	3.20	0.86
2800.00	2237.58	4.67	9.72	3.32	0.86

Tailwater Channel Data - Box 215+65

Tailwater Channel Option: Irregular Channel
 Channel Slope: Irregular Channel

User Defined Channel Cross-Section

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	2238.91	0.0400
2	15.00	2232.91	0.0400
3	65.00	2232.91	0.0400
4	80.00	2238.91	0.0000

Roadway Data for Crossing: Box 215+65

Roadway Profile Shape: Constant Roadway Elevation
 Crest Length: 250.00 ft
 Crest Elevation: 2244.80 ft
 Roadway Surface: Paved
 Roadway Top Width: 142.00 ft

C.2 Channel & Ditch Calculations

C.2.1 Channels

FEMA Wash - Embankment Riprap Sizing

Starting Station	Ending Station	d50 (in)	Riprap height (from channel bottom) (ft)	n-value ¹
198+70	204+59	12	4.5	0.063
194+92	198+70	18	3.8	0.074
183+41	194+92	12	3.7	0.063
177+00 (tie in to box riprap)	183+41	12	4.4	0.061

Notes: 1) n-value taken from Table 7.7 of Drainage Design Manual for Maricopa County: Hydraulics, December 14, 2018.

C.2.2 Roadside Ditches

Project: Carefree Highway - Cave Creek Rd to Scottsdale Widening
Location: Scottsdale AZ
Date: 6/12/2024
Subject: Ditch/Channel Design Summary

Project Number: 3010.0100309.000
Project Engineer: M. Jacobsen
Checker: L. Vick

Ditch ID	Road Alignment	Contributing Subbasins	From Station	To Station	Manning's 'n'	Lt Side Slope (ft/ft)	Rt Side Slope (ft/ft)	Max Channel Slope (%)	Channel Slope (ft/ft)	Required Channel Depth (in)	Required Channel Depth (ft)	Required Channel Width (ft)	Channel 50-Yr Flow (cfs)	Max Channel Velocity 50-yr (ft/s)	Notes
EB Channel 1	Carefree Hwy	M-01+OFF-17+OFF-18+RD-08+DA-01	120+69	122+12	0.025; 0.073	3/1	3/1	5.07	0.0507	24.00	2.00	12.0	55.75	4.5	No lining for slopes < 1.00%. D50=9" riprap lining for slopes = 5.07%.
EB Channel 2	Carefree Hwy	M-01+OFF-17A	127+10	130+00	0.049	3/1	3/1	2.99	0.0299	6.00	0.50	3.0	1.21	1.9	d50=3" riprap lining.
EB Channel 3	Carefree Hwy	OFF-16A; OFF-16	130+33	139+72	0.025; 0.049	3/1	3/1	3.04	0.0304	15.60	1.30	7.8	12.52	3.9	No lining for slopes < 1.22%. D50=3" riprap lining for slopes > 1.22%.
EB Channel 4	Carefree Hwy	OFF-15	140+81	143+90	0.025; 0.049	3/1	3/1	3.62	0.0362	4.80	0.40	2.4	0.70	2.2	No lining for slopes < 1.80%. D50=3" riprap lining for slopes > 1.80%.
EB Channel 5	Carefree Hwy	OFF-14	145+33	151+23	0.025; 0.049	3/1	3/1	4.32	0.0432	13.20	1.10	6.6	7.68	3.5	No lining for slopes < 1.31%. D50=3" riprap lining for slopes > 1.31%.
EB Channel 6	Carefree Hwy	OFF-13 TOTAL	151+63	152+71	0.025; 0.049; 0.069	3/1	3/1	6.67	0.0667	15.60	1.30	7.8	14.90	3.7	No lining for slopes < 1.20%. D50=3" riprap lining for slopes 1.20% - 4.60%. D50=6" riprap lining for slopes 4.60% - 9.11%.
EB Channel 7	Carefree Hwy	OFF-13A	153+80	161+65	0.025; 0.049	3/1	3/1	3.09	0.0309	15.60	1.30	7.8	14.63	3.6	No lining for slopes < 1.20%. D50=3" riprap lining for slopes 1.20% - 3.09%.
WB Channel 1	Carefree Hwy	OFF-12	164+28	168+75	0.025; 0.049	4/1	3/1	4.09	0.0409	9.60	0.80	5.6	6.03	3.3	No lining for slopes < 1.35%. D50=3" riprap lining for slopes 1.35% - 5.20%.
WB Channel 1A	Carefree Hwy	B-3	149+49	150+45	0.049	4/1	3/1	3.01	0.0301	12.00	1.00	7.0	9.00	3.1	d50=3" riprap lining.
WB Channel 1B	Carefree Hwy	OFF-11	171+87	173+87	0.049	4/1	3/1	4.73	0.0473	12.00	1.00	7.0	10.02	3.7	d50=3" riprap lining.
WB Channel 2 Westbound	Carefree Hwy	OFF-10W	174+77	176+74	0.025; 0.049	4/1	3/1	2.55	0.0255	3.60	0.30	2.1	0.50	1.9	No lining for slopes < 1.89%. D50=3" riprap lining for slopes > 1.89%.
WB Channel 2 Eastbound	Carefree Hwy	OFF-10E	176+74	177+55	0.025; 0.049	4/1	3/1	2.87	0.0287	2.40	0.20	1.4	0.22	1.2	No lining for slopes < 2.11%. D50=3" riprap lining for slopes > 2.11%.
WB Channel 3	Carefree Hwy	OFF-9A	177+69	179+75	0.025; 0.049	4/1	3/1	0.96	0.0096	25.20	2.10	14.7	48.09	3.0	d50=3" riprap lining.
WB Channel 4 WB to STA 180+15 Culvert	Carefree Hwy	OFF-8B	180+15	183+00	0.049; 0.069	4/1	3/1	5.86	0.0586	18.00	1.50	10.5	21.95	3.8	D50=3" riprap lining for slopes 1.37% - 2.83%. D50=6" riprap lining for slopes 4.06 - 5.86%.
WB Channel 4 WB to STA 183+00 Culvert	Carefree Hwy	OFF-8W1; OFF-8W TOTAL	183+00	186+00	0.025; 0.049; 0.069	4/1	3/1	5.92	0.0592	10.80	0.90	6.3	5.93; 7.71	2.9	No lining for slopes < 1.31%. D50=3" riprap lining for slopes 1.31% - 4.14%. D50=6" riprap lining for slopes 5.26% - 5.92%.
WB Channel 4 Eastbound	Carefree Hwy	OFF-8E	186+00	186+34	0.025	4/1	3/1	0.77	0.0077	3.60	0.30	2.1	0.60	1.5	No lining required.
WB Channel 5B Westbound	Carefree Hwy	OFF-7W	186+77	190+46	0.025; 0.049; 0.069	3/1	2/1	8.30	0.0830	9.60	0.80	4.0	3.24	2.9	No lining for slopes < 1.48%. D50=3" riprap lining for slopes 1.48% - 5.51%. D50=6" riprap lining for slopes 8.30%.
WB Channel 5B Eastbound	Carefree Hwy	OFF-7E	190+46	192+35	0.025; 0.049	3/1	2/1	2.18	0.0218	6.00	0.50	2.5	0.73	1.5	No lining for slopes < 1.80%. D50=3" riprap lining for slopes > 1.80%.
WB Channel 6	Carefree Hwy	OFF-6	192+57	193+29	0.069; 0.073	4/1	3/1	9.39	0.0939	16.80	1.40	9.8	23.11	4.4	D50=6" riprap lining for slopes = 4.52%. D50=9" riprap lining for slopes = 9.39%.
WB Channel 7	Carefree Hwy	OFF-5	194+41	195+64	0.025; 0.049	4/1	3/1	5.66	0.0566	3.60	0.30	2.1	0.23	1.5	No lining for slopes < 2.09%. D50=3" riprap lining for slopes > 2.09%.
WB Channel 8 Westbound	Carefree Hwy	OFF-4 TOTAL	195+64	203+77	0.049; 0.069	3/1	5/2	7.46	0.0746	9.60	0.80	4.4	3.94	2.8	D50=3" riprap lining for slopes 1.72% - 3.37%. D50=6" riprap lining for slopes = 7.46%.
WB Channel 8 Eastbound	Carefree Hwy	OFF-4E	203+77	204+17	0.049	3/1	5/2	3.52	0.0352	2.40	0.20	1.1	0.07	1.0	D50=3" riprap lining

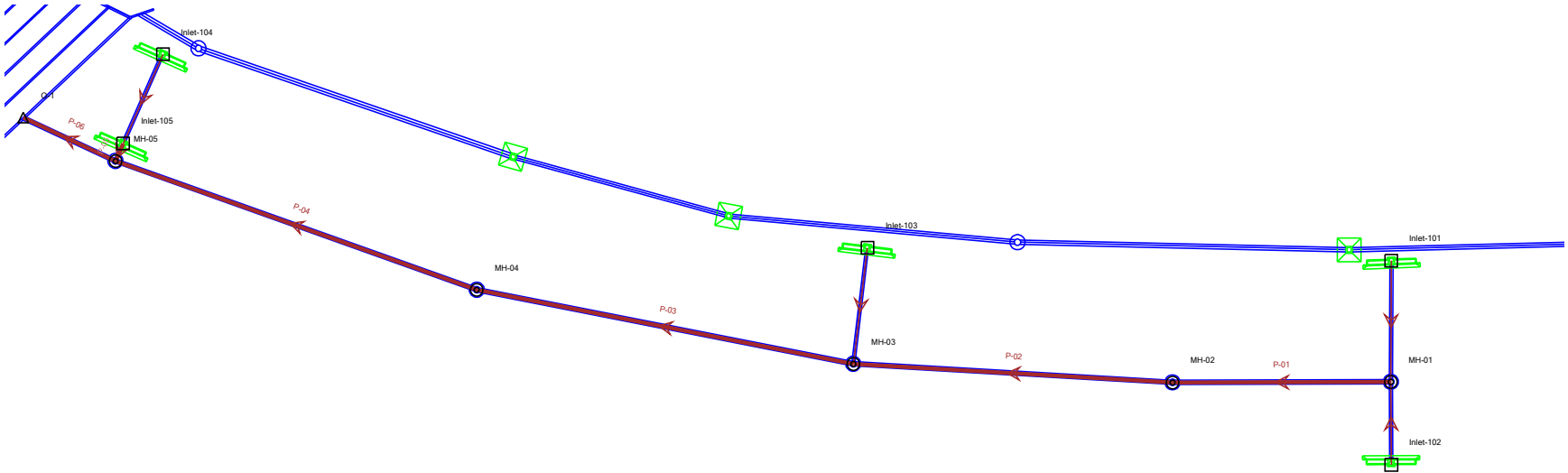
Notes:

- 1) Ditches are v-ditches unless otherwise noted to have a bottom width.
- 2) Normal depth, velocity and channel capacities calculated using Bentley Flowmaster V8i.

C.3 Storm Drain System

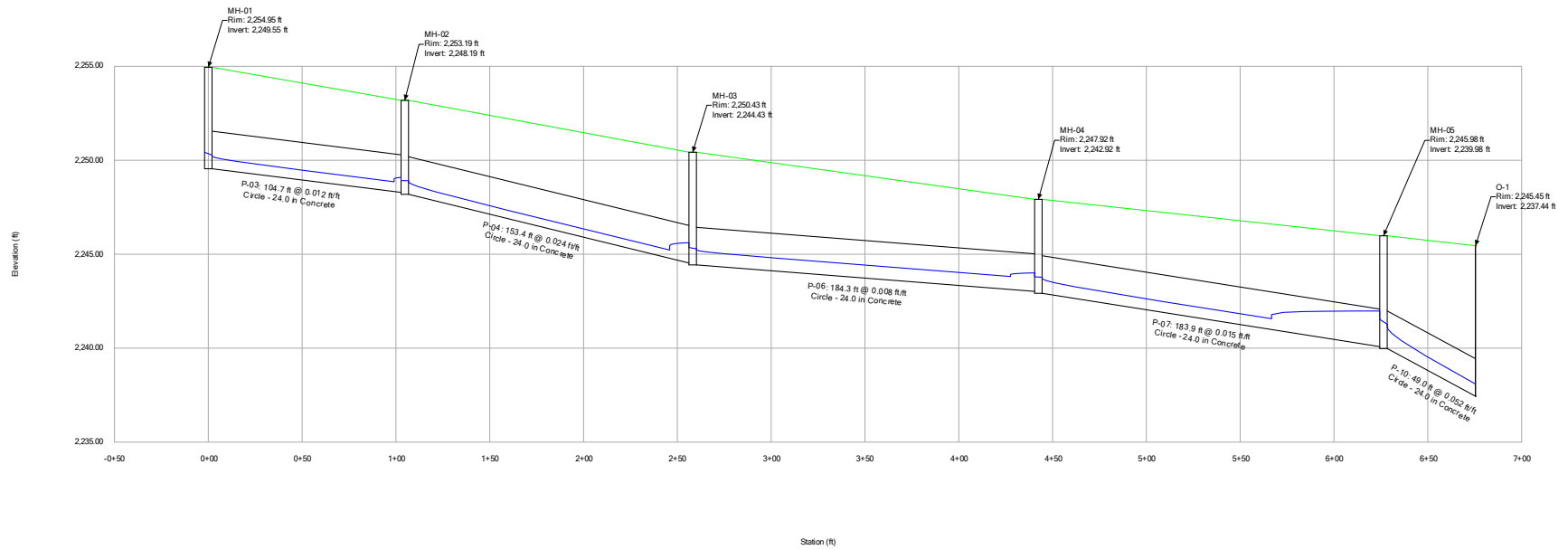
C.3.1 Storm Drain Mainline Calculations

Scenario: 10-yr



Profile Report

Engineering Profile - Profile - East CBC 215+65 (Carefree.stsw)



FlexTable: Conduit Table

Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (Scaled) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Manning's n	Flow (cfs)	Velocity (ft/s)
P-01	Inlet-101	2,250.47	MH-01	2,250.05	58.1	0.007	18.0	0.013	1.70	3.89
P-02	Inlet-102	2,250.21	MH-01	2,250.05	39.7	0.004	18.0	0.013	2.00	3.30
P-03	MH-01	2,249.55	MH-02	2,248.29	104.7	0.012	24.0	0.013	3.70	5.67
P-04	MH-02	2,248.19	MH-03	2,244.53	153.4	0.024	24.0	0.013	3.70	7.23
P-05	Inlet-103	2,245.21	MH-03	2,244.93	56.1	0.005	18.0	0.013	1.40	3.22
P-06	MH-03	2,244.43	MH-04	2,243.02	184.3	0.008	24.0	0.013	5.10	5.28
P-07	MH-04	2,242.92	MH-05	2,240.08	183.9	0.015	24.0	0.013	5.10	6.80
P-08	Inlet-104	2,240.76	Inlet-105	2,240.58	46.9	0.004	18.0	0.013	1.50	2.99
P-09	Inlet-105	2,240.58	MH-05	2,240.48	9.2	0.011	18.0	0.013	5.30	6.15
P-10	MH-05	2,239.98	O-1	2,237.44	49.0	0.052	24.0	0.013	10.40	12.83

FlexTable: Catch Basin Table

ID	Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Flow (Additional Subsurface) (cfs)	Hydraulic Grade Line (In) (ft)
31	Inlet-101	2,254.47	2,254.47	2,250.47	1.70	2,251.07
32	Inlet-102	2,254.21	2,254.21	2,250.21	2.00	2,250.88
33	Inlet-103	2,249.21	2,249.21	2,245.21	1.40	2,245.76
132	Inlet-104	2,244.76	2,244.76	2,240.76	1.50	2,242.18
134	Inlet-105	2,245.81	2,245.81	2,240.58	3.80	2,242.01

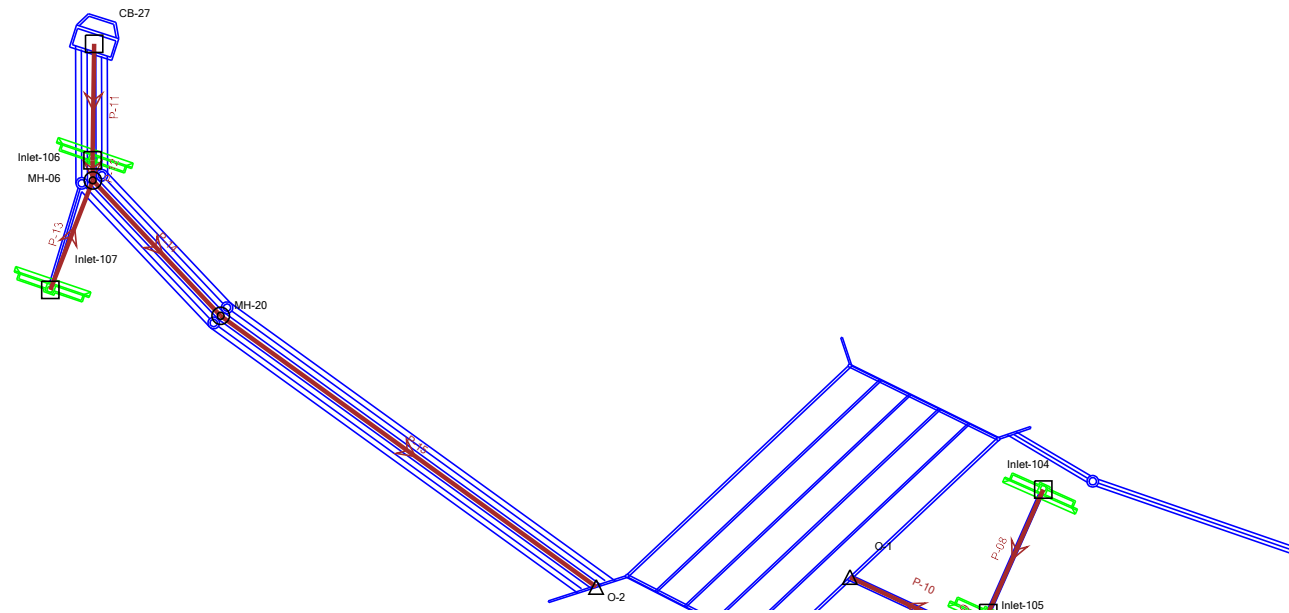
FlexTable: Manhole Table

Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert in 1) (ft)	Flow (Total Out) (cfs)	Hydraulic Grade Line (Out) (ft)	Headloss Method	Hydraulic Grade Line (In) (ft)
MH-05	2,245.98	2,245.98	2,240.08	10.40	2,241.27	HEC-22 Energy (Third Edition)	2,241.53
MH-04	2,247.92	2,247.92	2,243.02	5.10	2,243.78	HEC-22 Energy (Third Edition)	2,243.79
MH-03	2,250.43	2,250.43	2,244.53	5.10	2,245.29	HEC-22 Energy (Third Edition)	2,245.36
MH-02	2,253.19	2,253.19	2,248.29	3.70	2,248.91	HEC-22 Energy (Third Edition)	2,248.92
MH-01	2,254.95	2,254.95	2,250.05	3.70	2,250.27	HEC-22 Energy (Third Edition)	2,250.43

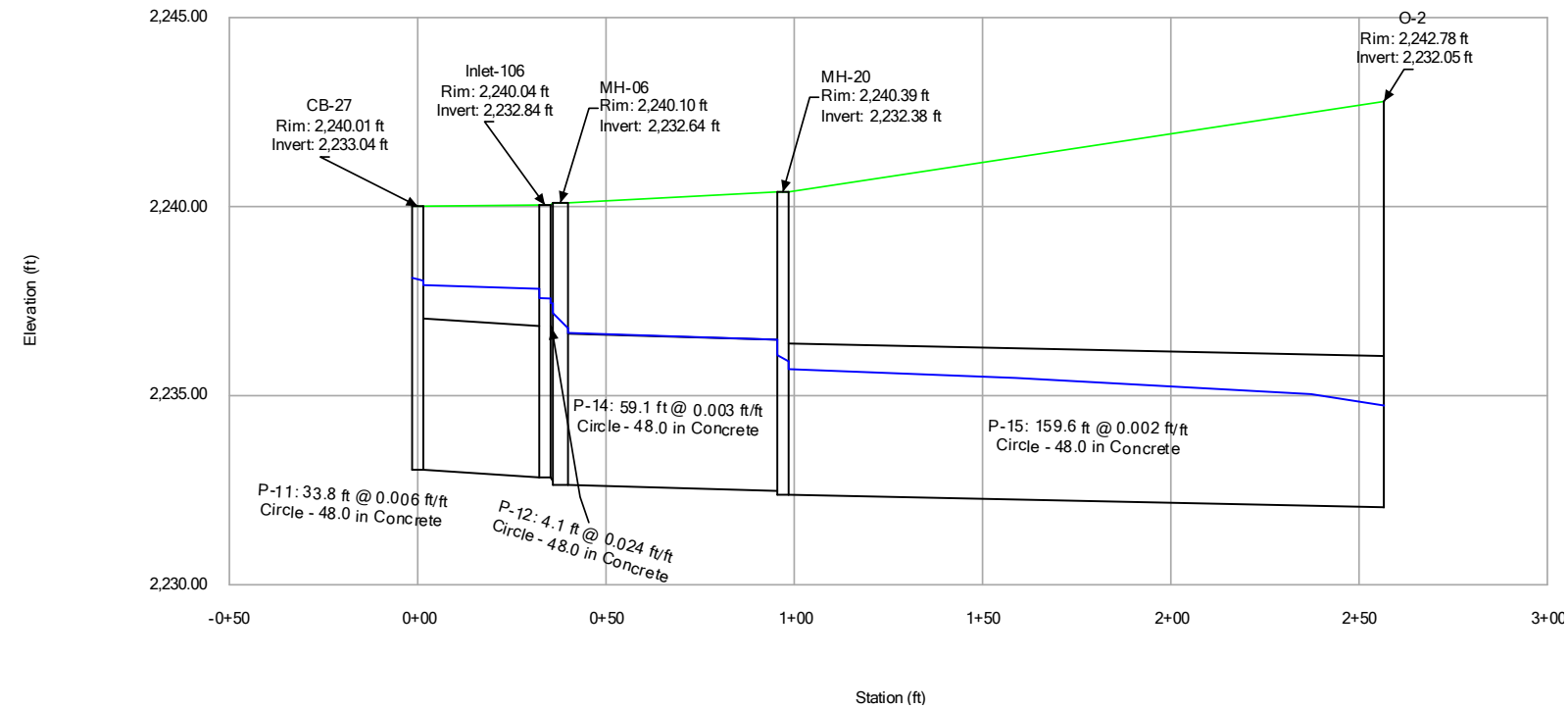
FlexTable: Outfall Table

Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
O-1	2,245.45	2,237.44	User Defined Tailwater	2,238.09	2,238.09	10.40

