

Bridges on Delicate Arch Road Final Hydraulics Report UT NP ARCH 100(2)

In partnership with:
National Park Service, Arches National Park
Grand County, UT

Federal Highway Administration
Central Federal Lands Highway Division



July 29, 2026

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Executive Summary

Hydrologic and hydraulic analyses were conducted for the UT NP ARCH 100(2), Bridges on Delicate Arch Road project located in Arches National Park, Grand County, UT. The project scope is to replace 3 existing culvert crossings on Salt Valley, Salt, and Winter Camp Wash with bridges that will improve flood capacity and sediment transport. The adopted hydraulic capacity design frequency is the 10-year flood. This was selected in agreement with Arches NP as a compromise between project impacts and maintenance of flow connectivity. Design peak flows were estimated using USGS regression equations and an NRCS rainfall-runoff model conducted in HEC-HMS. Adopted flows are based on the lower bound of the regression equations.

Proposed conditions two-dimensional hydraulic modeling was conducted using SRH-2D to estimate water surface elevations, depths, and flow velocities at the project sites. The proposed configuration at the sites are bridge structures with 1V:3H spill-through abutment slopes. Low chord elevations at the three sites will provide a minimum of two feet of freeboard above the 10-year design flood but in most cases will exceed this criterion. For the design storms evaluated, only the Salt Wash bridge experiences pressure flow and only for the 200-year event based on the average water surface elevation at the upstream face of the bridge. While the bridges are not overtopped, Delicate Arch Road will still experience roadway overtopping between Salt Valley Wash and Salt Wash as flow leaves the channel banks and road geometry is constrained by existing infrastructure.

Bridge scour evaluations were conducted in accordance with HEC-18 using a 100-year scour design flood and 200-year scour check flood. Class 3 riprap abutment embankment protection is specified at the three bridges. The tables below summarize the hydraulic and scour results at the three sites.

Salt Valley Wash Hydraulic Data				
	Q (cfs)	V (ft/s)	WS El. (ft)	Scour El. (ft)
Q ₂	216	7.8	4287.8	---
Q ₁₀	1,117	11.3	4290.7	---
Q ₅₀	2,837	13.5	4292.1	---
Q ₁₀₀	3,920	13.8	4293.0	4271.1
Q ₂₀₀	4,851	14.0	4293.5	4271.0
Notes:	Water surface elevations are at upstream face of bridge.			
	Maximum 10-year WS. El. used to determine freeboard = 4,290.7' (measured at upstream face of bridge).			
	Hydraulic capacity requirements: Bridge low chord provides a minimum 2.0 feet of freeboard above 10-year water surface elevation. Refer to Section 4.6.3 for freeboard values.			

Salt Wash Hydraulic Data				
	Q (cfs)	V (ft/s)	WS El. (ft)	Scour El. (ft)
Q ₂	494	3.4	4284.1	---
Q ₁₀	2,170	6.3	4287.1	---
Q ₅₀	5,106	7.9	4289.3	---
Q ₁₀₀	7,066	8.4	4290.0	4270.1
Q ₂₀₀	8,367	8.5	4290.6	4270.1
Notes:	Water surface elevations are at upstream face of bridge.			
	Maximum 10-year WS. El. used to determine freeboard = 4,287.1' (measured at upstream face of bridge).			
	Hydraulic capacity requirements: Bridge low chord provides a minimum 2.0 feet of freeboard above 10-year water surface elevation. Refer to Section 4.6.3 for freeboard values.			

Winter Camp Wash Hydraulic Data				
	Q (cfs)	V (ft/s)	WS El. (ft)	Scour El. (ft)
Q ₂	494	7.3	4284.2	---
Q ₁₀	2,170	13.0	4286.6	---
Q ₅₀	5,106	15.5	4292.1	---
Q ₁₀₀	7,066	14.8	4292.5	4272.1
Q ₂₀₀	8,367	14.5	4293.0	4271.6
Notes:	Water surface elevations are at upstream face of bridge.			
	Maximum 10-year WS. El. used to determine freeboard = 4,286.6' (measured at upstream face of bridge).			
	Hydraulic capacity requirements: Bridge low chord provides a minimum 2.0 feet of freeboard above 10-year water surface elevation. Refer to Section 4.6.3 for freeboard values.			

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1 PROJECT BACKGROUND INFORMATION

1.1 PROJECT INFORMATION

The Central Federal Lands Highway Division (CFLHD) in cooperation with National Park Service, Arches National Park plan to replace 3 existing culvert crossings on Salt Valley, Salt, and Winter Camp Washes with bridges. Delicate Arch Road is located in Grand County, UT and provides access to Arches National Park. Project location map is shown in Figure 1. The scope of the project includes replacing the existing structures to address the recurring flooding and sediment deposition issues that require repeated closures of Delicate Arch Road.

According to the USGS National Hydrology Dataset (U.S. Geological Survey 2019) Delicate Arch Road crosses the 2 intermittent (Salt Valley and Winter Camp) washes and 1 perennial (Salt Wash) wash nearby their confluence in the Salt Wash Basin. The culvert crossings were installed in the mid 1990s and have received improvements to allow unobstructed streamflow and sediment transport downstream. A previous project, Arches National Park UT PRA ARCH 10 (2), assessed the condition of Salt Valley Wash crossing. The recommendations indicated that at even at full capacity, the culverts are significantly undersized.



Figure 1: Project Location Map

1.2 EXISTING STRUCTURE

The existing structure on Salt Valley Wash consists of a 75' long 5-barrel corrugated metal pipe arches with a span of 48" and rise of 33". The pipe arch has a headwall at the inlet and has a projecting outlet configuration. The crossing has a deteriorated and undermined the outlet riprap apron present.

The existing structure on Salt Wash consists of a 48' long, 3-barrel concrete box culvert with each box cell having a span of 6' and 3' height. Both the inlet and outlet have a headwall & wingwall configuration. The culvert does not have any existing bank protection and scour countermeasures.

The exiting structure on Winter Camp Wash consists of a 46' long, 2-barrel concrete box culvert with each box cell having a span of 6' and 3' height.

1.3 FLOODPLAINS

The Federal Emergency Management Agency (FEMA) provides Flood Insurance Rate Maps (FIRMs) that detail special flood hazard areas. Lands inundated by the base flood (100-year) are subject to National Flood Insurance Program (NFIP) floodplain management regulations. The project area is located outside of a FEMA special hazard area . The project will not be subject to NFIP floodplain management regulations for backwater. For unregulated floodplain zones, the PDDM allows a maximum of 1-foot rise in proposed condition base flood elevations.

2 HYDRAULIC DESIGN CRITERIA

The Federal Lands Highway Project Development and Design Manual (PDDM) establishes the hydraulic design criteria for this project (Federal Lands Highway 2012). The scoping report indicates a design speed of 35 mph, a design average daily traffic (ADT) of 2,427. Based on these parameters, the corridor is classified as a high-standard roadway for hydraulic design purposes. The corresponding hydraulic design criteria is detailed in Table 1. Freeboard is defined as the vertical clearance between the low chord of the bridge and the design flood water surface elevation (WSE).

Table 1: PDDM Hydraulic Design Criteria

<i>High-Standard Roadway</i>	Design Frequency	Check Frequency	Design Criteria
Bridges	50-year	Greater of 100-year and overtopping (≤ 500 -year)	Minimum 2 ft. of freeboard at the design flood
			Woody debris potential is significant: 3.5 - 5.0 ft. of freeboard
			Ice flow potential is significant: 5.0 - 10.0 ft. of freeboard
Bridge Scour	100-year	200-year	Countermeasure design flood frequency: 200-year
			Use the worst case scour up to and including these events
Floodplain Encroachment	100-year	Overtopping (≤ 500 -year)	Unregulated base floodplain: rise ≤ 1.0 ft.
			Regulated floodplain with no detailed FEMA study: rise ≤ 1.0 ft.
			Regulated floodplain with detailed FEMA study: rise ≤ 0.00 ft.

Preliminary hydraulic modeling indicates significant challenges with meeting standard PDDM hydraulic capacity criteria at the three sites. The results of the preliminary analyses were presented to Park personnel during a meeting on August 7, 2023. Park personnel suggested a 5-year design frequency but the recommendation from Central Federal Lands is to use the 10-year design frequency to establish hydraulic capacity at the three sites.

Bridge stability analysis and design will follow standard FLH PDDM criteria. Bridge foundations will be designed using a 100-year scour design flood and a 200-year scour check flood. The adopted hydraulic design criteria for the project are shown in Table 2.

Table 2: Adopted Hydraulic Design Criteria

<i>High-Standard Roadway</i>	Design Frequency	Check Frequency	Design Criteria
Bridges	10-year	Greater of 100-year and overtopping (≤ 500 -year)	Minimum 2 ft. of freeboard at the design flood
Bridge Scour	100-year	200-year	Countermeasure design flood frequency: 200-year
			Use the worst case scour up to and including these events

3 HYDROLOGY

3.1 HYDROLOGIC SETTING AND TOPOGRAPHIC DATA

The project is located in the Colorado Plateau, desert terrain of the Arches National Park in Utah. The contributing drainage basins for each crossing selected for evaluation were delineated in the Watershed Modeling System (WMS) (Aquaveo 2021) and the StreamStats web application (U.S. Geological Survey 2019) using 10-meter Digital Elevation Model information obtained from the USGS National Map (U.S. Geological Survey 2018). Precipitation was determined for each basin using the StreamStats web application or the NOAA National Weather Service Precipitation Frequency Data Server (NOAA 2011), as applicable to the hydrologic method for the basin of interest. Hydrologic information including mean basin elevation, mean annual precipitation, and drainage basin sizes may be found in Appendix B as well as Table 3 below. Drainage basin delineations are shown in Figure 2.

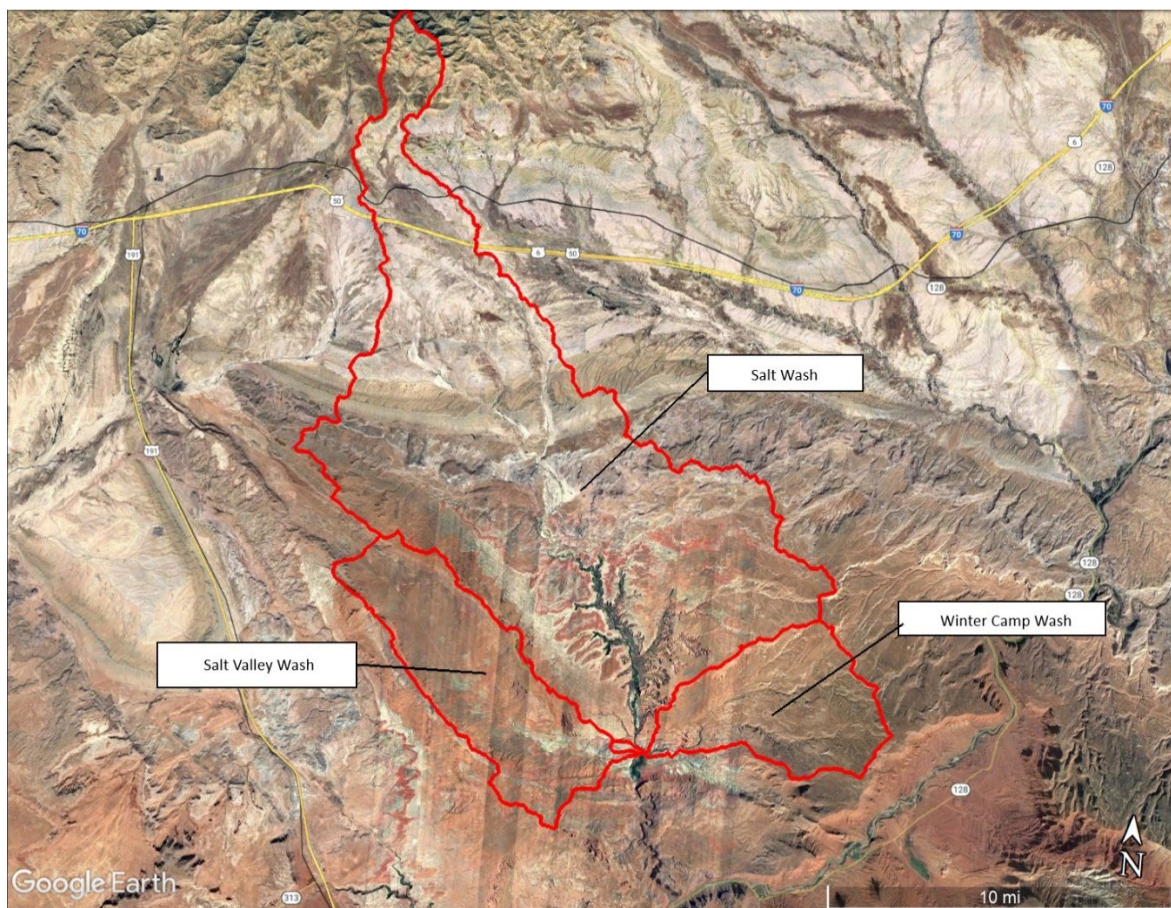


Figure 2: Basin Delineation

3.2 BASIN CHARACTERISTICS

The drainage basins for Salt Valley, Salt and Winter Camp Wash were delineated using available 10-meter Worldwide Elevation Data information obtained from WMS. Additional hydrologic information is included in the StreamStats output report in Appendix A. A summary of general basin characteristics is provided in Table 3.

Table 3: Basin Characteristics, Salt Valley Wash

Basin	Drainage Area (sq. mi.)	Mean Basin Elevation (ft.)	Mean Basin Slope (%)	Mean Annual Precipitation (in.)
Salt Valley Wash	26.69	4,898	9.8	9.62
Salt Wash	117.01	4,880	10.9	9.48
Winter Camp Wash	19.36	5,188	10.9	9.48

3.3 AVAILABLE HYDROLOGIC DATA

According to the USGS National Water Information System (NWIS) (U.S. Geological Survey 2023) there are no active USGS peak streamflow stations within the project limits. The closest USGS active station is located on Mill Creek BLW Pack Creek near Moab, UT, approximately 10.8 miles south of Salt Valley Wash. However, this station does not have sufficient records to analyze stream flow.

Two inactive peakflow stations are located at Cresent Wash near Cresent Junction, Utah (approximately 21.8 miles northwest of Salt Valley Wash) and Kane Springs Canyon near Moab, Utah (approximately 23.2 miles south of Salt Valley Wash). Since peak flow stream data from these stations was included in the development of the USGS regression equations, as described in section 3.4, no additional analyses was conducted using this data. Table 4 describes available station information.

Table 4: Available Peak Streamflow Information

USGS Station	Location	Latitude	Longitude	Drainage Area (sq mi.)	Period of Record	Total Peak Streamflow Records	Status
09328900	Cresent Wash near Cresent Junction, UT	38°56'32"	109°49'14"	23.30	1959-1968	10	Inactive
09185200	Kane Springs Canyon near Moab, UT	38°24'00"	109°27'00"	17.80	1959-1974	15	Inactive

3.4 REGRESSION EQUATION ESTIMATES

The Utah regression equations presented in USGS Report 2007-5158 (U.S. Geological Survey 2007) were used as one method to estimate design flows. The project limits are located in Colorado Plateau Hydrologic Region (6). The equations developed for this region relate peak discharge to drainage area & mean basin elevation, using explanatory predictor variable (EPV) ranges of 0.87 – 532 square miles and 4,300-9,380 feet. The average standard error of prediction varies from 60-108% for various storm events, as shown in the table below. The regression results are also shown in Table 5.

Table 5: Regression Equation Peak Flow Estimates

Basin	Annual Exceedance Probability (%)	Return Period (Year)	Peak Flow Estimate (cfs)	Standard Error of Prediction (%)
Salt Valley Wash	50	2	520	108
	20	5	1,310	80
	10	10	2,100	70
	4	25	3,540	62
	2	50	4,940	60
	1	100	6,880	61
	0.5	200	8,580	62
	0.2	500	11,800	66
Salt Wash	50	2	1,190	108
	20	5	2,680	80
	10	10	4,080	70
	4	25	6,560	62
	2	50	8,890	60
	1	100	12,400	61
	0.5	200	14,800	62
	0.2	500	19,900	66
Winter Camp Wash	50	2	376	108
	20	5	970	80
	10	10	1,570	70
	4	25	2,670	62
	2	50	3,750	60
	1	100	5,220	61
	0.5	200	6,560	62
	0.2	500	9,080	66

3.5 RAINFALL-RUNOFF MODEL ESTIMATES

Rainfall-runoff modeling was conducted using the hydrologic modeling software HEC-HMS Version 4.4.1 (U.S. Army Corps of Engineers 2020). Additional information is included in Appendix B.

3.5.1 Precipitation

Point precipitation values for the project basins were obtained from NOAA Atlas 14, Volume 8, Version 2 (Perica, Martin and al. 2020) using the Precipitation Frequency Data Server (NOAA 2011) tool in HEC-HMS (U.S. Army Corps of Engineers 2020). Precipitation values at the basins' centroid were obtained and used to represent precipitation over the entire basin. Point precipitation values for a duration of 24 hours are provided in Table 6.

Table 6: NOAA Atlas 14 24-Hour Point Precipitation

Basin	Annual Exceedance Probability (%)	Return Period (Year)	Point Precipitation (in.)
Salt Valley Wash	50	2	1.11
	20	5	1.38
	10	10	1.60
	4	25	1.93
	2	50	2.19
	1	100	2.47
	0.5	200	2.76
	0.2	500	3.48
Salt Wash	50	2	1.10
	20	5	1.36
	10	10	1.58
	4	25	1.88
	2	50	2.12
	1	100	2.37
	0.5	200	2.63
	0.2	500	2.80
Winter Camp Wash	50	2	1.18
	20	5	1.47
	10	10	1.71
	4	25	2.05
	2	50	2.33
	1	100	2.63
	0.5	200	2.94
	0.2	500	3.39

3.5.2 Model Parameters

The NRCS curve number (CN) unit hydrograph method was used to estimate peak runoff (Natural Resources Conservation Service 1997). The model employed NRCS Web Soil Survey soil data (citation) and land cover information obtained from the 2011 National Land Cover Dataset (Multi-Resolution Land Characteristics Consortium 2018). Time of concentration was estimated using the watershed lag time method.

The Salt Wash basin includes hydrologic soil groups (HSG) A, B, C and D. The Salt Valley Wash basin includes hydrologic soil groups A, B and D. The Winter Camp Wash basin includes hydrologic soil groups A and D. The composite curve number for each basin was adjusted to consider an initial abstraction ratio of 0.05.

Based on NLCD information, the majority of the basin areas are comprised of shrub/scrub land cover type. Upon evaluation of site information, this land use was adjusted as discussed in Section 3.6. Table 7 presents the composite curve number, time of concentration and travel lag time computed. Curve Numbers were based on fair conditions. Time of concentration was computed for the fair conditions, using the NRCS Lag Method (SCS Method).

Table 7 : Composite Curve Numbers and Travel Time

Basin	Curve Number	Time of Concentration, hours	Lag time, hours
Salt Valley Wash	79	6.65	3.99
Salt Wash	77	10.66	6.40
Winter Camp Wash	63	5.55	3.33

The NPS Arches National Park Services website (National Park Service 2021) states that grasses and grassland grow throughout the park and is indicated as one of the various vegetation types that covers the area, particularly grasslands dominated by needle and thread grass. The Anderson Land Cover Classification System (Anderson, et al. 1983), a paper referenced by the NLCD to create its classification, explains that a herbaceous rangeland in desert environments is usually represented in transitional situations to desert shrub.

Two scenarios were modeled in HEC-HMS to account for potential peak flow differences due to varying land cover classifications. In the first scenario, land cover identified as shrub/scrub was assigned a runoff curve number corresponding to desert shrub obtained from Table 5.4 of HDS-2 (Federal Highway Administration 2002). For the second scenario the curve number for shrub/scrub was assigned based on a herbaceous land cover classification from Table 5.5 of HDS-2. When comparing the two rainfall-runoff model scenarios, it was determined that a desert shrub land cover type resulted in lower peak flows than a herbaceous land cover type. For this project it was assumed that a herbaceous land cover best represents the basins and provides a slightly more conservative curve number than desert shrub.

3.6 ADOPTED DESIGN FLOWS

Two methods were used to compute the design flows for the project, USGS regression equations and an NRCS rainfall-runoff model. Within the NRCS method analysis, 2 models were evaluated, with the curve number being the varied parameter as discussed in Section 3.5.2.

Peak flow differences when comparing regression equations and rainfall-runoff model results varied for the three basins. The upper and lower bounds of the regression equations, computed from the standard error as shown in Figure 3 to Figure 5, were used as an aid in the comparisons. When considering the explanatory variables used in the regression equations for the Colorado Plateau Hydrologic Region (Region 6), Salt Valley and Salt Wash fell within the lower quartile of the drainage areas used and Winter Camp was in the smallest 5%. Mean basin elevation for the basins on this project were also lower than approximately 80% of the basins used to develop the regression equations.

The rainfall-runoff models developed used basin specific parameters, such as hydrologic soil group, land cover, and rainfall depth to determine peak flows. As shown in Table 8, the results of the NRCS method produced flows that were generally lower than the results of the lower bound of the regression equations. Based on this analysis, the USGS regression equations appear to overpredict flows for these drainage basins. To provide more conservative flows than the results of the NRCS method, the lower bounds of the regression equations were selected as the design flows for the three basins. Adopted design flows can be found in Table 9.

Table 8 : Peak Flow Comparison

Basin	Annual Exceedance Probability (%)	Return Period (Year)	Peak Flow Results		
			CN - Herbaceous	Streamstats	Lower Limit
			cfs	cfs	Cfs
Salt Valley Wash	50	2	239	520	216
	20	5	409	1,310	648
	10	10	582	2,100	1,117
	4	25	895	3,540	2,001
	2	50	1,196	4,940	2,837
	1	100	1,577	6,880	3,920
	0.5	200	2,101	8,580	4,851
	0.2	500	3,192	11,800	6,468
Salt Wash	50	2	1,070	1,190	494
	20	5	1,721	2,680	1,326
	10	10	2,367	4,080	2,170
	4	25	3,475	6,560	3,709
	2	50	4,474	8,890	5,106
	1	100	5,690	12,400	7,066
	0.5	200	7,304	14,800	8,367
	0.2	500	10,703	19,900	10,907
Winter Camp Wash	50	2	167	376	156
	20	5	295	970	480
	10	10	432	1,570	835
	4	25	677	2,670	1,510
	2	50	924	3,750	2,154
	1	100	1237	5,220	2,975
	0.5	200	1669	6,560	3,709
	0.2	500	2570	9,080	4,977

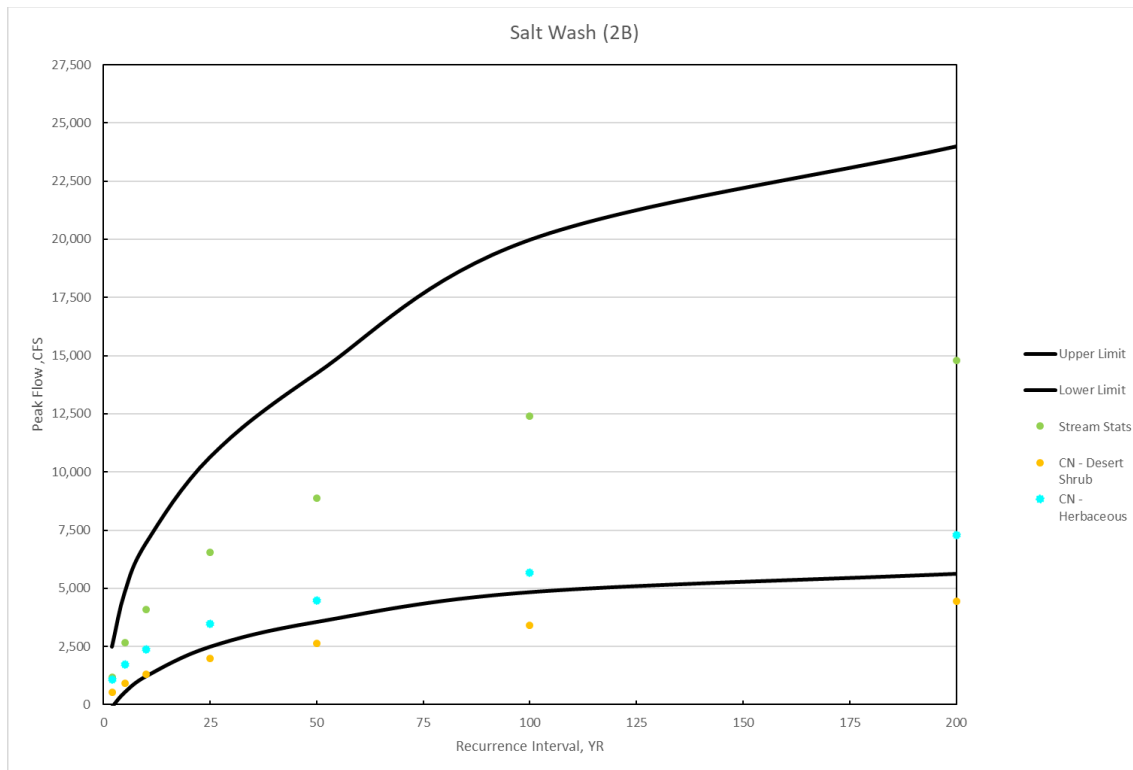


Figure 3: Salt Wash Peak Flow Comparison

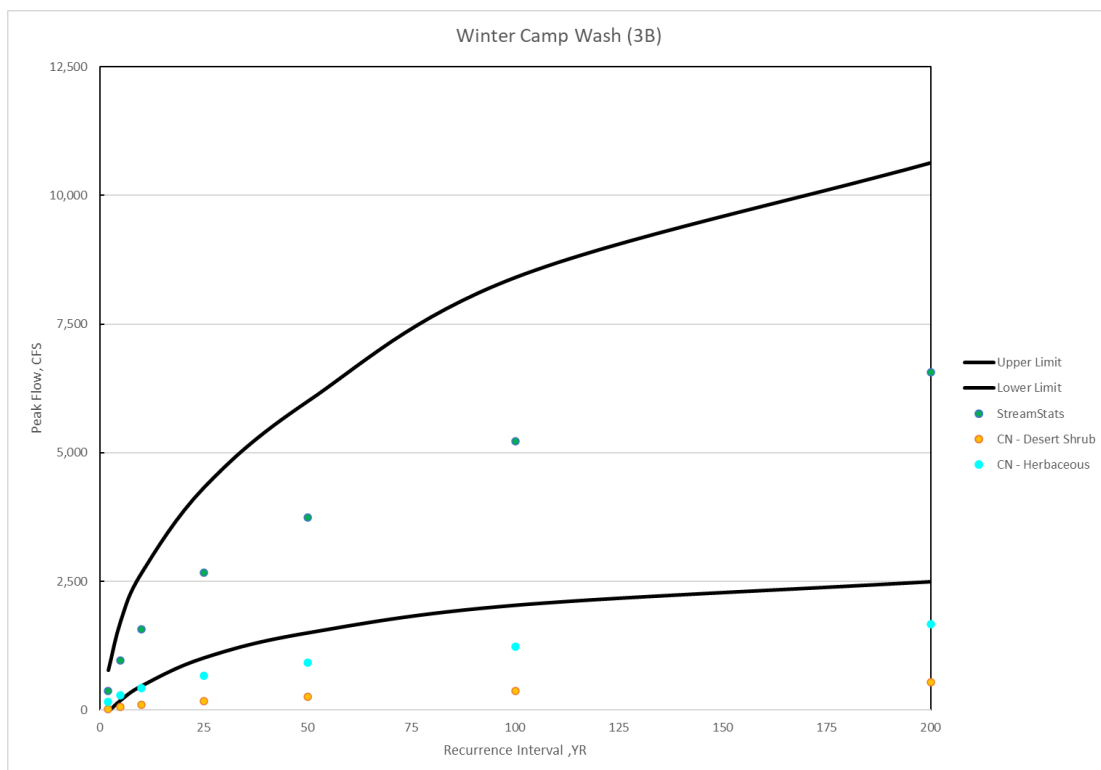


Figure 4: Winter Camp Wash Peak Flow Comparison

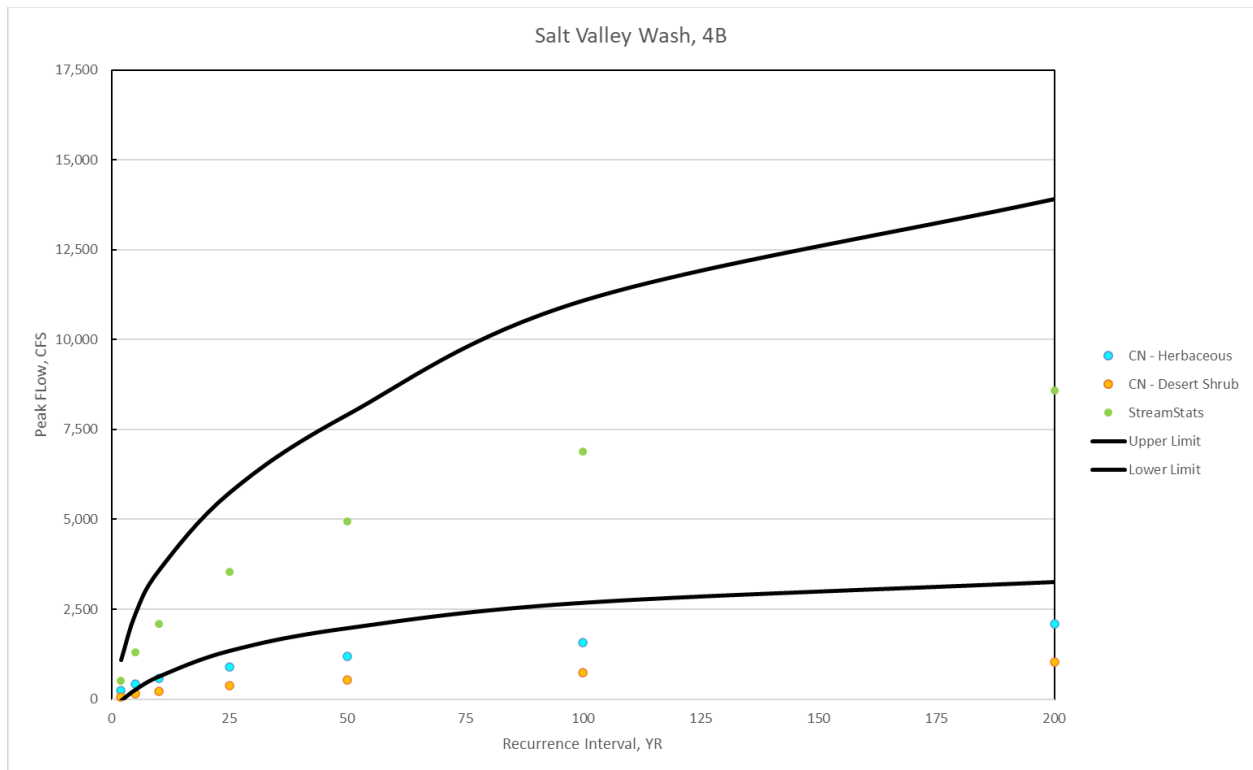


Figure 5 : Salt Valley Wash Peak Flow Comparison

Table 9: Adopted Design Flows

Basin	Annual Exceedance Probability (%)	Return Period (Year)	Peak Flow (cfs)
Salt Valley Wash	50	2	216
	20	5	648
	10	10	1,117
	4	25	2,001
	2	50	2,837
	1	100	3,920
	0.5	200	4,851
	0.2	500	6,468
Salt Wash	50	2	494
	20	5	1,326
	10	10	2,170
	4	25	3,709
	2	50	5,106
	1	100	7,066
	0.5	200	8,367
	0.2	500	10,907
Winter Camp Wash	50	2	156
	20	5	480
	10	10	835
	4	25	1,510
	2	50	2,154
	1	100	2,975
	0.5	200	3,709
	0.2	500	4,977

4 HYDRAULIC ANALYSIS

4.1 HYDRAULIC SETTING

All three washes on the project cross Delicate Arch Road and have a confluence downstream of the road crossings. Winter Camp Wash and Salt Wash have a confluence 750 feet downstream of Delicate Arch Road. Approximately 2,000 feet downstream of this point, Salt Wash has confluence with Salt Valley Wash. Salt Valley Wash and Winter Camp Wash are ephemeral drainages, while Salt Wash is a perennial stream.