Scenario: 10-yr



Profile Report
Engineering Profile - Profile - West of CBC 215+65 (Carefree.stsw)



FlexTable: Conduit Table

Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (Scaled) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Manning's n	Flow (cfs)	Velocity (ft/s)
P-11	CB-27	2,233.04	Inlet-106	2,232.84	40.3	0.006	48.0	0.013	154.77	6.16
P-12	Inlet-106	2,232.84	MH-06	2,232.74	6.9	0.024	48.0	0.013	156.17	6.21
P-13	Inlet-107	2,235.42	MH-06	2,235.18	40.7	0.007	18.0	0.013	1.60	0.91
P-14	MH-06	2,232.64	MH-20	2,232.48	64.5	0.003	48.0	0.013	157.77	6.28
P-15	MH-20	2,232.38	O-2	2,232.05	160.4	0.002	48.0	0.013	157.77	6.28

FlexTable: Catch Basin Table

ID	Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Flow (Additional Subsurface) (cfs)	Hydraulic Grade Line (In) (ft)
36	Inlet-106	2,240.04	2,240.04	2,232.84	1.40	2,237.58
37	Inlet-107	2,239.42	2,239.42	2,235.42	1.60	2,237.80
154	CB-27	2,240.01	2,240.01	2,233.04	154.77	2,238.12

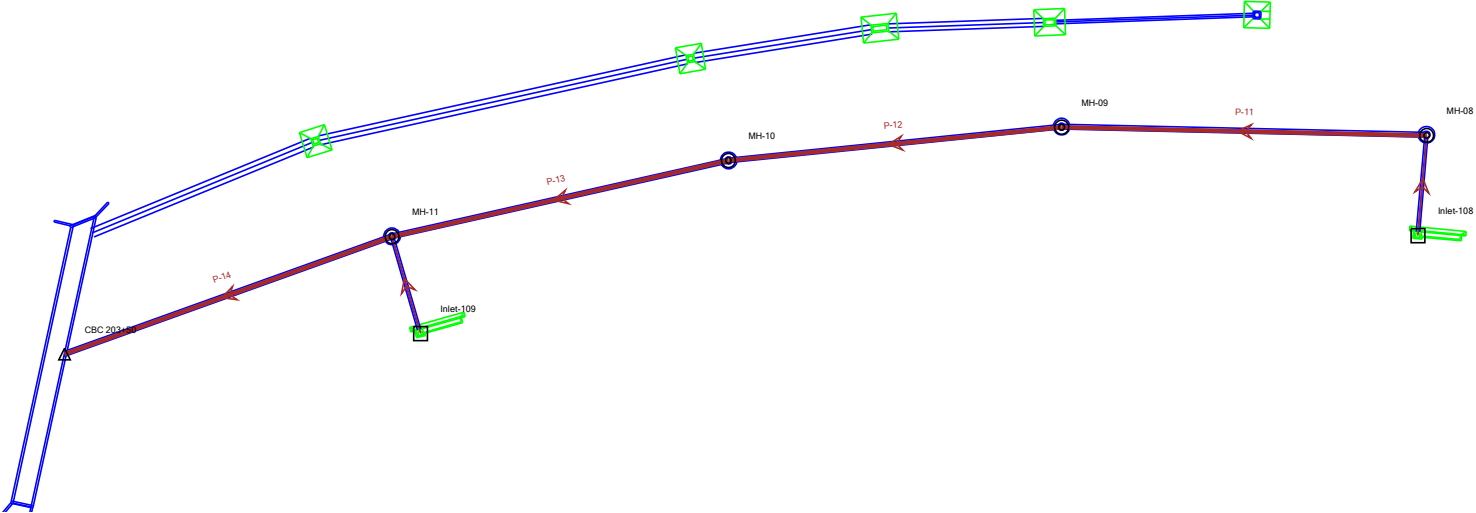
FlexTable: Manhole Table

Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert in 1) (ft)	Flow (Total Out) (cfs)	Hydraulic Grade Line (Out) (ft)	Headloss Method	Hydraulic Grade Line (In) (ft)
MH-06	2,240.10	2,240.10	2,232.74	157.77	2,236.78	HEC-22 Energy (Third Edition)	2,237.19
MH-20	2,240.39	2,240.39	2,232.48	157.77	2,235.91	HEC-22 Energy (Third Edition)	2,236.07

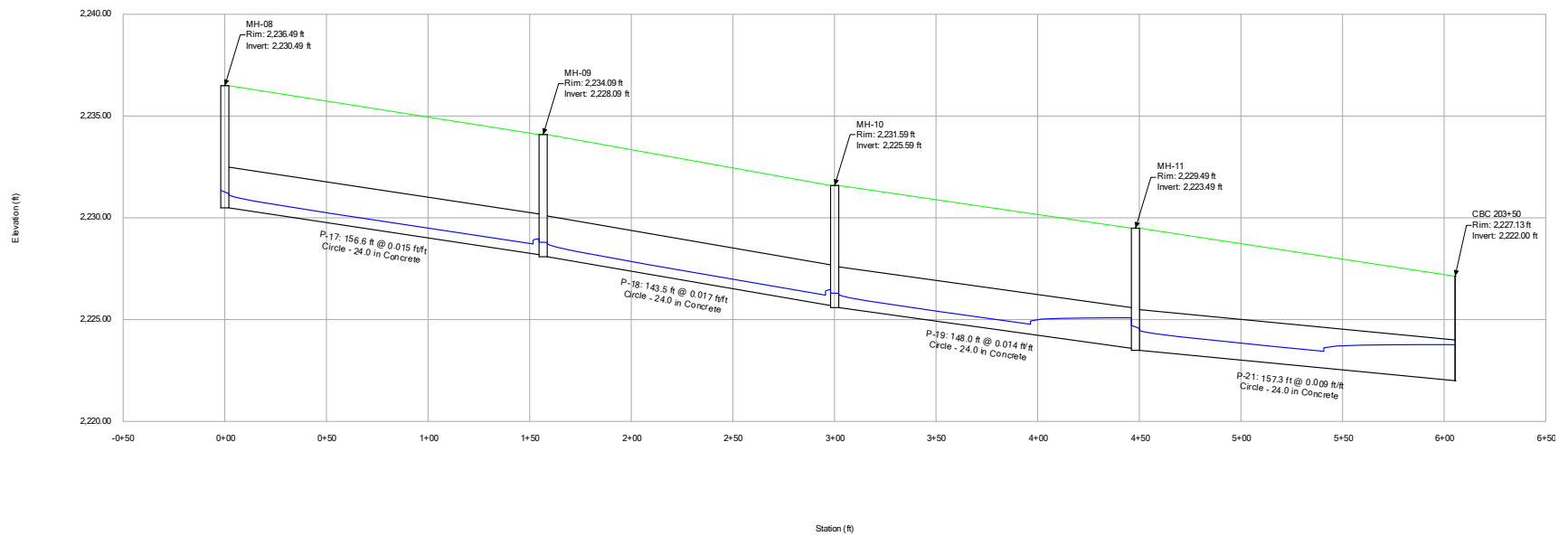
FlexTable: Outfall Table

Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
O-2	2,242.78	2,232.05	Free Outfall		2,234.74	157.77

Scenario: 10-yr



Profile Report **Engineering Profile - Profile - CBC 203+50 (Carefree.stsw)**



FlexTable: Conduit Table

Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (Scaled) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Manning's n	Flow (cfs)	Velocity (ft/s)
P-16	Inlet-108	2,231.18	MH-08	2,230.99	31.3	0.006	18.0	0.013	3.50	4.45
P-17	MH-08	2,230.49	MH-09	2,228.19	156.6	0.015	24.0	0.013	3.50	5.99
P-18	MH-09	2,228.09	MH-10	2,225.69	143.5	0.017	24.0	0.013	3.50	6.28
P-19	MH-10	2,225.59	MH-11	2,223.59	148.0	0.014	24.0	0.013	3.50	5.82
P-20	Inlet-109	2,224.18	MH-11	2,223.99	31.2	0.006	18.0	0.013	4.30	4.69
P-21	MH-11	2,223.49	CBC 203+50	2,222.00	157.3	0.009	24.0	0.013	7.80	6.41

FlexTable: Catch Basin Table

ID	Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Flow (Additional Subsurface) (cfs)	Hydraulic Grade Line (In) (ft)
38	Inlet-108	2,235.18	2,235.18	2,231.18	3.50	2,232.06
39	Inlet-109	2,228.18	2,228.18	2,224.18	4.30	2,225.22

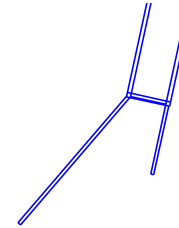
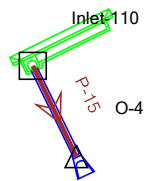
FlexTable: Manhole Table

Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert in 1) (ft)	Flow (Total Out) (cfs)	Hydraulic Grade Line (Out) (ft)	Headloss Method	Hydraulic Grade Line (In) (ft)
MH-11	2,229.49	2,229.49	2,223.59	7.80	2,224.56	HEC-22 Energy (Third Edition)	2,224.72
MH-10	2,231.59	2,231.59	2,225.69	3.50	2,226.29	HEC-22 Energy (Third Edition)	2,226.30
MH-09	2,234.09	2,234.09	2,228.19	3.50	2,228.79	HEC-22 Energy (Third Edition)	2,228.80
MH-08	2,236.49	2,236.49	2,230.99	3.50	2,231.19	HEC-22 Energy (Third Edition)	2,231.35

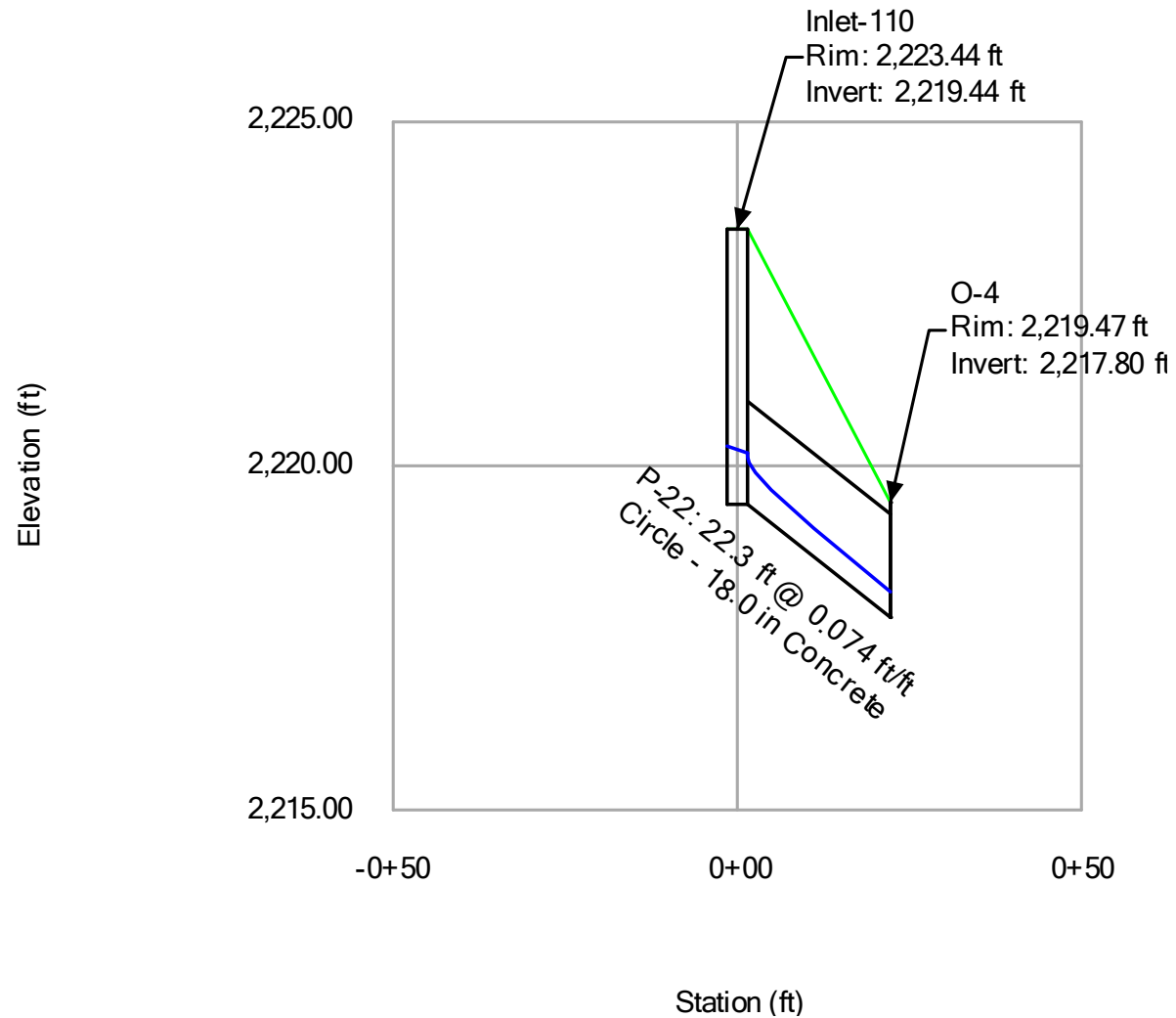
FlexTable: Outfall Table

Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
CBC 203+50	2,227.13	2,222.00	User Defined Tailwater	2,223.77	2,223.77	7.80

Scenario: 10-yr



Profile Report
Engineering Profile - Profile - 202+07 (Carefree.stsw)



FlexTable: Conduit Table

Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (Scaled) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Manning's n	Flow (cfs)	Velocity (ft/s)
P-22	Inlet-110	2,219.44	O-4	2,217.80	22.3	0.074	18.0	0.013	3.30	10.77

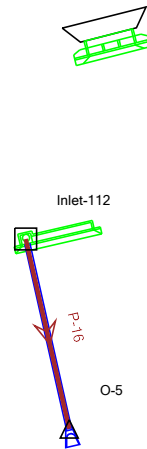
FlexTable: Catch Basin Table

ID	Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Flow (Additional Subsurface) (cfs)	Hydraulic Grade Line (In) (ft)
40	Inlet-110	2,223.44	2,223.44	2,219.44	0.00	2,220.29

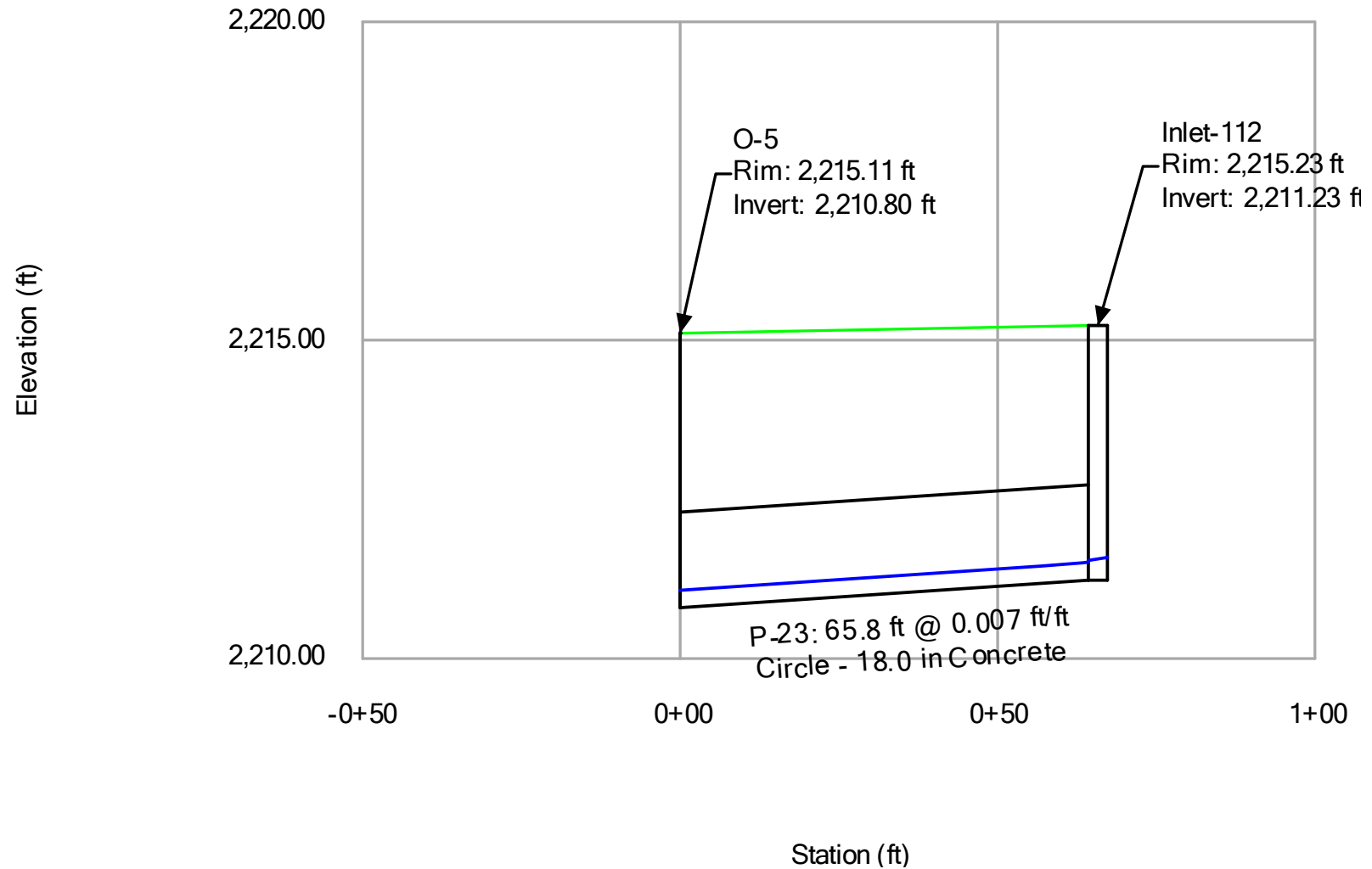
FlexTable: Outfall Table

Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
O-4	2,219.47	2,217.80	Free Outfall		2,218.17	3.30

Scenario: 10-yr



Profile Report
Engineering Profile - Profile - 198+24 (Carefree.stsw)



FlexTable: Conduit Table

Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (Scaled) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Manning's n	Flow (cfs)	Velocity (ft/s)
P-23	Inlet-112	2,211.23	O-5	2,210.80	54.0	0.007	18.0	0.013	0.62	2.80

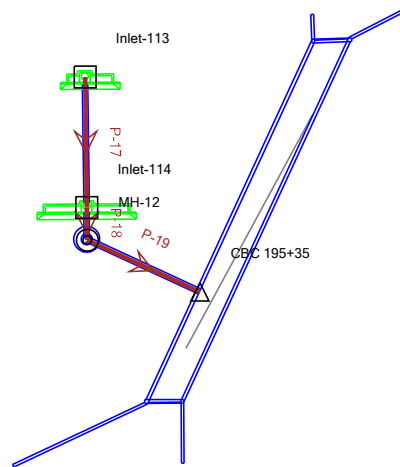
FlexTable: Catch Basin Table

ID	Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Flow (Additional Subsurface) (cfs)	Hydraulic Grade Line (In) (ft)
41	Inlet-112	2,215.23	2,215.23	2,211.23	0.00	2,211.59