4.2 HYDRAULIC MODEL DEVELOPMENT

Two-dimensional hydraulic modeling simulations were conducted using SRH-2D (U.S. Bureau of Reclamation 2020) to estimate water surface elevations, water depths, and flow velocities at the project sites. The SRH-2D computational mesh generation and model pre- and post-processing was performed using the surface-water modeling system (SMS) interface (Aquaveo 2023). Due to the proximity of the stream confluences a single hydraulic model encompassed all three sites.

4.3 TOPOGRAPHIC INFORMATION

Two sources of topographic information were used to develop the hydraulic models: field survey information collected by CFLHD along the project corridor in January 2023 and LiDAR information provided by The NPS-Arches National Park in December 2022. The two sources were merged and used in the SRH-2D analysis. The resulting topographic surface is shown in Figure 6. All elevations for the study are referenced to the North American Vertical Datum of 1988 (NAVD88).

SRH-2D uses a computational mesh to solve the two-dimensional flow equations (depth-averaged St. Venant equations). The mesh defines the underlying topography and geometric properties of each computational element. The mesh was developed using the merged topographic information as shown in Figure 7.

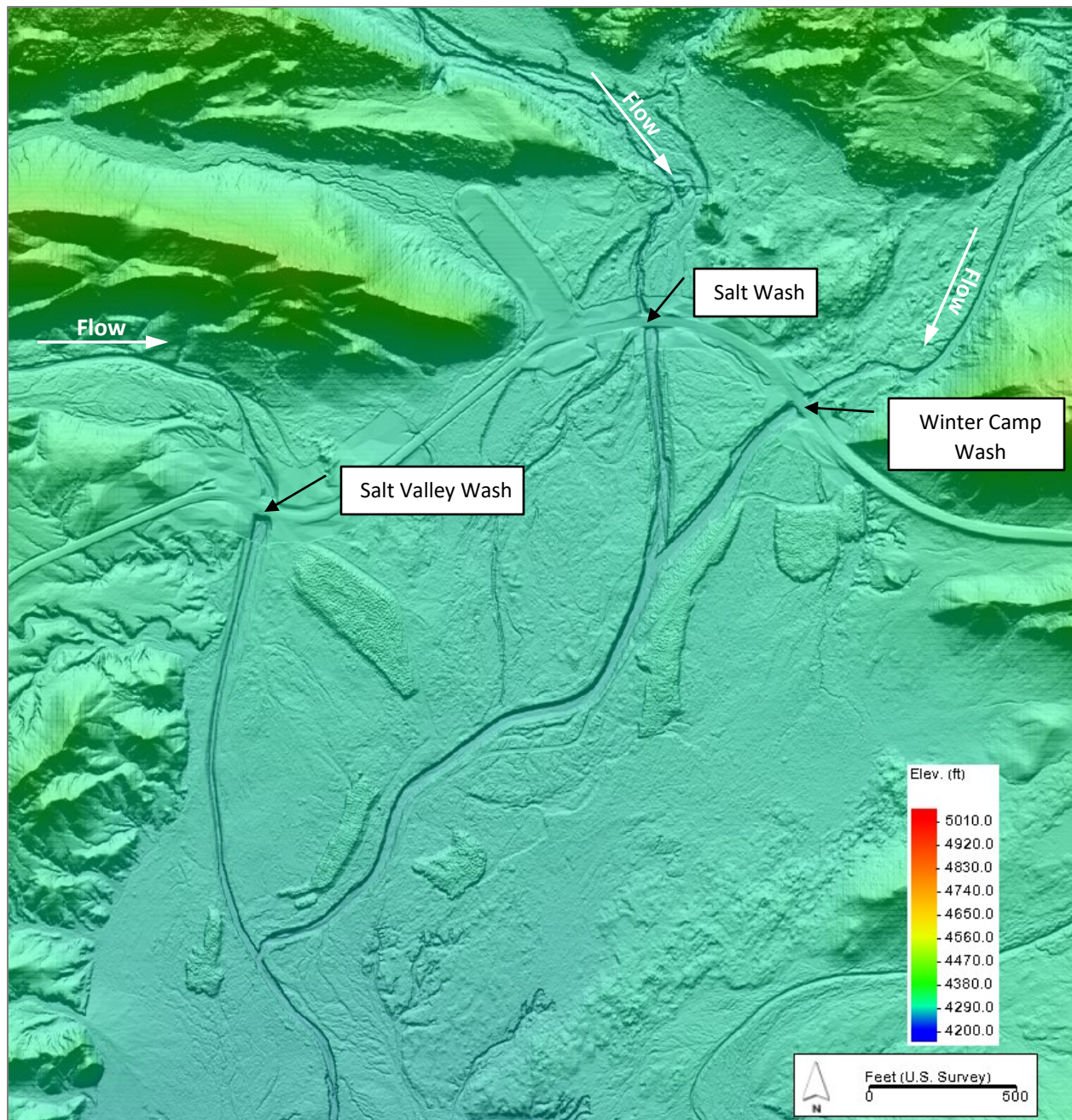


Figure 6: Field Survey Merged with LiDAR

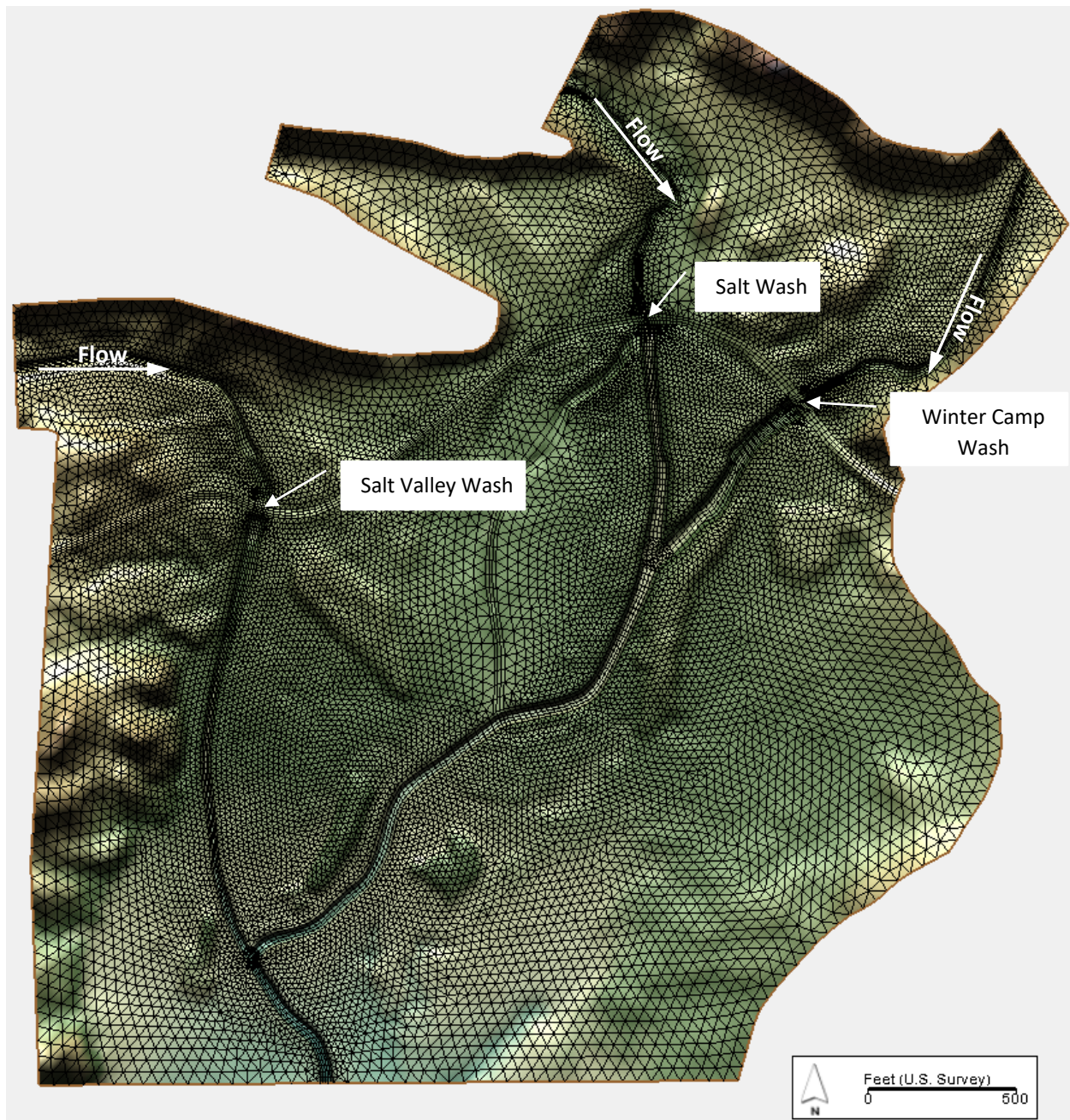


Figure 7 : SRH-2D Mesh

4.4 BOUNDARY CONDITIONS

Seven boundary conditions were specified in the model. The upstream boundary conditions for all existing crossings was specified as Inlet-Q constant discharge using the adopted design flows values. The downstream boundary condition was placed below the confluence of all three drainages and was specified as Exit-H with constant water surface elevation obtained using the SMS channel calculator, composite Manning's n , and the slope downstream of the boundary of the model to compute normal depth. For existing conditions, three HY-8 internal boundary conditions were established at each crossing to simulate culvert hydraulics. For proposed conditions, these were substituted with pressure flow

boundary conditions developed using the SMS 3D Structure tool. In addition, bridge piers were simulated using holes in the mesh representing the average pier dimensions. The boundary condition locations are shown in Figure 8.

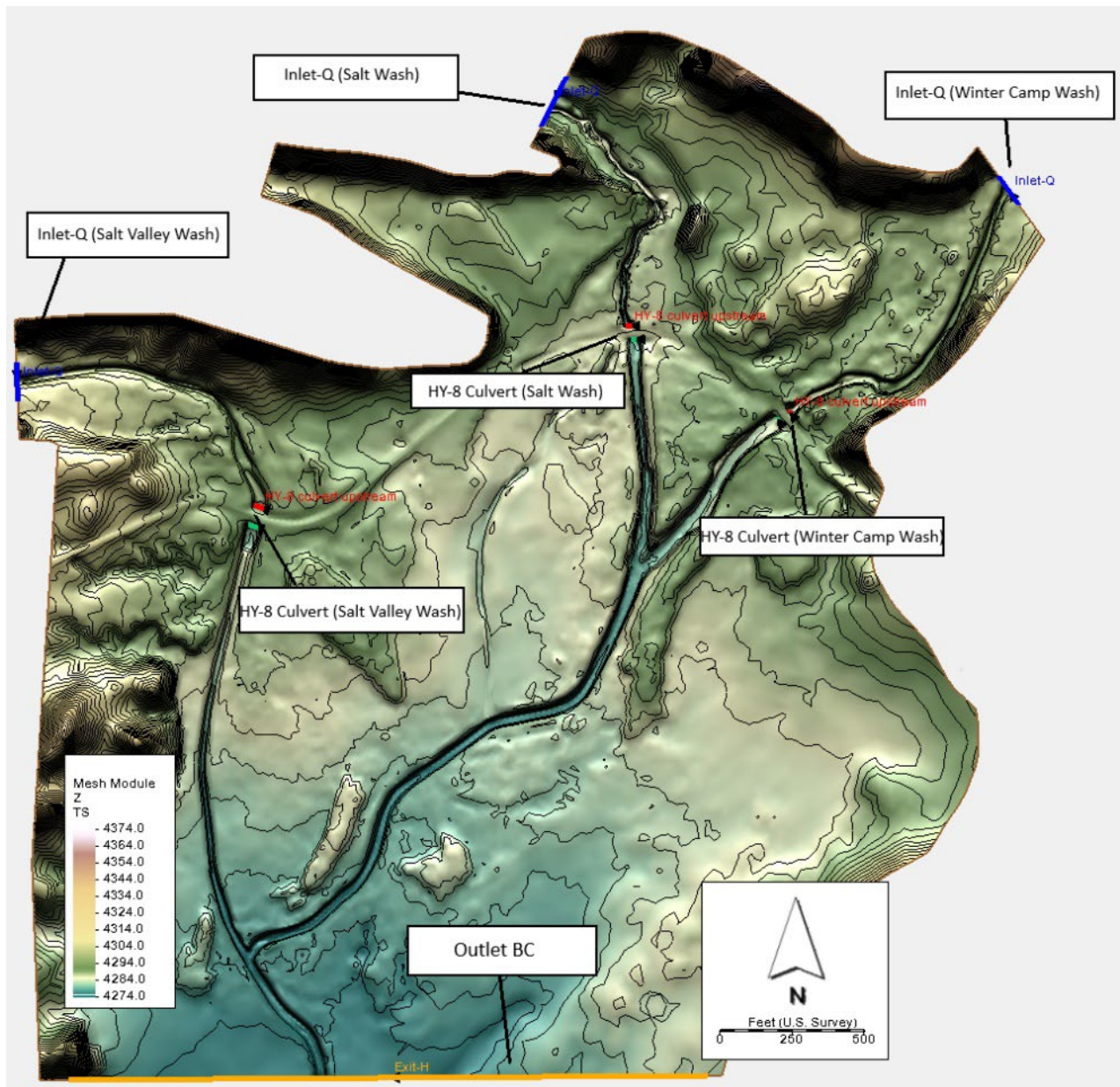


Figure 8: Boundary Conditions

4.5 LAND COVER

SRH-2D uses Manning's "n" values to compute friction corresponding to the roughness of the streambed and floodplain. Land use was delineated using aerial imagery and topographic information. Figure 9 provides a breakdown of roughness values, obtained from Table 3-1 of the HEC-RAS Hydraulic Reference

Manual (U.S. Army Corps of Engineers 2020) used within the project domain. Table 10 provides the values selected for land cover roughness coefficient.

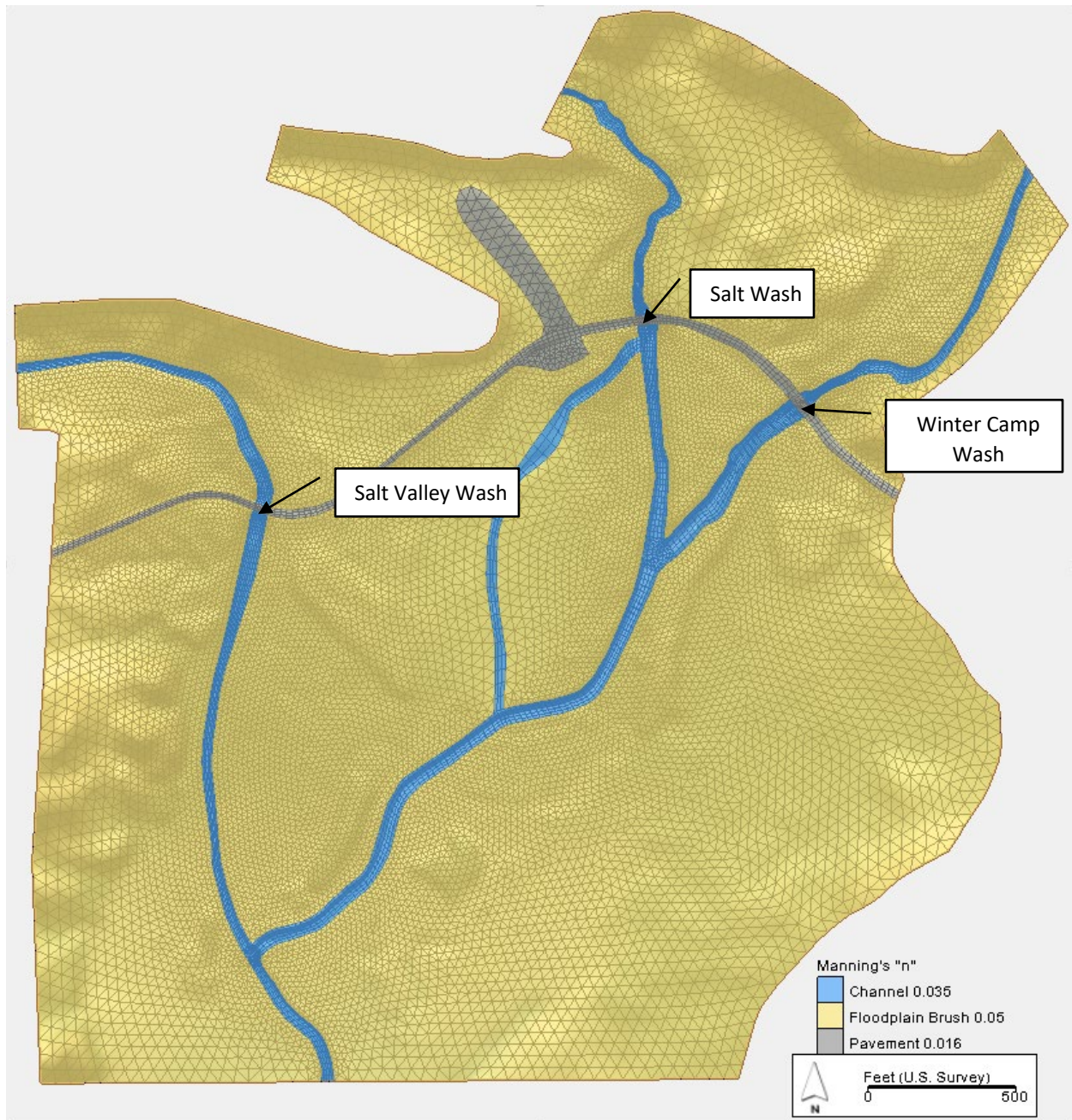


Figure 9: Land Cover and Manning's Roughness

Table 10 : Manning's Roughness Coefficients

Land Use	Manning's "n"
Channel	0.035
Floodplain Brush	0.05
Pavement	0.016

4.6 HYDRAULIC MODEL RESULTS

Hydraulic simulations were conducted for the 2-, 10-, 25-, 50-, 100-, and 200- year return periods using the parameters described in preceding sections. Hydraulic results and water surface profiles were extracted along cross sections and channel profiles, as depicted in Figure 10 through Figure 12. The cross section was placed at the assumed upstream face of the proposed bridges for comparison of existing and proposed conditions. The water surface elevation profiles were extracted approximately along the channel thalweg. Due to the two-dimensional model domain, the profile does not necessarily represent the maximum water surface elevations but shows the general profile shape through the crossings. To establish the minimum freeboard requirements the maximum water surface elevation at the upstream face of the proposed bridges was used.

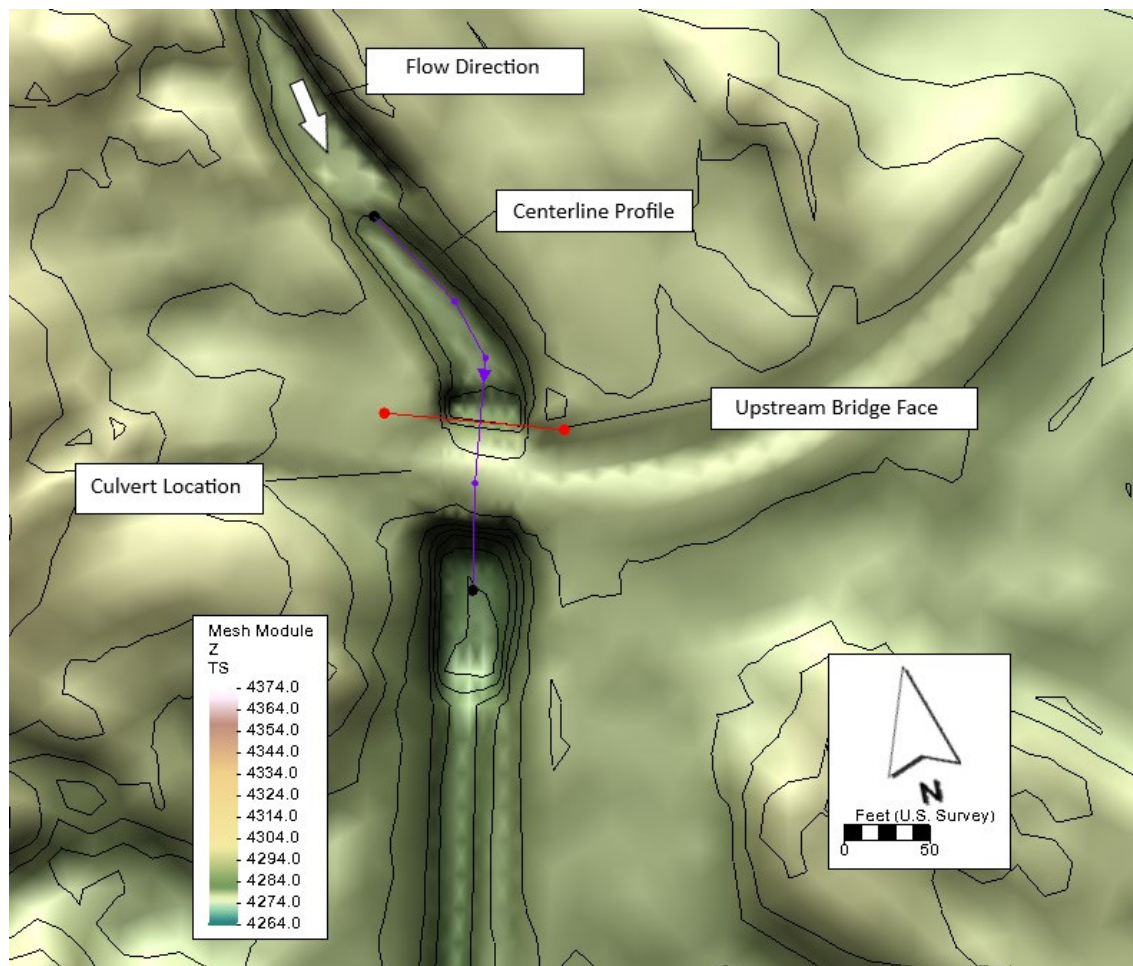


Figure 10: Profile and Cross Section Upstream, Salt Valley Wash

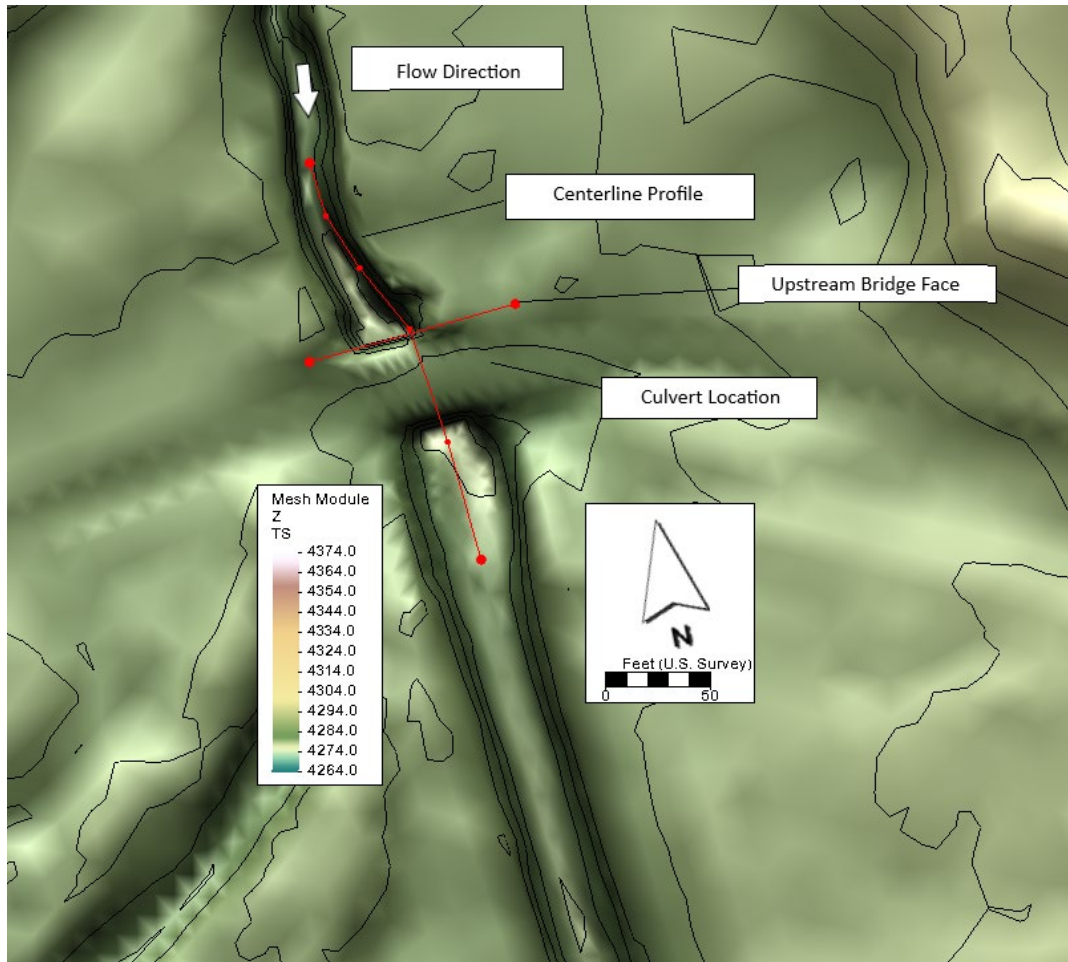


Figure 11: Profile and Cross Section Upstream, Salt Wash

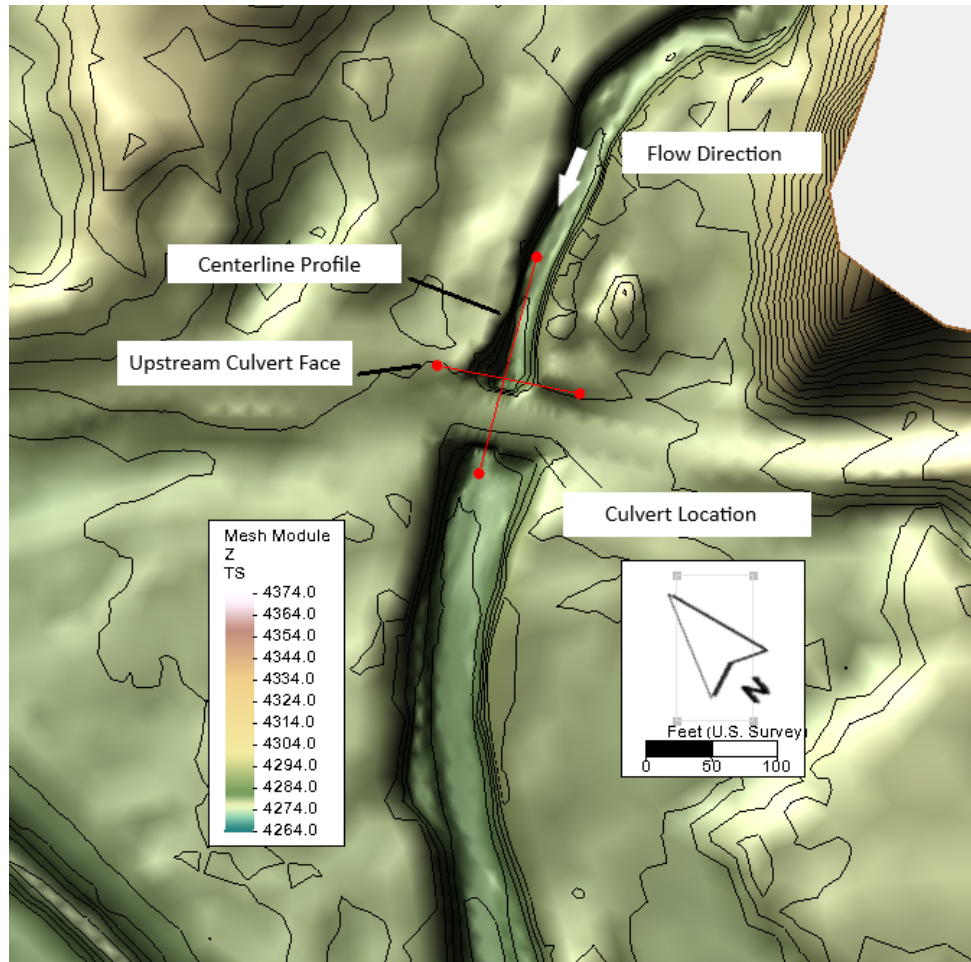


Figure 12: Profile and Cross Section Upstream, Winter Camp Wash

4.6.1 Existing Conditions Model Results

Table 11 to Table 13 show the existing conditions hydraulic model results for the 2-, 10-, 50-, 100-, and 200-year storm events. Figure 13 to Figure 15 show the water surface profiles. As can be seen the three sites show significant overtopping in almost all events. Maps showing the two-dimensional water surface elevation results are included in Appendix C.

Table 11 : Existing Conditions Hydraulic Results – Salt Valley Wash

Return Period (Year)	Velocity (ft/s)		Depth (ft)		WSEL (ft)	
	Average	Maximum	Average	Maximum	Average	Maximum
2	2.7	4.5	1.6	2.4	4288.8	4288.9
10	2.9	6.3	2.6	5.4	4291.9	4292.3
50	4.7	8.8	3.5	6.5	4292.8	4292.9
100	5.7	9.5	3.9	6.9	4293.2	4293.4
200	5.1	9.2	3.7	6.6	4293.0	4293.1

Table 12 : Existing Conditions Hydraulic Results – Salt Wash

Return Period (Year)	Velocity (ft/s)		Depth (ft)		WSEL (ft)	
	Average	Maximum	Average	Maximum	Average	Maximum
2	2.4	3.8	0.4	1.0	4284.7	4285.0
10	4.5	6.4	2.5	3.2	4286.9	4287.2
50	5.5	8.0	4.0	4.5	4288.3	4288.6
100	5.9	8.5	4.6	5.3	4289.0	4289.3
200	5.6	8.2	4.2	4.8	4288.6	4288.9

Table 13 : Existing Conditions Hydraulic Results – Winter Camp Wash

Return Period (Year)	Velocity (ft/s)		Depth (ft)		WSEL (ft)	
	Average	Maximum	Average	Maximum	Average	Maximum
2	0.5	0.9	0.7	1.4	4286.1	4286.1
10	3.2	4.3	1.8	5.0	4289.5	4290.1
50	4.8	7.6	2.3	6.1	4290.3	4291.0
100	5.3	8.4	2.7	6.5	4290.7	4291.4
200	5.0	8.1	2.5	6.3	4290.5	4291.2

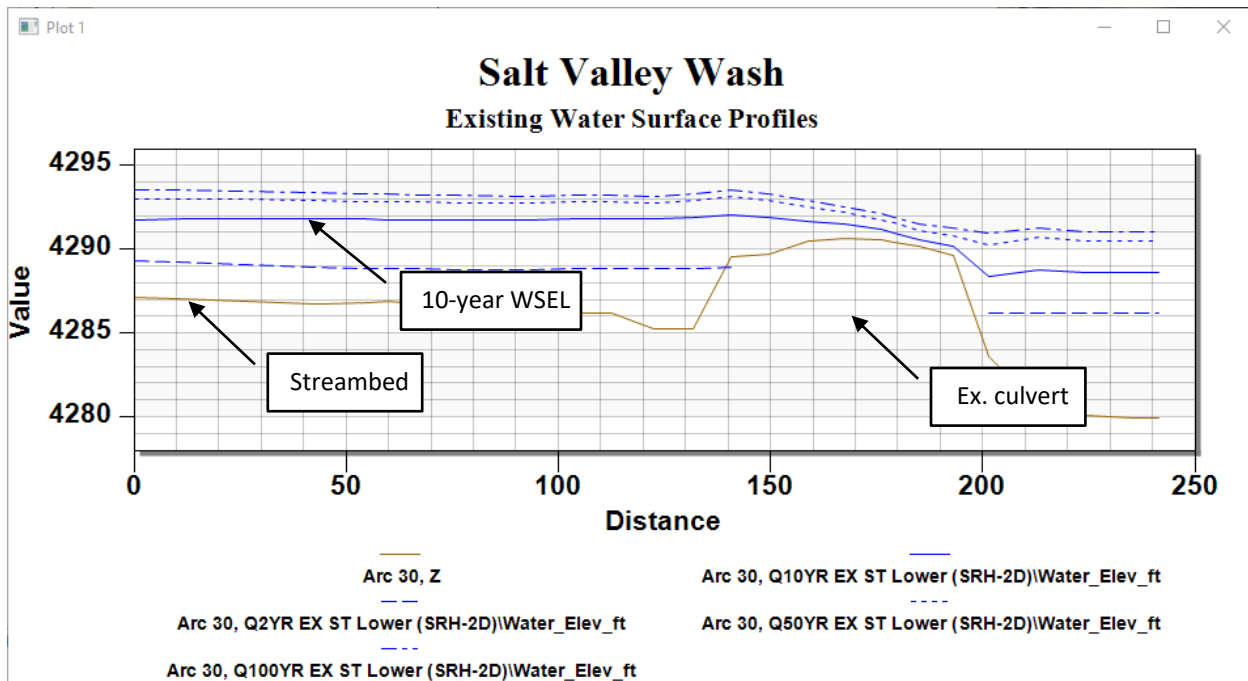


Figure 13 : Existing Salt Valley Wash Profile

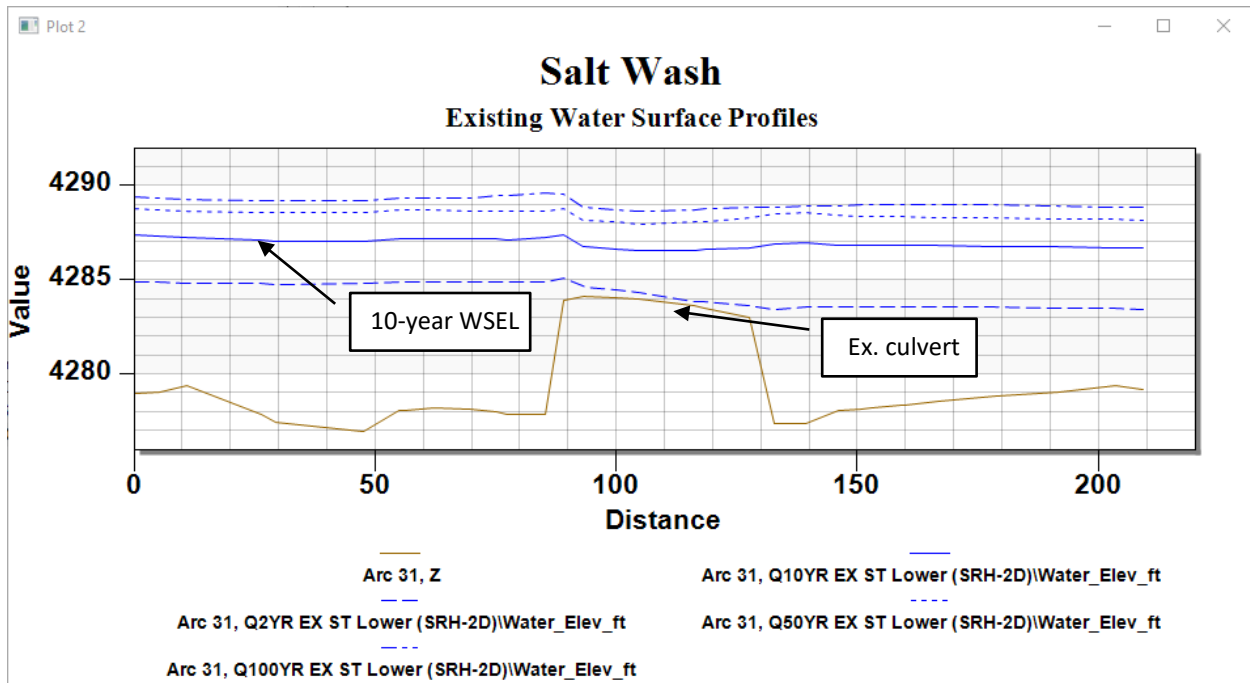


Figure 14 : Existing Salt Wash Profile

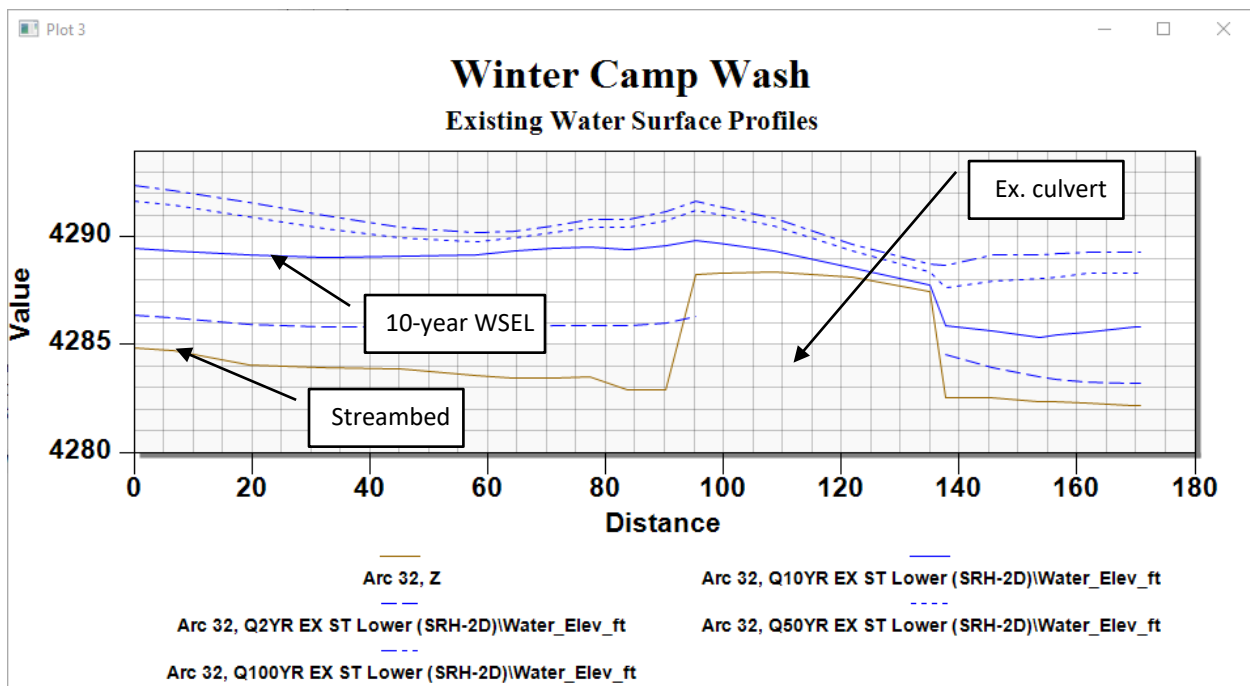


Figure 15: Existing Winter Camp Wash Profile

4.6.2 Proposed Conditions Model Results

Proposed conditions were established by modifying the existing topographic data and SRH-2D mesh to account for the existing culvert and roadway embankment removal. Other parameters, such as inlet and outlet boundary conditions and land cover, remained as in the existing condition. For Salt Valley Wash, the roadway will be realigned approximately 40 feet northeast as shown in the project plans. The proposed channel through the bridges will match downstream and upstream existing channel conditions to the extent practicable. Proposed abutments consist of spill-through 1V:3H slopes. Table 14 through Table 16 show the proposed conditions hydraulic model results extracted upstream of the bridges for the 2-, 10-, 50-, 100-year, and 200-year storm events. Figure 16 through Figure 18 show the water surface profiles cut along the channel centerline. Maps showing the two-dimensional water surface elevation results are included in Appendix D.

Table 14 : Proposed Conditions Hydraulic Results – Salt Valley Wash

Return Period (Year)	Velocity (ft/s)		Depth (ft)		WSEL (ft)	
	Average	Maximum	Average	Average	Average	Maximum
2	5.8	7.8	0.6	1.0	4287.2	4287.8
10	7.5	11.3	1.5	2.7	4289.4	4290.7
50	9.1	13.5	2.8	4.7	4291.2	4292.1
100	10.3	13.8	3.4	5.4	4291.8	4293.0
200	10.8	14.0	3.7	5.8	4292.1	4293.5

Table 15 : Proposed Conditions Hydraulic Results – Salt Wash

Return Period (Year)	Velocity (ft/s)		Depth (ft)		WSEL (ft)	
	Average	Maximum	Average	Maximum	Average	Maximum
2	2.0	3.4	3.4	5.9	4283.5	4284.1
10	3.9	6.3	4.7	9.4	4286.6	4287.1
50	5.9	7.9	5.4	11.2	4288.3	4289.3
100	6.2	8.4	6.1	12.1	4289.0	4290.0
200	6.2	8.5	6.5	12.6	4289.4	4290.6

Table 16 : Proposed Conditions Hydraulic Results – Winter Camp Wash

Return Period (Year)	Velocity (ft/s)		Depth (ft)		WSEL (ft)	
	Average	Maximum	Average	Maximum	Average	Maximum
2	5.6	7.3	0.8	1.2	4284.1	4284.2
10	7.9	13.0	1.5	2.7	4285.8	4286.6
50	7.9	15.5	1.3	4.7	4288.9	4292.1
100	8.3	14.8	2.0	5.9	4289.6	4292.5
200	8.7	14.5	2.5	6.7	4290.2	4293.0

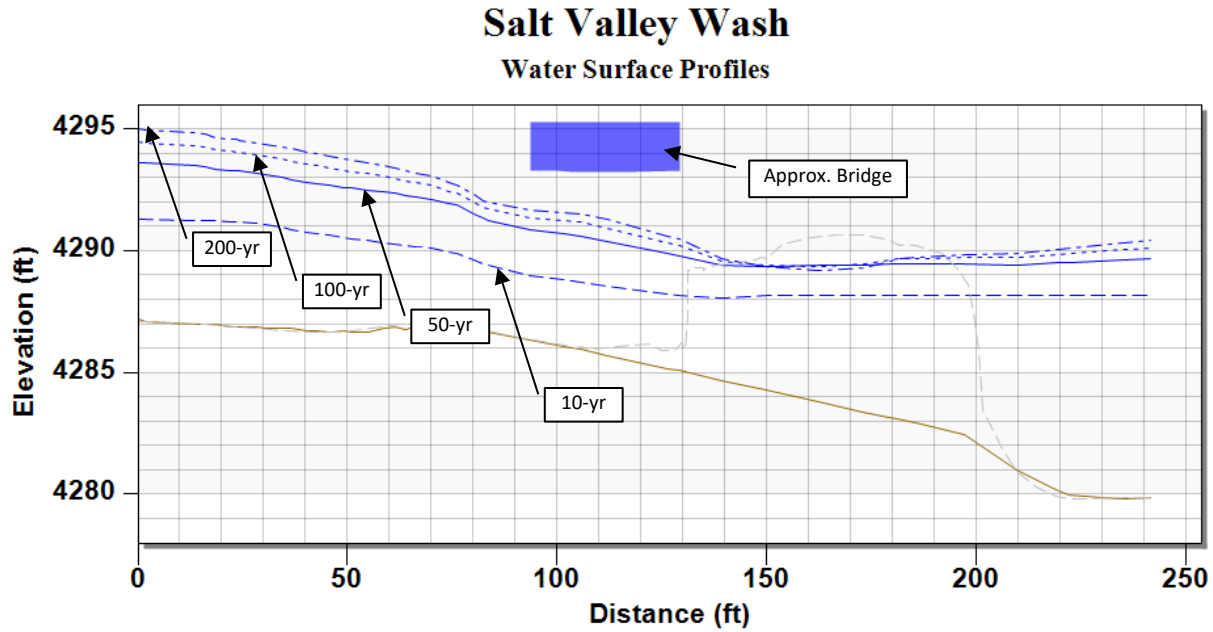


Figure 16 : Proposed Salt Valley Wash Profile

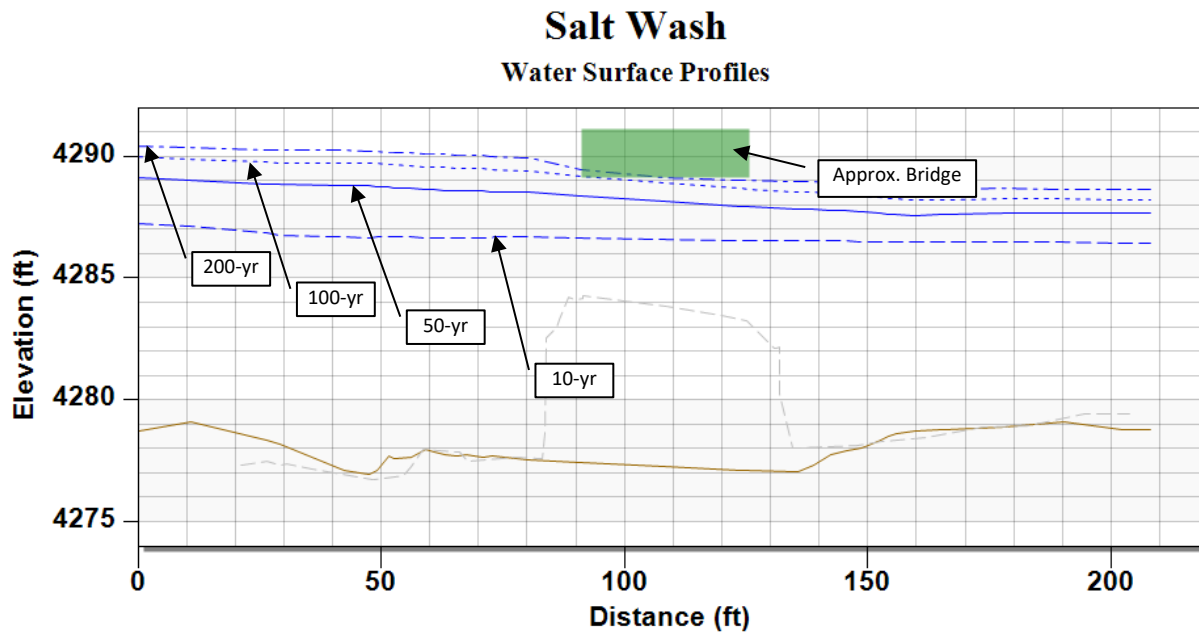


Figure 17 : Proposed Salt Wash Profile

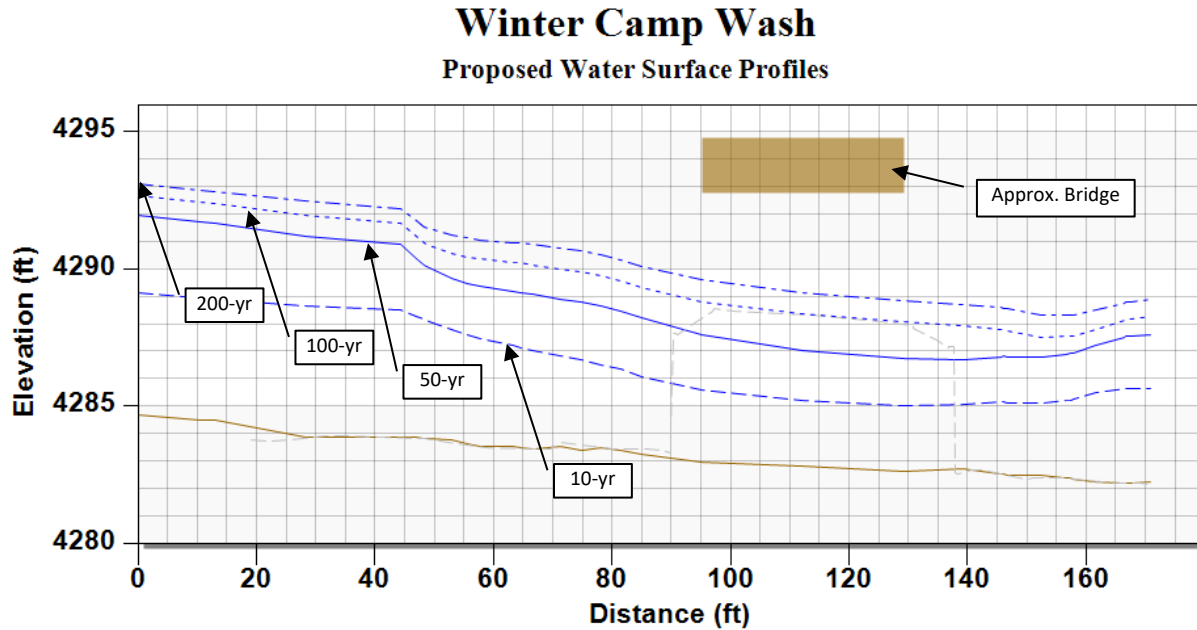


Figure 18 : Proposed Winter Camp Wash Profile

4.6.3 Bridge Freeboard

Bridge freeboard using average and maximum waters surface elevations at the upstream face of the bridges is reported in Table 17 through Table 19. Bridge freeboard was targeted to be a minimum of 2-feet for a 10-year design storm. As shown in the tables the desired freeboard criteria is satisfied. For the design storms evaluated, only the Salt Wash bridge experiences pressure flow and only for the 200-year event based on average conditions.

Table 17 : Bridge Freeboard – Salt Valley Wash

Return Period (Year)	WSEL (ft)		Bridge Low Chord (ft)	Freeboard (ft)	
	Average	Maximum		Average	Minimum
2	4287.2	4287.8	4295.0	7.8	7.3
10	4289.4	4290.7		5.6	4.4
50	4291.2	4292.1		3.9	3.0
100	4291.8	4293.0		3.3	2.1
200	4292.1	4293.5		2.9	1.5

Table 18 : Bridge Freeboard – Salt Wash

Return Period (Year)	WSEL (ft)		Bridge Low Chord (ft)	Freeboard (ft)	
	Average	Maximum		Average	Minimum
2	4283.5	4284.1	4289.1	5.6	5.1
10	4286.6	4287.1		2.6	2.1
50	4288.3	4289.3		0.8	-0.2
100	4289.0	4290.0		0.1	-0.8
200	4289.4	4290.6		-0.3	-1.5

Table 19 : Bridge Freeboard – Winter Camp Wash

Return Period (Year)	WSEL (ft)		Bridge Low Chord (ft)	Freeboard (ft)	
	Average	Maximum		Average	Minimum
2	4284.1	4284.2	4293.0	8.9	8.8
10	4285.8	4286.6		7.2	6.4
50	4288.9	4292.1		4.1	0.9
100	4289.6	4292.5		3.3	0.5
200	4290.2	4293.0		2.8	0.0

4.7 SCOUR EVALUATION

Bridge scour was evaluated for the three bridges in accordance with HEC-18 (Federal Highway Administration 2012). As stated in Section 2, scour is evaluated using a 100-year scour design flood and the 200-year scour check flood. Total scour is the combination of long-term degradation, contraction scour and local scour (pier and abutment scour). For this project, abutment scour was estimated using the NCHRP 24-20 method.

4.7.1 Geotechnical Investigation

Streambed samples were collected at Salt Valley Wash and Winter Camp Wash as part of the subsurface investigation documented in the project Geotechnical Report. Streambed materials were generally classified as poorly graded sands (SP). A gradation analysis of streambed material resulted in median particle sizes (D50) of 0.37 mm (0.0012 ft) and 0.31 mm (0.0010 ft) for the two sample sites. Due to the similarity the smallest median particle size was used to conduct the scour evaluation. Long term degradation was assumed to be zero based on the observed flow conditions of the washes and site conditions showing deposition. Any degradation evident at the sites appeared to be local and induced by the undersized culverts. It is expected that the installation of the bridges will improve the sediment connectivity at the crossings and channels

Contraction scour can occur under two conditions: live-bed and clear-water. Live-bed scour occurs when there is sediment transport of bed material from the upstream reach into the bridge section. Clear-water scour occurs when there is no transport of bed material into the bridge section. The applicable scour case is determined by comparing the mean velocity of the channel with the critical velocity for initiation of

motion using the median size (D_{50}) of the streambed materials. Based on the materials observed on site and the results of the geotechnical investigation a live bed scour condition can be expected. Abutment scour was estimated using the NCHRP 24-20 method which applies an amplification factor to the contraction scour at the abutments. A type a (main channel) scour condition was assumed in accordance with HEC-18. Pier scour was based on the HEC-18 pier scour equation. For the three sites, abutment scour depths were less than pier scour depths. Due to the potential for abutment flanking and lateral channel migrations it is recommended that the maximum scour elevations associated with pier scour are applied to both abutments and piers, and that they are referenced to the channel thalweg. A summary of total scour depths and recommended scour elevations are shown in Table 20. Additional details can be found in Appendix D.

Table 20: Total Scour Results

Bridge Site	Design Flood	Long Term Degradation (ft)	Contraction Scour (ft)	Pier Scour (ft)	Total Scour (ft)	Reference Elevation (ft)	Total Scour Elevation (ft)
Salt Valley Wash	100-year	0	1.43	7.44	8.87	4,280.0	4,271.1
	200-year	0	1.46	7.56	9.02	4,280.0	4,271.0
Salt Wash	100-year	0	0.61	6.32	6.93	4,277.0	4,270.1
	200-year	0	0.61	6.25	6.86	4,277.0	4,270.1
Winter Camp Wash	100-year	0	2.55	7.81	10.36	4,282.5	4,272.1
	200-year	0	3.1	7.84	10.94	4,282.5	4,271.6

Since the foundations are designed for total scour, no additional scour countermeasures are required for foundation stability. To protect the abutment slopes abutment embankment riprap is required at all three sites. Riprap sizing was evaluated using the 100-year scour design flood, the resulting riprap sizes varied from Class 2 up to Class 7. Due to difficulties sourcing riprap in the project area Class 3 was selected for abutment embankment protection at all sites. Riprap should be embedded a minimum of 2 feet below streambed level and extend a minimum of 25-feet behind and around the abutments. Riprap thickness should be approximately 30-inches. Class 1, Type A geotextile filter is recommended on in-situ soils with less than 15% passing a #200 (0.075 mm) sieve. For Salt Valley Wash left bank (looking downstream), abutment riprap should transition into bank protection and extend an additional 25-feet upstream. Riprap layout details can be found in the project plans.

5 REFERENCES

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Appendix A

Existing Site Conditions

Existing Conditions Photos

Salt Valley Wash

BRG: 332°NW (T) POS: 38°44'0"N, 109°31'26"W ±13ft ALT: 4271ft



Upstream of Salt Valley Wash

BRG: 201°S (T) POS: 38°44'1"N, 109°31'26"W ±13ft ALT: 4275ft



Inlet of Salt Valley Wash

BRG: 180°S (T) POS: 38°44'0"N, 109°31'26"W ±13ft ALT: 4279ft



Downstream of Salt Valley Wash

BRG: 15°N (T) POS: 38°44'0"N, 109°31'26"W ±13ft ALT: 4261ft



Outlet of Salt Valley Wash

Salt Wash

BRG: 181°S (T) POS: 38°44'7"N, 109°31'10"W ±13ft ALT: 4266ft



Inlet of Salt Wash

BRG: 151°SE (T) POS: 38°44'6"N, 109°31'10"W ±13ft ALT: 4268ft



Downstream of Salt Wash

BRG: 24°NE (T) POS: 38°44'6"N, 109°31'10"W ±13ft ALT: 4271ft



Outlet of Salt Wash

Winter Camp Wash



Upstream of Winter Camp Wash



Condition of Existing Culvert

BRG: 245°SW (T) POS: 38°44'3"N, 109°31'3"W ±13ft ALT: 4270ft



Winter Camp Wash, Downstream

Appendix B

Hydrology

StreamStats Salt Valley Wash

8/4/22, 9:24 AM

StreamStats

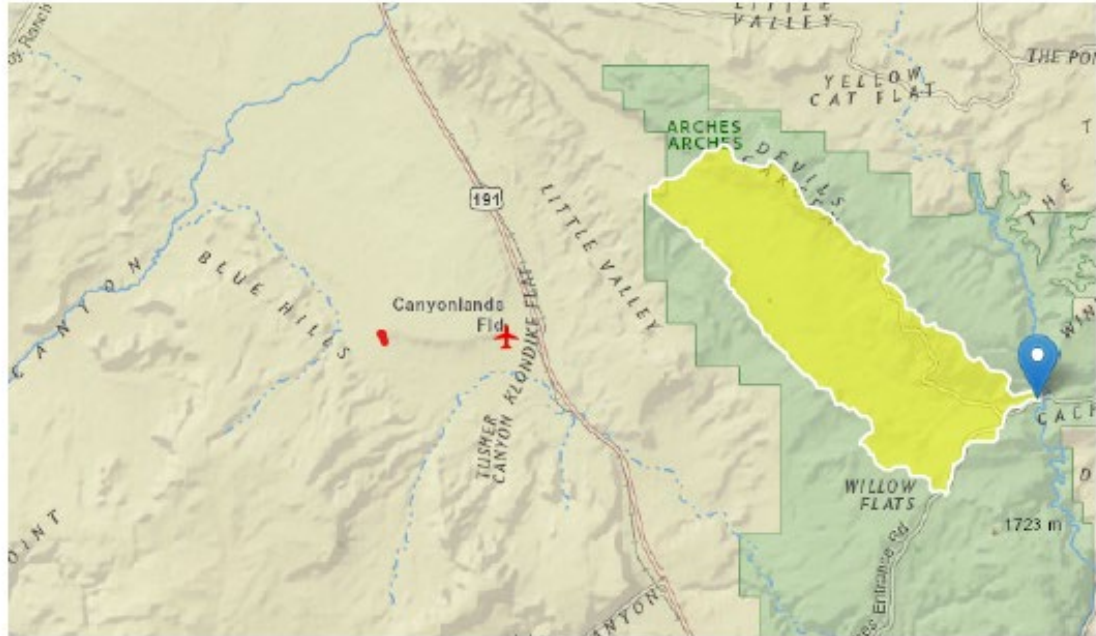
Salt Valley Wash StreamStats Report

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Workspace ID: UT20220804152301034000

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Time: 2022-08-04 09:23:16 -0600



 Collapse All

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
APRAVPRE	Mean April Precipitation	0.96	inches
AUGAVPRE	Mean August Precipitation	0.89	inches
BSLDEM10M	Mean basin slope computed from 10 m DEM	10.5	percent
DECAVPRE	Mean December Precipitation	0.66	inches
DRNAREA	Area that drains to a point on a stream	26.7	square miles

<https://streamstats.usgs.gov/ss/>

1/3

Parameter Code	Parameter Description	Value	Unit
ELEV	Mean Basin Elevation	4900	feet
FEBAVPRE	Mean February Precipitation	0.59	inches
FOREST	Percentage of area covered by forest	1.32	percent
JANAVPRE	Mean January Precipitation	0.75	inches
JULAVPRE	Mean July Precipitation	0.91	inches
JUNAVPRE	Mean June Precipitation	0.44	inches
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	1.15	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	0.18	percent
LU92HRBN	Percent Natural Herbaceous Upland from NLCD1992	5.18	percent
MARAVPRE	Mean March Precipitation	1.03	inches
MAYAVPRE	Mean May Precipitation	1.01	inches
NOVAVPRE	Mean November Precipitation	0.96	inches
OCTAVPRE	Mean October Precipitation	1.47	inches
PRECIP	Mean Annual Precipitation	9.62	inches
SEPAVPRE	Mean September Precipitation	0.85	inches
SLOP30_10M	Percent area with slopes greater than 30 percent from 10-meter NED	7.14	percent

➤ Peak-Flow Statistics

Peak-Flow Statistics Parameters [Region 6]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	26.7	square miles	0.87	532
ELEV	Mean Basin Elevation	4900	feet	4300	9380

Peak-Flow Statistics Flow Report [Region 6]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	ASEp	Equiv. Yrs.
50-percent AEP flood	520	ft ³ /s	108	108	1.4
20-percent AEP flood	1310	ft ³ /s	80	80	3
10-percent AEP flood	2100	ft ³ /s	70	70	5.1
4-percent AEP flood	3540	ft ³ /s	62	62	8.4
2-percent AEP flood	4940	ft ³ /s	60	60	11
1-percent AEP flood	6880	ft ³ /s	61	61	13
0.5-percent AEP flood	8580	ft ³ /s	62	62	14.4
0.2-percent AEP flood	11800	ft ³ /s	66	66	15.4

Peak-Flow Statistics Citations

Kenney, T.A., Wilkowske, C.D., and Wright, S.J., 2007, Methods for Estimating Magnitude and Frequency of Peak Flows for Natural Streams in Utah: U.S. Geological Survey Scientific Investigations Report 2007-5158, 28 p. (<http://pubs.usgs.gov/sir/2007/5158/>)

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Application Version: 4.10.1

StreamStats Services Version: 1.2.22

NSS Services Version: 2.2.1

StreamStats Salt Wash

8/4/22, 8:49 AM

StreamStats

Salt Wash StreamStats Report

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Workspace ID: UT20220804144437309000
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Time: 2022-08-04 08:44:51 -0600



Collapse All

> Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
APRAVPRE	Mean April Precipitation	0.88	inches
AUGAVPRE	Mean August Precipitation	0.84	inches
BSLDEM10M	Mean basin slope computed from 10 m DEM	10.4	percent
DECAVPRE	Mean December Precipitation	0.6	inches
DRNAREA	Area that drains to a point on a stream	117	square miles

<https://streamstats.usgs.gov/ss/>

1/3

Parameter Code	Parameter Description	Value	Unit
ELEV	Mean Basin Elevation	4880	feet
FEBAVPRE	Mean February Precipitation	0.56	inches
FOREST	Percentage of area covered by forest	0.42	percent
JANAVPRE	Mean January Precipitation	0.76	inches
JULAVPRE	Mean July Precipitation	0.8	inches
JUNAVPRE	Mean June Precipitation	0.4	inches
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	0.3	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	0.14	percent
LU92HRBN	Percent Natural Herbaceous Upland from NLCD1992	9.4	percent
MARAVPRE	Mean March Precipitation	1	inches
MAYAVPRE	Mean May Precipitation	0.97	inches
NOVAVPRE	Mean November Precipitation	0.83	inches
OCTAVPRE	Mean October Precipitation	1.33	inches
PRECIP	Mean Annual Precipitation	9.48	inches
SEPAVPRE	Mean September Precipitation	0.87	inches
SLOP30_10M	Percent area with slopes greater than 30 percent from 10-meter NED	7.65	percent