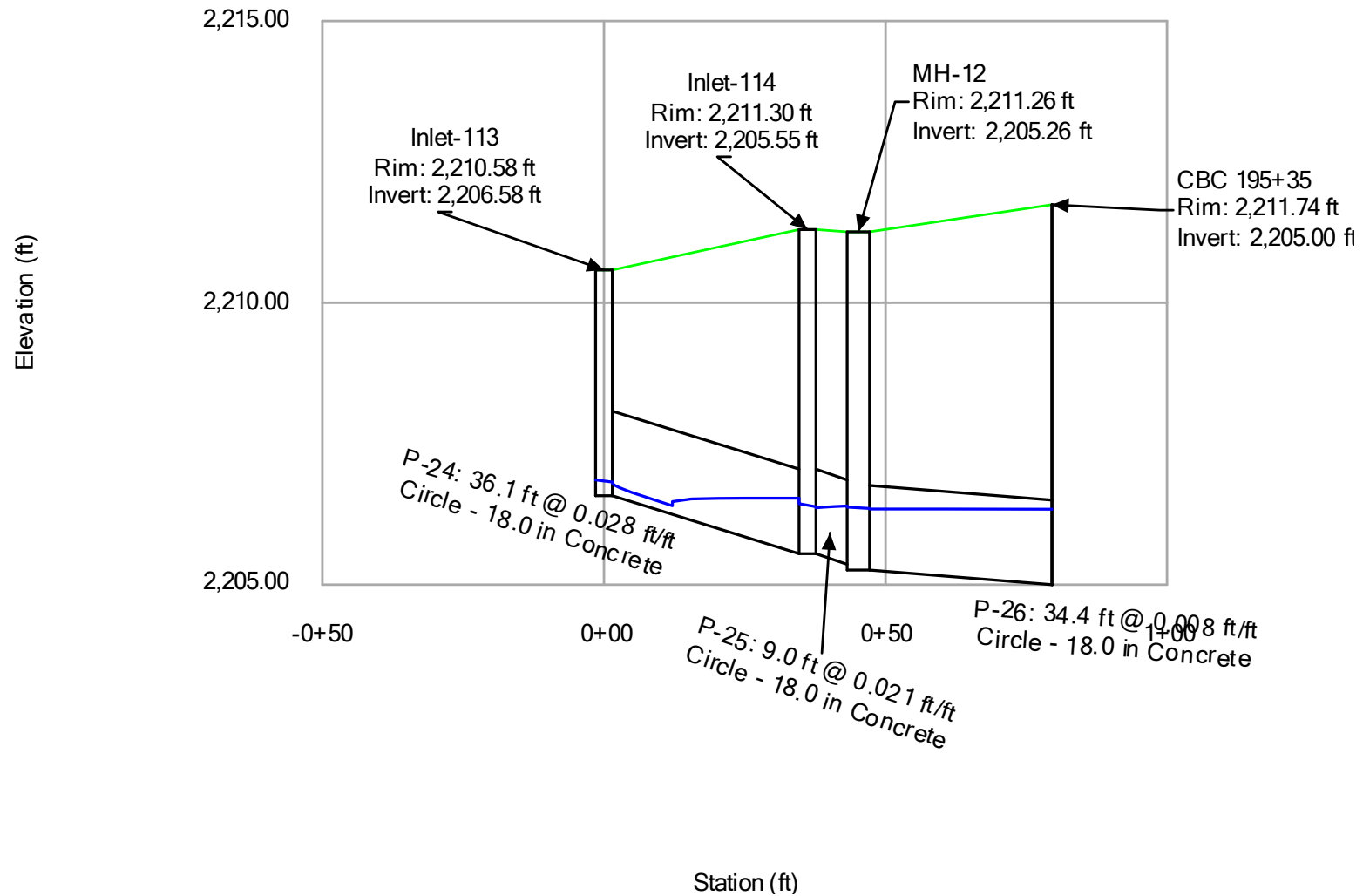
FlexTable: Outfall Table

Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
O-5	2,215.11	2,210.80	Free Outfall		2,211.07	0.62

Scenario: 10-yr



Profile Report **Engineering Profile - Profile - CBC 195+35 (Carefree.stsw)**



FlexTable: Conduit Table

Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (Scaled) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Manning's n	Flow (cfs)	Velocity (ft/s)
P-24	Inlet-113	2,206.58	Inlet-114	2,205.55	36.1	0.028	18.0	0.013	0.37	4.02
P-25	Inlet-114	2,205.55	MH-12	2,205.36	9.0	0.021	18.0	0.013	2.47	6.34
P-26	MH-12	2,205.26	CBC 195+35	2,205.00	34.4	0.008	18.0	0.013	2.47	4.39

FlexTable: Catch Basin Table

ID	Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Flow (Additional Subsurface) (cfs)	Hydraulic Grade Line (In) (ft)
42	Inlet-113	2,210.58	2,210.58	2,206.58	0.00	2,206.86
137	Inlet-114	2,211.30	2,211.30	2,205.55	2.10	2,206.44

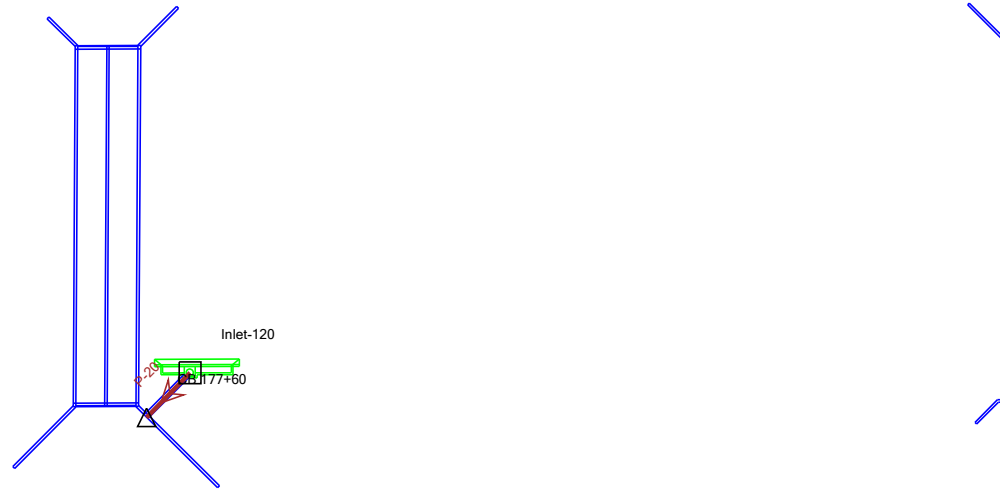
FlexTable: Manhole Table

Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert in 1) (ft)	Flow (Total Out) (cfs)	Hydraulic Grade Line (Out) (ft)	Headloss Method	Hydraulic Grade Line (In) (ft)
MH-12	2,211.26	2,211.26	2,205.36	2.47	2,206.35	HEC-22 Energy (Third Edition)	2,206.38

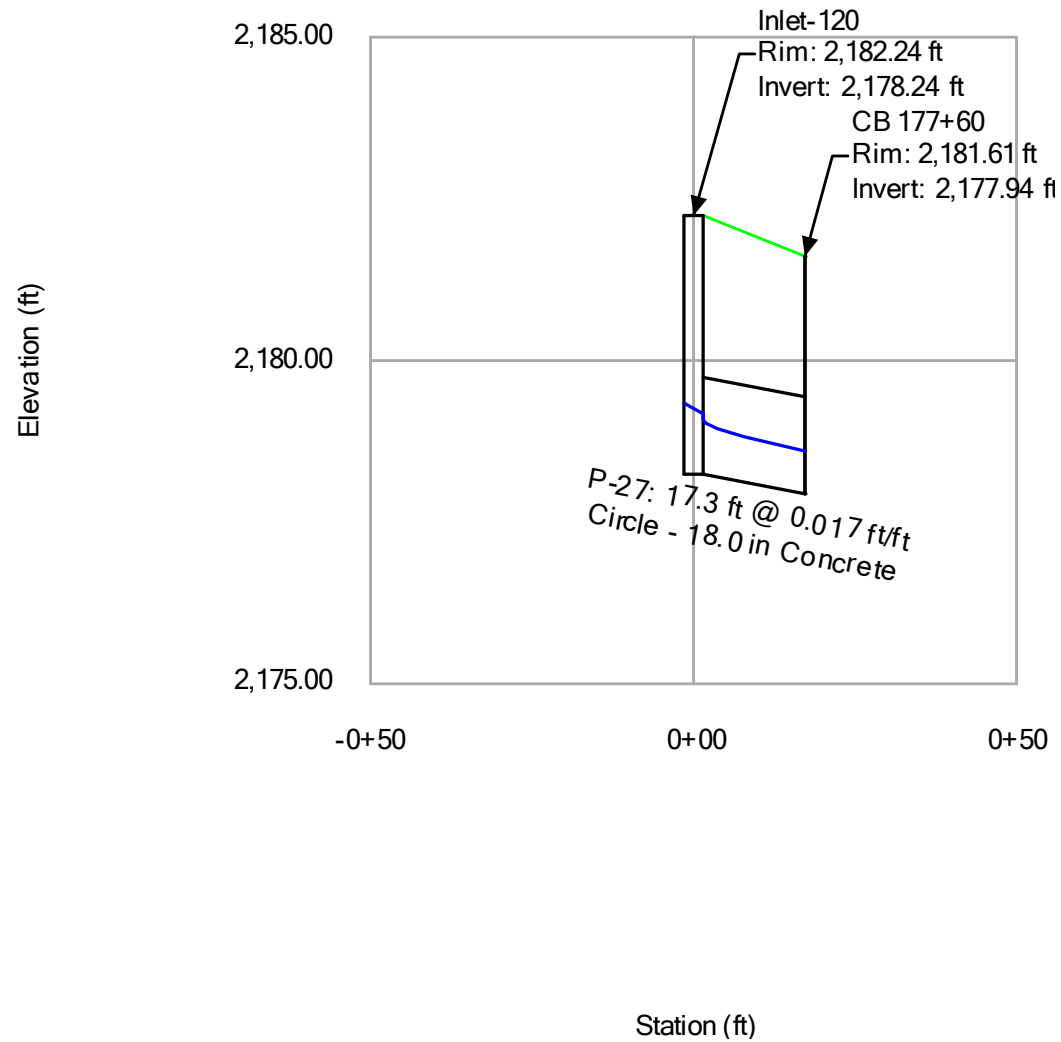
FlexTable: Outfall Table

Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
CBC 195+35	2,211.74	2,205.00	User Defined Tailwater	2,206.34	2,206.34	2.47

Scenario: 10-yr



Profile Report
Engineering Profile - Profile - CBC 177+60 (Carefree.stsw)



FlexTable: Conduit Table

Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (Scaled) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Manning's n	Flow (cfs)	Velocity (ft/s)
P-27	Inlet-120	2,178.24	CB 177+60	2,177.94	17.3	0.017	18.0	0.013	4.80	7.12

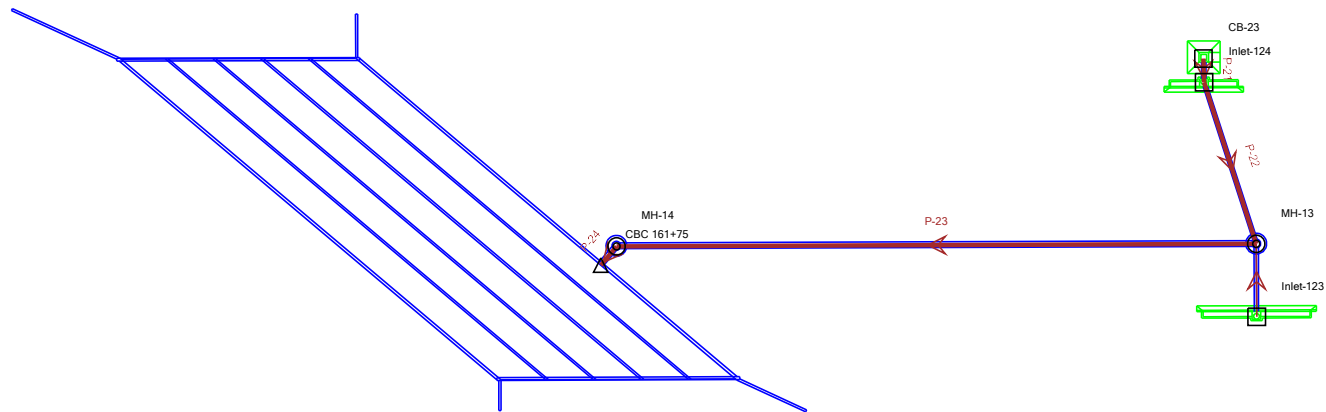
FlexTable: Catch Basin Table

ID	Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Flow (Additional Subsurface) (cfs)	Hydraulic Grade Line (In) (ft)
44	Inlet-120	2,182.24	2,182.24	2,178.24	0.00	2,179.34

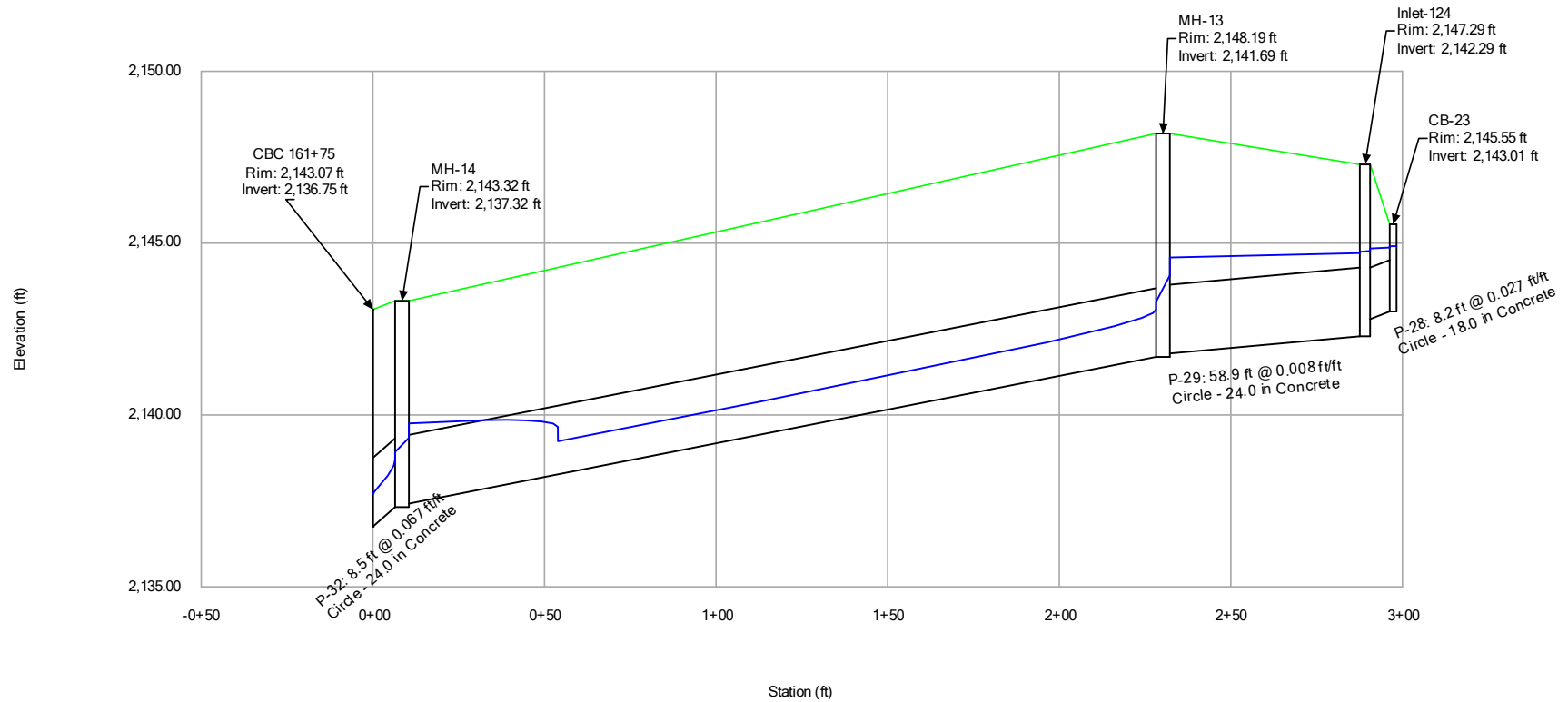
FlexTable: Outfall Table

Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
CB 177+60	2,181.61	2,177.94	User Defined Tailwater	0.00	2,178.60	4.80

Scenario: 10-yr



Profile Report **Engineering Profile - Profile - CBC 161+75 (Carefree.stsw)**



FlexTable: Conduit Table

Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (Scaled) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Manning's n	Flow (cfs)	Velocity (ft/s)
P-28	CB-23	2,143.01	Inlet-124	2,142.79	8.2	0.027	18.0	0.013	6.00	3.40
P-29	Inlet-124	2,142.29	MH-13	2,141.79	58.9	0.008	24.0	0.013	10.60	3.37
P-30	Inlet-123	2,143.23	MH-13	2,142.19	25.2	0.041	18.0	0.013	4.10	10.73
P-31	MH-13	2,141.69	MH-14	2,137.42	221.7	0.019	24.0	0.013	14.70	9.83
P-32	MH-14	2,137.32	CBC 161+75	2,136.75	8.5	0.067	24.0	0.013	14.70	15.52

FlexTable: Catch Basin Table

ID	Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Flow (Additional Subsurface) (cfs)	Hydraulic Grade Line (In) (ft)
47	Inlet-123	2,147.73	2,147.73	2,143.23	4.10	2,144.70
122	CB-23	2,145.55	2,145.55	2,143.01	6.00	2,144.92

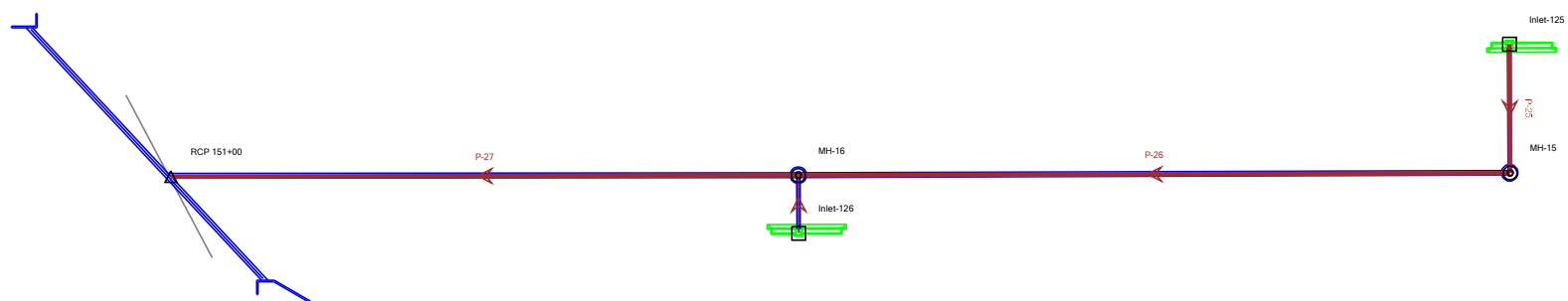
FlexTable: Manhole Table

Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert in 1) (ft)	Flow (Total Out) (cfs)	Hydraulic Grade Line (Out) (ft)	Headloss Method	Hydraulic Grade Line (In) (ft)
MH-14	2,143.32	2,143.32	2,137.42	14.70	2,138.92	HEC-22 Energy (Third Edition)	2,139.33
MH-13	2,148.19	2,148.19	2,141.79	14.70	2,143.29	HEC-22 Energy (Third Edition)	2,144.06

FlexTable: Outfall Table

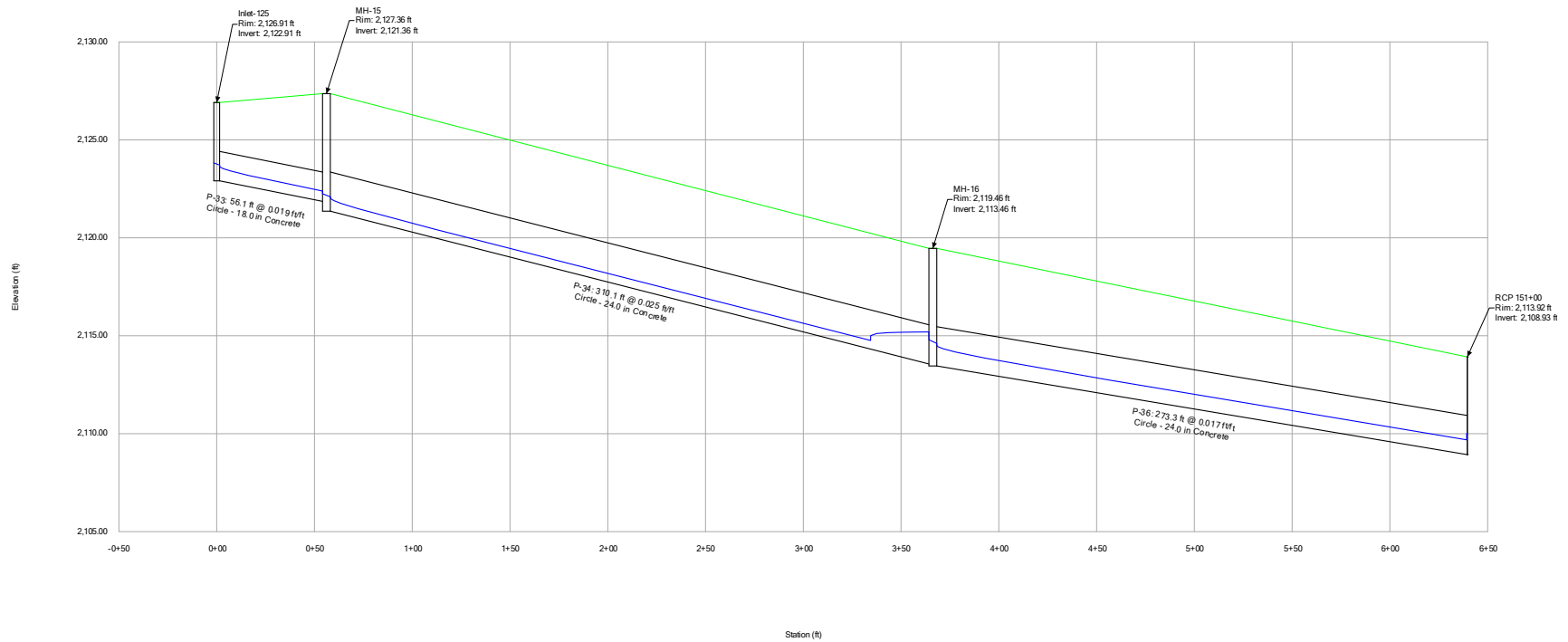
Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
CBC 161+75	2,143.07	2,136.75	User Defined Tailwater	2,137.69	2,137.71	14.70