➤ Peak-Flow Statistics

Peak-Flow Statistics Parameters [Region 6]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	117	square miles	0.87	532
ELEV	Mean Basin Elevation	4880	feet	4300	9380

Peak-Flow Statistics Flow Report [Region 6]

PIL: Prediction Interval-Lower, Plu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	ASEp	Equiv. Yrs.
50-percent AEP flood	1190	ft ³ /s	108	108	1.4
20-percent AEP flood	2680	ft ³ /s	80	80	3
10-percent AEP flood	4080	ft ³ /s	70	70	5.1
4-percent AEP flood	6560	ft ³ /s	62	62	8.4
2-percent AEP flood	8890	ft ³ /s	60	60	11
1-percent AEP flood	12400	ft ³ /s	61	61	13
0.5-percent AEP flood	14800	ft ³ /s	62	62	14.4
0.2-percent AEP flood	19900	ft ³ /s	66	66	15.4

Peak-Flow Statistics Citations

Kenney, T.A., Wilkowske, C.D., and Wright, S.J., 2007, Methods for Estimating Magnitude and Frequency of Peak Flows for Natural Streams in Utah: U.S. Geological Survey Scientific Investigations Report 2007-5158, 28 p. (<http://pubs.usgs.gov/sir/2007/5158/>)

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Application Version: 4.10.1

StreamStats Services Version: 1.2.22

NSS Services Version: 2.2.1

StreamStats Winter Camp Wash

8/4/22, 9:32 AM

StreamStats

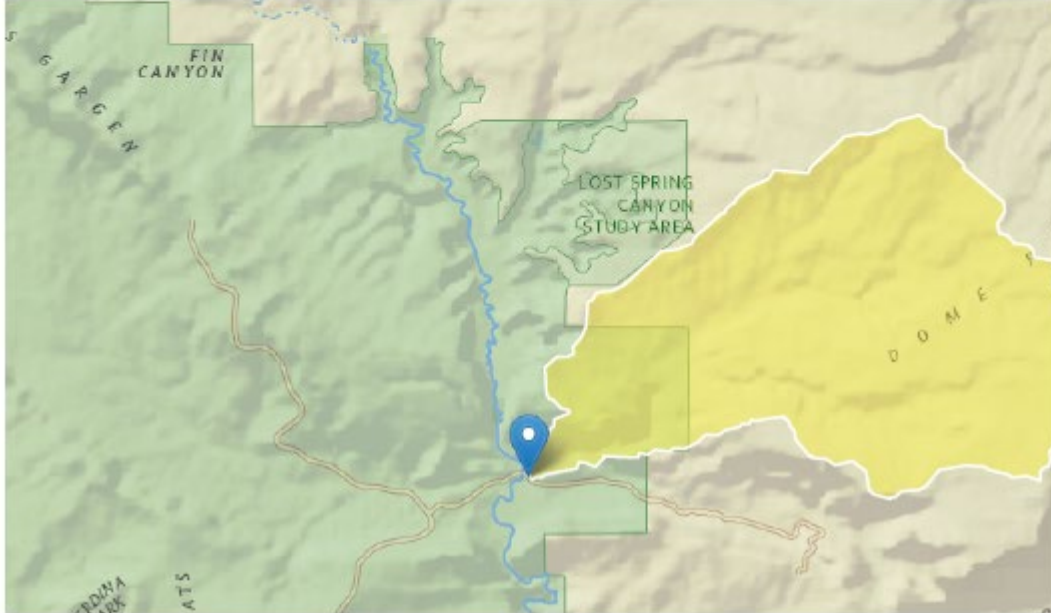
Winter Camp Wash StreamStats Report

Region ID: UT

Workspace ID: UT20220804152839316000

Clicked Point (Latitude, Longitude): 38.73403, -109.51730

Time: 2022-08-04 09:28:53 -0600



[+ Collapse All](#)

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
APRAVPRE	Mean April Precipitation	1.06	inches
AUGAVPRE	Mean August Precipitation	0.95	inches
BSLDEM10M	Mean basin slope computed from 10 m DEM	11.5	percent
DECAVPRE	Mean December Precipitation	0.7	inches
DRNAREA	Area that drains to a point on a stream	19.2	square miles

<https://streamstats.usgs.gov/ss/>

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Parameter Code	Parameter Description	Value	Unit
ELEV	Mean Basin Elevation	5190	feet
FEBVPRE	Mean February Precipitation	0.68	inches
FOREST	Percentage of area covered by forest	0.18	percent
JANVPRE	Mean January Precipitation	0.77	inches
JULVPRE	Mean July Precipitation	1.05	inches
JUNVPRE	Mean June Precipitation	0.5	inches
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	0	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	0.000153	percent
LU92HRBN	Percent Natural Herbaceous Upland from NLCD1992	4.5	percent
MARVPRE	Mean March Precipitation	1.13	inches
MAYVPRE	Mean May Precipitation	1.12	inches
NOVAVPRE	Mean November Precipitation	1.14	inches
OCTVPRE	Mean October Precipitation	1.61	inches
PRECIP	Mean Annual Precipitation	10.6	inches
SEPAVPRE	Mean September Precipitation	0.92	inches
SLOP30_10M	Percent area with slopes greater than 30 percent from 10-meter NED	6.89	percent

➤ Peak-Flow Statistics

Peak-Flow Statistics Parameters [Region 6]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	19.2	square miles	0.87	532
ELEV	Mean Basin Elevation	5190	feet	4300	9380

Peak-Flow Statistics Flow Report [Region 6]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	ASEp	Equiv. Yrs.
50-percent AEP flood	376	ft ³ /s	108	108	1.4
20-percent AEP flood	970	ft ³ /s	80	80	3
10-percent AEP flood	1570	ft ³ /s	70	70	5.1
4-percent AEP flood	2670	ft ³ /s	62	62	8.4
2-percent AEP flood	3750	ft ³ /s	60	60	11
1-percent AEP flood	5220	ft ³ /s	61	61	13
0.5-percent AEP flood	6560	ft ³ /s	62	62	14.4
0.2-percent AEP flood	9080	ft ³ /s	66	66	15.4

Peak-Flow Statistics Citations

Kenney, T.A., Wilkowske, C.D., and Wright, S.J., 2007, Methods for Estimating Magnitude and Frequency of Peak Flows for Natural Streams in Utah: U.S. Geological Survey Scientific Investigations Report 2007-5158, 28 p. (<http://pubs.usgs.gov/sir/2007/5158/>)

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Application Version: 4.10.1

StreamStats Services Version: 1.2.22

NSS Services Version: 2.2.1

Precipitation Frequency Data Server Information – Salt Valley Wash

8/16/22, 2:58 PM

Precipitation Frequency Data Server



NOAA Atlas 14, Volume 1, Version 5
Location name: Thompson, Utah, USA*
Latitude: 38.7624°, Longitude: -109.6102°
Elevation: 4805.39 ft**
* source: E8RI Maps
** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Helm, Lillian Hiner, Kazungu Maitani, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypsak, Dale Unruh, Fenglin Yan, Michael Yetka, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchon

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) ¹									
Duration	Average recurrence interval (years)								
	1	2	5	10	25	50	100	500	1000
5-min	0.110 (0.096-0.129)	0.141 (0.127-0.167)	0.191 (0.170-0.226)	0.239 (0.213-0.285)	0.313 (0.277-0.377)	0.378 (0.332-0.464)	0.456 (0.396-0.575)	0.548 (0.467-0.711)	0.632 (0.573-0.938)
10-min	0.167 (0.146-0.196)	0.214 (0.193-0.254)	0.291 (0.259-0.344)	0.363 (0.325-0.434)	0.476 (0.422-0.575)	0.575 (0.505-0.706)	0.695 (0.602-0.876)	0.834 (0.711-1.08)	1.05 (0.872-1.43)
15-min	0.207 (0.181-0.243)	0.265 (0.239-0.314)	0.361 (0.321-0.426)	0.451 (0.403-0.538)	0.590 (0.523-0.712)	0.713 (0.626-0.875)	0.861 (0.746-1.09)	1.03 (0.861-1.34)	1.31 (1.08-1.77)
30-min	0.279 (0.244-0.327)	0.357 (0.322-0.423)	0.486 (0.432-0.574)	0.607 (0.542-0.725)	0.794 (0.704-0.959)	0.961 (0.843-1.18)	1.16 (1.00-1.46)	1.39 (1.19-1.81)	1.76 (1.46-2.38)
60-min	0.345 (0.302-0.405)	0.442 (0.398-0.523)	0.601 (0.535-0.711)	0.751 (0.671-0.897)	0.983 (0.871-1.19)	1.19 (1.04-1.46)	1.44 (1.24-1.81)	1.72 (1.47-2.24)	2.18 (1.80-2.95)
2-hr	0.422 (0.376-0.489)	0.532 (0.468-0.613)	0.711 (0.626-0.820)	0.875 (0.764-1.00)	1.15 (0.983-1.32)	1.40 (1.17-1.62)	1.71 (1.39-1.99)	2.07 (1.63-2.44)	2.67 (2.00-3.22)
3-hr	0.469 (0.420-0.531)	0.587 (0.522-0.667)	0.763 (0.679-0.860)	0.926 (0.817-1.04)	1.19 (1.03-1.34)	1.44 (1.23-1.63)	1.74 (1.45-2.01)	2.10 (1.72-2.47)	2.70 (2.12-3.26)
6-hr	0.588 (0.534-0.651)	0.728 (0.663-0.809)	0.921 (0.839-1.01)	1.09 (0.984-1.20)	1.35 (1.20-1.50)	1.56 (1.38-1.74)	1.83 (1.58-2.06)	2.19 (1.86-2.49)	2.79 (2.30-3.29)
12-hr	0.723 (0.658-0.796)	0.898 (0.818-0.992)	1.12 (1.01-1.23)	1.30 (1.18-1.44)	1.57 (1.41-1.74)	1.79 (1.59-1.98)	2.02 (1.78-2.27)	2.30 (1.99-2.59)	2.88 (2.45-3.30)
24-hr	0.887 (0.812-0.974)	1.11 (1.01-1.21)	1.38 (1.26-1.51)	1.60 (1.46-1.77)	1.93 (1.73-2.14)	2.19 (1.93-2.45)	2.47 (2.15-2.81)	2.76 (2.36-3.21)	3.18 (2.65-3.82)
2-day	0.978 (0.897-1.07)	1.22 (1.12-1.33)	1.51 (1.38-1.64)	1.75 (1.59-1.92)	2.10 (1.88-2.32)	2.38 (2.10-2.66)	2.69 (2.32-3.06)	3.01 (2.55-3.51)	3.87 (2.85-4.21)
3-day	1.05 (0.963-1.15)	1.31 (1.20-1.43)	1.63 (1.48-1.78)	1.89 (1.72-2.07)	2.27 (2.04-2.52)	2.58 (2.28-2.89)	2.91 (2.52-3.32)	3.27 (2.77-3.81)	4.20 (3.11-4.56)
4-day	1.13 (1.03-1.23)	1.40 (1.28-1.54)	1.75 (1.59-1.91)	2.03 (1.84-2.23)	2.45 (2.19-2.71)	2.78 (2.45-3.12)	3.14 (2.72-3.58)	3.52 (2.99-4.11)	4.54 (3.36-4.91)
7-day	1.28 (1.17-1.40)	1.60 (1.46-1.74)	1.99 (1.82-2.18)	2.31 (2.10-2.54)	2.77 (2.48-3.08)	3.14 (2.78-3.53)	3.54 (3.07-4.05)	3.96 (3.37-4.62)	5.06 (3.77-5.51)
10-day	1.43 (1.31-1.56)	1.78 (1.63-1.95)	2.22 (2.03-2.43)	2.58 (2.34-2.83)	3.08 (2.77-3.41)	3.48 (3.09-3.89)	3.91 (3.41-4.43)	4.35 (3.74-5.02)	5.53 (4.18-5.94)
20-day	1.81 (1.65-1.99)	2.26 (2.06-2.48)	2.82 (2.56-3.09)	3.25 (2.93-3.58)	3.85 (3.44-4.27)	4.31 (3.81-4.82)	4.79 (4.18-5.42)	5.28 (4.53-6.07)	6.48 (4.99-7.00)
30-day	2.19 (2.00-2.40)	2.73 (2.49-2.99)	3.37 (3.07-3.69)	3.88 (3.51-4.25)	4.55 (4.08-5.03)	5.07 (4.49-5.65)	5.60 (4.90-6.30)	6.13 (5.28-7.00)	7.42 (5.78-8.00)
45-day	2.64 (2.40-2.87)	3.29 (2.99-3.59)	4.05 (3.68-4.42)	4.65 (4.22-5.08)	5.45 (4.89-6.00)	6.05 (5.38-6.72)	6.67 (5.86-7.48)	7.29 (6.32-8.29)	8.76 (6.90-9.43)
60-day	3.09 (2.82-3.38)	3.85 (3.51-4.21)	4.72 (4.29-5.16)	5.39 (4.88-5.90)	6.26 (5.63-6.89)	6.92 (6.16-7.67)	7.57 (6.67-8.47)	8.22 (7.16-9.30)	9.71 (7.77-10.4)

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

https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_printpage.html?lat=38.7624&lon=-109.6102&data-depth&units=english&series=pds

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Precipitation Frequency Data Server Information – Salt Wash

8/16/22, 3:02 PM

Precipitation Frequency Data Server



NOAA Atlas 14, Volume 1, Version 5
Location name: Thompson, Utah, USA*
Latitude: 38.9186°, Longitude: -109.6161°
Elevation: 4821.88 ft**
* source: ESRI Maps
** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Helm, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishant Roy, Carl Trypsak, Dale Umruh, Fenglin Yan, Michael Yetka, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchon

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & arials](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.105 (0.092-0.123)	0.135 (0.121-0.160)	0.186 (0.163-0.218)	0.233 (0.205-0.276)	0.308 (0.266-0.367)	0.375 (0.320-0.452)	0.455 (0.381-0.559)	0.549 (0.449-0.690)	0.697 (0.550-0.908)	0.833 (0.639-1.12)
10-min	0.160 (0.140-0.187)	0.206 (0.184-0.244)	0.283 (0.249-0.333)	0.355 (0.312-0.421)	0.469 (0.406-0.558)	0.570 (0.486-0.687)	0.692 (0.580-0.851)	0.834 (0.683-1.05)	1.06 (0.837-1.38)	1.27 (0.972-1.71)
15-min	0.199 (0.174-0.232)	0.256 (0.228-0.302)	0.350 (0.308-0.412)	0.440 (0.387-0.521)	0.581 (0.503-0.692)	0.707 (0.603-0.852)	0.858 (0.719-1.06)	1.03 (0.847-1.30)	1.32 (1.04-1.71)	1.57 (1.21-2.12)
30-min	0.267 (0.234-0.313)	0.344 (0.307-0.407)	0.472 (0.415-0.555)	0.592 (0.521-0.702)	0.782 (0.677-0.932)	0.952 (0.812-1.15)	1.16 (0.968-1.42)	1.39 (1.14-1.75)	1.77 (1.40-2.31)	2.12 (1.62-2.85)
60-min	0.331 (0.290-0.387)	0.426 (0.380-0.503)	0.584 (0.514-0.687)	0.733 (0.645-0.869)	0.967 (0.838-1.15)	1.18 (1.00-1.42)	1.43 (1.20-1.76)	1.72 (1.41-2.17)	2.19 (1.73-2.86)	2.62 (2.01-3.53)
2-hr	0.403 (0.358-0.467)	0.510 (0.449-0.586)	0.686 (0.603-0.787)	0.846 (0.740-0.966)	1.12 (0.952-1.28)	1.36 (1.14-1.57)	1.66 (1.35-1.93)	2.02 (1.58-2.38)	2.59 (1.94-3.14)	3.13 (2.26-3.86)
3-hr	0.450 (0.403-0.511)	0.564 (0.502-0.642)	0.737 (0.656-0.833)	0.898 (0.791-1.01)	1.15 (1.00-1.31)	1.39 (1.19-1.59)	1.69 (1.40-1.94)	2.04 (1.65-2.40)	2.62 (2.04-3.17)	3.15 (2.38-3.90)
6-hr	0.566 (0.513-0.628)	0.703 (0.638-0.783)	0.894 (0.811-0.987)	1.06 (0.955-1.18)	1.31 (1.17-1.46)	1.53 (1.34-1.71)	1.78 (1.54-2.03)	2.13 (1.81-2.44)	2.72 (2.23-3.17)	3.26 (2.61-3.94)
12-hr	0.697 (0.634-0.768)	0.865 (0.790-0.958)	1.08 (0.982-1.19)	1.26 (1.14-1.39)	1.53 (1.37-1.69)	1.74 (1.54-1.93)	1.97 (1.73-2.21)	2.24 (1.94-2.54)	2.80 (2.38-3.22)	3.33 (2.78-3.98)
24-hr	0.889 (0.817-0.971)	1.10 (1.02-1.21)	1.36 (1.25-1.49)	1.58 (1.44-1.73)	1.88 (1.71-2.07)	2.12 (1.90-2.34)	2.37 (2.10-2.65)	2.63 (2.30-2.98)	2.99 (2.56-3.47)	3.36 (2.81-4.02)
2-day	0.977 (0.901-1.06)	1.21 (1.12-1.32)	1.49 (1.37-1.62)	1.72 (1.57-1.87)	2.04 (1.85-2.23)	2.29 (2.05-2.52)	2.56 (2.26-2.85)	2.84 (2.47-3.22)	3.23 (2.74-3.76)	3.55 (2.94-4.24)
3-day	1.03 (0.953-1.12)	1.28 (1.18-1.40)	1.58 (1.45-1.72)	1.83 (1.67-1.98)	2.17 (1.96-2.37)	2.44 (2.18-2.69)	2.72 (2.40-3.04)	3.02 (2.62-3.42)	3.44 (2.91-4.00)	3.78 (3.13-4.50)
4-day	1.09 (1.00-1.19)	1.36 (1.25-1.48)	1.68 (1.54-1.82)	1.93 (1.77-2.10)	2.30 (2.08-2.51)	2.59 (2.31-2.85)	2.89 (2.55-3.22)	3.21 (2.78-3.63)	3.65 (3.09-4.23)	4.01 (3.32-4.76)
7-day	1.23 (1.13-1.34)	1.52 (1.40-1.66)	1.88 (1.73-2.04)	2.16 (1.98-2.35)	2.57 (2.32-2.80)	2.87 (2.58-3.17)	3.20 (2.83-3.57)	3.54 (3.08-4.01)	4.01 (3.41-4.66)	4.38 (3.65-5.22)
10-day	1.36 (1.25-1.48)	1.69 (1.55-1.84)	2.08 (1.91-2.27)	2.39 (2.19-2.61)	2.83 (2.56-3.10)	3.16 (2.84-3.49)	3.51 (3.11-3.91)	3.87 (3.38-4.36)	4.36 (3.73-5.03)	4.76 (3.99-5.62)
20-day	1.65 (1.51-1.81)	2.06 (1.88-2.25)	2.53 (2.31-2.77)	2.91 (2.64-3.17)	3.41 (3.08-3.74)	3.79 (3.39-4.18)	4.18 (3.70-4.65)	4.57 (3.99-5.13)	5.09 (4.37-5.82)	5.48 (4.63-6.36)
30-day	2.00 (1.83-2.19)	2.49 (2.27-2.72)	3.04 (2.77-3.32)	3.46 (3.15-3.79)	4.02 (3.63-4.42)	4.44 (3.98-4.91)	4.86 (4.32-5.41)	5.28 (4.63-5.93)	5.82 (5.01-6.65)	6.22 (5.29-7.22)
45-day	2.34 (2.15-2.55)	2.91 (2.66-3.17)	3.55 (3.25-3.85)	4.03 (3.69-4.38)	4.67 (4.24-5.09)	5.13 (4.63-5.63)	5.59 (5.00-6.17)	6.03 (5.34-6.72)	6.59 (5.76-7.45)	6.99 (6.04-8.01)
60-day	2.71 (2.49-2.97)	3.37 (3.09-3.67)	4.10 (3.75-4.46)	4.65 (4.25-5.05)	5.36 (4.87-5.84)	5.87 (5.30-6.43)	6.38 (5.71-7.03)	6.86 (6.09-7.62)	7.46 (6.54-8.40)	7.89 (6.84-9.00)

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

https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_printpage.html?lat=38.9186&lon=-109.6161&data=depth&units=english&series=pds

1/4

Precipitation Frequency Data Server Information – Winter Camp Wash

8/16/22, 3:00 PM

Precipitation Frequency Data Server



NOAA Atlas 14, Volume 1, Version 5
Location name: Thompson, Utah, USA*
Latitude: 38.7601°, Longitude: -109.4489°
Elevation: 5137.55 ft**
* source: ESRI Maps
** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

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NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aeriels](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.113 (0.099-0.132)	0.145 (0.129-0.170)	0.197 (0.174-0.232)	0.245 (0.218-0.291)	0.321 (0.283-0.385)	0.387 (0.339-0.473)	0.467 (0.404-0.585)	0.560 (0.476-0.722)	0.706 (0.584-0.951)	0.840 (0.678-1.18)
10-min	0.171 (0.151-0.201)	0.220 (0.197-0.259)	0.299 (0.265-0.352)	0.373 (0.333-0.443)	0.488 (0.431-0.587)	0.589 (0.516-0.720)	0.710 (0.615-0.891)	0.852 (0.724-1.10)	1.07 (0.889-1.45)	1.28 (1.03-1.79)
15-min	0.212 (0.186-0.249)	0.273 (0.244-0.321)	0.371 (0.329-0.437)	0.463 (0.412-0.550)	0.605 (0.535-0.728)	0.730 (0.639-0.892)	0.880 (0.762-1.10)	1.06 (0.898-1.36)	1.33 (1.10-1.79)	1.58 (1.28-2.22)
30-min	0.286 (0.251-0.335)	0.367 (0.329-0.433)	0.499 (0.443-0.588)	0.623 (0.555-0.740)	0.815 (0.720-0.980)	0.983 (0.861-1.20)	1.19 (1.03-1.49)	1.42 (1.21-1.84)	1.79 (1.48-2.42)	2.13 (1.72-2.99)
60-min	0.354 (0.310-0.415)	0.455 (0.407-0.535)	0.618 (0.548-0.728)	0.771 (0.687-0.916)	1.01 (0.891-1.21)	1.22 (1.07-1.49)	1.47 (1.27-1.84)	1.76 (1.50-2.27)	2.22 (1.84-2.99)	2.64 (2.13-3.71)
2-hr	0.433 (0.386-0.502)	0.546 (0.480-0.628)	0.730 (0.643-0.841)	0.897 (0.786-1.03)	1.18 (1.01-1.35)	1.44 (1.20-1.66)	1.74 (1.42-2.04)	2.12 (1.67-2.50)	2.72 (2.05-3.28)	3.28 (2.38-4.04)
3-hr	0.483 (0.432-0.547)	0.605 (0.537-0.686)	0.785 (0.697-0.884)	0.953 (0.838-1.07)	1.22 (1.06-1.38)	1.47 (1.26-1.67)	1.78 (1.49-2.04)	2.15 (1.75-2.52)	2.75 (2.17-3.32)	3.31 (2.52-4.08)
6-hr	0.608 (0.553-0.673)	0.755 (0.685-0.837)	0.952 (0.867-1.05)	1.13 (1.02-1.25)	1.39 (1.24-1.55)	1.62 (1.43-1.81)	1.89 (1.63-2.13)	2.26 (1.93-2.58)	2.88 (2.37-3.33)	3.44 (2.78-4.12)
12-hr	0.757 (0.689-0.832)	0.938 (0.857-1.04)	1.17 (1.06-1.29)	1.36 (1.23-1.50)	1.64 (1.47-1.82)	1.87 (1.66-2.07)	2.11 (1.86-2.37)	2.40 (2.09-2.71)	3.01 (2.57-3.44)	3.58 (3.00-4.14)
24-hr	0.950 (0.867-1.04)	1.18 (1.08-1.30)	1.47 (1.34-1.62)	1.71 (1.55-1.89)	2.05 (1.84-2.28)	2.33 (2.07-2.61)	2.63 (2.30-2.98)	2.94 (2.53-3.39)	3.39 (2.85-4.01)	3.76 (3.09-4.55)
2-day	1.05 (0.965-1.16)	1.31 (1.20-1.44)	1.63 (1.48-1.78)	1.89 (1.71-2.07)	2.27 (2.03-2.51)	2.57 (2.27-2.87)	2.90 (2.52-3.28)	3.25 (2.77-3.75)	3.75 (3.11-4.46)	4.17 (3.37-5.10)
3-day	1.14 (1.04-1.25)	1.42 (1.30-1.55)	1.77 (1.61-1.94)	2.07 (1.86-2.27)	2.49 (2.22-2.76)	2.83 (2.49-3.16)	3.19 (2.77-3.62)	3.58 (3.05-4.14)	4.14 (3.44-4.93)	4.61 (3.73-5.63)
4-day	1.23 (1.12-1.35)	1.54 (1.40-1.69)	1.92 (1.74-2.11)	2.25 (2.02-2.47)	2.71 (2.41-3.01)	3.08 (2.71-3.45)	3.49 (3.02-3.96)	3.92 (3.34-4.53)	4.54 (3.76-5.40)	5.05 (4.09-6.16)
7-day	1.43 (1.30-1.57)	1.78 (1.62-1.96)	2.23 (2.02-2.46)	2.61 (2.35-2.88)	3.14 (2.80-3.50)	3.57 (3.14-4.01)	4.03 (3.49-4.60)	4.52 (3.85-5.24)	5.22 (4.33-6.22)	5.79 (4.70-7.08)
10-day	1.60 (1.46-1.77)	2.00 (1.82-2.20)	2.51 (2.27-2.76)	2.92 (2.63-3.22)	3.50 (3.13-3.90)	3.98 (3.51-4.45)	4.47 (3.89-5.07)	5.00 (4.28-5.75)	5.76 (4.81-6.79)	6.39 (5.22-7.70)
20-day	2.07 (1.88-2.29)	2.60 (2.35-2.86)	3.22 (2.91-3.56)	3.72 (3.34-4.12)	4.40 (3.92-4.90)	4.93 (4.34-5.52)	5.47 (4.76-6.20)	6.02 (5.17-6.91)	6.79 (5.71-7.94)	7.38 (6.12-8.78)
30-day	2.52 (2.29-2.77)	3.14 (2.85-3.45)	3.87 (3.51-4.26)	4.45 (4.01-4.91)	5.23 (4.68-5.82)	5.83 (5.16-6.53)	6.45 (5.64-7.27)	7.07 (6.11-8.08)	7.91 (6.71-9.21)	8.57 (7.15-10.1)
45-day	3.06 (2.78-3.36)	3.82 (3.46-4.20)	4.71 (4.26-5.17)	5.40 (4.88-5.96)	6.34 (5.67-7.04)	7.05 (6.26-7.89)	7.79 (6.83-8.78)	8.54 (7.40-9.75)	9.56 (8.12-11.1)	10.4 (8.67-12.2)
60-day	3.63 (3.29-4.00)	4.53 (4.10-4.99)	5.55 (5.01-6.11)	6.33 (5.69-7.00)	7.36 (6.56-8.16)	8.13 (7.20-9.08)	8.90 (7.81-10.0)	9.68 (8.40-11.0)	10.7 (9.15-12.4)	11.5 (9.68-13.5)

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

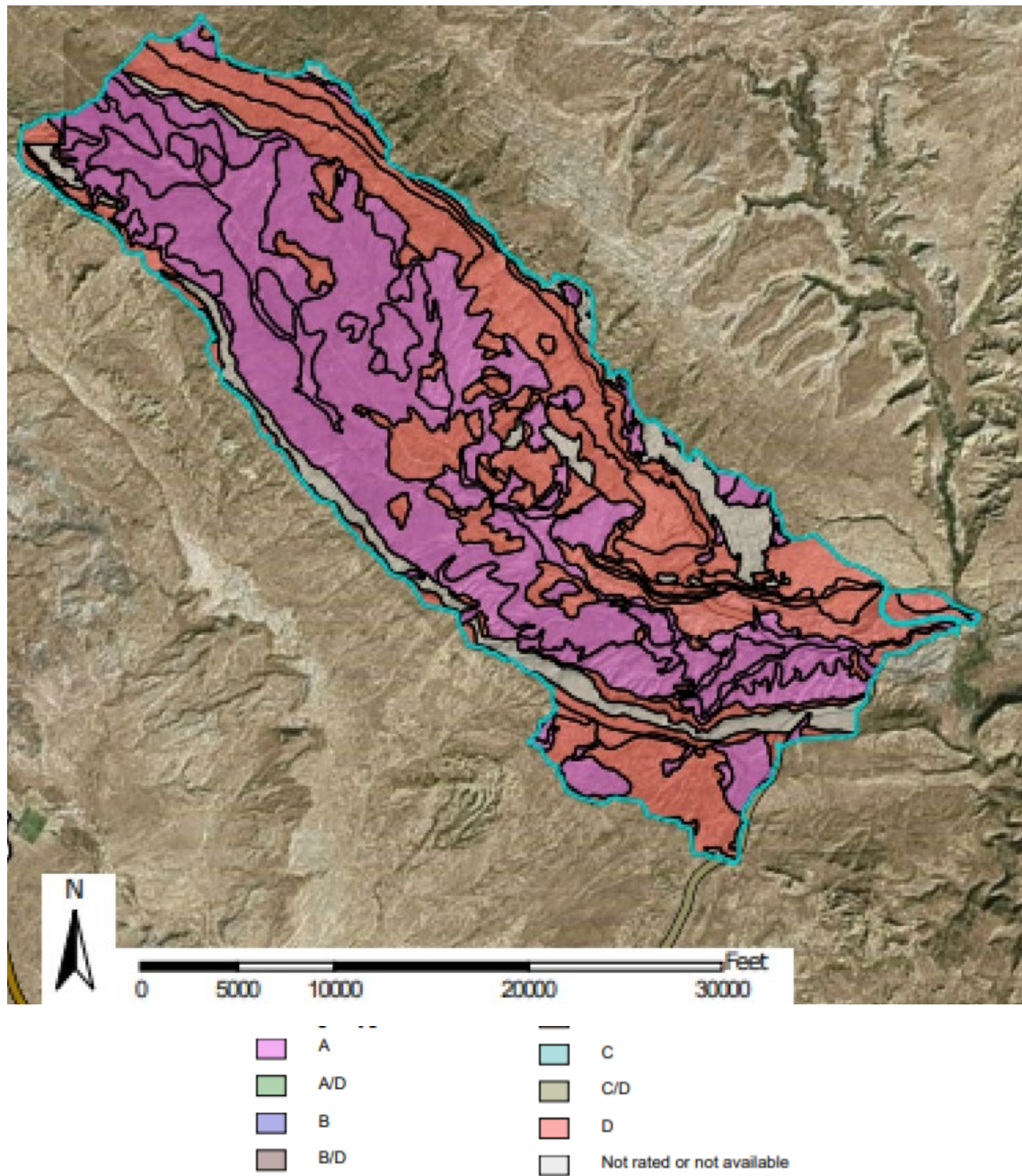
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1/4

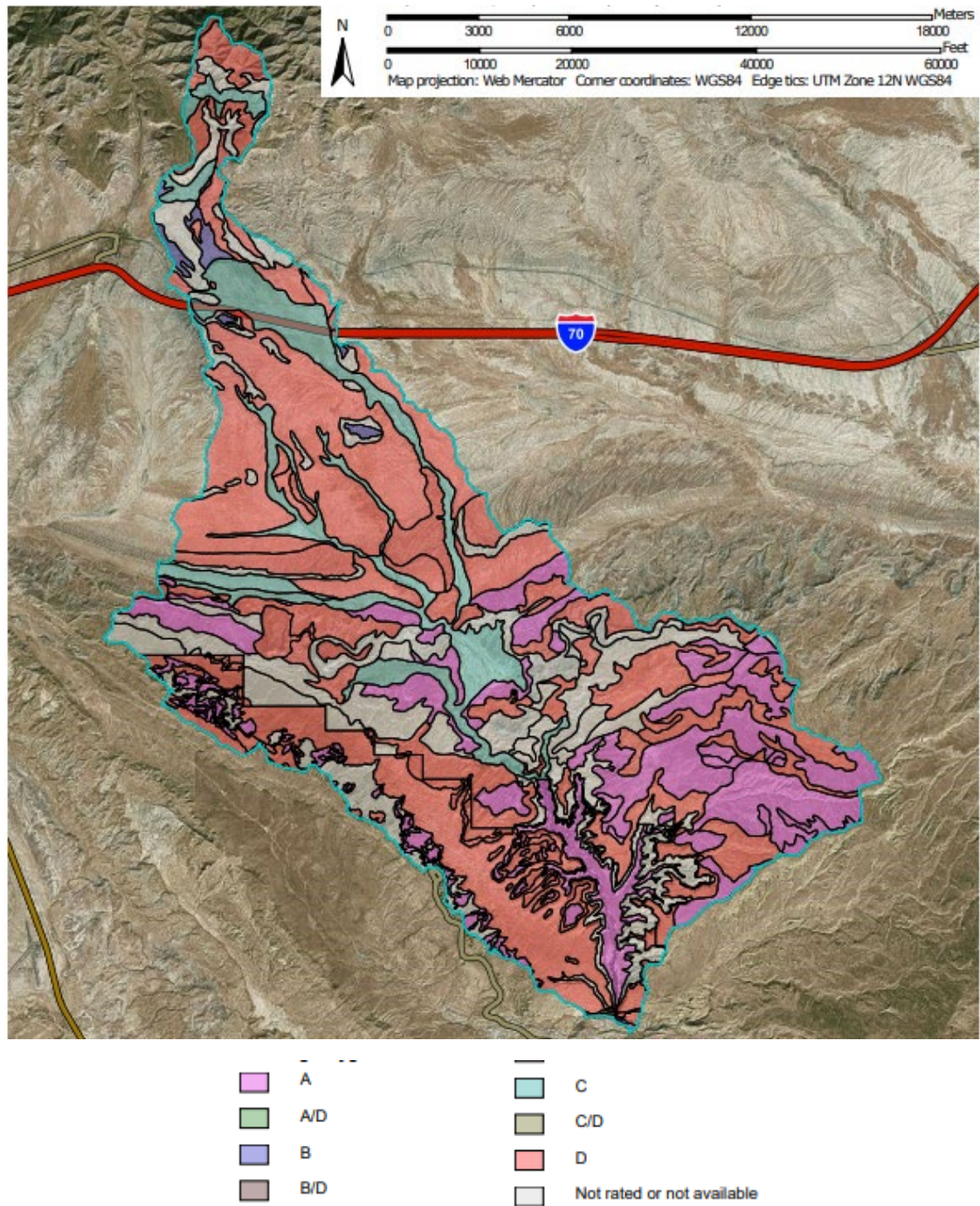
Runoff Curve Number Report

Web Soil Survey

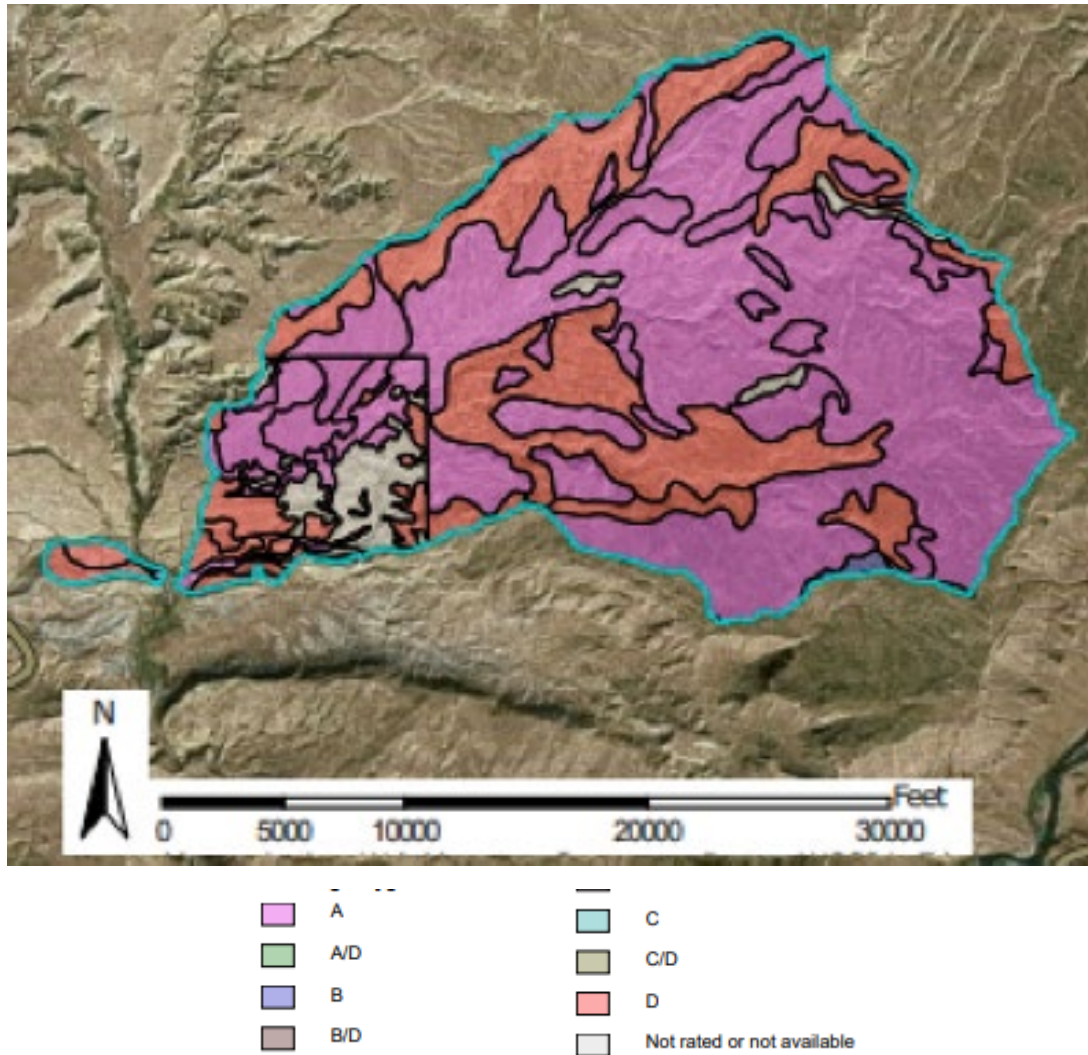
Salt Valley Wash



Salt Wash



Winter Camp Wash



Runoff Curve Number for Arid and Semiarid Rangelands

Table 9–2 Runoff curve numbers for arid and semiarid rangelands ^{1/}

Cover description covertypes	hydrologic condition ^{2/}	Hydrologic soil group ^{3/}			
		A	B	C	D
Herbaceous—mixture of grass, weeds and low-growing brush, with brush the minor element	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sage-grass—sage with an understory of grass	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, paloverde, mesquite, and cactus	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

^{1/} Average runoff condition, and $I_a = 0.2$ s. For range in humid regions, use table 9–1.

^{2/} Poor: <30% ground cover (litter, grass, and brush overstory).

Fair: 30 to 70% ground cover.

Good: >70% ground cover.

^{3/} Curve numbers for group A have been developed only for desert shrub.

Adjusted Curve Number

Salt Valley Wash (4B), Web Soil Survey	
Curve Number	79.10
Curve Number, Adjustment Factor 0.05	71.09
Maximum Potential Retention, S (inches)	4.07
Initial Abstraction, I_a (inches)	0.20
Time of Concentration, T_c (hr)	6.65
Lag Time, T_{Lag} (hr)	3.99

Salt Wash (2B), Web Soil Survey	
Curve Number	83.34
Curve Number, Adjustment Factor 0.05	77.22
Maximum Potential Retention, S (inches)	2.95
Initial Abstraction, I_a (inches)	0.15
Time of Concentration, T_c (hr)	10.6
Lag Time, T_{Lag} (hr)	6.36

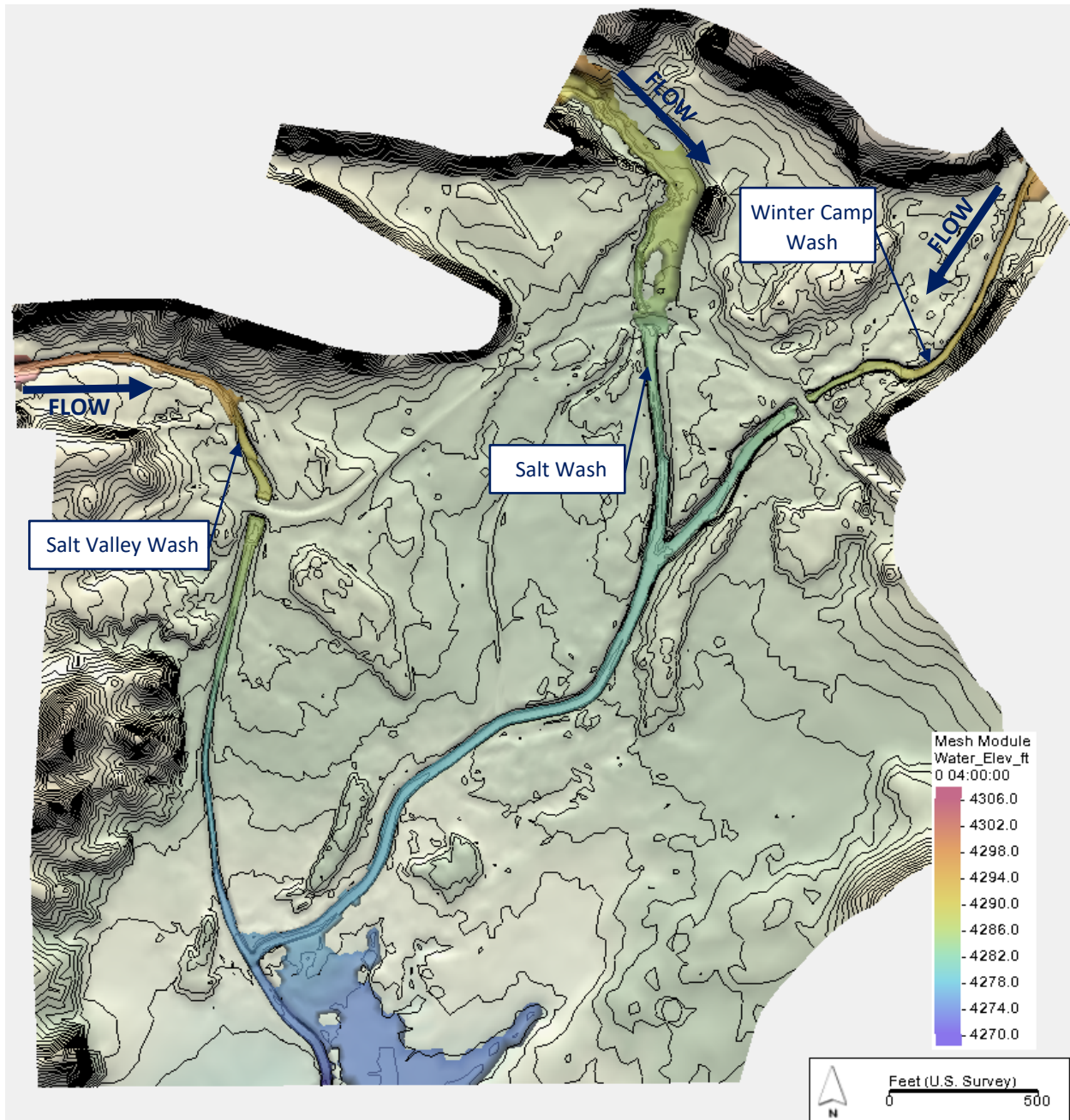
Winter Camp Wash (3B), Web Soil Survey	
Curve Number	76.75
Curve Number, Adjustment Factor 0.05	67.76
Maximum Potential Retention, S (inches)	4.76
Initial Abstraction, I_a (inches)	0.24
Time of Concentration, T_c (hr)	5.55
Lag Time, T_{Lag} (hr)	3.33