Scenario: 10-yr



Profile Report

Engineering Profile - Profile - RCP 151+00 (Carefree.stsw)



FlexTable: Conduit Table

Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (Scaled) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Manning's n	Flow (cfs)	Velocity (ft/s)
P-33	Inlet-125	2,122.91	MH-15	2,121.86	56.1	0.019	18.0	0.013	3.80	6.86
P-34	MH-15	2,121.36	MH-16	2,113.56	310.1	0.025	24.0	0.013	3.80	7.43
P-35	Inlet-126	2,115.01	MH-16	2,113.96	25.2	0.042	18.0	0.013	4.90	9.83
P-36	MH-16	2,113.46	RCP 151+00	2,108.93	273.3	0.017	24.0	0.013	8.70	8.09

FlexTable: Catch Basin Table

ID	Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Flow (Additional Subsurface) (cfs)	Hydraulic Grade Line (In) (ft)
48	Inlet-126	2,119.01	2,119.01	2,115.01	4.90	2,116.13
49	Inlet-125	2,126.91	2,126.91	2,122.91	3.80	2,123.82

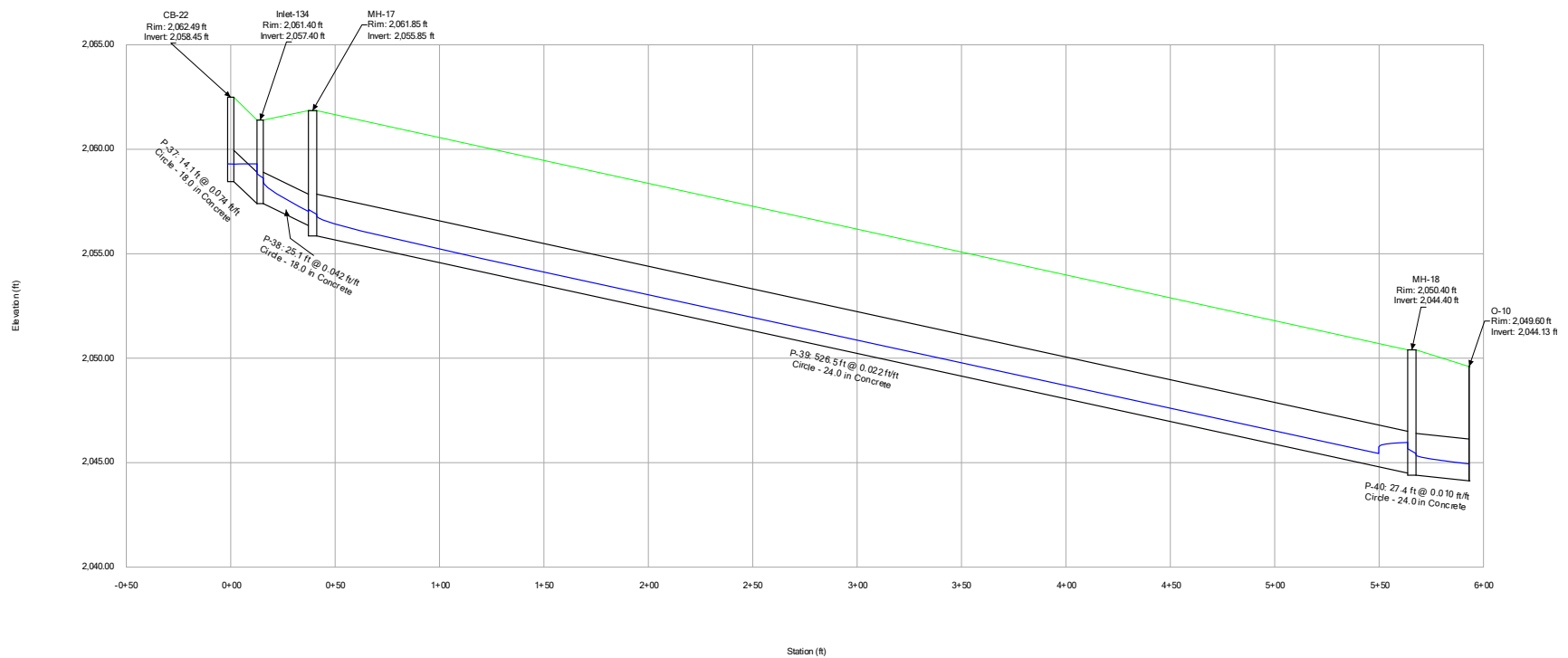
FlexTable: Manhole Table

Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert in 1) (ft)	Flow (Total Out) (cfs)	Hydraulic Grade Line (Out) (ft)	Headloss Method	Hydraulic Grade Line (In) (ft)
MH-16	2,119.46	2,119.46	2,113.56	8.70	2,114.61	HEC-22 Energy (Third Edition)	2,114.79
MH-15	2,127.36	2,127.36	2,121.86	3.80	2,122.09	HEC-22 Energy (Third Edition)	2,122.25

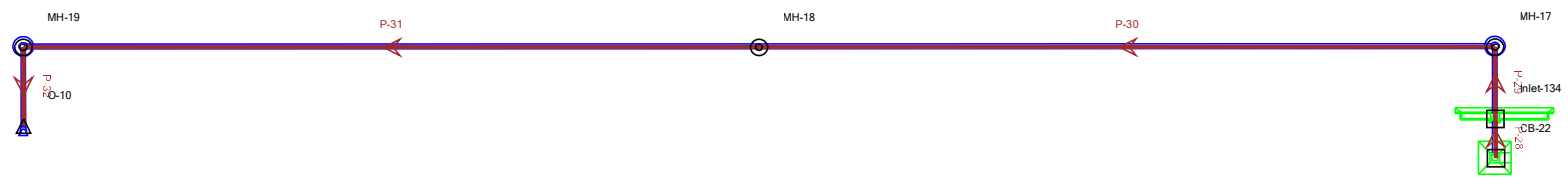
FlexTable: Outfall Table

Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
RCP 151+00	2,113.92	2,108.93	User Defined Tailwater	2,110.03	2,110.03	8.70

Profile Report **Engineering Profile - Profile - 122+10 to 127+23 (Carefree.stsw)**



Scenario: 10-yr



FlexTable: Conduit Table

Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (Scaled) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Manning's n	Flow (cfs)	Velocity (ft/s)
P-37	CB-22	2,058.45	Inlet-134	2,057.40	14.1	0.074	18.0	0.013	1.20	8.01
P-38	Inlet-134	2,057.40	MH-17	2,056.35	25.1	0.042	18.0	0.013	7.30	10.99
P-39	MH-17	2,055.85	MH-18	2,044.50	526.5	0.022	24.0	0.013	7.30	8.48
P-40	MH-18	2,044.40	O-10	2,044.13	27.4	0.010	24.0	0.013	7.30	6.38

FlexTable: Catch Basin Table

ID	Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Flow (Additional Subsurface) (cfs)	Hydraulic Grade Line (In) (ft)
50	Inlet-134	2,061.40	2,061.40	2,057.40	6.10	2,058.83
121	CB-22	2,062.49	2,062.49	2,058.45	1.20	2,059.30

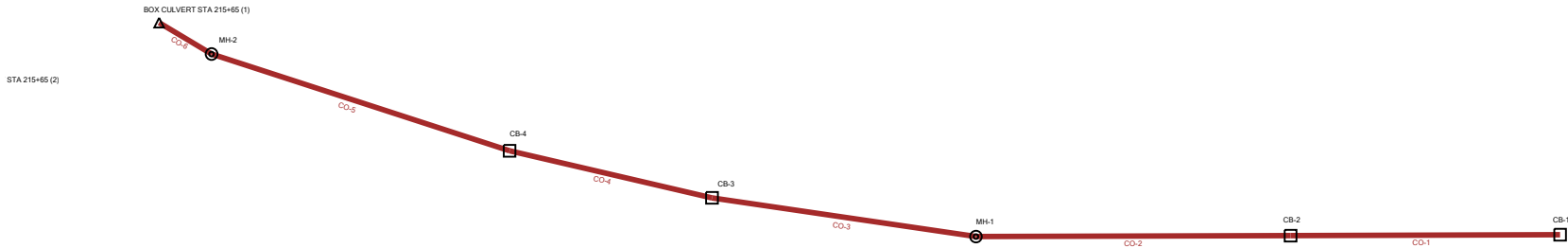
FlexTable: Manhole Table

Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert in 1) (ft)	Flow (Total Out) (cfs)	Hydraulic Grade Line (Out) (ft)	Headloss Method	Hydraulic Grade Line (In) (ft)
MH-18	2,050.40	2,050.40	2,044.50	7.30	2,045.43	HEC-22 Energy (Third Edition)	2,045.67
MH-17	2,061.85	2,061.85	2,056.35	7.30	2,056.88	HEC-22 Energy (Third Edition)	2,057.12

FlexTable: Outfall Table

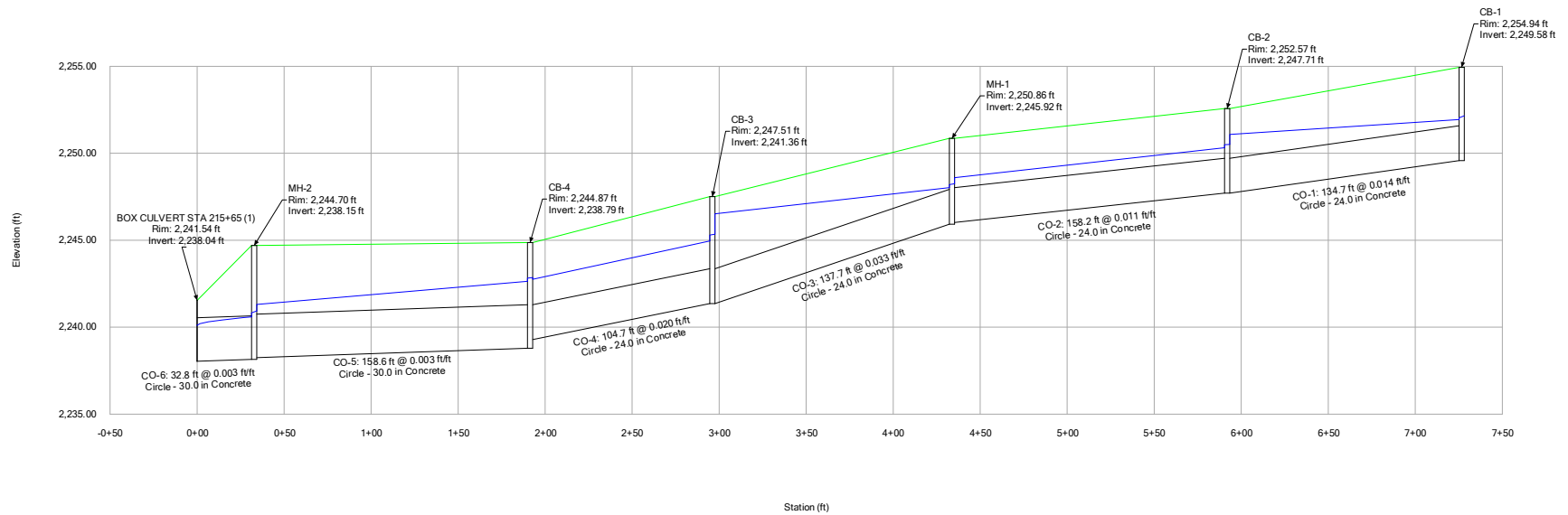
Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
O-10	2,049.60	2,044.13	Free Outfall		2,044.94	7.30

Scenario: 50-yr



Profile Report

Engineering Profile - East of Box 223+75 (OffsiteSD.stsw)



FlexTable: Conduit Table

Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (User Defined) (ft)	Length (Scaled) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Manning's n	Flow (cfs)	Velocity (ft/s)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)
CO-1	CB-1	2,249.58	CB-2	2,247.71	134.7	138.1	0.014	24.0	0.013	18.02	5.74	2,251.94	2,251.09
CO-2	CB-2	2,247.71	MH-1	2,246.02	158.2	161.2	0.011	24.0	0.013	23.62	7.52	2,250.32	2,248.60
CO-3	MH-1	2,245.92	CB-3	2,241.36	137.7	136.7	0.033	24.0	0.013	23.62	7.52	2,248.02	2,246.52
CO-4	CB-3	2,241.36	CB-4	2,239.29	104.7	106.5	0.020	24.0	0.013	32.83	10.45	2,244.96	2,242.75
CO-5	CB-4	2,238.79	MH-2	2,238.25	158.6	160.6	0.003	30.0	0.013	37.63	7.67	2,242.64	2,241.31
CO-6	MH-2	2,238.15	BOX CULVERT STA 215+65 (1)	2,238.04	32.8	31.3	0.003	30.0	0.013	37.63	7.67	2,240.60	2,240.12

FlexTable: Catch Basin Table

Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Headloss Method	Flow (Additional Subsurface) (cfs)	Hydraulic Grade Line (In) (ft)
CB-1	2,254.94	2,254.94	2,249.58	HEC-22 Energy (Third Edition)	18.02	2,252.16
CB-2	2,252.57	2,252.57	2,247.71	HEC-22 Energy (Third Edition)	5.60	2,250.51
CB-3	2,247.51	2,247.51	2,241.36	HEC-22 Energy (Third Edition)	9.21	2,245.35
CB-4	2,244.87	2,244.87	2,238.79	HEC-22 Energy (Third Edition)	4.80	2,242.86

FlexTable: Manhole Table

Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert in 1) (ft)	Flow (Total Out) (cfs)	Hydraulic Grade Line (Out) (ft)	Headloss Method	Hydraulic Grade Line (In) (ft)
MH-1	2,250.86	2,250.86	2,246.02	23.62	2,248.20	HEC-22 Energy (Third Edition)	2,248.25
MH-2	2,244.70	2,244.70	2,238.25	37.63	2,240.83	HEC-22 Energy (Third Edition)	2,240.93

FlexTable: Outfall Table

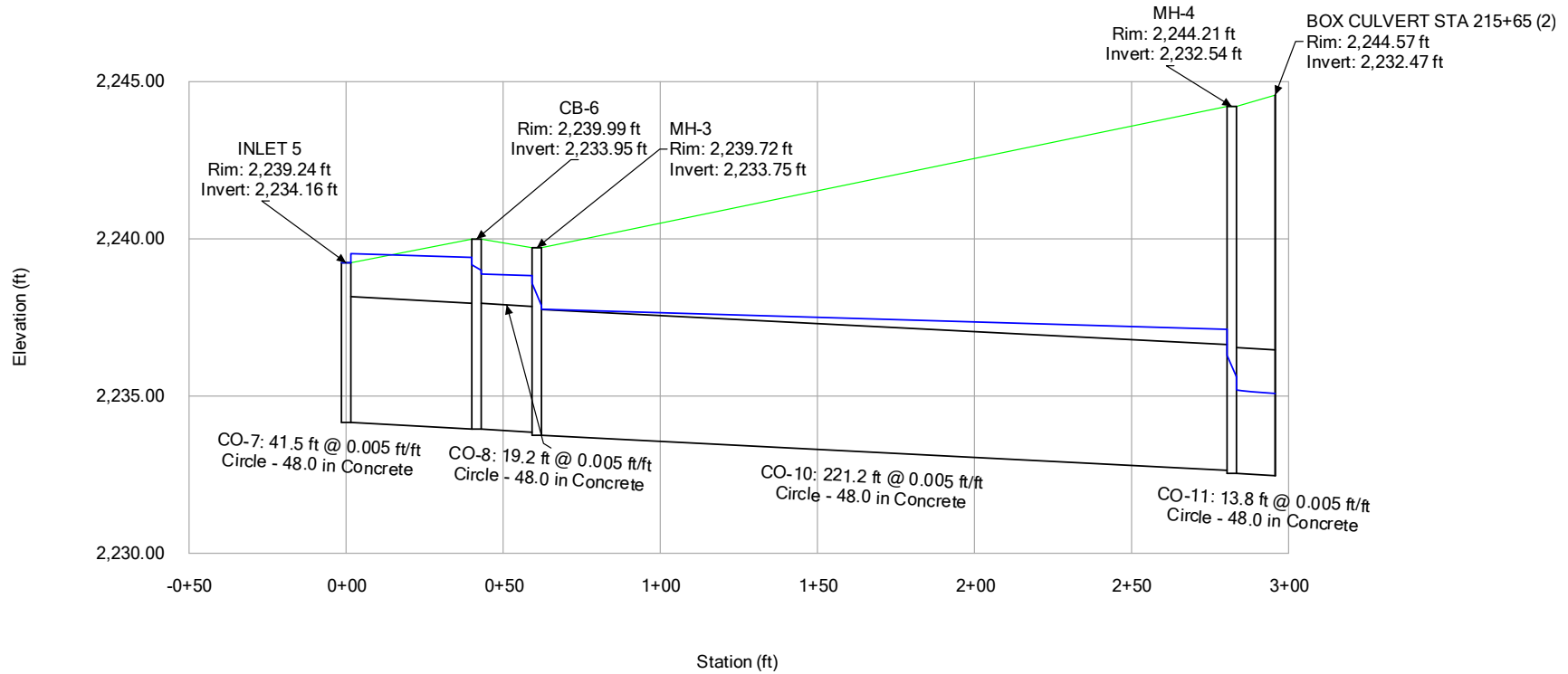
Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
BOX CULVERT STA 215+65 (1)	2,241.54	2,238.04	Free Outfall		2,240.12	37.63

Scenario: 50-yr

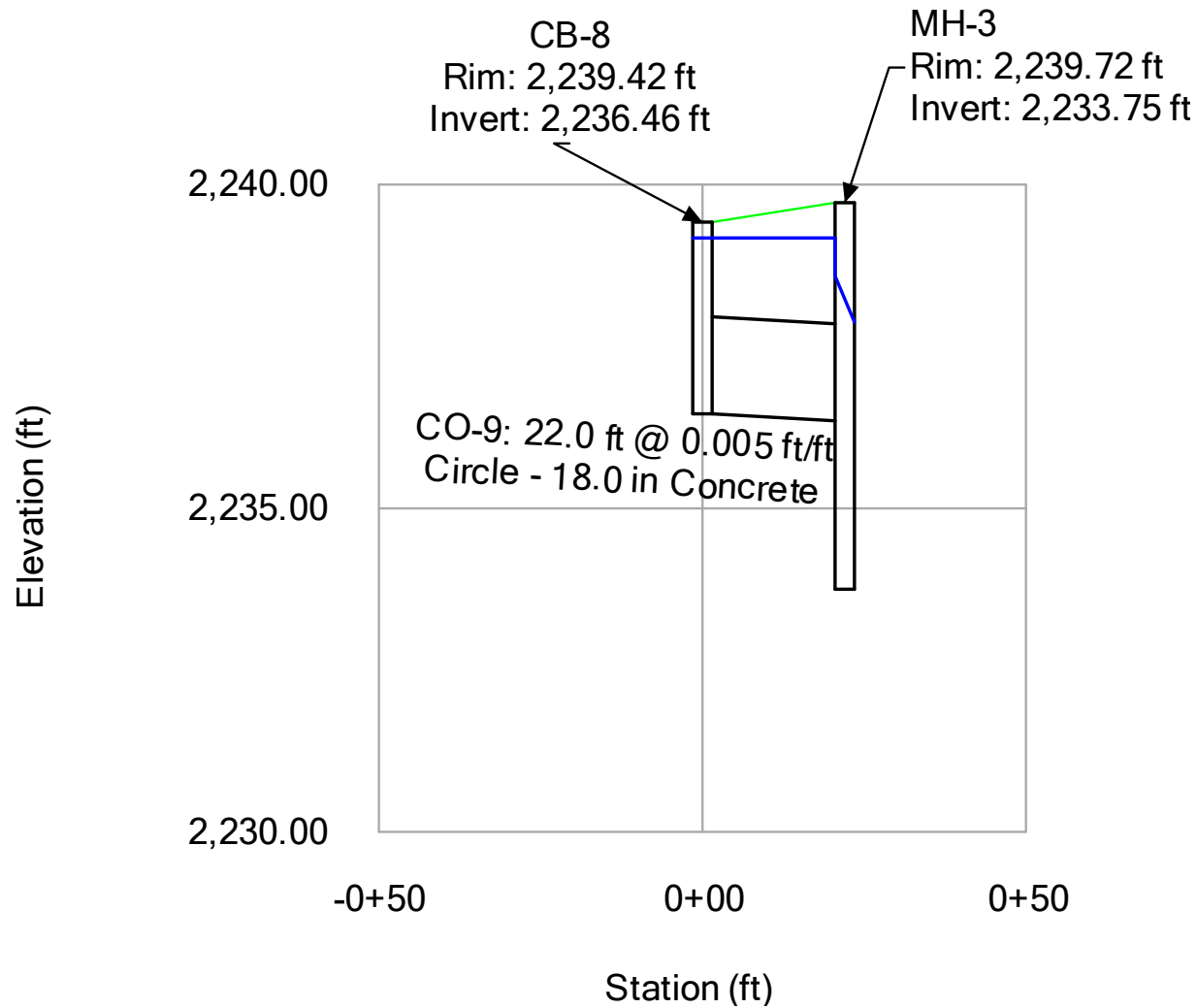


Profile Report

Engineering Profile - West of Box 213+00 Prof1 (OffsiteSD.stsw)