Appendix C

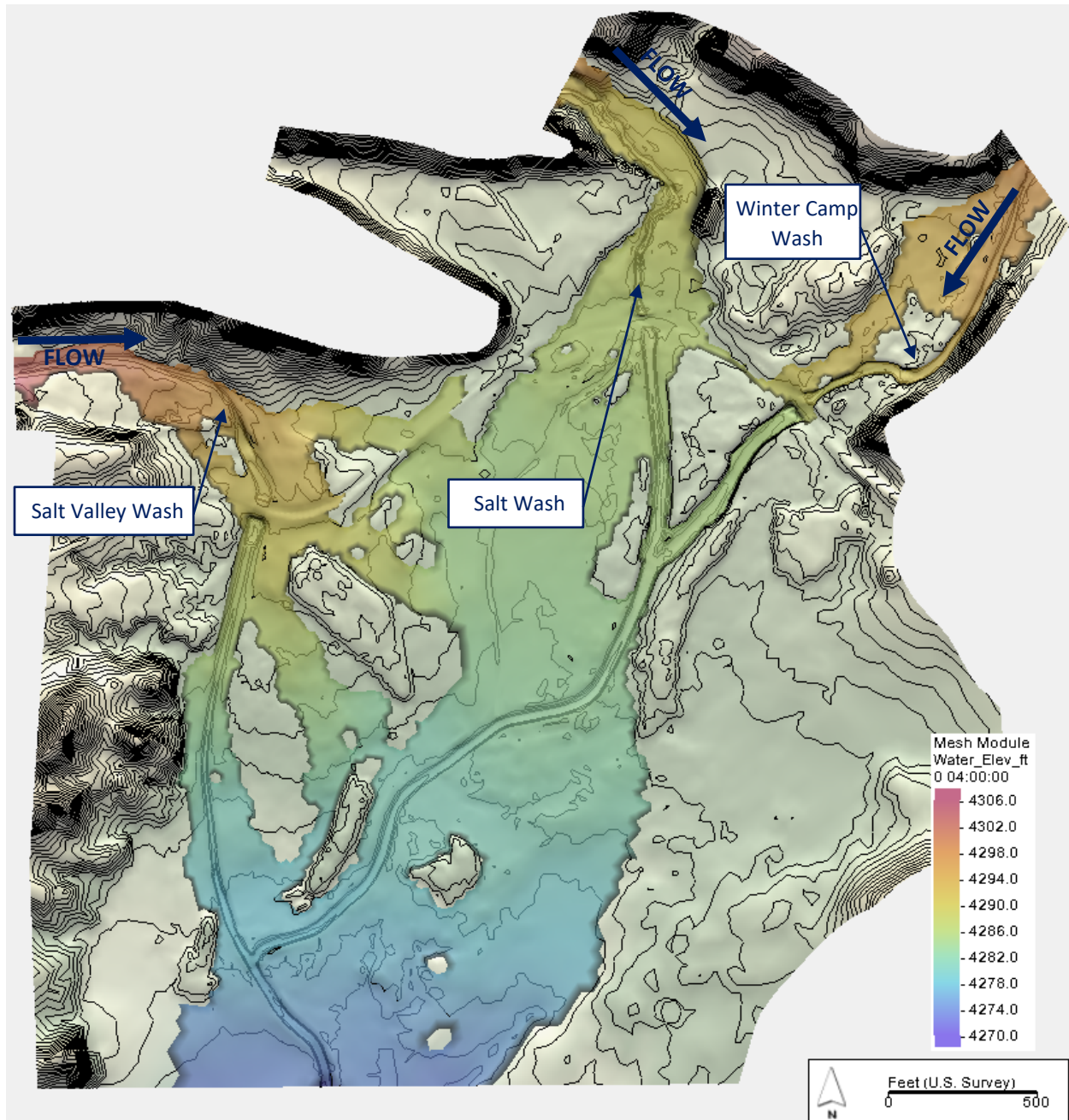
Hydraulics – Existing Conditions

SRH-2D Results

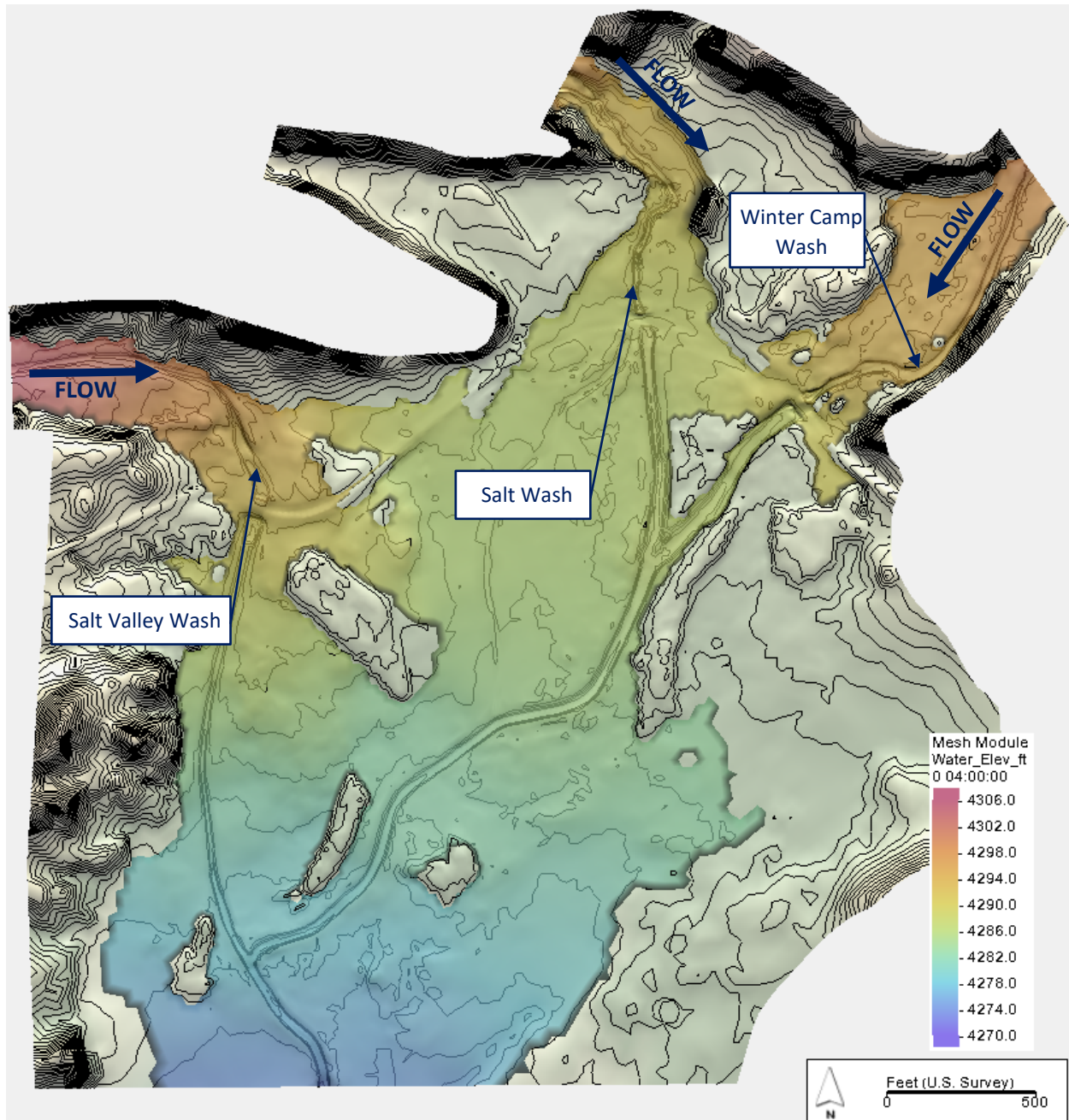
2-Year Water Surface Elevation



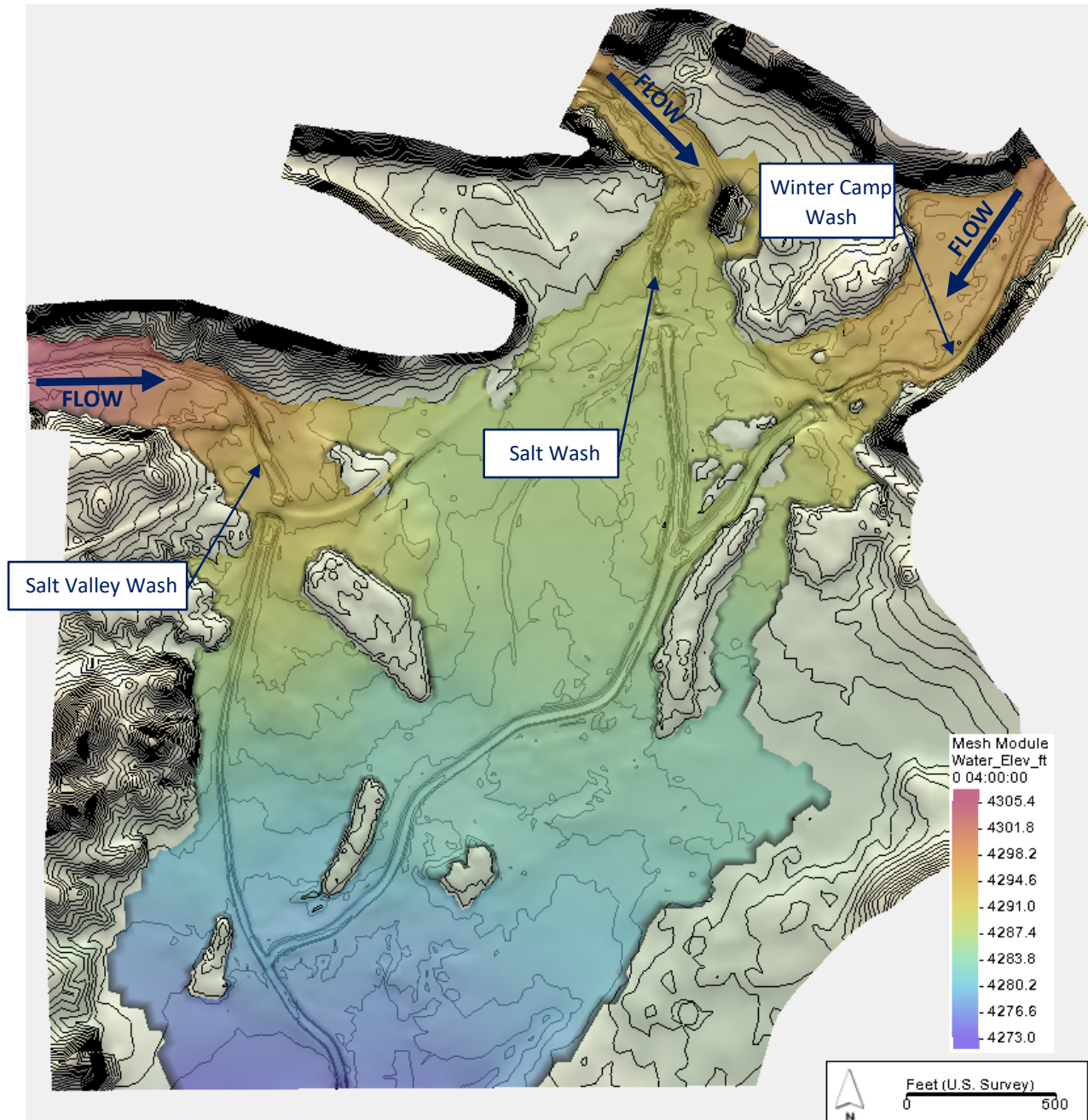
10-Year Water Surface Elevation



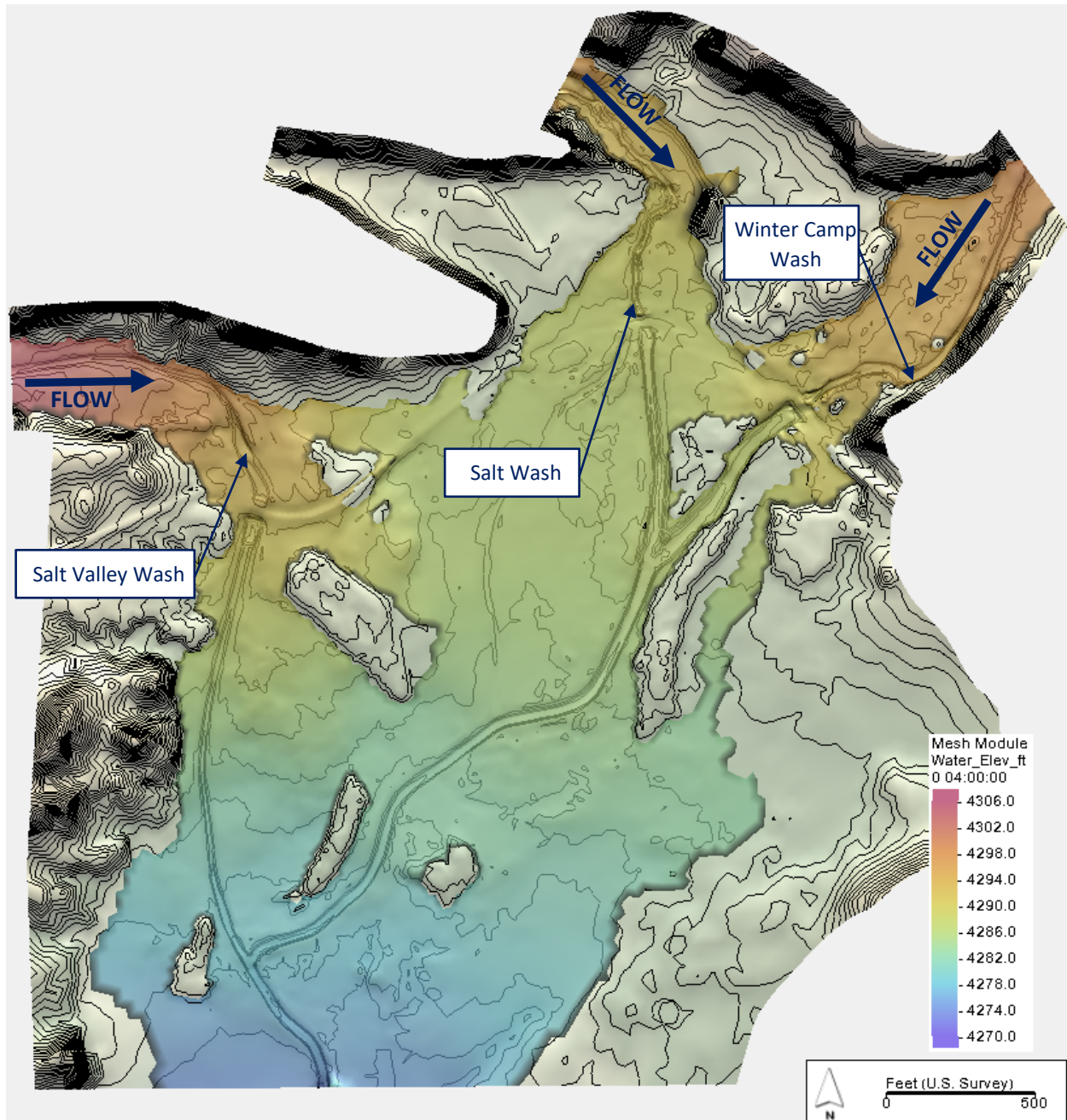
50-Year Water Surface Elevation



100-Year Water Surface Elevation



200-Year Water Surface Elevation

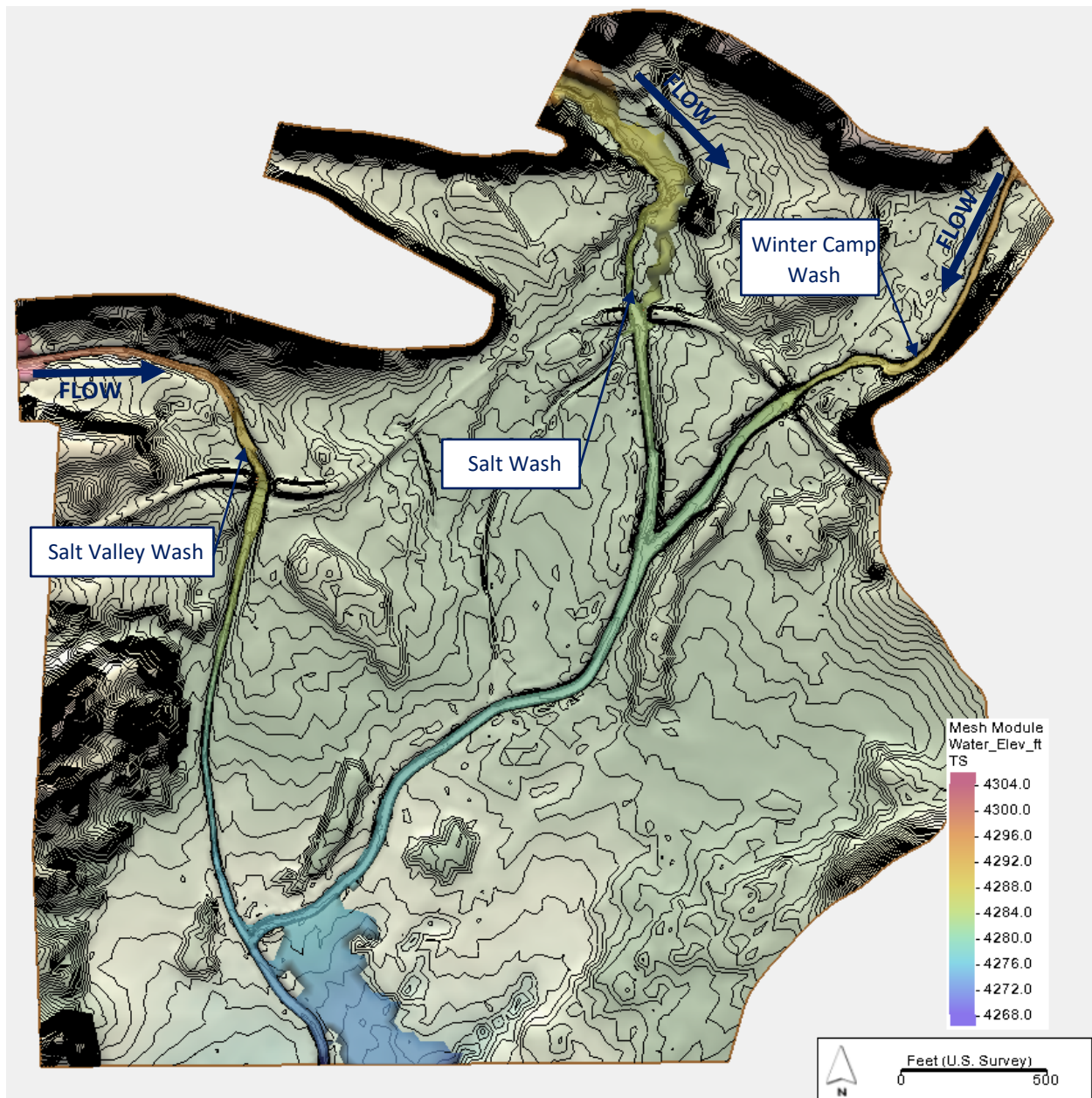


Appendix D

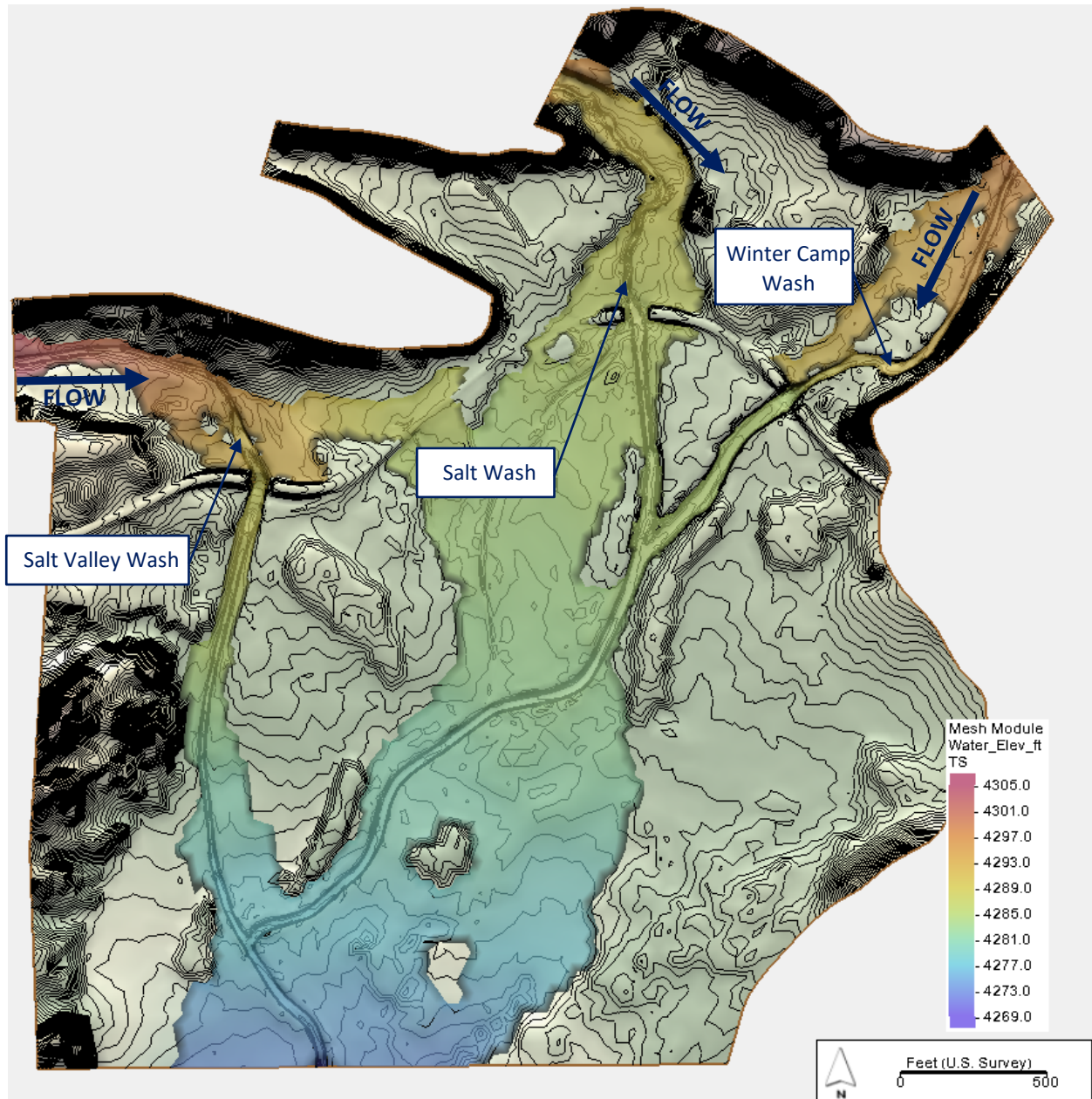
Hydraulics – Proposed Conditions

SRH-2D Results

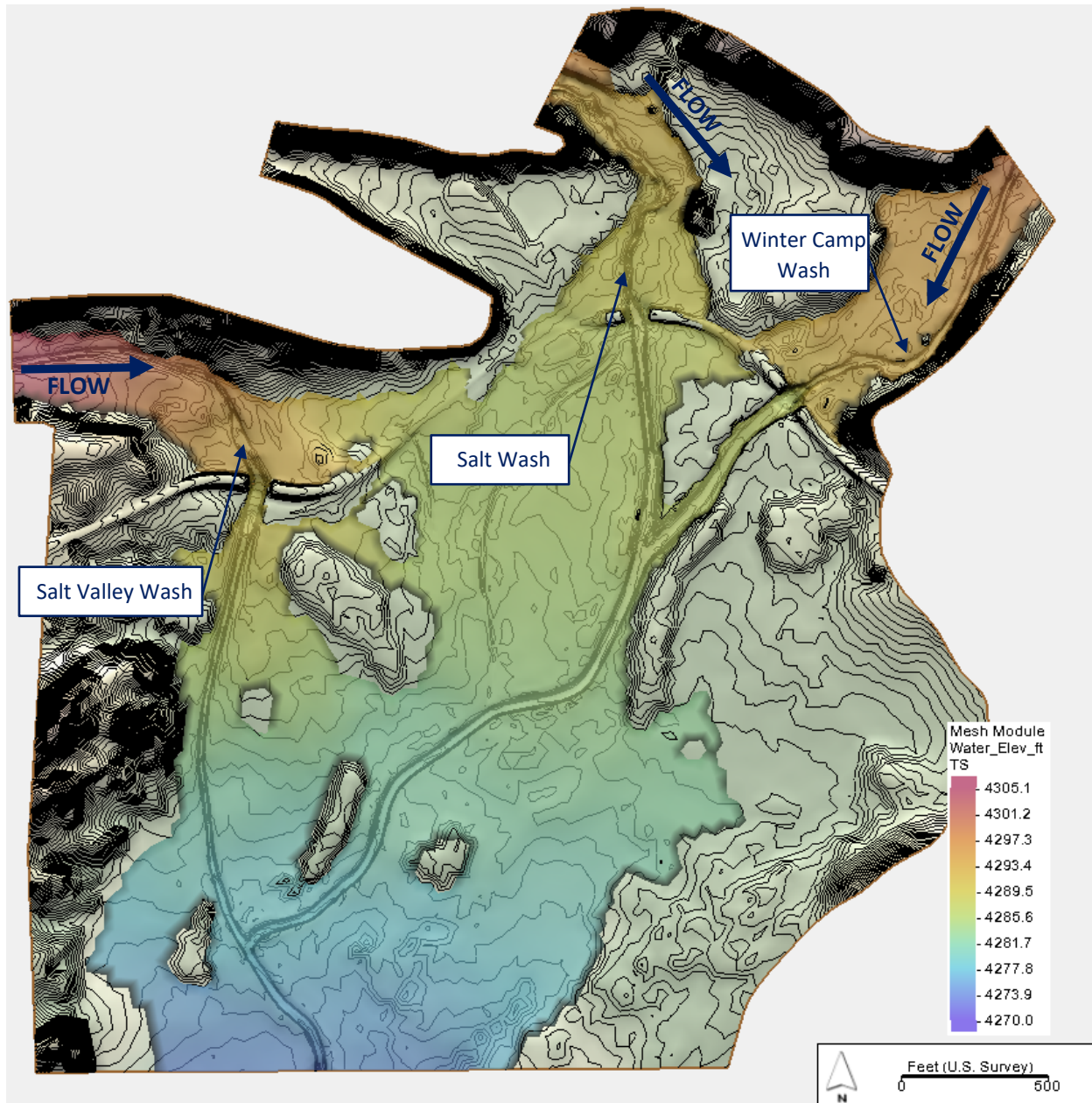
2-Year Water Surface Elevation



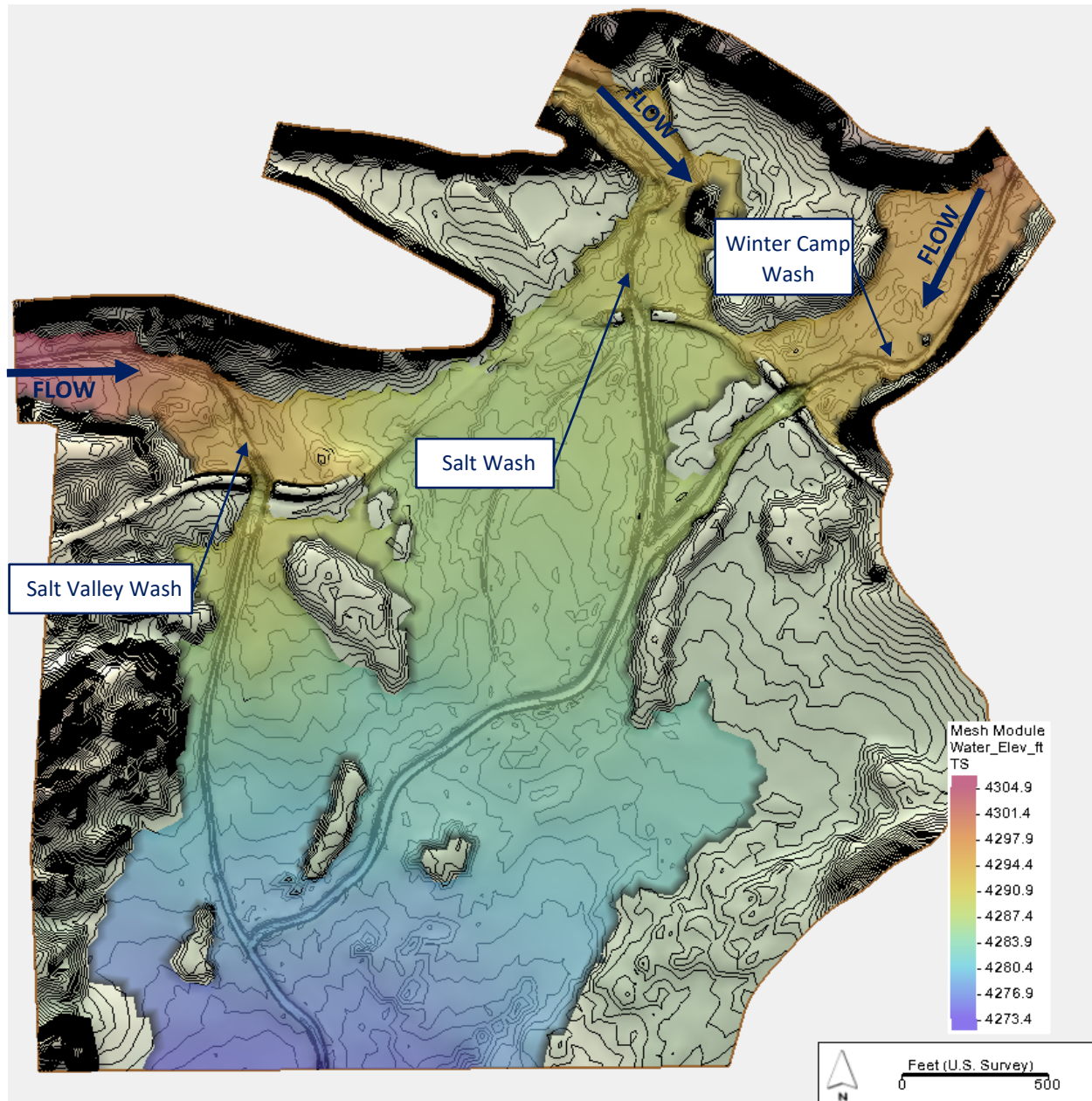
10-Year Water Surface Elevation



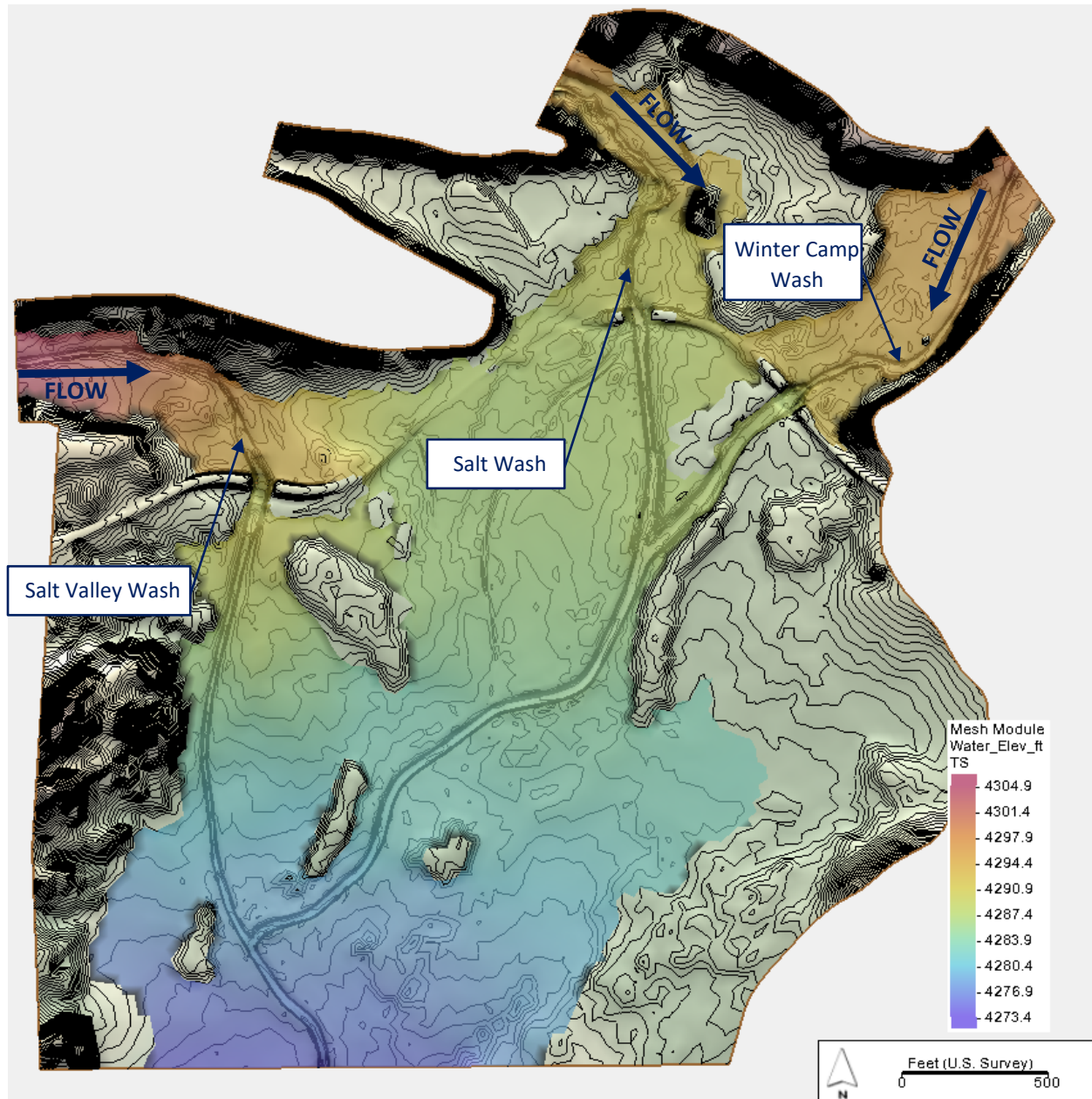
50-Year Water Surface Elevation



100-Year Water Surface Elevation



200-Year Water Surface Elevation



Bridge Scour Evaluation

Salt Valley Wash 100-Year

Contraction Scour
✕

Computation Method: Clear-Water and Live-Bed Scour

Parameter	Value	Units	Notes
Pressure Scour Method			
Compute Pressure Scour (Vertical Contraction Scour)	☐		
Input Parameters			
Input Parameters for Scour Condition			
Average Depth Upstream of Contraction (y1)	4.98	ft	(hu) in pressure scour
D50 (D50)	0.304800	mm	0.2 mm is the lower limit for ...
Average Velocity Upstream (V)	11.05	ft/s	
Computed Contraction Scour Condition	Live Bed		Vc < V
Input Parameters for Live Bed			
Temperature of Water	60.00	°F	Used to determine the fall v...
Slope of Energy Grade Line at Approach Section (S1)	0.014917	ft/ft	
Discharge in Contracted Section (Q2)	2761.96	cfs	
Discharge Upstream that is Transporting Sediment (Q1)	1180.18	cfs	
Bottom Width in Contracted Section (W2)	55.01	ft	Remove widths occupied by ...
Width Upstream that is Transporting Sediment (W1)	21.46	ft	
Depth Prior to Scour in Contracted Section (y0)	3.96	ft	
Unit Weight of Water (gamma w)	62.40	lb/ft^3	
Unit Weight of Sediment (gamma s)	165.00	lb/ft^3	
Results			
Results of Scour Condition			
Critical velocity above which bed material of size D and s...	1.46	ft/s	
Results of Clear Water Method			
Diameter of the smallest nontransportable particle in the ...	0.381000	mm	
Average Depth in Contracted Section after Scour (y2)	24.07	ft	
Scour Depth (ys)	20.11	ft	Negative values imply 'zero' ...
Results of Live Bed Method			
k1 (k1)	0.690000		
Shear Velocity (V*)	1.55	ft/s	
Fall Velocity (T)	0.13	ft/s	
Average Depth in Contracted Section after Scour (y2)	5.39	ft	
Scour Depth (ys)	1.43	ft	Negative values imply 'zero' ...
Shear Applied to Bed by Live-Bed Scour (theta 0)	0.4973	lb/ft^2	
Shear Required for Movement of D50 Partide (Tau c)	0.0040	lb/ft^2	
Recommendations			
Recommended Scour Condition	Live Bed		Determined by comparing sc...
Recommended Scour Depth	1.43	ft	Negative values imply 'zero' ...
Override Recommended Scour Condition	☐		

OK
Cancel

Pier Scour
✕

Computation Method: HEC-18

Parameter	Value	Units	Notes
Input Parameters			
Pier Shape (K1)	Group of Cylinders		
Bed Condition (K3)	Clear-Water Scour		Dune Height is N/A
Depth Upstream of Pier (y1)	5.53	ft	
Velocity Upstream of Pier (V1)	12.93	ft/s	
Width of Pier (a)	2.00	ft	width for the zero skew co...
Angle of Attack (K2)	40.36	Degrees	
Spacing between Columns of Piers (S)	14.00	ft	Column center to column c...
Number of Columns (n)	3		
Results			
Froude Number Upstream (Fr1)	0.97		
Correction Factor for Pier Nose Shape (K1)	1.00		
Correction Factor of Angle of Attack (K2)	1.00		
Spacing to Pier Width (s/a)	7.00		
Correction Factor for Bed Condition (K3)	1.10		
Scour Depth (ys)	7.44	ft	
Scour Hole			
Angle of Repose (theta)	44.00	degrees	
Use the Pier Width as the Bottom Width of Scour Hole	☒		
Scour Hole Bottom Width (K)	2.00	ft	
Scour Hole Top Width (W)	15.14	ft	

OK
Cancel

Pier Scour
✕

Computation Method: HEC-18

Parameter	Value	Units	Notes
Input Parameters			
Pier Shape (K1)	Group of Cylinders		
Bed Condition (K3)	Clear-Water Scour		Dune Height is N/A
Depth Upstream of Pier (y1)	5.53	ft	
Velocity Upstream of Pier (V1)	12.93	ft/s	
Width of Pier (a)	2.00	ft	width for the zero skew co...
Angle of Attack (K2)	5.99	Degrees	
Spacing between Columns of Piers (S)	14.00	ft	Column center to column c...
Number of Columns (n)	3		
Results			
Froude Number Upstream (Fr1)	0.97		
Correction Factor for Pier Nose Shape (K1)	1.00		
Correction Factor of Angle of Attack (K2)	1.00		
Spacing to Pier Width (s/a)	7.00		
Correction Factor for Bed Condition (K3)	1.10		
Scour Depth (ys)	7.44	ft	
Scour Hole			
Angle of Repose (theta)	44.00	degrees	
Use the Pier Width as the Bottom Width of Scour Hole	☒		
Scour Hole Bottom Width (K)	2.00	ft	
Scour Hole Top Width (W)	15.14	ft	

OK
Cancel

Abutment Scour
✕

Computation Method: NCHRP

Parameter	Value	Units	Notes
Input Parameters			
Scour Condition	Compute		
Scour Condition Location	Type a (Main Channel)		
Abutment Type (k1)	Spill-through abutment		
Unit Discharge, Upstream in Main Channel (q1)	54.99	cfs/ft	
Unit Discharge in Constricted Area (q2)	50.21	cfs/ft	
D50 (D50)	0.304800	mm	0.2 mm is the lower limit for coh..
Upstream Flow Depth (y1)	4.98	ft	
Define Shear Stress of Floodplain	☐		
Flow Depth prior to Scour (y0)	5.19	ft	Depth at Abutment Toe
Results			
q2 / q1	0.91		
Average Velocity Upstream (V)	11.05	ft/s	
Critical Velocity above which Bed Material of Size D and Sm...	1.46	ft/s	Used in contraction scour calcula
Scour Condition	Live Bed		
Scour Condition	a (Main Channel)		
Amplification Factor (alpha A or alpha B)	1.20		
Flow Depth including Contraction Scour (yc)	4.60	ft	
Scour depth from Long-Term Degradation calculations	0.00	ft	
Maximum Flow Depth including Abutment Scour (ymax)	5.52	ft	Including the long-term scour de.
Scour Hole Depth (ys)	0.33	ft	Negative values imply 'zero' sco..
Scour Hole			
Angle of Repose (theta)	44.00	degrees	

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OK
Cancel

Abutment Scour
✕

Computation Method: NCHRP

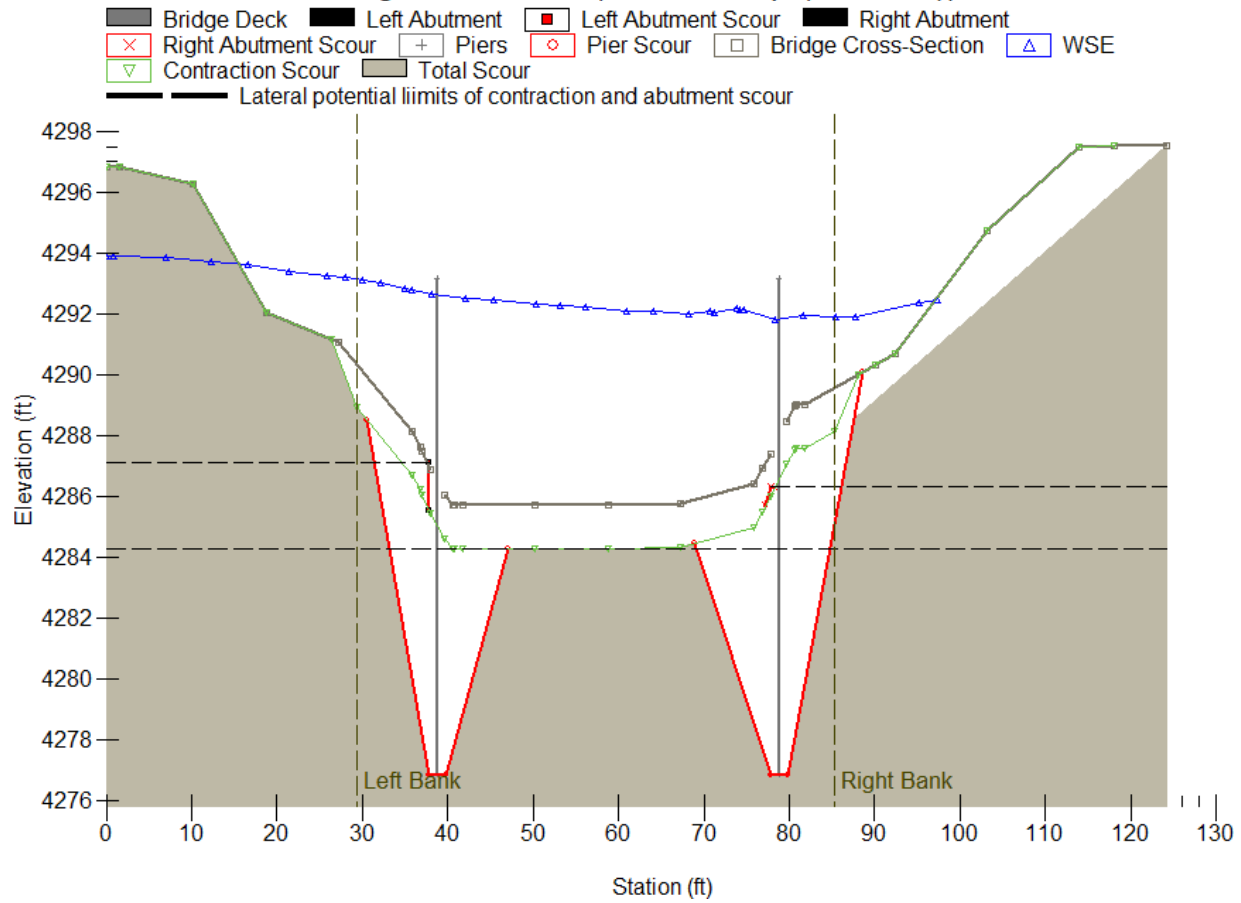
Parameter	Value	Units	Notes
Input Parameters			
Scour Condition	Compute		
Scour Condition Location	Type a (Main Channel)		
Abutment Type (k1)	Spill-through abutment		
Unit Discharge, Upstream in Main Channel (q1)	54.99	cfs/ft	
Unit Discharge in Constricted Area (q2)	50.21	cfs/ft	
D50 (D50)	0.304800	mm	0.2 mm is the lower limit for coh..
Upstream Flow Depth (y1)	4.98	ft	
Define Shear Stress of Floodplain	☐		
Flow Depth prior to Scour (y0)	2.15	ft	Depth at Abutment Toe
Results			
q2 / q1	0.91		
Average Velocity Upstream (V)	11.05	ft/s	
Critical Velocity above which Bed Material of Size D and Sm...	1.46	ft/s	Used in contraction scour calcula
Scour Condition	Live Bed		
Scour Condition	a (Main Channel)		
Amplification Factor (alpha A or alpha B)	1.20		
Flow Depth including Contraction Scour (yc)	4.60	ft	
Scour depth from Long-Term Degradation calculations	0.00	ft	
Maximum Flow Depth including Abutment Scour (ymax)	5.52	ft	Including the long-term scour de.
Scour Hole Depth (ys)	3.38	ft	Negative values imply 'zero' sco..
Scour Hole			
Angle of Repose (theta)	44.00	degrees	

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OK

Cancel

Bridge Scour Plot (Q100Y Prop (SRH-2D))



Salt Valley Wash 200-Year

Contraction Scour

Computation Method: Clear-Water and Live-Bed Scour

Parameter	Value	Units	Notes
Pressure Scour Method			
Compute Pressure Scour (Vertical Contraction Scour)	☐		
Input Parameters			
Input Parameters for Scour Condition			
Average Depth Upstream of Contraction (y1)	5.28	ft	(hu) in pressure scour
D50 (D50)	0.304800	mm	0.2 mm is the lower limit for ...
Average Velocity Upstream (V)	11.42	ft/s	
Computed Contraction Scour Condition	Live Bed		Vc < V
Input Parameters for Live Bed			
Temperature of Water	60.00	°F	Used to determine the fall v...
Slope of Energy Grade Line at Approach Section (S1)	0.014157	ft/ft	
Discharge in Contracted Section (Q2)	3039.21	cfs	
Discharge Upstream that is Transporting Sediment (Q1)	1295.38	cfs	
Bottom Width in Contracted Section (W2)	55.16	ft	Remove widths occupied by ...
Width Upstream that is Transporting Sediment (W1)	21.46	ft	
Depth Prior to Scour in Contracted Section (y0)	4.26	ft	
Unit Weight of Water (gamma w)	62.40	lb/ft^3	
Unit Weight of Sediment (gamma s)	165.00	lb/ft^3	
Results			
Results of Scour Condition			
Critical velocity above which bed material of size D and s...	1.47	ft/s	
Results of Clear Water Method			
Diameter of the smallest nontransportable particle in the ...	0.381000	mm	
Average Depth in Contracted Section after Scour (y2)	26.06	ft	
Scour Depth (ys)	21.81	ft	Negative values imply 'zero' ...
Results of Live Bed Method			
k1 (k1)	0.690000		
Shear Velocity (V*)	1.55	ft/s	
Fall Velocity (T)	0.13	ft/s	
Average Depth in Contracted Section after Scour (y2)	5.72	ft	
Scour Depth (ys)	1.46	ft	Negative values imply 'zero' ...
Shear Applied to Bed by Live-Bed Scour (theta 0)	0.5419	lb/ft^2	
Shear Required for Movement of D50 Partide (Tau c)	0.0040	lb/ft^2	
Recommendations			
Recommended Scour Condition	Live Bed		Determined by comparing sc...
Recommended Scour Depth	1.46	ft	Negative values imply 'zero' ...
Override Recommended Scour Condition	☐		

OK

Cancel

Contraction Scour
✕

Computation Method: Clear-Water and Live-Bed Scour

Parameter	Value	Units	Notes
Pressure Scour Method			
Compute Pressure Scour (Vertical Contraction Scour)	☐		
Input Parameters			
Input Parameters for Scour Condition			
Average Depth Upstream of Contraction (y_1)	5.28	ft	(h_u) in pressure scour
D50 (D50)	0.304800	mm	0.2 mm is the lower limit for ...
Average Velocity Upstream (V)	11.42	ft/s	
Computed Contraction Scour Condition	Live Bed		$V_c < V$
Input Parameters for Live Bed			
Temperature of Water	60.00	°F	Used to determine the fall v...
Slope of Energy Grade Line at Approach Section (S_1)	0.014157	ft/ft	
Discharge in Contracted Section (Q_2)	3039.21	cfs	
Discharge Upstream that is Transporting Sediment (Q_1)	1295.38	cfs	
Bottom Width in Contracted Section (W_2)	55.16	ft	Remove widths occupied by ...
Width Upstream that is Transporting Sediment (W_1)	21.46	ft	
Depth Prior to Scour in Contracted Section (y_0)	4.26	ft	
Unit Weight of Water (γ_w)	62.40	lb/ft ³	
Unit Weight of Sediment (γ_s)	165.00	lb/ft ³	
Results			
Results of Scour Condition			
Critical velocity above which bed material of size D and s...	1.47	ft/s	
Results of Clear Water Method			
Diameter of the smallest nontransportable particle in the ...	0.381000	mm	
Average Depth in Contracted Section after Scour (y_2)	26.06	ft	
Scour Depth (y_s)	21.81	ft	Negative values imply 'zero' ...
Results of Live Bed Method			
k_1 (k_1)	0.690000		
Shear Velocity (V^*)	1.55	ft/s	
Fall Velocity (T)	0.13	ft/s	
Average Depth in Contracted Section after Scour (y_2)	5.72	ft	
Scour Depth (y_s)	1.46	ft	Negative values imply 'zero' ...
Shear Applied to Bed by Live-Bed Scour (θ_0)	0.5419	lb/ft ²	
Shear Required for Movement of D50 Particle (τ_c)	0.0040	lb/ft ²	
Recommendations			
Recommended Scour Condition	Live Bed		Determined by comparing sc...
Recommended Scour Depth	1.46	ft	Negative values imply 'zero' ...
Override Recommended Scour Condition	☐		