Profile Report
Engineering Profile - West of Box 213+00 Prof2 (OffsiteSD.stsw)



FlexTable: Conduit Table

Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (User Defined) (ft)	Length (Scaled) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Manning's n	Flow (cfs)	Velocity (ft/s)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)
CO-7	INLET 5	2,234.16	CB-6	2,233.95	41.5	44.7	0.005	48.0	0.013	154.77	6.16	2,239.53	2,239.41
CO-8	CB-6	2,233.95	MH-3	2,233.85	19.2	21.9	0.005	48.0	0.013	154.77	6.16	2,238.88	2,238.83
CO-9	CB-8	2,236.46	MH-3	2,236.35	22.0	25.6	0.005	18.0	0.013	0.00	0.00	2,239.18	2,239.18
CO-10	MH-3	2,233.75	MH-4	2,232.64	221.2	224.1	0.005	48.0	0.013	154.77	6.16	2,237.76	2,237.12
CO-11	MH-4	2,232.54	BOX CULVERT STA 215+65 (2)	2,232.47	13.8	15.4	0.005	48.0	0.013	154.77	8.95	2,235.20	2,235.08

FlexTable: Catch Basin Table

Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Headloss Method	Flow (Additional Subsurface) (cfs)	Hydraulic Grade Line (In) (ft)
CB-6	2,239.99	2,239.99	2,233.95	HEC-22 Energy (Third Edition)	0.00	2,239.17
CB-8	2,239.42	2,239.42	2,236.46	HEC-22 Energy (Third Edition)	0.00	2,239.18
INLET 5	2,239.24	2,239.24	2,234.16	HEC-22 Energy (Third Edition)	154.77	2,239.24

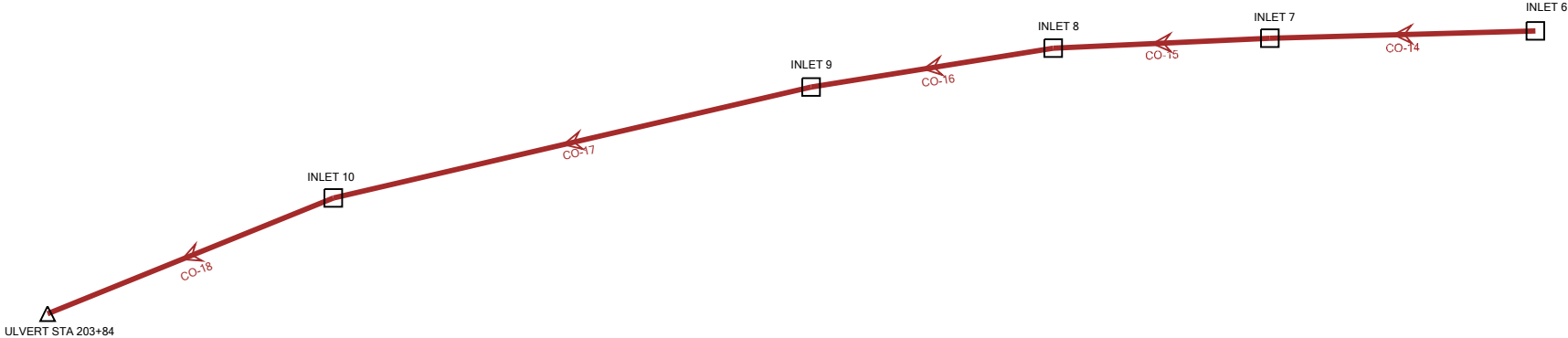
FlexTable: Manhole Table

Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert in 1) (ft)	Flow (Total Out) (cfs)	Hydraulic Grade Line (Out) (ft)	Headloss Method	Hydraulic Grade Line (In) (ft)
MH-3	2,239.72	2,239.72	2,233.85	154.77	2,237.88	HEC-22 Energy (Third Edition)	2,238.59
MH-4	2,244.21	2,244.21	2,232.64	154.77	2,235.61	HEC-22 Energy (Third Edition)	2,236.29

FlexTable: Outfall Table

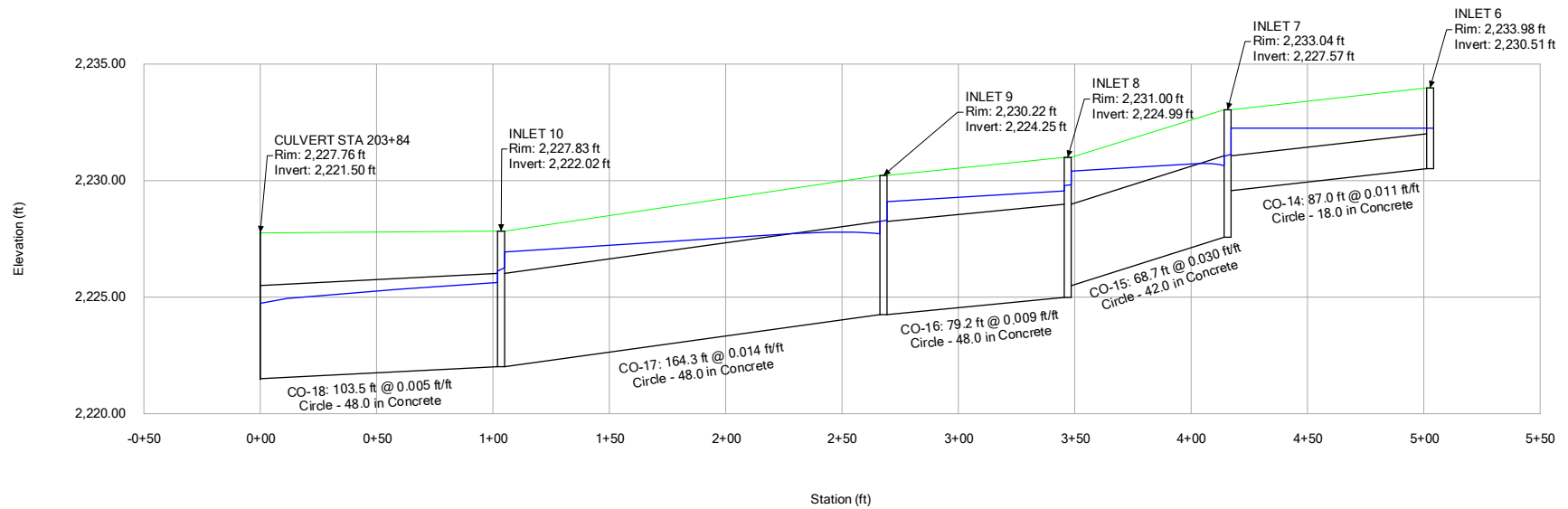
Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
BOX CULVERT STA 215+65 (2)	2,244.57	2,232.47	Free Outfall		2,235.08	154.77

Scenario: 50-yr



Profile Report

Engineering Profile - West of Box STA 204+00 (OffsiteSD.stsw)



FlexTable: Conduit Table

Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Length (User Defined) (ft)	Length (Scaled) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Manning's n	Flow (cfs)	Velocity (ft/s)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)
CO-14	INLET 6	2,230.51	INLET 7	2,229.57	87.0	90.1	0.011	18.0	0.013	0.40	0.23	2,232.25	2,232.25
CO-15	INLET 7	2,227.57	INLET 8	2,225.49	68.7	73.6	0.030	42.0	0.013	76.19	17.56	2,230.64	2,230.41
CO-16	INLET 8	2,224.99	INLET 9	2,224.25	79.2	83.2	0.009	48.0	0.013	108.99	8.67	2,229.56	2,229.10
CO-17	INLET 9	2,224.25	INLET 10	2,222.02	164.3	166.4	0.014	48.0	0.013	113.63	14.31	2,227.72	2,226.94
CO-18	INLET 10	2,222.02	CULVERT STA 203+84	2,221.50	103.5	104.6	0.005	48.0	0.013	114.85	9.14	2,225.63	2,224.73

FlexTable: Catch Basin Table

Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Headloss Method	Flow (Additional Subsurface) (cfs)	Hydraulic Grade Line (In) (ft)
INLET 6	2,233.98	2,233.98	2,230.51	HEC-22 Energy (Third Edition)	0.40	2,232.25
INLET 7	2,233.04	2,233.04	2,227.57	HEC-22 Energy (Third Edition)	75.79	2,231.13
INLET 8	2,231.00	2,231.00	2,224.99	HEC-22 Energy (Third Edition)	32.80	2,229.82
INLET 9	2,230.22	2,230.22	2,224.25	HEC-22 Energy (Third Edition)	4.64	2,228.31
INLET 10	2,227.83	2,227.83	2,222.02	HEC-22 Energy (Third Edition)	1.22	2,226.26

FlexTable: Outfall Table

Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
CULVERT STA 203+84	2,227.76	2,221.50	Free Outfall		2,224.73	114.85

C.3.2 Catch Basin Inlets

Project: Carefree Highway
Location: Town of Queen Creek, AZ
Date: June 7, 2024
Subject: Inlet Summary Calculations
 Source: Drainage Design Manual for Maricopa County, Arizona : Hydrology, 2013

Inlet (ID)	Road	Station	Offset (ft)	Contributing Subbasins	Inlet Type ¹	Detail	Inlet Opening Length (ft)	Slope (ft/ft)	Roadway Cross Slope [ft/ft]	Subbasin Flow (cfs)	Bypass Flow (cfs)	Total Flow (Including Bypass) (cfs)	Length (L _t) for total interception [ft]	Length (L _c) for Clogging Factor ⁵ [L _t *1.25]	Efficiency [%]	Captured Flow (cfs)	Bypass Flow (cfs)	Bypass To (Inlet ID)	Maximum Allowable Spread (ft)	Calculated Spread (ft)	Spread Acceptable? (Yes/No)
Inlet-101	Carefree WB	222+58	+41	DA-35	CB Type I (M-2)	MAG 542	23	0.0203	0.0200	2.1	-	2.1	32.0	40.0	0.79	1.7	0.46	Inlet-103	31.5	8.6	Yes
Inlet-102	Carefree EB	222+57	+53	DA-34	CB Type I (M-2)	MAG 542	23	0.0210	0.0200	2.8	-	2.8	36.3	45.4	0.72	2.0	0.79	Inlet-105	17.5	9.4	Yes
Inlet-103	Carefree WB	220+01	+39	DA-33	CB Type I (M-2)	MAG 542	23	0.0219	0.0200	1.3	0.46	1.7	30.0	37.5	0.82	1.4	0.31	Inlet-104	17.5	7.9	Yes
Inlet-104	Carefree WB	216+37	+39	DA-32	CB Type I (M-1)	MAG 542	20	0.0146	0.0200	1.6	0.3	1.9	27.6	34.5	0.79	1.5	0.40	Inlet-106	17.5	6.3	Yes
Inlet-105	Carefree EB	216+37	+8	DA-31	CB Type I (M-2)	MAG 542	37	0.0139	0.0200	3.3	0.8	4.1	37.5	46.8	0.94	3.8	0.24	Inlet-107	12.5	8.8	Yes
Inlet-106	Carefree WB	212+89	+8	DA-30	CB Type I (M-1)	MAG 542	20	0.0158	0.0200	1.4	0.4	1.8	27.8	34.8	0.79	1.4	0.39	Inlet-108	12.5	5.9	Yes
Inlet-107	Carefree EB	212+90	+39	DA-29	CB Type I (M-2)	MAG 542	23	0.0228	0.0200	1.8	0.2	2.1	32.7	40.9	0.77	1.6	0.47	Inlet-108	17.5	5.5	Yes
Inlet-108	Carefree EB/WB	209+92	+42	DA-28	CB Type I (M-2)	MAG 542	37	0.0175	0.0200	3.0	0.9	3.8	39.2	49.0	0.92	3.5	0.30	Inlet-109	23.5	8.0	Yes
Inlet-109	Carefree EB/WB	205+39	+42	DA-27	CB Type I (M-2)	MAG 542	37	0.0185	0.0200	4.7	0.3	5.0	44.7	55.9	0.86	4.3	0.72	Inlet-110	23.5	8.5	Yes
Inlet-110	Carefree EB/WB	202+07	+37	DA-26	CB Type I (M-2)	MAG 542	37	0.0201	0.0200	3.0	0.7	3.7	40.2	50.2	0.91	3.3	0.33	Inlet-112	17.5	10.7	Yes
Inlet-111	Carefree WB	198+61	+39	DA-25	OG Scupper	MAG 206	16	0.0247	0.0200	1.9	-	1.9	32.1	40.1	0.60	1.1	0.75	Inlet-113	17.5	5.5	Yes
Inlet-112	Carefree EB	198+24	+8	DA-24	CB Type I (M-2)	MAG 542	23	0.0223	0.0200	2.1	0.3	2.4	34.7	43.4	0.74	1.8	0.62	Inlet-114	12.5	6.3	Yes
Inlet-113	Carefree WB	194+91	+39	DA-23	CB Type I (M-2)	MAG 542	23	0.0145	0.0200	1.4	0.7	2.2	29.2	36.6	0.83	1.8	0.37	Inlet-115	17.5	10.6	Yes
Inlet-114	Carefree EB	194+91	+3	DA-22	CB Type I (M-2)	MAG 542	23	0.0152	0.0200	2.0	0.6	2.6	31.9	39.9	0.79	2.1	0.56	Inlet-116	23.5	14.5	Yes
Inlet-115	Carefree WB	190+64	+39	DA-21	OG Scupper	MAG 206	16	0.0130	0.0200	2.0	0.4	2.3	29.1	36.3	0.65	1.5	0.82	Inlet-117	17.5	9.1	Yes
Inlet-116	Carefree EB	190+59	+39	DA-20	OG Scupper	MAG 206	16	0.0130	0.0200	2.5	0.6	3.1	32.6	40.8	0.59	1.8	1.25	Inlet-118	17.5	10.0	Yes
Inlet-117	Carefree WB	186+95	+39	DA-19	OG Scupper	MAG 206	16	0.0207	0.0200	1.5	0.8	2.3	33.4	41.8	0.58	1.4	0.98	Inlet-119	17.5	8.6	Yes
Inlet-118	Carefree EB	186+37	+39	DA-18	OG Scupper	MAG 206	16	0.0197	0.0200	2.3	1.2	3.5	39.2	49.0	0.51	1.8	1.73	Inlet-120	17.5	10.1	Yes
Inlet-119	Carefree WB	180+59	+39	DA-17	OG Scupper	MAG 206	16	0.0222	0.0200	2.6	1.0	3.6	40.9	51.1	0.49	1.8	1.82	Inlet-121	17.5	10.9	Yes
Inlet-120	Carefree EB	177+84	+39	DA-16	CB Type I (M-2)	MAG 542	37	0.0176	0.0200	4.0	1.7	5.7	46.3	57.9	0.84	4.8	0.91	Inlet-122	17.5	13.9	Yes
Inlet-121	Carefree WB	175+13	+39	DA-15	OG Scupper	MAG 206	16	0.0180	0.0200	2.2	1.8	4.0	40.3	50.3	0.50	2.0	2.02	Inlet-124	17.5	9.9	Yes
Inlet-122	Carefree EB	168+58	+38	DA-14	OG Scupper	MAG 206	16	0.0227	0.0200	5.0	0.9	5.9	50.8	63.5	0.41	2.4	3.50	Inlet-123	17.5	11.5	Yes
Inlet-123	Carefree EB	164+69	+39	DA-13	CB Type I (M-2)	MAG 542	37	0.0361	0.0200	2.0	3.5	5.5	56.8	71.0	0.73	4.1	1.47	Inlet-126	17.5	11.2	Yes
Inlet-124	Carefree WB	164+51	+39	DA-12	CB Type I (M-2)	MAG 542	37	0.0269	0.0200	4.1	2.0	6.1	54.1	67.7	0.76	4.6	1.47	Inlet-125	17.5	11.7	Yes
Inlet-125	Carefree WB	156+96	+39	DA-10	CB Type I (M-2)	MAG 542	37	0.0274	0.0200	3.2	1.5	4.7	48.8	61.0	0.81	3.8	0.88	Inlet-127	17.5	11.2	Yes
Inlet-126	Carefree EB	153+86	+39	DA-11	CB Type I (M-2)	MAG 542	37	0.0263	0.0200	5.2	1.5	6.6	55.7	69.7	0.74	4.9	1.70	Inlet-128	17.5	12.0	Yes
Inlet-127	Carefree WB	149+32	+38	DA-09	OG Scupper	MAG 206	16	0.0237	0.0200	3.1	0.9	4.0	43.6	54.5	0.46	1.9	2.13	Inlet-129	17.5	10.2	Yes
Inlet-128	Carefree EB	146+05	+39	DA-08	OG Scupper	MAG 206	16	0.0216	0.0200	4.5	1.7	6.2	51.0	63.7	0.41	2.5	3.67	Inlet-130	17.5	14.1	Yes
Inlet-129	Carefree WB	143+66	+39	DA-07	OG Scupper	MAG 206	16	0.0153	0.0200	2.1	2.1	4.2	39.1	48.9	0.51	2.1	2.06	Inlet-131	17.5	13.0	Yes
Inlet-130	Carefree EB	140+92	+38	DA-06	OG Scupper	MAG 206	16	0.0172	0.0200	2.7	3.7	6.4	48.3	60.4	0.43	2.7	3.67	Inlet-132	17.5	11.3	Yes
Inlet-131	Carefree WB	137+93	+39	DA-05	OG Scupper	MAG 206	16	0.0298	0.0200	2.3	2.1	4.4	48.6	60.7	0.42	1.8	2.52	Inlet-133	17.5	10.3	Yes
Inlet-132	Carefree EB	135+75	+38	DA-04	OG Scupper	MAG 206	16	0.0285	0.0200	3.1	3.7	6.8	57.6	71.9	0.36	2.5	4.30	Inlet-134	17.5	13.1	Yes
Inlet-133	Carefree WB	133+17	+39	DA-03	OG Scupper	MAG 206	16	0.0207	0.0200	1.9	2.5	4.4	43.8	54.8	0.46	2.1	2.39	---	17.5	10.9	Yes
Inlet-134	Carefree EB	127+23	+39	DA-02	CB Type I (M-2)	MAG 542	37	0.0212	0.0200	4.2	4.3	8.5	57.9	72.4	0.72	6.1	2.33	Inlet-135	17.5	13.5	Yes
Inlet-135	Carefree EB	119+38	+39	DA-01	OG Scupper	MAG 206	16	0.0214	0.0200	4.4	2.3	6.7	52.8	66.0	0.39	2.7	4.09	---	17.5	12.7	Yes

- Notes:**
 1) Effective opening for curb inlets is 80% for on Grade and 50% for Sump.
 2) Captured flow calculations were performed using Bentley Flowmaster V8i.
 3) Scupper openings are 3 (4-foot) per MAG STD DET 206
 4) Spread and gutter velocity calculated using Bentley FlowMaster program.
 5) Inlet Clogging Factor adjusts Length for total interception (Lt) by x1.25 per Pinal County Drainage Manual; Table 6.8

C.3.3 Area Drains

Project: Carefree Highway - Cave Creek Rd to Scottsdale Rd
Location: Scottsdale, AZ
Date: 5/29/2024
Subject: Grated Inlet Design Summary

Project Number: 3010.0100309.000
Project Engineer: M. Jacobsen
Checker: L. Vick

Inlet ID	Station	Contributing Subbasins	Detail	Depth of Flow	Discharge at Inlet Q ₅₀	# of Grates Required	Efficiency	Intercepted Flow	Bypass Flow
				(ft)	(cfs)		%	(cfs)	(cfs)
OFFSITE INLET 1	223+75	OFF-2A (OFFSITE INLETS)	MAG 537	1.20	21.47	2	83.94	18.02	3.45
OFFSITE INLET 2	222+37	OFF-2B (OFFSITE INLETS)	MAG 537	0.80	6.42	1	87.25	5.60	0.82
OFFSITE INLET 3	219+30	OFF-2C (OFFSITE INLETS)	MAG 537	1.10	10.16	1	90.66	9.21	0.95
OFFSITE INLET 4	218+19	OFF-2D (OFFSITE INLETS)	MAG 537	0.70	5.01	1	95.81	4.80	0.21
OFFSITE INLET 5	212+76	OFF-3B	ADOT SD 6.35	-	154.77	-	-	-	-
OFFSITE INLET 6	209+17	OFF-3D0 (OFFSITE INLETS)	MAG 537	0.30	0.40	1	100.00	0.40	0.00
OFFSITE INLET 7	208+31	OFF-3D1 (OFFSITE INLETS)	MAG 537	2.10	87.88	4	86.24	75.79	12.09
OFFSITE INLET 8	207+60	OFF-3D2 (OFFSITE INLETS)	MAG 537	1.50	36.39	3	90.15	32.81	3.58
OFFSITE INLET 9	206+80	OFF-3D3 (OFFSITE INLETS)	MAG 537	0.70	4.72	1	98.26	4.64	0.08
OFFSITE INLET 10	205+20	OFF-3D4 (OFFSITE INLETS)	MAG 537	0.60	1.22	1	100.00	1.22	0.00

Source: Drainage Design Manual for Maricopa County Volume II: Hydraulics, December 14, 2018

Notes: Grated catch basin calculations performed in FlowMaster.

C.3.4 Inlet Spacing & Roadway Spread

Spread - 119+50 - south half street (DA-01)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.02153
Discharge	6.70

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	1.10
0+00.50	1.10
0+00.58	0.60
0+02.00	0.57
0+29.00	0.03
0+30.42	0.00
0+30.50	0.50
0+31.00	0.50

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 1.10)	(0+31.00, 0.50)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	3.0
Elevation Range	0.00 to 1.10 ft
Flow Area	1.6
Wetted Perimeter	12.91
Hydraulic Radius	1.5
Top Width	12.69
Normal Depth	3.0
Critical Depth	4.1
Critical Slope	0.00455
Velocity	4.17
Velocity Head	0.27
Specific Energy	0.52
Froude Number	2.069
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0
------------------	-----

Spread - 119+50 - south half street (DA-01)

GVF Input Data	
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	3.0
Critical Depth	4.1
Channel Slope	0.02153
Critical Slope	0.00455

Spread - 127+50 - south half street (DA-02)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.02527
Discharge	8.50

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	1.10
0+00.50	1.10
0+00.58	0.60
0+02.00	0.57
0+29.00	0.03
0+30.42	0.00
0+30.50	0.50
0+31.00	0.50
0+39.01	0.62
0+41.01	0.65

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 1.10)	(0+39.01, 0.62)	0.013
(0+39.01, 0.62)	(0+41.01, 0.65)	0.030

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	3.2
Elevation Range	0.00 to 1.10 ft
Flow Area	1.8
Wetted Perimeter	13.71
Hydraulic Radius	1.6
Top Width	13.48
Normal Depth	3.2
Critical Depth	4.5
Critical Slope	0.00441
Velocity	4.70
Velocity Head	0.34
Specific Energy	0.61
Froude Number	2.265
Flow Type	Supercritical

Spread - 127+50 - south half street (DA-02)

GVF Input Data	
Downstream Depth	0.0
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	3.2
Critical Depth	4.5
Channel Slope	0.02527
Critical Slope	0.00441

Spread - 133+50 - north half street (DA-03)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.02057
Discharge	4.40

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.50
0+00.58	0.00
0+02.00	0.03
0+29.00	0.57
0+30.42	0.60
0+30.50	1.10
0+31.00	1.10

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 0.50)	(0+31.00, 1.10)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	2.6
Elevation Range	0.00 to 1.10 ft
Flow Area	1.2
Wetted Perimeter	11.11
Hydraulic Radius	1.3
Top Width	10.92
Normal Depth	2.6
Critical Depth	3.4
Critical Slope	0.00482
Velocity	3.70
Velocity Head	0.21
Specific Energy	0.43
Froude Number	1.979
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0
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Spread - 133+50 - north half street (DA-03)

GVF Input Data	
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.6
Critical Depth	3.4
Channel Slope	0.02057
Critical Slope	0.00482

Spread - 136+00 - south half street (DA-04)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.01860
Discharge	6.80

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	1.32
0+00.50	1.32
0+00.58	0.82
0+02.00	0.79
0+40.00	0.03
0+41.42	0.00
0+41.50	0.50
0+42.00	0.50
0+48.01	0.64
0+56.01	0.82
0+58.01	0.86

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 1.32)	(0+42.00, 0.50)	0.013
(0+42.00, 0.50)	(0+48.01, 0.64)	0.030
(0+48.01, 0.64)	(0+56.01, 0.82)	0.013
(0+56.01, 0.82)	(0+58.01, 0.86)	0.030

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	3.1
Elevation Range	0.00 to 1.32 ft
Flow Area	1.7
Wetted Perimeter	13.31
Hydraulic Radius	1.5
Top Width	13.09
Normal Depth	3.1
Critical Depth	4.1
Critical Slope	0.00454
Velocity	3.98
Velocity Head	0.25
Specific Energy	0.51

Spread - 136+00 - south half street (DA-04)

Results	
Froude Number	1.940
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	3.1
Critical Depth	4.1
Channel Slope	0.01860
Critical Slope	0.00454

Spread - 138+25 - north half street (DA-05)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.02795
Discharge	4.40

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.50
0+00.58	0.00
0+02.00	0.03
0+29.00	0.57
0+30.46	0.60
0+30.50	1.10
0+31.00	1.10

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 0.50)	(0+31.00, 1.10)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	2.5
Elevation Range	0.00 to 1.10 ft
Flow Area	1.1
Wetted Perimeter	10.50
Hydraulic Radius	1.2
Top Width	10.32
Normal Depth	2.5
Critical Depth	3.4
Critical Slope	0.00482
Velocity	4.15
Velocity Head	0.27
Specific Energy	0.47
Froude Number	2.280
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0
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Spread - 138+25 - north half street (DA-05)

GVF Input Data	
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.5
Critical Depth	3.4
Channel Slope	0.02795
Critical Slope	0.00482

Spread - 141+00 - south half street (DA-06)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.03590
Discharge	6.40

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	1.10
0+00.50	1.10
0+00.58	0.60
0+02.00	0.57
0+29.00	0.03
0+30.42	0.00
0+30.50	0.50
0+31.00	0.50
0+39.01	0.62
0+41.01	0.65

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 1.10)	(0+39.01, 0.62)	0.013
(0+39.01, 0.62)	(0+41.01, 0.65)	0.030

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	2.7
Elevation Range	0.00 to 1.10 ft
Flow Area	1.3
Wetted Perimeter	11.53
Hydraulic Radius	1.3
Top Width	11.33
Normal Depth	2.7
Critical Depth	4.0
Critical Slope	0.00458
Velocity	5.00
Velocity Head	0.39
Specific Energy	0.61
Froude Number	2.624
Flow Type	Supercritical

Spread - 141+00 - south half street (DA-06)

GVF Input Data

Downstream Depth	0.0
Length	0.00
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.7
Critical Depth	4.0
Channel Slope	0.03590
Critical Slope	0.00458

Spread - 143+75 - north half street (DA-07)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.00750
Discharge	4.20

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.50
0+00.58	0.00
0+02.00	0.03
0+29.00	0.57
0+30.42	0.60
0+30.50	1.10
0+31.00	1.10

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 0.50)	(0+31.00, 1.10)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	3.1
Elevation Range	0.00 to 1.10 ft
Flow Area	1.7
Wetted Perimeter	13.20
Hydraulic Radius	1.5
Top Width	12.98
Normal Depth	3.1
Critical Depth	3.4
Critical Slope	0.00485
Velocity	2.50
Velocity Head	0.10
Specific Energy	0.36
Froude Number	1.227
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0
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Spread - 143+75 - north half street (DA-07)

GVF Input Data	
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	3.1
Critical Depth	3.4
Channel Slope	0.00750
Critical Slope	0.00485

Spread - 146+00 - south half street (DA-08)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.01051
Discharge	6.20

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	1.32
0+00.50	1.32
0+00.58	0.82
0+02.00	0.79
0+40.09	0.03
0+41.50	0.00
0+41.59	0.50
0+42.09	0.50
0+48.10	0.64
0+56.10	0.82
0+58.10	0.86

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 1.32)	(0+42.09, 0.50)	0.013
(0+42.09, 0.50)	(0+48.10, 0.64)	0.030
(0+48.10, 0.64)	(0+56.10, 0.82)	0.013
(0+56.10, 0.82)	(0+58.10, 0.86)	0.030

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	3.4
Elevation Range	0.00 to 1.32 ft
Flow Area	2.0
Wetted Perimeter	14.33
Hydraulic Radius	1.7
Top Width	14.09
Normal Depth	3.4
Critical Depth	3.9
Critical Slope	0.00460
Velocity	3.13
Velocity Head	0.15
Specific Energy	0.43

Spread - 146+00 - south half street (DA-08)

Results	
Froude Number	1.473
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	3.4
Critical Depth	3.9
Channel Slope	0.01051
Critical Slope	0.00460

Spread - 149+50 - north half street (DA-09)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.02428
Discharge	4.00

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.50
0+00.58	0.00
0+02.00	0.03
0+29.00	0.57
0+30.42	0.60
0+30.50	1.10
0+31.00	1.10

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 0.50)	(0+31.00, 1.10)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	2.4
Elevation Range	0.00 to 1.10 ft
Flow Area	1.0
Wetted Perimeter	10.40
Hydraulic Radius	1.2
Top Width	10.22
Normal Depth	2.4
Critical Depth	3.3
Critical Slope	0.00488
Velocity	3.84
Velocity Head	0.23
Specific Energy	0.43
Froude Number	2.122
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0
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Spread - 149+50 - north half street (DA-09)

GVF Input Data	
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.4
Critical Depth	3.3
Channel Slope	0.02428
Critical Slope	0.00488

Spread - 154+00 - south half street (DA-11)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.02026
Discharge	4.70

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	1.10
0+00.50	1.10
0+00.58	0.60
0+02.00	0.57
0+29.00	0.03
0+30.42	0.00
0+30.50	0.50
0+31.00	0.50
0+39.00	0.62
0+41.00	0.65

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 1.10)	(0+39.00, 0.62)	0.013
(0+39.00, 0.62)	(0+41.00, 0.65)	0.030

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	2.7
Elevation Range	0.00 to 1.10 ft
Flow Area	1.3
Wetted Perimeter	11.43
Hydraulic Radius	1.3
Top Width	11.24
Normal Depth	2.7
Critical Depth	3.5
Critical Slope	0.00477
Velocity	3.73
Velocity Head	0.22
Specific Energy	0.44
Froude Number	1.964
Flow Type	Supercritical

Spread - 154+00 - south half street (DA-11)

GVF Input Data

Downstream Depth	0.0
Length	0.00
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.7
Critical Depth	3.5
Channel Slope	0.02026
Critical Slope	0.00477

Spread - 157+25 - north half street (DA-10)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.02846
Discharge	6.60

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.50
0+00.58	0.00
0+02.00	0.03
0+29.00	0.57
0+30.42	0.60
0+30.50	1.10
0+31.00	1.10

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 0.50)	(0+31.00, 1.10)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	2.9
Elevation Range	0.00 to 1.10 ft
Flow Area	1.4
Wetted Perimeter	12.18
Hydraulic Radius	1.4
Top Width	11.97
Normal Depth	2.9
Critical Depth	4.0
Critical Slope	0.00456
Velocity	4.62
Velocity Head	0.33
Specific Energy	0.57
Froude Number	2.359
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0
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Spread - 157+25 - north half street (DA-10)

GVF Input Data	
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.9
Critical Depth	4.0
Channel Slope	0.02846
Critical Slope	0.00456

Spread - 164+75 - north half street (DA-12)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.02772
Discharge	6.10

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.50
0+00.58	0.00
0+02.00	0.03
0+40.00	0.79
0+41.42	0.82
0+41.50	1.32
0+42.00	1.32

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 0.50)	(0+42.00, 1.32)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	2.8
Elevation Range	0.00 to 1.32 ft
Flow Area	1.4
Wetted Perimeter	11.87
Hydraulic Radius	1.4
Top Width	11.67
Normal Depth	2.8
Critical Depth	3.9
Critical Slope	0.00461
Velocity	4.49
Velocity Head	0.31
Specific Energy	0.55
Froude Number	2.323
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0
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Spread - 164+75 - north half street (DA-12)

GVF Input Data	
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.8
Critical Depth	3.9
Channel Slope	0.02772
Critical Slope	0.00461

Spread - 164+75 - south half street (DA-13)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.02772
Discharge	5.50

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	1.10
0+00.50	1.10
0+00.58	0.60
0+02.00	0.57
0+29.00	0.03
0+30.42	0.00
0+30.50	0.50
0+31.00	0.50
0+39.00	0.62
0+41.00	0.65

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 1.10)	(0+39.00, 0.62)	0.013
(0+39.00, 0.62)	(0+41.00, 0.65)	0.030

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	2.7
Elevation Range	0.00 to 1.10 ft
Flow Area	1.3
Wetted Perimeter	11.44
Hydraulic Radius	1.3
Top Width	11.24
Normal Depth	2.7
Critical Depth	3.7
Critical Slope	0.00468
Velocity	4.37
Velocity Head	0.30
Specific Energy	0.52
Froude Number	2.299
Flow Type	Supercritical

Spread - 164+75 - south half street (DA-13)

GVF Input Data	
Downstream Depth	0.0
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.7
Critical Depth	3.7
Channel Slope	0.02772
Critical Slope	0.00468

Spread - 168+75 - south half street (DA-14)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.02802
Discharge	5.90

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	1.10
0+00.50	1.10
0+00.58	0.60
0+02.00	0.57
0+29.00	0.03
0+30.42	0.00
0+30.50	0.50
0+31.00	0.50
0+39.19	0.62
0+41.19	0.65

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 1.10)	(0+39.19, 0.62)	0.013
(0+39.19, 0.62)	(0+41.19, 0.65)	0.030

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	2.7
Elevation Range	0.00 to 1.10 ft
Flow Area	1.3
Wetted Perimeter	11.71
Hydraulic Radius	1.4
Top Width	11.51
Normal Depth	2.7
Critical Depth	3.9
Critical Slope	0.00463
Velocity	4.47
Velocity Head	0.31
Specific Energy	0.54
Froude Number	2.325
Flow Type	Supercritical

Spread - 168+75 - south half street (DA-14)

GVF Input Data	
Downstream Depth	0.0
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.7
Critical Depth	3.9
Channel Slope	0.02802
Critical Slope	0.00463

Spread - 175+25 - north half street (DA-15)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.02910
Discharge	4.00

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.50
0+00.58	0.00
0+02.00	0.03
0+29.00	0.57
0+30.42	0.60
0+30.50	1.10
0+31.00	1.10

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 0.50)	(0+31.00, 1.10)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	2.4
Elevation Range	0.00 to 1.10 ft
Flow Area	1.0
Wetted Perimeter	10.05
Hydraulic Radius	1.2
Top Width	9.89
Normal Depth	2.4
Critical Depth	3.3
Critical Slope	0.00488
Velocity	4.11
Velocity Head	0.26
Specific Energy	0.46
Froude Number	2.308
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0
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Spread - 175+25 - north half street (DA-15)

GVF Input Data	
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.4
Critical Depth	3.3
Channel Slope	0.02910
Critical Slope	0.00488

Spread - 178+00 - south half street (DA-16)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.00940
Discharge	5.70

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	1.10
0+00.50	1.10
0+00.58	0.60
0+02.00	0.57
0+29.00	0.03
0+30.42	0.00
0+30.50	0.50
0+31.00	0.50
0+39.00	0.62
0+41.00	0.65

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 1.10)	(0+39.00, 0.62)	0.013
(0+39.00, 0.62)	(0+41.00, 0.65)	0.030

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	3.3
Elevation Range	0.00 to 1.10 ft
Flow Area	1.9
Wetted Perimeter	14.17
Hydraulic Radius	1.6
Top Width	13.94
Normal Depth	3.3
Critical Depth	3.8
Critical Slope	0.00465
Velocity	2.95
Velocity Head	0.13
Specific Energy	0.41
Froude Number	1.393
Flow Type	Supercritical

Spread - 178+00 - south half street (DA-16)

GVF Input Data

Downstream Depth	0.0
Length	0.00
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	3.3
Critical Depth	3.8
Channel Slope	0.00940
Critical Slope	0.00465

Spread - 180+75 - north half street (DA-17)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.01377
Discharge	3.60

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.50
0+00.58	0.00
0+02.00	0.03
0+29.00	0.57
0+30.42	0.60
0+30.50	1.10
0+31.00	1.10

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 0.50)	(0+31.00, 1.10)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	2.6
Elevation Range	0.00 to 1.10 ft
Flow Area	1.2
Wetted Perimeter	11.11
Hydraulic Radius	1.3
Top Width	10.92
Normal Depth	2.6
Critical Depth	3.2
Critical Slope	0.00495
Velocity	3.03
Velocity Head	0.14
Specific Energy	0.36
Froude Number	1.619
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0
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Spread - 180+75 - north half street (DA-17)

GVF Input Data	
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.6
Critical Depth	3.2
Channel Slope	0.01377
Critical Slope	0.00495

Spread - 186+50 - south half street (DA-18)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.01996
Discharge	3.50

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	1.10
0+00.50	1.10
0+00.58	0.60
0+02.00	0.57
0+29.00	0.03
0+30.42	0.00
0+30.50	0.50
0+31.00	0.50
0+39.00	0.62
0+41.00	0.65

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 1.10)	(0+39.00, 0.62)	0.013
(0+39.00, 0.62)	(0+41.00, 0.65)	0.030

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	2.4
Elevation Range	0.00 to 1.10 ft
Flow Area	1.0
Wetted Perimeter	10.26
Hydraulic Radius	1.2
Top Width	10.09
Normal Depth	2.4
Critical Depth	3.1
Critical Slope	0.00497
Velocity	3.45
Velocity Head	0.19
Specific Energy	0.39
Froude Number	1.919
Flow Type	Supercritical

Spread - 186+50 - south half street (DA-18)

GVF Input Data	
Downstream Depth	0.0
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.4
Critical Depth	3.1
Channel Slope	0.01996
Critical Slope	0.00497

Spread - 187+25 - north half street (DA-19)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.01996
Discharge	2.30

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.50
0+00.58	0.00
0+02.00	0.03
0+29.00	0.57
0+30.42	0.60
0+30.50	1.10
0+31.00	1.10

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 0.50)	(0+31.00, 1.10)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	2.1
Elevation Range	0.00 to 1.10 ft
Flow Area	0.7
Wetted Perimeter	8.77
Hydraulic Radius	1.0
Top Width	8.62
Normal Depth	2.1
Critical Depth	2.6
Critical Slope	0.00525
Velocity	3.11
Velocity Head	0.15
Specific Energy	0.32
Froude Number	1.870
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0
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Spread - 187+25 - north half street (DA-19)

GVF Input Data	
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.1
Critical Depth	2.6
Channel Slope	0.01996
Critical Slope	0.00525

Spread - 190+75 - north half street (DA-21)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.01522
Discharge	2.30

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.50
0+00.58	0.00
0+02.00	0.03
0+29.00	0.57
0+30.42	0.60
0+30.50	1.10
0+31.00	1.10

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 0.50)	(0+31.00, 1.10)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	2.2
Elevation Range	0.00 to 1.10 ft
Flow Area	0.8
Wetted Perimeter	9.22
Hydraulic Radius	1.1
Top Width	9.07
Normal Depth	2.2
Critical Depth	2.6
Critical Slope	0.00525
Velocity	2.81
Velocity Head	0.12
Specific Energy	0.30
Froude Number	1.648
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0
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Spread - 190+75 - north half street (DA-21)

GVF Input Data	
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.2
Critical Depth	2.6
Channel Slope	0.01522
Critical Slope	0.00525

Spread - 190+75 - south half street (DA-20)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.01615
Discharge	3.10

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	1.10
0+00.50	1.10
0+00.58	0.60
0+02.00	0.57
0+29.00	0.03
0+30.42	0.00
0+30.50	0.50
0+31.00	0.50
0+37.01	0.59
0+45.01	0.71
0+47.01	0.74

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 1.10)	(0+45.01, 0.71)	0.013
(0+45.01, 0.71)	(0+47.01, 0.74)	0.030

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	2.4
Elevation Range	0.00 to 1.10 ft
Flow Area	1.0
Wetted Perimeter	10.20
Hydraulic Radius	1.2
Top Width	10.03
Normal Depth	2.4
Critical Depth	3.0
Critical Slope	0.00505
Velocity	3.09
Velocity Head	0.15
Specific Energy	0.35
Froude Number	1.725
Flow Type	Supercritical

Spread - 190+75 - south half street (DA-20)

Results

GVF Input Data

Downstream Depth	0.0
Length	0.00
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.4
Critical Depth	3.0
Channel Slope	0.01615
Critical Slope	0.00505

Spread - 195+00 - north half street (DA-23)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.00599
Discharge	2.20

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.50
0+00.58	0.00
0+02.00	0.03
0+29.00	0.57
0+30.42	0.60
0+30.50	1.10
0+31.00	1.10

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 0.50)	(0+31.00, 1.10)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	2.5
Elevation Range	0.00 to 1.10 ft
Flow Area	1.1
Wetted Perimeter	10.80
Hydraulic Radius	1.2
Top Width	10.62
Normal Depth	2.5
Critical Depth	2.6
Critical Slope	0.00528
Velocity	1.96
Velocity Head	0.06
Specific Energy	0.27
Froude Number	1.061
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0
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Spread - 195+00 - north half street (DA-23)

GVF Input Data	
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.5
Critical Depth	2.6
Channel Slope	0.00599
Critical Slope	0.00528

Spread - 195+00 - south half street (DA-22)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.01095
Discharge	2.60

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.50
0+00.58	0.00
0+02.00	0.02
0+40.00	0.44
0+41.42	0.45
0+41.50	0.95
0+42.00	0.95
0+50.01	1.07
0+52.01	1.10

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 0.50)	(0+50.01, 1.07)	0.013
(0+50.01, 1.07)	(0+52.01, 1.10)	0.030

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	1.9
Elevation Range	0.00 to 1.10 ft
Flow Area	1.2
Wetted Perimeter	14.68
Hydraulic Radius	1.0
Top Width	14.54
Normal Depth	1.9
Critical Depth	2.2
Critical Slope	0.00553
Velocity	2.22
Velocity Head	0.08
Specific Energy	0.24
Froude Number	1.377
Flow Type	Supercritical

Spread - 195+00 - south half street (DA-22)

GVF Input Data	
Downstream Depth	0.0
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	1.9
Critical Depth	2.2
Channel Slope	0.01095
Critical Slope	0.00553