OK
Cancel

Pier Scour
✕

Computation Method: HEC-18

Parameter	Value	Units	Notes
Input Parameters			
Pier Shape (K1)	Group of Cylinders		
Bed Condition (K3)	Clear-Water Scour		Dune Height is N/A
Depth Upstream of Pier (y1)	5.86	ft	
Velocity Upstream of Pier (V1)	13.18	ft/s	
Width of Pier (a)	2.00	ft	width for the zero skew co...
Angle of Attack (K2)	17.08	Degrees	
Spacing between Columns of Piers (S)	14.00	ft	Column center to column c...
Number of Columns (n)	3		
Results			
Froude Number Upstream (Fr1)	0.96		
Correction Factor for Pier Nose Shape (K1)	1.00		
Correction Factor of Angle of Attack (K2)	1.00		
Spacing to Pier Width (s/a)	7.00		
Correction Factor for Bed Condition (K3)	1.10		
Scour Depth (ys)	7.56	ft	
Scour Hole			
Angle of Repose (theta)	44.00	degrees	
Use the Pier Width as the Bottom Width of Scour Hole	☒		
Scour Hole Bottom Width (K)	2.00	ft	
Scour Hole Top Width (W)	15.38	ft	

OK
Cancel

Abutment Scour
✕

Computation Method: NCHRP

Parameter	Value	Units	Notes
Input Parameters			
Scour Condition	Compute		
Scour Condition Location	Type a (Main Channel)		
Abutment Type (k1)	Spill-through abutment		
Unit Discharge, Upstream in Main Channel (q1)	60.36	cfs/ft	
Unit Discharge in Constricted Area (q2)	55.10	cfs/ft	
D50 (D50)	0.304800	mm	0.2 mm is the lower limit for coh...
Upstream Flow Depth (y1)	5.28	ft	
Define Shear Stress of Floodplain	☐		
Flow Depth prior to Scour (y0)	5.76	ft	Depth at Abutment Toe
Results			
q2 / q1	0.91		
Average Velocity Upstream (V)	11.42	ft/s	
Critical Velocity above which Bed Material of Size D and Sm...	1.47	ft/s	Used in contraction scour calcula...
Scour Condition	Live Bed		
Scour Condition	a (Main Channel)		
Amplification Factor (alpha A or alpha B)	1.20		
Flow Depth including Contraction Scour (yc)	4.89	ft	
Scour depth from Long-Term Degradation calculations	0.00	ft	
Maximum Flow Depth including Abutment Scour (ymax)	5.86	ft	Including the long-term scour de...
Scour Hole Depth (ys)	0.10	ft	Negative values imply 'zero' sco...
Scour Hole			
Angle of Repose (theta)	44.00	degrees	
Ratio of Bottom Width of Scour Hole to Scour Hole Depth	0.00		1.0 means the bottom width will ...
Scour Hole Bottom Width (K)	0.00	ft	
Scour Hole Top Width (W)	0.10	ft	

OK
Cancel

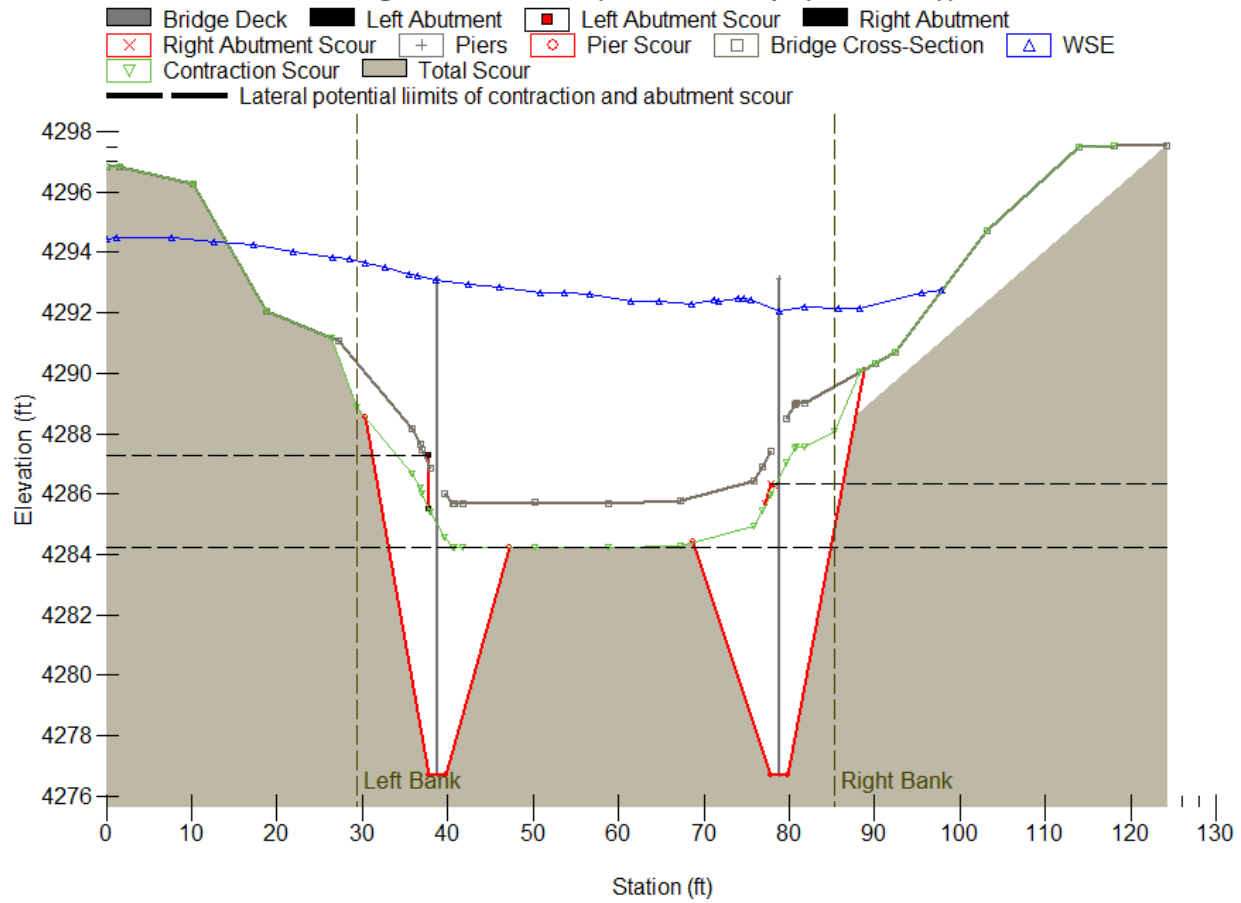
Abutment Scour
✕

Computation Method: INCHRP

Parameter	Value	Units	Notes
Input Parameters			
Scour Condition	Compute		
Scour Condition Location	Type a (Main Channel)		
Abutment Type (k1)	Spill-through abutment		
Unit Discharge, Upstream in Main Channel (q1)	60.36	cfs/ft	
Unit Discharge in Constricted Area (q2)	55.10	cfs/ft	
D50 (D50)	0.304800	mm	0.2 mm is the lower limit for coh...
Upstream Flow Depth (y1)	5.28	ft	
Define Shear Stress of Floodplain	☐		
Flow Depth prior to Scour (y0)	2.34	ft	Depth at Abutment Toe
Results			
q2 / q1	0.91		
Average Velocity Upstream (V)	11.42	ft/s	
Critical Velocity above which Bed Material of Size D and Sm...	1.47	ft/s	Used in contraction scour calcula...
Scour Condition	Live Bed		
Scour Condition	a (Main Channel)		
Amplification Factor (alpha A or alpha B)	1.20		
Flow Depth including Contraction Scour (yc)	4.89	ft	
Scour depth from Long-Term Degradation calculations	0.00	ft	
Maximum Flow Depth including Abutment Scour (ymax)	5.86	ft	Including the long-term scour de...
Scour Hole Depth (ys)	3.53	ft	Negative values imply 'zero' sco...
Scour Hole			
Angle of Repose (theta)	44.00	degrees	
Ratio of Bottom Width of Scour Hole to Scour Hole Depth	0.00		1.0 means the bottom width will ...
Scour Hole Bottom Width (K)	0.00	ft	
Scour Hole Top Width (W)	3.65	ft	

OK
Cancel

Bridge Scour Plot (Q200Y Prop (SRH-2D))



Salt Valley Wash Riprap

Riprap Analysis Abutment
Geotextile/Granular Filter Design...

Structure type: Abutment/Guide Bank

Parameter	Value	Units	Notes
Channel Parameters			
Select Channel	<Define Local Data>		
	Channel Calculator...		
Input Parameters			
	Transfer Values From Channel Calcu...		
Structure Type	abutment		
Abutment Type	spill-through abutment		
Set-back Length	0.001	ft	The set-back length is the distance from the near edge of the main channel to t...
Main Channel Average Flow Depth	3.400	ft	
Flow Depth at Toe of Abutment	3.200	ft	
Total Discharge	2810.000	cfs	Calculations will use either total or overbank discharges. Bolded values indicate...
Overbank Discharge	0.001	cfs	
Total Bridge Area	250.000	ft^2	
Setback Area	0.001	ft^2	
Maximum Channel Velocity	13.800	ft/s	
Specific Gravity of Riprap	2.650		
Results			
Set-back ratio	0.000		
Characteristic Velocity	11.240	ft/s	
Froude Number at the Abutment Toe	1.108		
Abutment Coefficient	0.610		
D50	371.068	mm	
Riprap Shape	Riprap shape should be angular		
Riprap Class			
Riprap Class Name	CLASS IV		
Riprap Class Order	4		
D15	266.70	mm	This value is an 'average' of the size fraction range for the selected riprap class
D50	393.70	mm	This value is an 'average' of the size fraction range for the selected riprap class
D85	533.40	mm	This value is an 'average' of the size fraction range for the selected riprap cl
D100	762.00	mm	This value is an 'average' of the size fraction range for the selected riprap class
Layout			
Riprap Thickness	30.000	in	
Minimum Horizontal Extent of the Toe Apron from the Abutment Toe	6.400	ft	
Minimum Extent of "Wrap Around" beyond the Abutment Radius, along the Approach Embankment	25.000	ft	See HEC 23, Figure 14.7

OK
Cancel

Riprap Analysis Bank

Structure type:
Revetment (channel slopes 2% or less)
Geotextile/Granular Filter Design...

Parameter	Value	Units	Notes
Channel Parameters			
Select Channel	<Define Local Data>		
	Channel Calculator...		
Input Parameters			
	Transfer Values From Channel Calcu...		
Channel Type	natural channel		
Local Depth of Flow	5.000	ft	
Riprap Shape	angular rock		
Stability Coefficient	0.300		This value is updated by the selected Riprap Shape
Blanket Thickness Coefficient	1.000		
Channel Cross-sectional Average Velocity	8.000	ft/s	
Centerline Radius of Curvature of Channel Bend	150	ft	Infinite Radius for straight channels are approximated by using a large number
Width of Water Surface at Upstream End of Channel Bend	60.000	ft	
Bank Angle	3.000	H:V (_:1)	.966 < Bank Angle < 4.011
Bank Angle	18.4	degrees	14 < Bank Angle < 46
Protection Location	outside of bend		
Specific Gravity of Riprap	2.650		
Safety Factor	1.100		
Results			
Side Slope Correction Factor	0.977		
Velocity Distribution Coefficient	1.203		
Design Velocity	12.265	ft/s	Design velocity never less than average channel velocity
D30	306.459	mm	
D50	367.751	mm	
Riprap Class			
Riprap Class Name	CLASS IV		
Riprap Class Order	4		
D15	266.70	mm	This value is an 'average' of the size fraction range for the selected riprap class
D50	393.70	mm	This value is an 'average' of the size fraction range for the selected riprap class
D85	533.40	mm	This value is an 'average' of the size fraction range for the selected riprap class
D100	762.00	mm	This value is an 'average' of the size fraction range for the selected riprap class
Layout			
Minimum Riprap Thickness	30.000	in	

OK
Cancel

Salt Wash 100-Year

Contraction Scour

Computation Method: Clear-Water and Live-Bed Scour

Parameter	Value	Units	Notes
Pressure Scour Method			
Compute Pressure Scour (Vertical Contraction Scour)	☐		
Input Parameters			
Input Parameters for Scour Condition			
Average Depth Upstream of Contraction (y1)	9.47	ft	(hu) in pressure scour
D50 (D50)	0.304800	mm	0.2 mm is the lower limit for ...
Average Velocity Upstream (V)	7.79	ft/s	
Computed Contraction Scour Condition	Live Bed		Vc < V
Input Parameters for Live Bed			
Temperature of Water	60.00	°F	Used to determine the fall v...
Slope of Energy Grade Line at Approach Section (S1)	0.001963	ft/ft	
Discharge in Contracted Section (Q2)	3698.54	cfs	
Discharge Upstream that is Transporting Sediment (Q1)	2047.33	cfs	
Bottom Width in Contracted Section (W2)	59.24	ft	Remove widths occupied by ...
Width Upstream that is Transporting Sediment (W1)	27.76	ft	
Depth Prior to Scour in Contracted Section (y0)	9.11	ft	
Unit Weight of Water (gamma w)	62.40	lb/ft^3	
Unit Weight of Sediment (gamma s)	165.00	lb/ft^3	
Results			
Results of Scour Condition			
Critical velocity above which bed material of size D and s...	1.62	ft/s	
Results of Clear Water Method			
Diameter of the smallest nontransportable particle in the ...	0.381000	mm	
Average Depth in Contracted Section after Scour (y2)	29.01	ft	
Scour Depth (ys)	19.90	ft	Negative values imply 'zero' ...
Results of Live Bed Method			
k1 (k1)	0.690000		
Shear Velocity (V*)	0.77	ft/s	
Fall Velocity (T)	0.13	ft/s	
Average Depth in Contracted Section after Scour (y2)	9.32	ft	
Scour Depth (ys)	0.21	ft	Negative values imply 'zero' ...
Shear Applied to Bed by Live-Bed Scour (theta 0)	0.3087	lb/ft^2	
Shear Required for Movement of D50 Partide (Tau c)	0.0040	lb/ft^2	
Recommendations			
Recommended Scour Condition	Live Bed		Determined by comparing sc...
Recommended Scour Depth	0.21	ft	Negative values imply 'zero' ...
Override Recommended Scour Condition	☐		

OK
Cancel

Pier Scour
✕

Computation Method: HEC-18

Parameter	Value	Units	Notes
Input Parameters			
Pier Shape (K1)	Group of Cylinders		
Bed Condition (K3)	Clear-Water Scour		Dune Height is N/A
Depth Upstream of Pier (y1)	11.72	ft	
Velocity Upstream of Pier (V1)	6.99	ft/s	
Width of Pier (a)	2.00	ft	width for the zero skew co...
Angle of Attack (K2)	7.46	Degrees	
Spacing between Columns of Piers (S)	14.00	ft	Column center to column c...
Number of Columns (n)	3		
Results			
Froude Number Upstream (Fr1)	0.36		
Correction Factor for Pier Nose Shape (K1)	1.00		
Correction Factor of Angle of Attack (K2)	1.00		
Spacing to Pier Width (s/a)	7.00		
Correction Factor for Bed Condition (K3)	1.10		
Scour Depth (ys)	6.32	ft	
Scour Hole			
Angle of Repose (theta)	44.00	degrees	
Use the Pier Width as the Bottom Width of Scour Hole	☒		
Scour Hole Bottom Width (K)	2.00	ft	
Scour Hole Top Width (W)	12.86	ft	

OK
Cancel

Pier Scour
✕

Computation Method: HEC-18

Parameter	Value	Units	Notes
Input Parameters			
Pier Shape (K1)	Group of Cylinders		
Bed Condition (K3)	Clear-Water Scour		Dune Height is N/A
Depth Upstream of Pier (y1)	11.72	ft	
Velocity Upstream of Pier (V1)	6.99	ft/s	
Width of Pier (a)	2.00	ft	width for the zero skew co...
Angle of Attack (K2)	62.50	Degrees	
Spacing between Columns of Piers (S)	14.00	ft	Column center to column c...
Number of Columns (n)	3		
Results			
Froude Number Upstream (Fr1)	0.36		
Correction Factor for Pier Nose Shape (K1)	1.00		
Correction Factor of Angle of Attack (K2)	1.00		
Spacing to Pier Width (s/a)	7.00		
Correction Factor for Bed Condition (K3)	1.10		
Scour Depth (ys)	6.32	ft	
Scour Hole			
Angle of Repose (theta)	44.00	degrees	
Use the Pier Width as the Bottom Width of Scour Hole	☒		
Scour Hole Bottom Width (K)	2.00	ft	
Scour Hole Top Width (W)	12.86	ft	

OK
Cancel

Abutment Scour
✕

Computation Method: NCHRP

Parameter	Value	Units	Notes
Input Parameters			
Scour Condition	Compute		
Scour Condition Location	Type a (Main Channel)		
Abutment Type (k1)	Spill-through abutment		
Unit Discharge, Upstream in Main Channel (q1)	73.74	cfs/ft	
Unit Discharge in Constricted Area (q2)	62.44	cfs/ft	
D50 (D50)	0.304800	mm	0.2 mm is the lower limit for coh...
Upstream Flow Depth (y1)	9.47	ft	
Define Shear Stress of Floodplain	☐		
Flow Depth prior to Scour (y0)	9.66	ft	Depth at Abutment Toe
Results			
q2 / q1	0.85		
Average Velocity Upstream (V)	7.79	ft/s	
Critical Velocity above which Bed Material of Size D and Sm...	1.62	ft/s	Used in contraction scour calcula...
Scour Condition	Live Bed		
Scour Condition	a (Main Channel)		
Amplification Factor (alpha A or alpha B)	1.20		
Flow Depth including Contraction Scour (yc)	8.21	ft	
Scour depth from Long-Term Degradation calculations	0.00	ft	
Maximum Flow Depth including Abutment Scour (ymax)	9.85	ft	Including the long-term scour de...
Scour Hole Depth (ys)	0.19	ft	Negative values imply 'zero' sco...
Scour Hole			
Angle of Repose (theta)	44.00	degrees	
Ratio of Bottom Width of Scour Hole to Scour Hole Depth	0.00		1.0 means the bottom width will ...
Scour Hole Bottom Width (K)	0.00	ft	
Scour Hole Top Width (W)	0.20	ft	

OK
Cancel

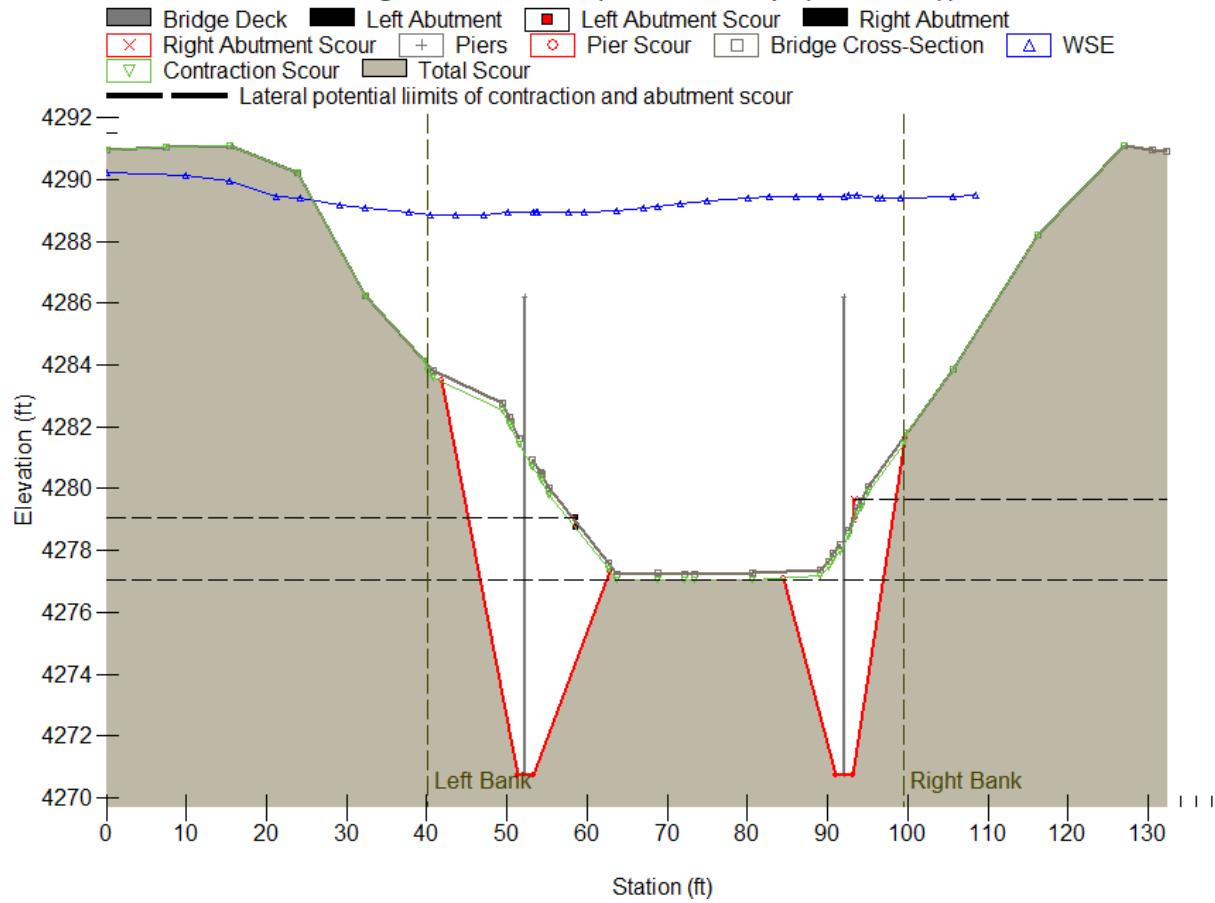
Abutment Scour
✕

Computation Method: NCHRP

Parameter	Value	Units	Notes
Input Parameters			
Scour Condition	Compute		
Scour Condition Location	Type a (Main Channel)		
Abutment Type (k1)	Spill-through abutment		
Unit Discharge, Upstream in Main Channel (q1)	73.74	cfs/ft	
Unit Discharge in Constricted Area (q2)	62.44	cfs/ft	
D50 (D50)	0.304800	mm	0.2 mm is the lower limit for coh...
Upstream Flow Depth (y1)	9.47	ft	
Define Shear Stress of Floodplain	☐		
Flow Depth prior to Scour (y0)	9.22	ft	Depth at Abutment Toe
Results			
q2 / q1	0.85		
Average Velocity Upstream (V)	7.79	ft/s	
Critical Velocity above which Bed Material of Size D and Sm...	1.62	ft/s	Used in contraction scour calcula...
Scour Condition	Live Bed		
Scour Condition	a (Main Channel)		
Amplification Factor (alpha A or alpha B)	1.20		
Flow Depth including Contraction Scour (yc)	8.21	ft	
Scour depth from Long-Term Degradation calculations	0.00	ft	
Maximum Flow Depth including Abutment Scour (ymax)	9.85	ft	Including the long-term scour de...
Scour Hole Depth (ys)	0.63	ft	Negative values imply 'zero' sco...
Scour Hole			
Angle of Repose (theta)	44.00	degrees	
Ratio of Bottom Width of Scour Hole to Scour Hole Depth	0.00		1.0 means the bottom width will ...
Scour Hole Bottom Width (K)	0.00	ft	
Scour Hole Top Width (W)	0.66	ft	

OK
Cancel

Bridge Scour Plot (Q100Y Prop (SRH-2D))



Salt Wash 200-Year

Contraction Scour

Computation Method: Clear-Water and Live-Bed Scour

Parameter	Value	Units	Notes
Pressure Scour Method			
Compute Pressure Scour (Vertical Contraction Scour)	☐		
Input Parameters			
Input Parameters for Scour Condition			
Average Depth Upstream of Contraction (y1)	10.00	ft	(hu) in pressure scour
D50 (D50)	0.304800	mm	0.2 mm is the lower limit for ...
Average Velocity Upstream (V)	8.46	ft/s	
Computed Contraction Scour Condition	Live Bed		Vc < V
Input Parameters for Live Bed			
Temperature of Water	60.00	°F	Used to determine the fall v...
Slope of Energy Grade Line at Approach Section (S1)	0.003390	ft/ft	
Discharge in Contracted Section (Q2)	3938.36	cfs	
Discharge Upstream that is Transporting Sediment (Q1)	2348.20	cfs	
Bottom Width in Contracted Section (W2)	59.23	ft	Remove widths occupied by ...
Width Upstream that is Transporting Sediment (W1)	27.76	ft	
Depth Prior to Scour in Contracted Section (y0)	9.52	ft	
Unit Weight of Water (gamma w)	62.40	lb/ft^3	
Unit Weight of Sediment (gamma s)	165.00	lb/ft^3	
Results			
Results of Scour Condition			
Critical velocity above which bed material of size D and s...	1.64	ft/s	
Results of Clear Water Method			
Diameter of the smallest nontransportable particle in the ...	0.381000	mm	
Average Depth in Contracted Section after Scour (y2)	30.62	ft	
Scour Depth (ys)	21.10	ft	Negative values imply 'zero' ...
Results of Live Bed Method			
k1 (k1)	0.690000		
Shear Velocity (V*)	1.04	ft/s	
Fall Velocity (T)	0.13	ft/s	
Average Depth in Contracted Section after Scour (y2)	9.23	ft	
Scour Depth (ys)	-0.29	ft	Negative values imply 'zero' ...
Shear Applied to Bed by Live-Bed Scour (theta 0)	0.3555	lb/ft^2	
Shear Required for Movement of D50 Particle (Tau c)	0.0040	lb/ft^2	
Recommendations			
Recommended Scour Condition	Live Bed		Determined by comparing sc...
Recommended Scour Depth	0.00	ft	Negative values imply 'zero' ...
Override Recommended Scour Condition	☐		

OK
Cancel

Pier Scour
✕

Computation Method: HEC-18

Parameter	Value	Units	Notes
Input Parameters			
Pier Shape (K1)	Group of Cylinders		
Bed Condition (K3)	Clear-Water Scour		Dune Height is N/A
Depth Upstream of Pier (y1)	12.35	ft	
Velocity Upstream of Pier (V1)	6.72	ft/s	
Width of Pier (a)	2.00	ft	width for the zero skew co...
Angle of Attack (K2)	5.27	Degrees	
Spacing between Columns of Piers (S)	14.00	ft	Column center to column c...
Number of Columns (n)	3		
Results			
Froude Number Upstream (Fr1)	0.34		
Correction Factor for Pier Nose Shape (K1)	1.00		
Correction Factor of Angle of Attack (K2)	1.00		
Spacing to Pier Width (s/a)	7.00		
Correction Factor for Bed Condition (K3)	1.10		
Scour Depth (ys)	6.25	ft	
Scour Hole			
Angle of Repose (theta)	44.00	degrees	
Use the Pier Width as the Bottom Width of Scour Hole	☒		
Scour Hole Bottom Width (K)	2.00	ft	
Scour Hole Top Width (W)	12.73	ft	

OK
Cancel

Pier Scour
✕

Computation Method: HEC-18

Parameter	Value	Units	Notes
Input Parameters			
Pier Shape (K1)	Group of Cylinders		
Bed Condition (K3)	Clear-Water Scour		Dune Height is N/A
Depth Upstream of Pier (y1)	12.35	ft	
Velocity Upstream of Pier (V1)	6.72	ft/s	
Width of Pier (a)	2.00	ft	width for the zero skew co...
Angle of Attack (K2)	55.85	Degrees	
Spacing between Columns of Piers (S)	14.00	ft	Column center to column c...
Number of Columns (n)	3		
Results			
Froude Number Upstream (Fr1)	0.34		
Correction Factor for Pier Nose Shape (K1)	1.00		
Correction Factor of Angle of Attack (K2)	1.00		
Spacing to Pier Width (s/a)	7.00		
Correction Factor for Bed Condition (K3)	1.10		
Scour Depth (ys)	6.25	ft	
Scour Hole			
Angle of Repose (theta)	44.00	degrees	
Use the Pier Width as the Bottom Width of Scour Hole	☒		
Scour Hole Bottom Width (K)	2.00	ft	
Scour Hole Top Width (W)	12.73	ft	

OK
Cancel

Abutment Scour
✕

Computation Method: NCHRP

Parameter	Value	Units	Notes
Input Parameters			
Scour Condition	Compute		
Scour Condition Location	Type a (Main Channel)		
Abutment Type (k1)	Spill-through abutment		
Unit Discharge, Upstream in Main Channel (q1)	84.57	cfs/ft	
Unit Discharge in Constricted Area (q2)	66.49	cfs/ft	
D50 (D50)	0.304800	mm	0.2 mm is the lower limit for coh...
Upstream Flow Depth (y1)	10.00	ft	
Define Shear Stress of Floodplain	☐		
Flow Depth prior to Scour (y0)	10.10	ft	Depth at Abutment Toe
Results			
q2 / q1	0.79		
Average Velocity Upstream (V)	8.46	ft/s	
Critical Velocity above which Bed Material of Size D and Sm...	1.64	ft/s	Used in contraction scour calcula...
Scour Condition	Live Bed		
Scour Condition	a (Main Channel)		
Amplification Factor (alpha A or alpha B)	1.20		
Flow Depth including Contraction Scour (yc)	8.13	ft	
Scour depth from Long-Term Degradation calculations	0.00	ft	
Maximum Flow Depth including Abutment Scour (ymax)	9.76	ft	Including the long-term scour de...
Scour Hole Depth (ys)	-0.34	ft	Negative values imply 'zero' sco...
Scour Hole			
Angle of Repose (theta)	44.00	degrees	
Ratio of Bottom Width of Scour Hole to Scour Hole Depth	0.00		1.0 means the bottom width will ...

OK
Cancel

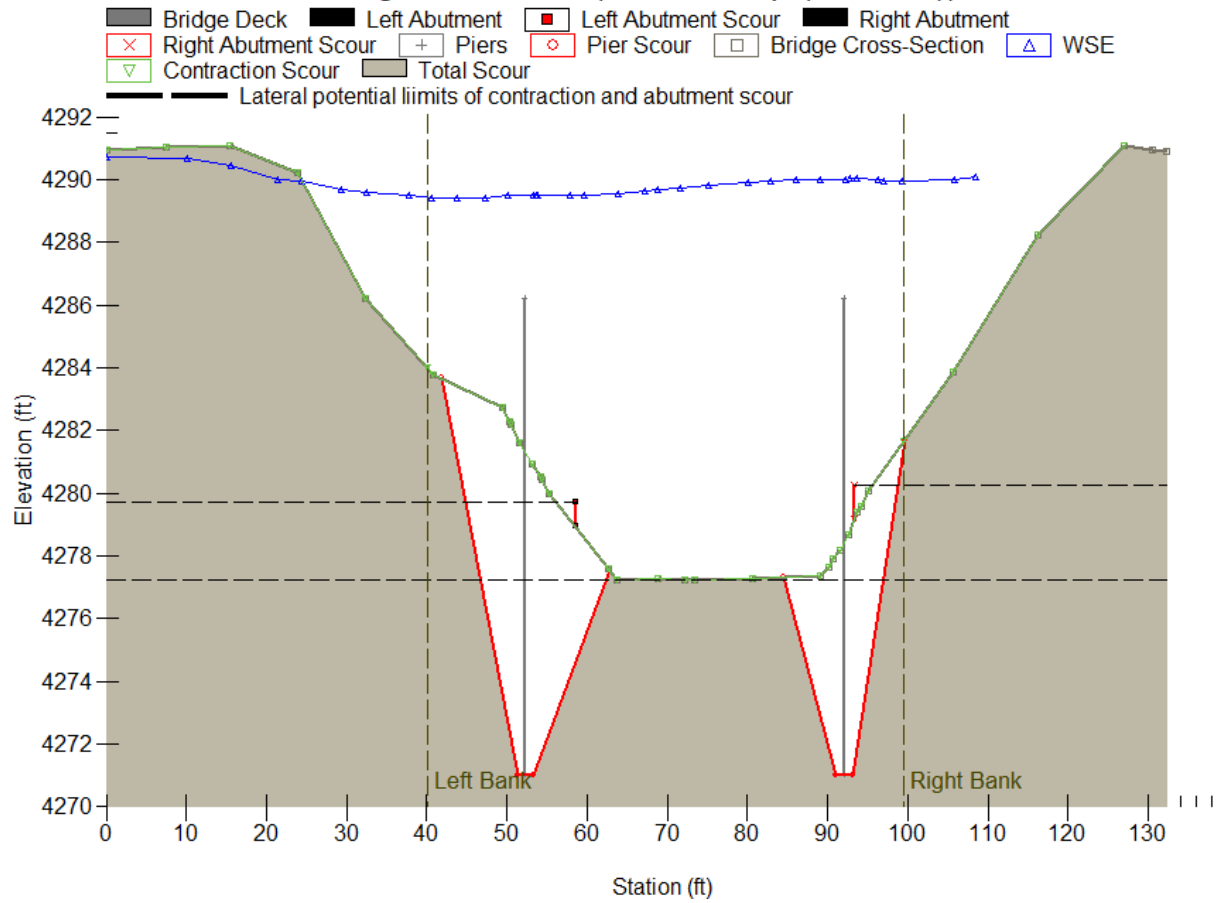
Abutment Scour
✕

Computation Method: NCHRP

Parameter	Value	Units	Notes
Input Parameters			
Scour Condition	Compute		
Scour Condition Location	Type a (Main Channel)		
Abutment Type (k1)	Spill-through abutment		
Unit Discharge, Upstream in Main Channel (q1)	84.57	cfs/ft	
Unit Discharge in Constricted Area (q2)	66.49	cfs/ft	
D50 (D50)	0.304800	mm	0.2 mm is the lower limit for coh...
Upstream Flow Depth (y1)	10.00	ft	
Define Shear Stress of Floodplain	☐		
Flow Depth prior to Scour (y0)	9.54	ft	Depth at Abutment Toe
Results			
q2 / q1	0.79		
Average Velocity Upstream (V)	8.46	ft/s	
Critical Velocity above which Bed Material of Size D and Sm...	1.64	ft/s	Used in contraction scour calcula...
Scour Condition	Live Bed		
Scour Condition	a (Main Channel)		
Amplification Factor (alpha A or alpha B)	1.20		
Flow Depth including Contraction Scour (yc)	8.13	ft	
Scour depth from Long-Term Degradation calculations	0.00	ft	
Maximum Flow Depth including Abutment Scour (ymax)	9.76	ft	Including the long-term scour de...
Scour Hole Depth (ys)	0.22	ft	Negative values imply 'zero' sco...
Scour Hole			
Angle of Repose (theta)	44.00	degrees	
Ratio of Bottom Width of Scour Hole to Scour Hole Depth	0.00		1.0 means the bottom width will ...
Scour Hole Bottom Width (K)	0.00	ft	
Scour Hole Top Width (W)	0.23	ft	

OK
Cancel

Bridge Scour Plot (Q200Y Prop (SRH-2D))



Salt Wash Riprap

Riprap Analysis

Structure type: Abutment/Guide Bank
Geotextile/Granular Filter Design...

Parameter	Value	Units	Notes
Channel Parameters			
Select Channel	<Define Local Data>		
	Channel Calculator...		
Input Parameters			
	Transfer Values From Channel Calculations		
Structure Type	abutment		
Abutment Type	spill-through abutment		
Set-back Length	0.001	ft	The set-back length is the distance from the near edge of the main channel to the toe of the abutment.
Main Channel Average Flow Depth	6.100	ft	
Flow Depth at Toe of Abutment	11.300	ft	
Total Discharge	4493.000	cfs	Calculations will use either total or overbank discharges. Bolded values indicate the value used in the calculations.
Overbank Discharge	0.001	cfs	
Total Bridge Area	687.000	ft^2	
Setback Area	0.001	ft^2	
Maximum Channel Velocity	8.400	ft/s	
Specific Gravity of Riprap	2.650		
Results			
Set-back ratio	0.000		
Characteristic Velocity	6.540	ft/s	
Froude Number at the Abutment Toe	0.343		
Abutment Coefficient	0.890		
D50	218.562	mm	
Riprap Shape	Riprap shape should be angular		
Riprap Class			
Riprap Class Name	CLASS II		
Riprap Class Order	2		
D15	177.80	mm	This value is an 'average' of the size fraction range for the selected riprap class
D50	241.30	mm	This value is an 'average' of the size fraction range for the selected riprap class
D85	330.20	mm	This value is an 'average' of the size fraction range for the selected riprap class
D100	457.20	mm	This value is an 'average' of the size fraction range for the selected riprap class
Layout			
Riprap Thickness	18.000	in	
Minimum Horizontal Extent of the Toe Apron from the Abutment Toe	22.600	ft	
Minimum Extent of "Wrap Around" beyond the Abutment Radius, along the Approach Embankment	25.000	ft	See HEC 23, Figure 14.7

OK
Cancel

Winter Camp Wash 100-Year

Contraction Scour
✕

Computation Method: Clear-Water and Live-Bed Scour

Parameter	Value	Units	Notes
Pressure Scour Method			
Compute Pressure Scour (Vertical Contraction Scour)	☐		
Input Parameters			
Input Parameters for Scour Condition			
Average Depth Upstream of Contraction (y1)	4.54	ft	(hu) in pressure scour
D50 (D50)	0.304800	mm	0.2 mm is the lower limit for ...
Average Velocity Upstream (V)	7.37	ft/s	
Computed Contraction Scour Condition	Live Bed		Vc < V
Input Parameters for Live Bed			
Temperature of Water	60.00	°F	Used to determine the fall v...
Slope of Energy Grade Line at Approach Section (S1)	0.008550	ft/ft	
Discharge in Contracted Section (Q2)	2808.82	cfs	
Discharge Upstream that is Transporting Sediment (Q1)	1080.27	cfs	
Bottom Width in Contracted Section (W2)	71.17	ft	Remove widths occupied by ...
Width Upstream that is Transporting Sediment (W1)	32.27	ft	
Depth Prior to Scour in Contracted Section (y0)	3.42	ft	
Unit Weight of Water (gamma w)	62.40	lb/ft^3	
Unit Weight of Sediment (gamma s)	165.00	lb/ft^3	
Results			
Results of Scour Condition			
Critical velocity above which bed material of size D and s...	1.44	ft/s	
Results of Clear Water Method			
Diameter of the smallest nontransportable particle in the ...	0.381000	mm	
Average Depth in Contracted Section after Scour (y2)	19.58	ft	
Scour Depth (ys)	16.17	ft	Negative values imply 'zero' ...
Results of Live Bed Method			
k1 (k1)	0.690000		
Shear Velocity (V*)	1.12	ft/s	
Fall Velocity (T)	0.13	ft/s	
Average Depth in Contracted Section after Scour (y2)	5.97	ft	
Scour Depth (ys)	2.55	ft	Negative values imply 'zero' ...
Shear Applied to Bed by Live-Bed Scour (theta 0)	0.2590	lb/ft^2	
Shear Required for Movement of D50 Particle (Tau c)	0.0040	lb/ft^2	
Recommendations			
Recommended Scour Condition	Live Bed		Determined by comparing sc...
Recommended Scour Depth	2.55	ft	Negative values imply 'zero' ...
Override Recommended Scour Condition	☐		

OK
Cancel

Pier Scour
✕

Computation Method: HEC-18

Parameter	Value	Units	Notes
Input Parameters			
Pier Shape (K1)	Group of Cylinders		
Bed Condition (K3)	Clear-Water Scour		Dune Height is N/A
Depth Upstream of Pier (y1)	6.20	ft	
Velocity Upstream of Pier (V1)	14.00	ft/s	
Width of Pier (a)	2.00	ft	width for the zero skew co...
Angle of Attack (K2)	67.08	Degrees	
Spacing between Columns of Piers (S)	14.00	ft	Column center to column c...
Number of Columns (n)	3		
Results			
Froude Number Upstream (Fr1)	0.99		
Correction Factor for Pier Nose Shape (K1)	1.00		
Correction Factor of Angle of Attack (K2)	1.00		
Spacing to Pier Width (s/a)	7.00		
Correction Factor for Bed Condition (K3)	1.10		
Scour Depth (ys)	7.81	ft	
Scour Hole			
Angle of Repose (theta)	44.00	degrees	
Use the Pier Width as the Bottom Width of Scour Hole	☒		
Scour Hole Bottom Width (K)	2.00	ft	
Scour Hole Top Width (W)	15.91	ft	

OK
Cancel

Pier Scour
✕

Computation Method: HEC-18

Parameter	Value	Units	Notes
Input Parameters			
Pier Shape (K1)	Group of Cylinders		
Bed Condition (K3)	Clear-Water Scour		Dune Height is N/A
Depth Upstream of Pier (y1)	6.20	ft	
Velocity Upstream of Pier (V1)	14.00	ft/s	
Width of Pier (a)	2.00	ft	width for the zero skew co...
Angle of Attack (K2)	56.75	Degrees	
Spacing between Columns of Piers (S)	14.00	ft	Column center to column c...
Number of Columns (n)	3		
Results			
Froude Number Upstream (Fr1)	0.99		
Correction Factor for Pier Nose Shape (K1)	1.00		
Correction Factor of Angle of Attack (K2)	1.00		
Spacing to Pier Width (s/a)	7.00		
Correction Factor for Bed Condition (K3)	1.10		
Scour Depth (ys)	7.81	ft	
Scour Hole			
Angle of Repose (theta)	44.00	degrees	
Use the Pier Width as the Bottom Width of Scour Hole	☒		
Scour Hole Bottom Width (K)	2.00	ft	
Scour Hole Top Width (W)	15.91	ft	

OK
Cancel

Abutment Scour
✕

Computation Method: NCHRP

Parameter	Value	Units	Notes
Input Parameters			
Scour Condition	Compute		
Scour Condition Location	Type a (Main Channel)		
Abutment Type (k1)	Spill-through abutment		
Unit Discharge, Upstream in Main Channel (q1)	33.48	cfs/ft	
Unit Discharge in Constricted Area (q2)	39.46	cfs/ft	
D50 (D50)	0.304800	mm	0.2 mm is the lower limit for coh...
Upstream Flow Depth (y1)	4.54	ft	
Define Shear Stress of Floodplain	☐		
Flow Depth prior to Scour (y0)	4.56	ft	Depth at Abutment Toe
Results			
q2 / q1	1.18		
Average Velocity Upstream (V)	7.37	ft/s	
Critical Velocity above which Bed Material of Size D and Sm...	1.44	ft/s	Used in contraction scour calcula...
Scour Condition	Live Bed		
Scour Condition	a (Main Channel)		
Amplification Factor (alpha A or alpha B)	1.67		
Flow Depth including Contraction Scour (yc)	5.23	ft	
Scour depth from Long-Term Degradation calculations	0.00	ft	
Maximum Flow Depth including Abutment Scour (ymax)	8.71	ft	Including the long-term scour de...
Scour Hole Depth (ys)	4.16	ft	Negative values imply 'zero' sco...
Scour Hole			
Angle of Repose (theta)	44.00	degrees	
Ratio of Bottom Width of Scour Hole to Scour Hole Depth	0.00		1.0 means the bottom width will ...
Scour Hole Bottom Width (K)	0.00	ft	
Scour Hole Top Width (W)	4.31	ft	

OK
Cancel

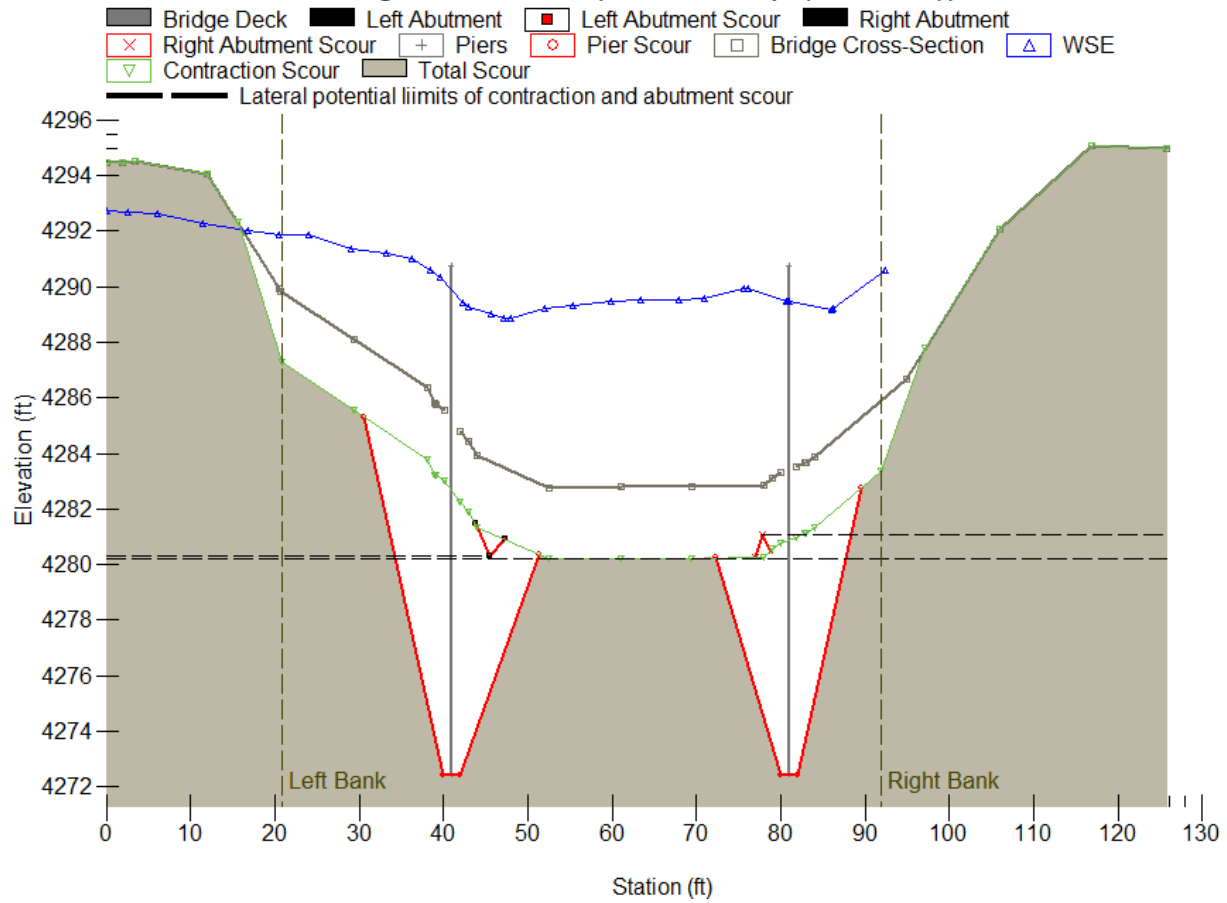
Abutment Scour
✕

Computation Method: NCHRP

Parameter	Value	Units	Notes
Input Parameters			
Scour Condition	Compute		
Scour Condition Location	Type a (Main Channel)		
Abutment Type (k1)	Spill-through abutment		
Unit Discharge, Upstream in Main Channel (q1)	33.48	cfs/ft	
Unit Discharge in Constricted Area (q2)	39.46	cfs/ft	
D50 (D50)	0.304800	mm	0.2 mm is the lower limit for coh...
Upstream Flow Depth (y1)	4.54	ft	
Define Shear Stress of Floodplain	☐		
Flow Depth prior to Scour (y0)	5.36	ft	Depth at Abutment Toe
Results			
q2 / q1	1.18		
Average Velocity Upstream (V)	7.37	ft/s	
Critical Velocity above which Bed Material of Size D and Sm...	1.44	ft/s	Used in contraction scour calcula...
Scour Condition	Live Bed		
Scour Condition	a (Main Channel)		
Amplification Factor (alpha A or alpha B)	1.67		
Flow Depth including Contraction Scour (yc)	5.23	ft	
Scour depth from Long-Term Degradation calculations	0.00	ft	
Maximum Flow Depth including Abutment Scour (ymax)	8.71	ft	Including the long-term scour de...
Scour Hole Depth (ys)	3.35	ft	Negative values imply 'zero' sco...
Scour Hole			
Angle of Repose (theta)	44.00	degrees	
Ratio of Bottom Width of Scour Hole to Scour Hole Depth	0.00		1.0 means the bottom width will ...
Scour Hole Bottom Width (K)	0.00	ft	
Scour Hole Top Width (W)	3.47	ft	

OK
Cancel

Bridge Scour Plot (Q100Y Prop (SRH-2D))



Winter Camp Wash 200-Year

Contraction Scour

Computation Method: Clear-Water and Live-Bed Scour

Parameter	Value	Units	Notes
Pressure Scour Method			
Compute Pressure Scour (Vertical Contraction Scour)	☐		
Input Parameters			
Input Parameters for Scour Condition			
Average Depth Upstream of Contraction (y1)	5.08	ft	(hu) in pressure scour
D50 (D50)	0.304800	mm	0.2 mm is the lower limit for ...
Average Velocity Upstream (V)	7.06	ft/s	
Computed Contraction Scour Condition	Live Bed		Vc < V
Input Parameters for Live Bed			
Temperature of Water	60.00	°F	Used to determine the fall v...
Slope of Energy Grade Line at Approach Section (S1)	0.008365	ft/ft	
Discharge in Contracted Section (Q2)	3277.89	cfs	
Discharge Upstream that is Transporting Sediment (Q1)	1156.67	cfs	
Bottom Width in Contracted Section (W2)	71.18	ft	Remove widths occupied by ...
Width Upstream that is Transporting Sediment (W1)	32.27	ft	
Depth Prior to Scour in Contracted Section (y0)	4.08	ft	
Unit Weight of Water (gamma w)	62.40	lb/ft^3	
Unit Weight of Sediment (gamma s)	165.00	lb/ft^3	
Results			
Results of Scour Condition			
Critical velocity above which bed material of size D and s...	1.46	ft/s	
Results of Clear Water Method			
Diameter of the smallest nontransportable particle in the ...	0.381000	mm	
Average Depth in Contracted Section after Scour (y2)	22.35	ft	
Scour Depth (ys)	18.27	ft	Negative values imply 'zero' ...
Results of Live Bed Method			
k1 (k1)	0.690000		
Shear Velocity (V*)	1.17	ft/s	
Fall Velocity (T)	0.13	ft/s	
Average Depth in Contracted Section after Scour (y2)	7.18	ft	
Scour Depth (ys)	3.10	ft	Negative values imply 'zero' ...
Shear Applied to Bed by Live-Bed Scour (theta 0)	0.2592	lb/ft^2	
Shear Required for Movement of D50 Particle (Tau c)	0.0040	lb/ft^2	
Recommendations			
Recommended Scour Condition	Live Bed		Determined by comparing sc...
Recommended Scour Depth	3.10	ft	Negative values imply 'zero' ...
Override Recommended Scour Condition	☐		

OK
Cancel

Pier Scour
✕

Computation Method: HEC-18

Parameter	Value	Units	Notes
Input Parameters			
Pier Shape (K1)	Group of Cylinders		
Bed Condition (K3)	Clear-Water Scour		Dune Height is N/A
Depth Upstream of Pier (y1)	6.96	ft	
Velocity Upstream of Pier (V1)	13.61	ft/s	
Width of Pier (a)	2.00	ft	width for the zero skew co...
Angle of Attack (K2)	33.21	Degrees	
Spacing between Columns of Piers (S)	14.00	ft	Column center to column c...
Number of Columns (n)	3		
Results			
Froude Number Upstream (Fr1)	0.91		
Correction Factor for Pier Nose Shape (K1)	1.00		
Correction Factor of Angle of Attack (K2)	1.00		
Spacing to Pier Width (s/a)	7.00		
Correction Factor for Bed Condition (K3)	1.10		
Scour Depth (ys)	7.84	ft	
Scour Hole			
Angle of Repose (theta)	44.00	degrees	
Use the Pier Width as the Bottom Width of Scour Hole	☒		
Scour Hole Bottom Width (K)	2.00	ft	
Scour Hole Top Width (W)	15.96	ft	

OK
Cancel

Pier Scour
✕

Computation Method: HEC-18

Parameter	Value	Units	Notes
Input Parameters			
Pier Shape (K1)	Group of Cylinders		
Bed Condition (K3)	Clear-Water Scour		Dune Height is N/A
Depth Upstream of Pier (y1)	6.96	ft	
Velocity Upstream of Pier (V1)	13.61	ft/s	
Width of Pier (a)	2.00	ft	width for the zero skew co...
Angle of Attack (K2)	47.06	Degrees	
Spacing between Columns of Piers (S)	14.00	ft	Column center to column c...
Number of Columns (n)	3		
Results			
Froude Number Upstream (Fr1)	0.91		
Correction Factor for Pier Nose Shape (K1)	1.00		
Correction Factor of Angle of Attack (K2)	1.00		
Spacing to Pier Width (s/a)	7.00		
Correction Factor for Bed Condition (K3)	1.10		
Scour Depth (ys)	7.84	ft	
Scour Hole			
Angle of Repose (theta)	44.00	degrees	
Use the Pier Width as the Bottom Width of Scour Hole	☒		
Scour Hole Bottom Width (K)	2.00	ft	
Scour Hole Top Width (W)	15.96	ft	

OK
Cancel

Abutment Scour
✕

Computation Method: NCHRP

Parameter	Value	Units	Notes
Input Parameters			
Scour Condition	Compute		
Scour Condition Location	Type a (Main Channel)		
Abutment Type (k1)	Spill-through abutment		
Unit Discharge, Upstream in Main Channel (q1)	35.85	cfs/ft	
Unit Discharge in Constricted Area (q2)	46.05	cfs/ft	
D50 (D50)	0.304800	mm	0.2 mm is the lower limit for coh...
Upstream Flow Depth (y1)	5.08	ft	
Define Shear Stress of Floodplain	☐		
Flow Depth prior to Scour (y0)	5.40	ft	Depth at Abutment Toe
Results			
q2 / q1	1.28		
Average Velocity Upstream (V)	7.06	ft/s	
Critical Velocity above which Bed Material of Size D and Sm...	1.46	ft/s	Used in contraction scour calcula...
Scour Condition	Live Bed		
Scour Condition	a (Main Channel)		
Amplification Factor (alpha A or alpha B)	1.67		
Flow Depth including Contraction Scour (yc)	6.29	ft	
Scour depth from Long-Term Degradation calculations	0.00	ft	
Maximum Flow Depth including Abutment Scour (ymax)	10.52	ft	Including the long-term scour de...
Scour Hole Depth (ys)	5.12	ft	Negative values imply 'zero' sco...
Scour Hole			
Angle of Repose (theta)	44.00	degrees	
Ratio of Bottom Width of Scour Hole to Scour Hole Depth	0.00		1.0 means the bottom width will ...
Scour Hole Bottom Width (K)	0.00	ft	
Scour Hole Top Width (W)	5.31	ft	

OK
Cancel

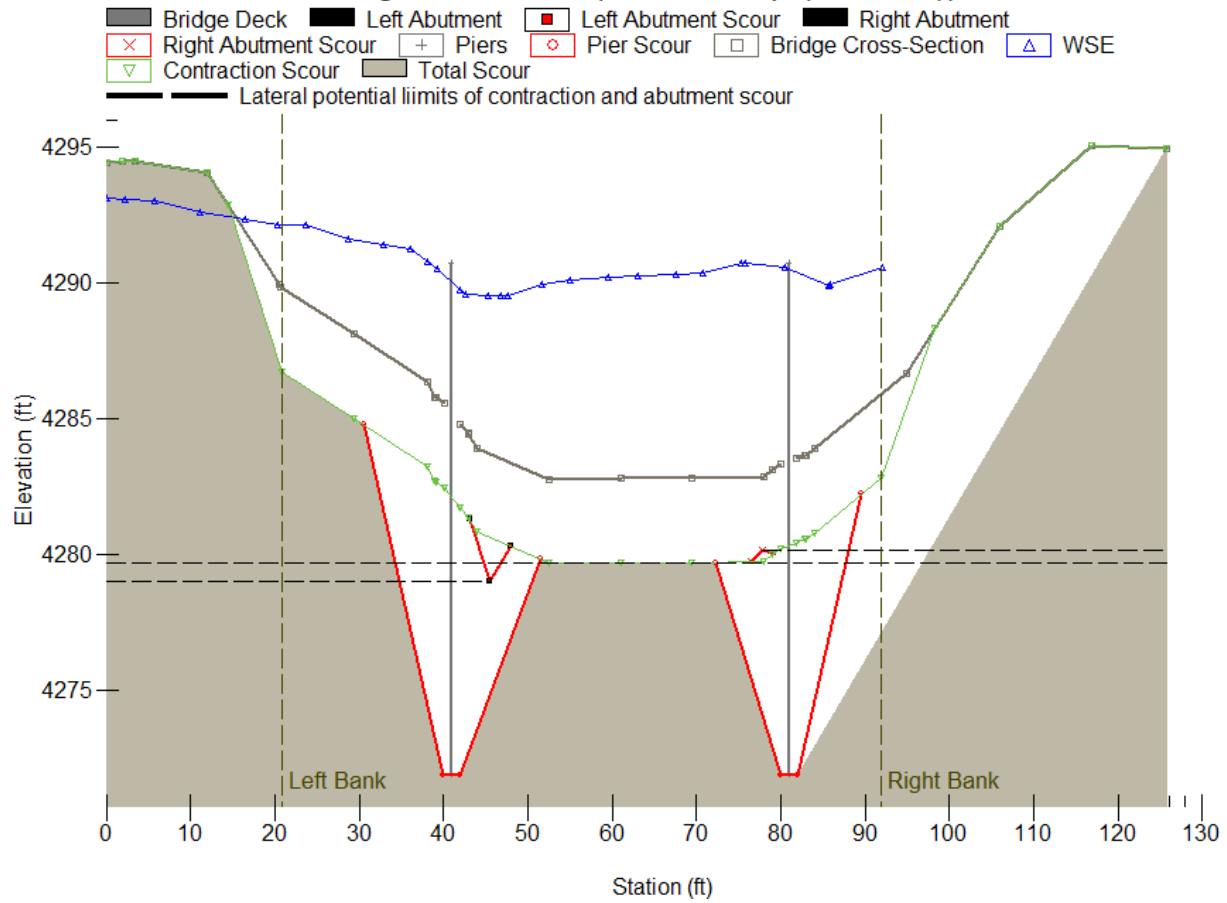
Abutment Scour
✕

Computation Method: NCHRP

Parameter	Value	Units	Notes
Input Parameters			
Scour Condition	Compute		
Scour Condition Location	Type a (Main Channel)		
Abutment Type (k1)	Spill-through abutment		
Unit Discharge, Upstream in Main Channel (q1)	35.85	cfs/ft	
Unit Discharge in Constricted Area (q2)	46.05	cfs/ft	
D50 (D50)	0.304800	mm	0.2 mm is the lower limit for coh...
Upstream Flow Depth (y1)	5.08	ft	
Define Shear Stress of Floodplain	☐		
Flow Depth prior to Scour (y0)	6.12	ft	Depth at Abutment Toe
Results			
q2 / q1	1.28		
Average Velocity Upstream (V)	7.06	ft/s	
Critical Velocity above which Bed Material of Size D and Sm...	1.46	ft/s	Used in contraction scour calcula...
Scour Condition	Live Bed		
Scour Condition	a (Main Channel)		
Amplification Factor (alpha A or alpha B)	1.67		
Flow Depth including Contraction Scour (yc)	6.29	ft	
Scour depth from Long-Term Degradation calculations	0.00	ft	
Maximum Flow Depth including Abutment Scour (ymax)	10.52	ft	Including the long-term scour de...
Scour Hole Depth (ys)	4.40	ft	Negative values imply 'zero' sco...
Scour Hole			
Angle of Repose (theta)	44.00	degrees	
Ratio of Bottom Width of Scour Hole to Scour Hole Depth	0.00		1.0 means the bottom width will ...
Scour Hole Bottom Width (K)	0.00	ft	
Scour Hole Top Width (W)	4.56	ft	

OK
Cancel

Bridge Scour Plot (Q200Y Prop (SRH-2D))



Winter Camp Wash Riprap

Riprap Analysis

Structure type: Abutment/Guide Bank
Geotextile/Granular Filter Design...

Parameter	Value	Units	Notes
Channel Parameters			
Select Channel	<Define Local Data>		
	Channel Calculator...		
Input Parameters			
	Transfer Values From Channel Calcu...		
Structure Type	abutment		
Abutment Type	spill-through abutment		
Set-back Length	0.001	ft	The set-back length is the distance from the near edge of the main channel to t...
Main Channel Average Flow Depth	2.000	ft	
Flow Depth at Toe of Abutment	5.200	ft	
Total Discharge	2825.000	cfs	Calculations will use either total or overbank discharges. Bolded values indicate...
Overbank Discharge	0.001	cfs	
Total Bridge Area	247.000	ft^2	
Setback Area	0.001	ft^2	
Maximum Channel Velocity	14.800	ft/s	
Specific Gravity of Riprap	2.650		
Results			
Set-back ratio	0.001		
Characteristic Velocity	11.437	ft/s	
Froude Number at the Abutment Toe	0.884		
Abutment Coefficient	0.610		
D50	566.113	mm	
Riprap Shape	Riprap shape should be angular		
Riprap Class			
Riprap Class Name	CLASS VII		
Riprap Class Order	7		
D15	444.50	mm	This value is an 'average' of the size fraction range for the selected riprap class
D50	647.70	mm	This value is an 'average' of the size fraction range for the selected riprap class
D85	889.00	mm	This value is an 'average' of the size fraction range for the selected riprap class
D100	1257.30	mm	This value is an 'average' of the size fraction range for the selected riprap class
Layout			
Riprap Thickness	49.500	in	
Minimum Horizontal Extent of the Toe Apron from the Abutment Toe	10.400	ft	
Minimum Extent of "Wrap Around" beyond the Abutment Radius, along the Approach Embankment	25.000	ft	See HEC 23, Figure 14.7

OK
Cancel