Spread - 198+50 - south half street (DA-24)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.02567
Discharge	2.40

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	1.07
0+00.50	1.07
0+00.58	0.00
0+02.00	0.05
0+29.00	0.89
0+30.42	0.94
0+30.50	1.44
0+31.00	1.44
0+37.01	1.53
0+45.01	1.65
0+47.01	1.68

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 1.07)	(0+45.01, 1.65)	0.013
(0+45.01, 1.65)	(0+47.01, 1.68)	0.030

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	2.4
Elevation Range	0.00 to 1.68 ft
Flow Area	0.6
Wetted Perimeter	6.50
Hydraulic Radius	1.2
Top Width	6.31
Normal Depth	2.4
Critical Depth	3.2
Critical Slope	0.00500
Velocity	3.85
Velocity Head	0.23
Specific Energy	0.43
Froude Number	2.155
Flow Type	Supercritical

Spread - 198+50 - south half street (DA-24)

Results

GVF Input Data

Downstream Depth	0.0
Length	0.00
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.4
Critical Depth	3.2
Channel Slope	0.02567
Critical Slope	0.00500

Spread - 198+75 - north half street (DA-25)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.02625
Discharge	1.90

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.50
0+00.58	0.00
0+02.00	0.05
0+29.00	0.97
0+30.42	1.00
0+30.50	1.50
0+31.00	1.50

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 0.50)	(0+31.00, 1.50)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	2.2
Elevation Range	0.00 to 1.50 ft
Flow Area	0.5
Wetted Perimeter	5.65
Hydraulic Radius	1.1
Top Width	5.49
Normal Depth	2.2
Critical Depth	3.0
Critical Slope	0.00510
Velocity	3.73
Velocity Head	0.22
Specific Energy	0.40
Froude Number	2.162
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0
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Spread - 198+75 - north half street (DA-25)

GVF Input Data	
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.2
Critical Depth	3.0
Channel Slope	0.02625
Critical Slope	0.00510

Spread - 202+25 - south half street (DA-26)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.02071
Discharge	3.70

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.68
0+35.07	0.03
0+36.49	0.00
0+36.57	0.50
0+37.07	0.50
0+45.08	0.62
0+47.08	0.65

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 0.68)	(0+45.08, 0.62)	0.013
(0+45.08, 0.62)	(0+47.08, 0.65)	0.030

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	2.4
Elevation Range	0.00 to 0.68 ft
Flow Area	1.1
Wetted Perimeter	10.87
Hydraulic Radius	1.2
Top Width	10.70
Normal Depth	2.4
Critical Depth	3.1
Critical Slope	0.00497
Velocity	3.49
Velocity Head	0.19
Specific Energy	0.39
Froude Number	1.957
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0
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Spread - 202+25 - south half street (DA-26)

GVF Input Data	
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.4
Critical Depth	3.1
Channel Slope	0.02071
Critical Slope	0.00497

Spread - 205+75 - whole street (DA-27)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.01518
Discharge	5.00

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	2.90
0+00.50	2.90
0+00.58	2.40
0+02.00	2.35
0+29.00	1.38
0+36.00	1.31
0+43.00	1.24
0+76.00	0.05
0+77.42	0.00
0+77.50	0.50
0+78.00	0.50
0+81.00	0.55
0+89.00	0.67
0+91.00	0.70

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 2.90)	(0+89.00, 0.67)	0.013
(0+89.00, 0.67)	(0+91.00, 0.70)	0.030

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	3.6
Elevation Range	0.00 to 2.90 ft
Flow Area	1.3
Wetted Perimeter	8.71
Hydraulic Radius	1.8
Top Width	8.45
Normal Depth	3.6
Critical Depth	4.6
Critical Slope	0.00446
Velocity	3.92
Velocity Head	0.24

Spread - 205+75 - whole street (DA-27)

Results	
Specific Energy	0.54
Froude Number	1.775
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	3.6
Critical Depth	4.6
Channel Slope	0.01518
Critical Slope	0.00446

Spread - 210+25 -whole street (DA-28)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.01150
Discharge	3.80

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	2.90
0+00.50	2.90
0+00.58	2.40
0+02.00	2.35
0+29.00	1.38
0+36.00	1.31
0+43.00	1.24
0+76.00	0.05
0+77.42	0.00
0+77.50	0.50
0+78.00	0.50
0+83.00	0.60
0+91.00	0.72

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 2.90)	(0+83.00, 0.60)	0.013
(0+83.00, 0.60)	(0+91.00, 0.72)	0.030

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	3.4
Elevation Range	0.00 to 2.90 ft
Flow Area	1.2
Wetted Perimeter	8.28
Hydraulic Radius	1.7
Top Width	8.03
Normal Depth	3.4
Critical Depth	4.1
Critical Slope	0.00463
Velocity	3.29
Velocity Head	0.17
Specific Energy	0.46

Spread - 210+25 -whole street (DA-28)

Results	
Froude Number	1.532
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	3.4
Critical Depth	4.1
Channel Slope	0.01150
Critical Slope	0.00463

Spread - 213+00 - north half street (DA-30)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.01645
Discharge	1.80

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	1.50
0+00.50	1.50
0+00.58	1.00
0+02.00	0.95
0+29.00	0.05
0+30.42	0.00
0+30.50	0.50
0+31.00	0.50

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 1.50)	(0+31.00, 0.50)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	2.4
Elevation Range	0.00 to 1.50 ft
Flow Area	0.6
Wetted Perimeter	6.12
Hydraulic Radius	1.2
Top Width	5.94
Normal Depth	2.4
Critical Depth	3.0
Critical Slope	0.00515
Velocity	3.07
Velocity Head	0.15
Specific Energy	0.35
Froude Number	1.724
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0
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Spread - 213+00 - north half street (DA-30)

GVF Input Data	
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.4
Critical Depth	3.0
Channel Slope	0.01645
Critical Slope	0.00515

Spread - 213+00 - south half street (DA-29)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.02650
Discharge	2.10

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	1.55
0+00.50	1.55
0+00.58	1.05
0+02.00	1.03
0+29.00	0.05
0+30.42	0.00
0+30.50	0.50
0+31.00	0.50
0+37.01	0.59
0+45.01	0.71
0+47.01	0.74

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 1.55)	(0+45.01, 0.71)	0.013
(0+45.01, 0.71)	(0+47.01, 0.74)	0.030

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	2.4
Elevation Range	0.00 to 1.55 ft
Flow Area	0.5
Wetted Perimeter	5.66
Hydraulic Radius	1.1
Top Width	5.48
Normal Depth	2.4
Critical Depth	3.3
Critical Slope	0.00501
Velocity	3.89
Velocity Head	0.23
Specific Energy	0.43
Froude Number	2.184
Flow Type	Supercritical

Spread - 213+00 - south half street (DA-29)

Results

GVF Input Data

Downstream Depth	0.0
Length	0.00
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.4
Critical Depth	3.3
Channel Slope	0.02650
Critical Slope	0.00501

Spread - 216+50 - north half street (DA-32)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.01104
Discharge	1.90

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.49
0+00.50	0.49
0+00.58	0.00
0+02.00	0.04
0+29.00	1.01
0+30.42	1.04
0+30.50	1.54
0+31.00	1.54

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 0.49)	(0+31.00, 1.54)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	2.5
Elevation Range	0.00 to 1.54 ft
Flow Area	0.7
Wetted Perimeter	6.47
Hydraulic Radius	1.3
Top Width	6.29
Normal Depth	2.5
Critical Depth	3.0
Critical Slope	0.00507
Velocity	2.72
Velocity Head	0.12
Specific Energy	0.33
Froude Number	1.440
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0
------------------	-----

Spread - 216+50 - north half street (DA-32)

GVF Input Data	
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.5
Critical Depth	3.0
Channel Slope	0.01104
Critical Slope	0.00507

Spread - 216+50 - south half street (DA-31)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.01060
Discharge	4.10

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.50
0+00.58	0.00
0+02.00	0.05
0+29.00	0.95
0+30.42	1.00
0+30.50	1.50
0+31.00	1.50
0+36.91	1.58
0+44.91	1.70
0+46.91	1.73

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 0.50)	(0+44.91, 1.70)	0.013
(0+44.91, 1.70)	(0+46.91, 1.73)	0.030

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	3.5
Elevation Range	0.00 to 1.73 ft
Flow Area	1.3
Wetted Perimeter	9.04
Hydraulic Radius	1.7
Top Width	8.79
Normal Depth	3.5
Critical Depth	4.1
Critical Slope	0.00461
Velocity	3.20
Velocity Head	0.16
Specific Energy	0.45
Froude Number	1.478
Flow Type	Supercritical

Spread - 216+50 - south half street (DA-31)

Results

GVF Input Data

Downstream Depth	0.0
Length	0.00
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	3.5
Critical Depth	4.1
Channel Slope	0.01060
Critical Slope	0.00461

Spread - 220+25 - north half street (DA-33)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.01708
Discharge	1.70

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.50
0+00.58	0.00
0+02.00	0.03
0+42.67	0.84
0+44.08	0.87
0+44.17	1.37
0+44.67	1.37

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 0.50)	(0+44.67, 1.37)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	1.9
Elevation Range	0.00 to 1.37 ft
Flow Area	0.6
Wetted Perimeter	8.05
Hydraulic Radius	0.9
Top Width	7.91
Normal Depth	1.9
Critical Depth	2.3
Critical Slope	0.00547
Velocity	2.72
Velocity Head	0.12
Specific Energy	0.27
Froude Number	1.708
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0
------------------	-----

Spread - 220+25 - north half street (DA-33)

GVF Input Data	
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	1.9
Critical Depth	2.3
Channel Slope	0.01708
Critical Slope	0.00547

Spread - 222+75 - north half street (DA-35)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.01708
Discharge	2.10

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	0.50
0+00.50	0.50
0+00.58	0.00
0+02.00	0.03
0+42.67	0.84
0+44.08	0.87
0+44.17	1.37
0+44.67	1.37

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 0.50)	(0+44.67, 1.37)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	2.0
Elevation Range	0.00 to 1.37 ft
Flow Area	0.7
Wetted Perimeter	8.71
Hydraulic Radius	1.0
Top Width	8.57
Normal Depth	2.0
Critical Depth	2.6
Critical Slope	0.00532
Velocity	2.87
Velocity Head	0.13
Specific Energy	0.30
Froude Number	1.731
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0
------------------	-----

Spread - 222+75 - north half street (DA-35)

GVF Input Data	
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.0
Critical Depth	2.6
Channel Slope	0.01708
Critical Slope	0.00532

Spread - 222+75 - south half street (DA-34)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.01998
Discharge	2.80

Section Definitions

Station (ft)	Elevation (ft)
0+00.00	1.38
0+00.50	1.38
0+00.58	0.88
0+02.00	0.85
0+43.00	0.03
0+44.42	0.00
0+44.50	0.50
0+45.00	0.50
0+46.00	0.40

Roughness Segment Definitions

Start Station & Elevation	End Station & Elevation	Roughness Coefficient
(0+00.00, 1.38)	(0+45.00, 0.50)	0.013
(0+45.00, 0.50)	(0+46.00, 0.40)	0.030

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	2.2
Elevation Range	0.00 to 1.38 ft
Flow Area	0.9
Wetted Perimeter	9.44
Hydraulic Radius	1.1
Top Width	9.28
Normal Depth	2.2
Critical Depth	2.9
Critical Slope	0.00512
Velocity	3.27
Velocity Head	0.17
Specific Energy	0.35
Froude Number	1.894
Flow Type	Supercritical

Spread - 222+75 - south half street (DA-34)

GVF Input Data	
Downstream Depth	0.0
Length	0.00
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	2.2
Critical Depth	2.9
Channel Slope	0.01998
Critical Slope	0.00512

APPENDIX D

Erosion Protection Measures

Flood Control District of Maricopa County
 Drainage Design Management System
 RIVER MECHANICS - RIPRAP
 Project Reference: CAREFREE HWY

6/28/2024

Page 1

ID	Type	Section ID	Design Q (cfs)	Slope (ft/ft)	Width (ft)	Average Velocity (ft/s)	Specific Weight Stone (lb/cu ft)	Specific Weight Water (lb/cu ft)	Specific Bank Slope (H:V)	Safety Factor	D50 (ft)	Thickness (ft)
130+00	Downstream of Grade Control/Drop Structure		-	-	-	5.38	150.00	62.43		1.00	0.77	0.00
139+50	Downstream of Grade Control/Drop Structure		-	-	-	11.79	150.00	62.43		1.00	3.69	0.00
143+50	Downstream of Grade Control/Drop Structure		-	-	-	15.56	150.00	62.43		1.00	6.42	0.00
151+00	Downstream of Grade Control/Drop Structure		-	-	-	7.63	150.00	62.43		1.00	1.54	0.00
161+75	Downstream of Grade Control/Drop Structure		-	-	-	15.82	150.00	62.43		1.00	6.64	0.00
168+50	Downstream of Grade Control/Drop Structure		-	-	-	12.42	150.00	62.43		1.00	4.09	0.00
171+75	Downstream of Grade Control/Drop Structure		-	-	-	9.82	150.00	62.43		1.00	2.56	0.00
174+06	Downstream of Grade Control/Drop Structure		-	-	-	5.89	150.00	62.43		1.00	0.92	0.00
177+60	Downstream of Grade Control/Drop Structure		-	-	-	10.25	150.00	62.43		1.00	2.79	0.00
180+15	Downstream of Grade Control/Drop Structure		-	-	-	9.18	150.00	62.43		1.00	2.23	0.00
183+00	Downstream of Grade Control/Drop Structure		-	-	-	4.79	150.00	62.43		1.00	0.61	0.00
186+32	Downstream of Grade Control/Drop Structure		-	-	-	12.82	150.00	62.43		1.00	4.36	0.00
192+10	Downstream of Grade Control/Drop Structure		-	-	-	13.24	150.00	62.43		1.00	4.65	0.00
195+35	Downstream of Grade Control/Drop Structure		-	-	-	8.50	150.00	62.43		1.00	1.92	0.00
203+84	Downstream of Grade Control/Drop Structure		-	-	-	15.63	150.00	62.43		1.00	6.48	0.00
215+65	Downstream of Grade Control/Drop Structure		-	-	-	19.98	150.00	62.43		1.00	10.59	0.00

Project: Carefree Highway
Location: Town of Queen Creek, AZ
Date: June 28, 2024
Subject: Lateral Erosion

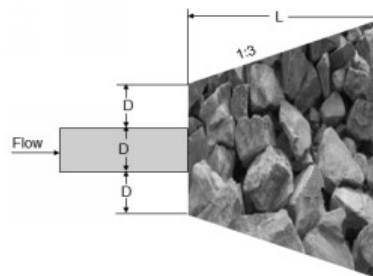
Culvert ID	Station	Type	Material	Dimensions	Discharge [cfs]	Inlet Depth ¹ [ft]	Outlet Depth ¹ [ft]	Outlet Velocity ¹ [fps]	Tailwater Chn'l Velocity [fps]	Calculated ² Rock D ₅₀ [ft]	Design Rock D ₅₀ [inches]	Apron Thickness [ft]	Apron Width [ft]	Apron Length [ft]
Culvert-1	130+00	Arch	concrete	28.5"x18"	15	2.18	1.50	5.38	2.97	0.77	9	1.8	7.1	12.5
Culvert-2	139+50	Pipe	concrete	3-24"	65	3.19	1.13	11.79	4.62	3.69				
Culvert-3	143+50	Box	concrete	4-10'x4'	1138	5.10	1.83	15.56	8.74	6.42				
Culvert-4	151+00	Pipe	concrete	24"	9.2	1.61	0.82	7.63	3.05	1.54	18	3.0	6.0	14.0
Culvert-5	161+75	Box	concrete	5-10'x4'	1792	6.32	4.00	15.82	11.70	6.64				
Culvert-6	168+50	Pipe	concrete	24"	13	1.99	0.73	12.42	4.13	4.09				
Culvert-7	171+75	Pipe	concrete	36"	51	4.07	2.07	9.82	6.72	2.56				
Culvert-8	174+06	Pipe	concrete	24"	2.8	0.79	0.42	5.89	1.68	0.92	12	2.2	6.0	12.0
Culvert-9	177+60	Box	concrete	2-8'x4'	389	4.51	2.37	10.25	7.94	2.79				
Culvert-10	180+15	Pipe	concrete	42"	72	4.57	2.66	9.18	4.60	2.23				
Culvert-11	183+00	Pipe	concrete	24"	6.8	1.45	0.92	4.79	2.71	0.61	9	1.8	6.0	10.0
Culvert-12	186+32	Pipe	concrete	24"	24	3.61	1.15	12.82	4.72	4.36				
Culvert-13	192+10	Pipe	concrete	30"	38	4.01	1.42	13.24	4.70	4.65				
Culvert-14	195+35	Box	concrete	1-8'x3'	148	3.85	2.18	8.50	4.81	1.92	24	4.0	12.0	16.0
Culvert-15	203+84	Box	concrete	1-8'x4'	283	6.23	2.26	15.63	7.79	6.48				
Culvert-16	215+65	Box	concrete	5-10'x6'	2362	6.99	2.36	19.98	9.19	10.59				

- Notes: 1) Culvert output from HY-8 models
2) Calculations from FCDMC's DDMSW-River Mechanics - Riprap
3) Riprap Apron Dimensions from FCDMC Manual, Volume II, Chapter 8

TABLE 8.6
APRON LENGTH AND THICKNESS
(USDOT, 2006)

d_{50} (in)	Apron Length (L, ft)	Apron Thickness (ft)
5	4D	$3.5 d_{50}$
6	4D	$3.3 d_{50}$
10	5D	$2.4 d_{50}$
14	6D	$2.2 d_{50}$
20	7D	$2.0 d_{50}$
22	8D	$2.0 d_{50}$

FIGURE 8.21
RIPRAP APRON PLAN VIEW



Project: Carefree Highway
Location: Town of Queen Creek, AZ
Date: June 28, 2024
Subject: Lateral Erosion

Lateral Erosion - State Standard Level 1

HEC-RAS River Station	Q (cfs)	Setback ⁽¹⁾ (ft)
1.6442	2467	50
1.6113	2467	50
1.5812	2622	51
1.5549	2622	51
1.5234	2822	53
1.4675	2779	53
1.4233	2779	53
1.3724	2779	53
1.3235	2854	53
1.2701	2274	48
1.2175	2274	48
1.1824	2764	53
0.9888	2849	53
0.9593	2849	53

References: *Arizona Department of Water Resources, State
Standard for Watercourse System Sediment
Balance 5-96, September 1996*

Notes: 1) $\text{Setback} = 1.0(Q_{100})^{0.5}$

Project: Carefree Highway
Location: Town of Queen Creek, AZ
Date: June 28, 2024
Subject: Lateral Erosion

Total Scour - DDMSW

HEC-RAS River Station	Long Term Scour (ft)	General Scour (ft)	Bedform Scour (ft)	Low Flow Scour (ft)	Total Scour (ft)	Max Scour (ft)	Average Scour (ft)
1.6442	2.82	1.43	1.22	1.95	7.42	8.11	7.33
1.6113	2.82	1.43	1.04	1.95	7.24		
1.5812	2.93	1.46	1.77	1.95	8.11		
1.5549	2.93	1.46	1.03	1.95	7.37		
1.5234	3.06	1.5	1.07	1.95	7.58		
1.4675	3.03	1.48	0.9	1.95	7.36		
1.4233	3.03	1.48	1.12	1.95	7.58		
1.3724	3.03	1.48	0.69	1.95	7.15		
1.3235	3.08	1.5	0.7	1.95	7.23		
1.2701	2.69	1.39	0.69	1.95	6.72		
1.2175	2.69	1.39	0.91	1.95	6.94		
1.1824	3.02	1.48	0.85	1.95	7.3		

APPENDIX E

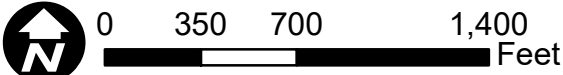
Exhibits

Legend

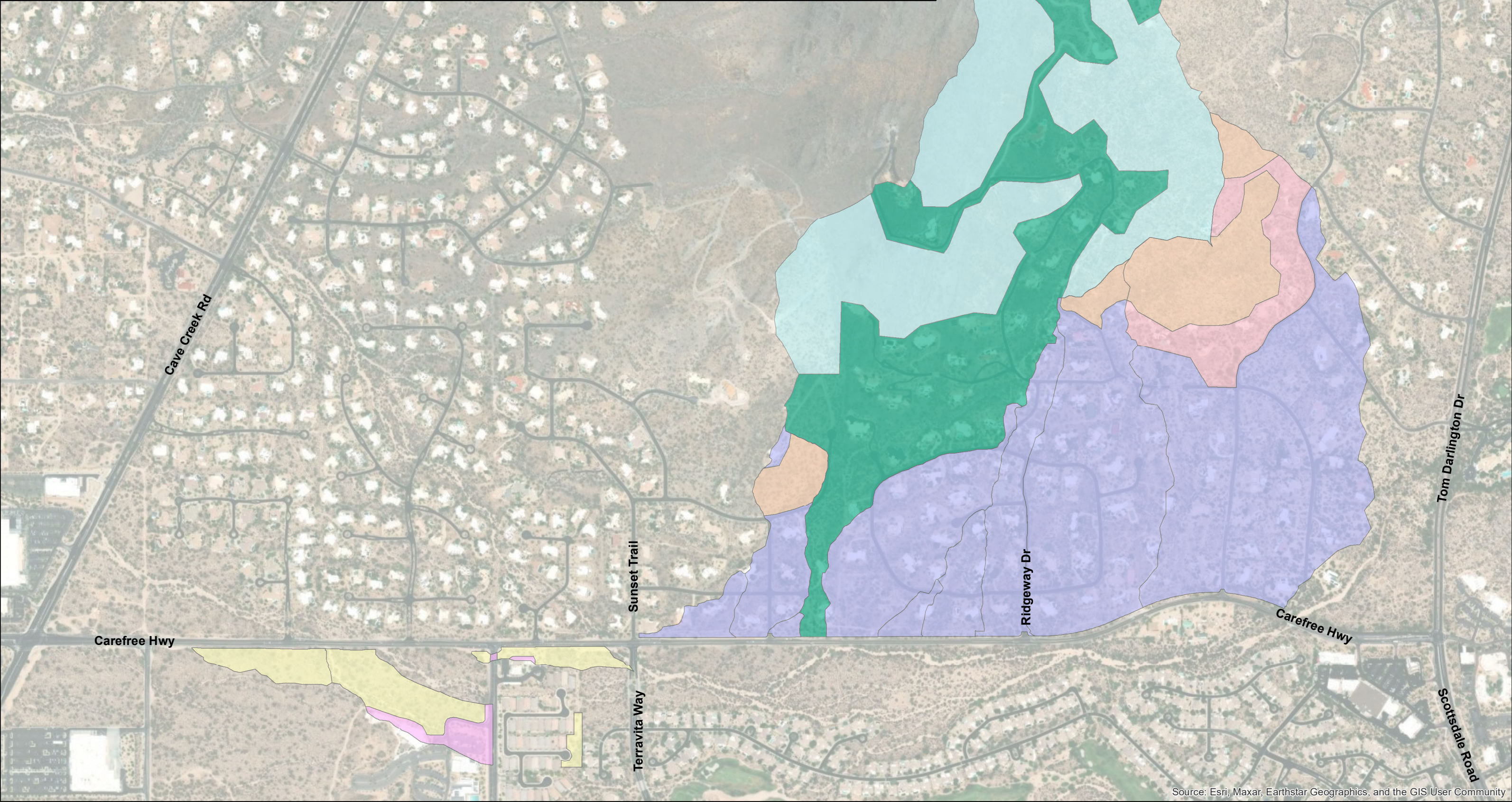
- Estate Residential (VLDR)
-
- Natural Desert

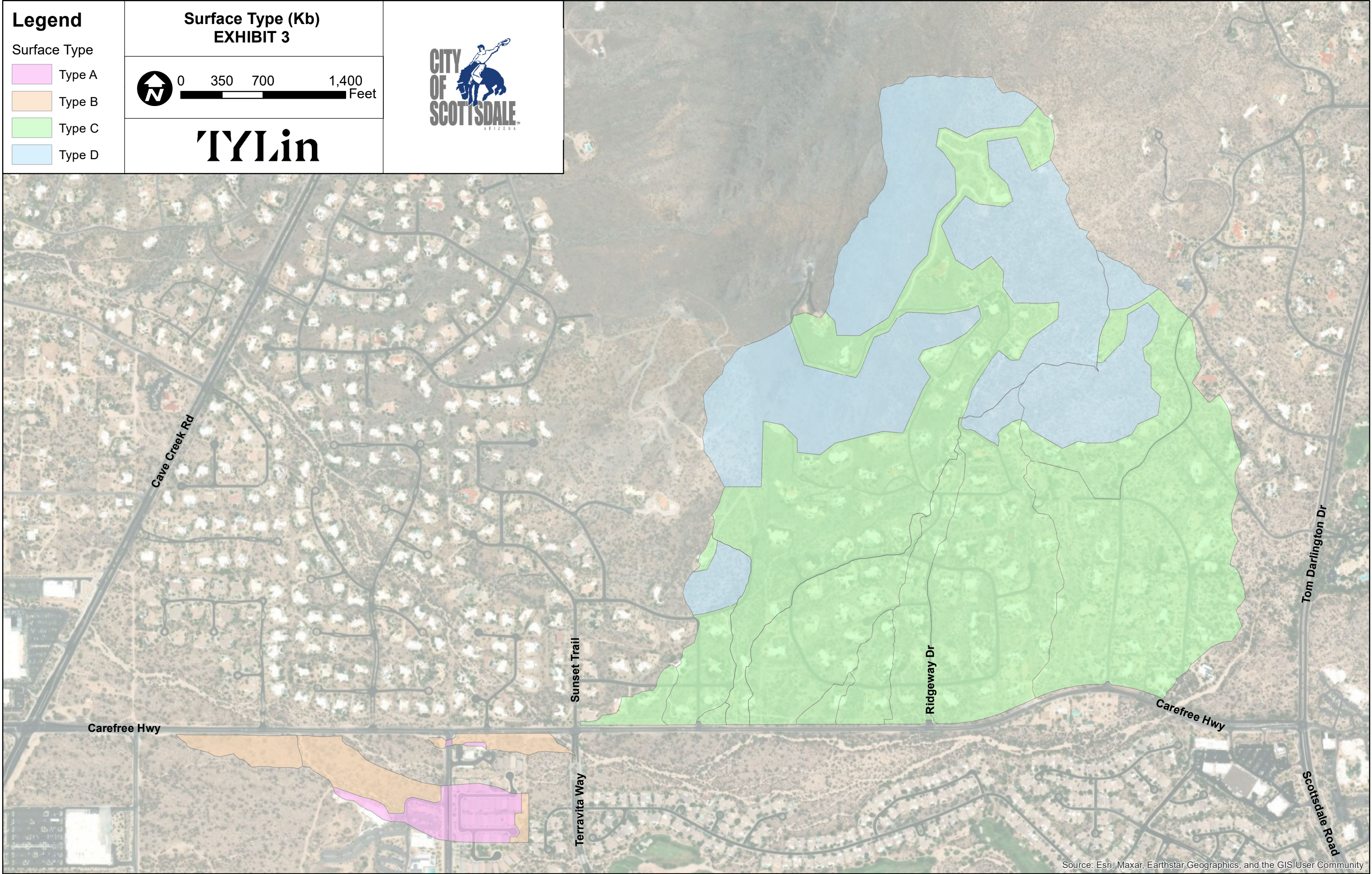
Open Space - Mountain TerrainCommercialMountain Terrain Slopes >10%

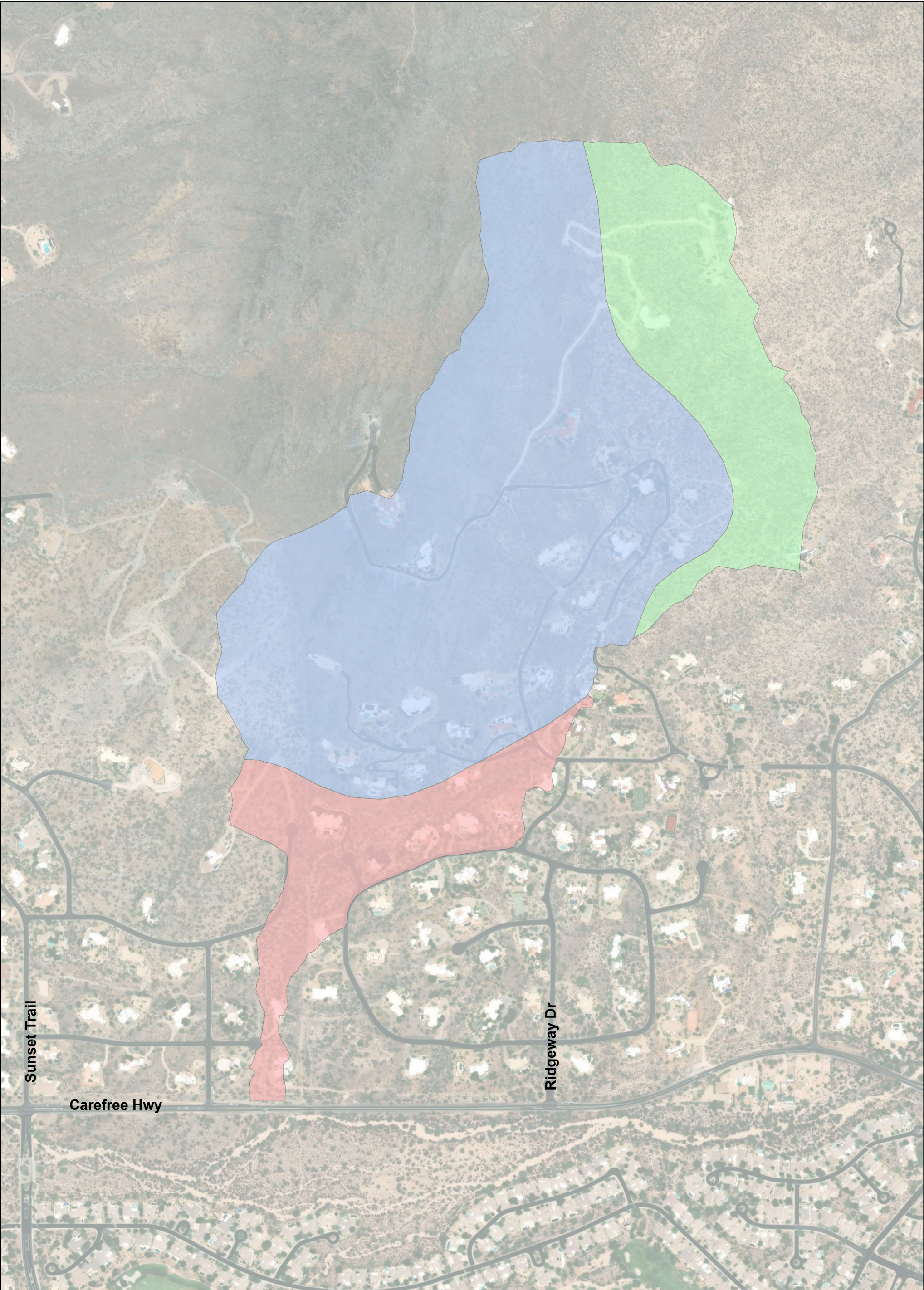
Land Use
EXHIBIT 2



TYLin



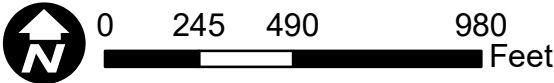




Legend

- Soil LID**
- 64533
 - 64563
 - 64572

**Soils Map
EXHIBIT 4**



TYLin



Legend

- Offsite Subbasin

Existing Culverts

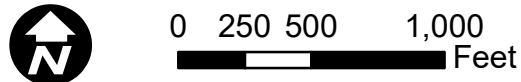
New Culverts

Wall
- Flowpath

FEMA Flood Zone

Existing Contours (10-ft)

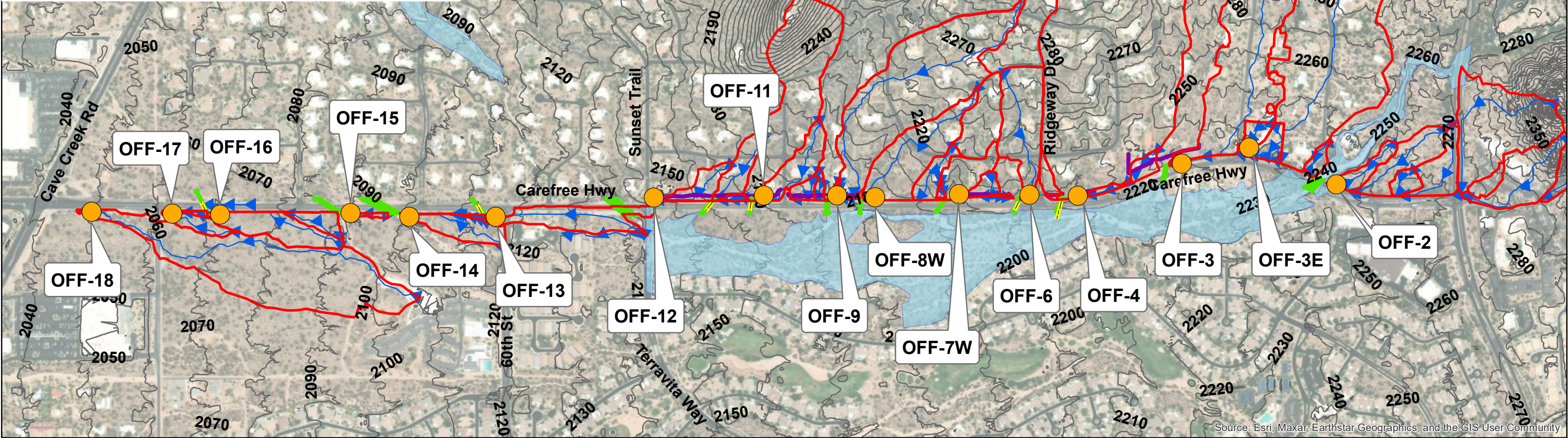
Offsite Hydrology - Roadside Ditches
EXHIBIT 5

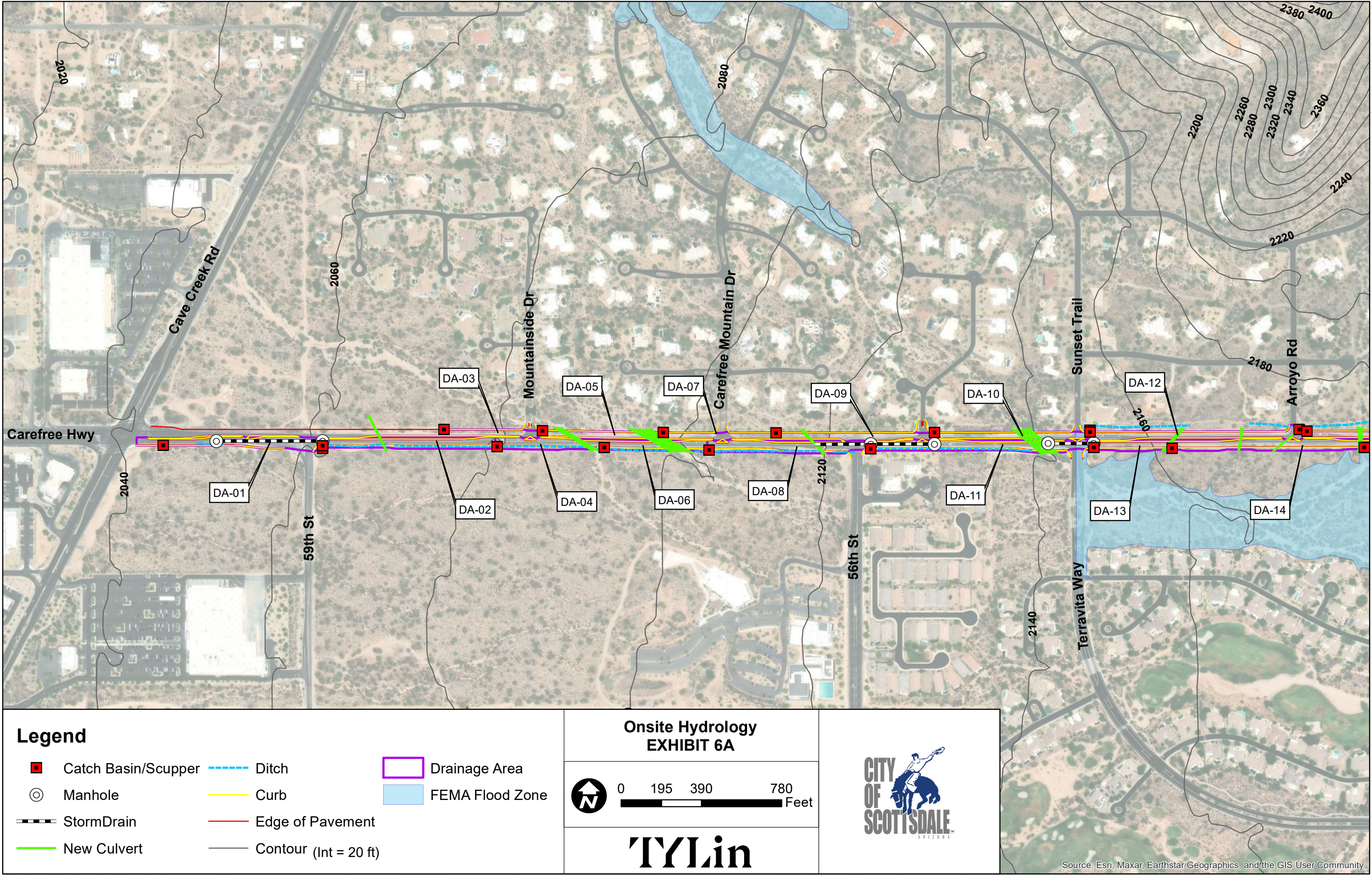


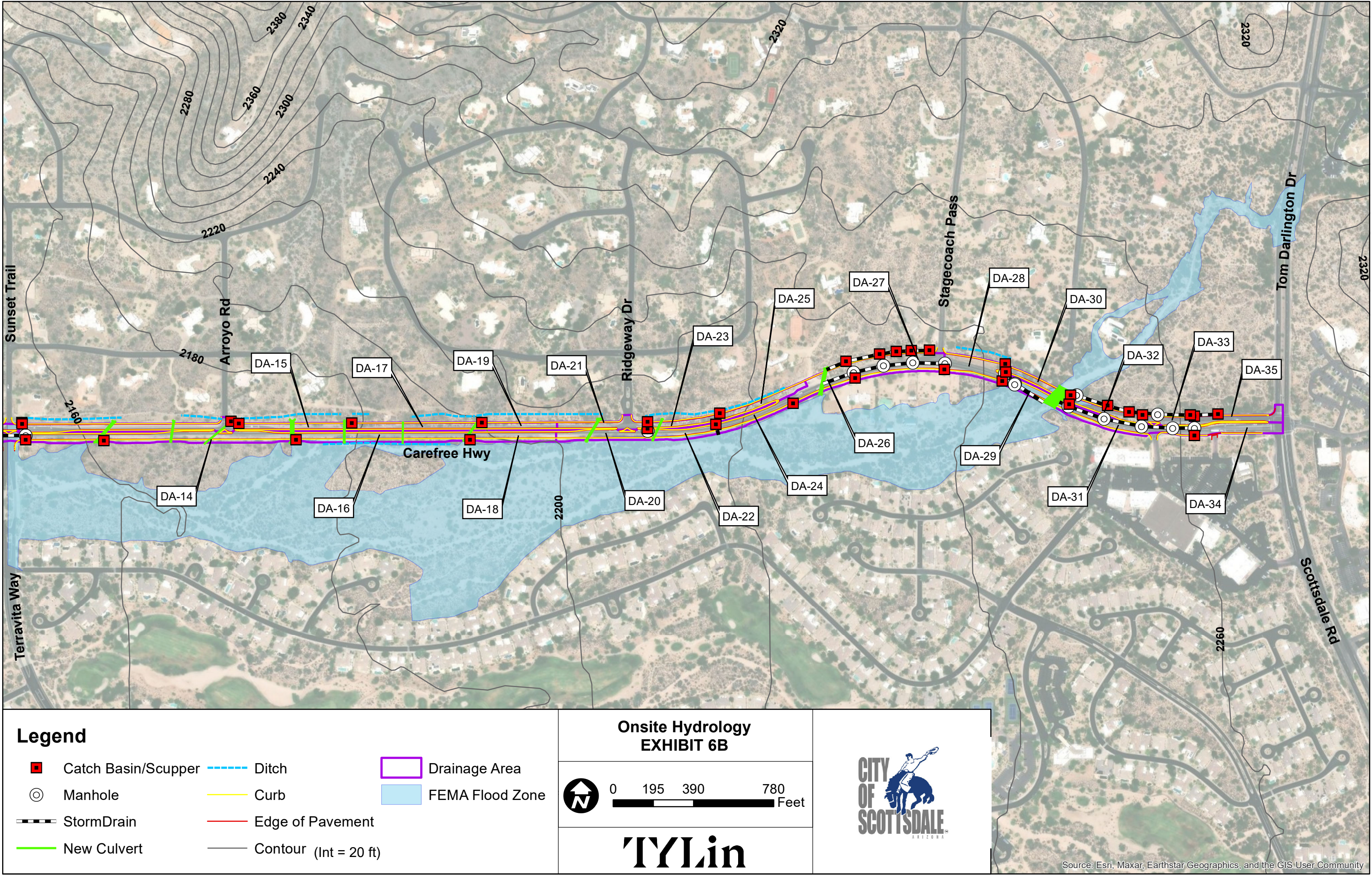
TYLin



Concentration Point	Roadside Ditch	Q10 (cfs)	Q50 (cfs)	Q100 (cfs)
OFF-2		61	102	125
OFF-3E		75	153	203
OFF-3		124	247	334
OFF-4	WB Channel 8	1.9	3.9	5.4
OFF-6	WB Channel 6	11	23	30
OFF-7W	WB Channel 5	1.6	3.2	4.2
OFF-8W	WB Channel 4	10	22	26
OFF-9	WB Channel 3	22	46	63
OFF-11	WB Channel 1B	5.1	11	15
OFF-12	WB Channel 1	2.9	6.0	7.8
OFF-13	EB Channel 6	9.5	15	17
OFF-14	EB Channel 5	4.5	7.7	9.2
OFF-15	EB Channel 4	0.4	0.7	0.8
OFF-16	EB Channel 3	7.6	13	16
OFF-17	EB Channel 2	2.7	4.4	5.6
OFF-18	EB Channel 1	24	42	52







APPENDIX F

Plan Sheets