PREPARED FOR:

STORMWATER REPORT







RAIL & BRIDGE IMPROVEMENTS

PORT OF STOCKTON

FINAL DESIGN

AUGUST 31, 2026

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1. Introduction

In recent years, the Port of Stockton has experienced a significant increase in annual rail throughput, resulting in constrained rail access and switching capacity and reduced rail storage Port-wide. Additionally, the Port has identified several prospective tenants seeking a new rail service, with a significant volume identified for the West Complex. Current access to the West Complex is only possible through the East Complex, over the existing San Joaquin River single-track rail bridge, and is heavily constrained by switching operations in the East Complex.

This stormwater report defines the major drainage design elements related to the proposed double lead track, and other associated improvements within the BNSF ROW. Hydraulic and hydrologic analysis of the Fresno Avenue underpass and San Joaquin River bridge is outside the scope of this report. Area-wide drainage evaluation is outside the scope of this report. A separate report will be prepared to analyze and discuss the entire project within the Port property.

1.1 Revisions

The following is a summary showing the revision tracking for the Drainage Report:

Table 1 – Revision Summary Table

Revision	E
Date	08/31/2026
Description	Final Stormwater Report
Prepared By	Arkaprabha Ghosh, PE
Checked By	Allene Rieger, PE
Approved By	Jon Marshall, PE

Previous Revisions	
Rev	Date
60% Design (B)	04/19/2024
90% Design (C)	01/14/2025
100% Design (D)	06/27/2025
Final Design (E)	08/31/2026

1.2 Project Location

The project is located at 2201 West Washington Street in Stockton, CA. The Port facility is located between MP 1123 and MP 1125 along the BNSF Stockton Subdivision. The Port of Stockton is the fourth largest Port in California by volume, shipping upwards of 4.7 million tons annually. It is also the largest inland Port in California, occupying approximately 4,200 acres.

The BNSF mainline of the Stockton subdivision provides rail access to the Port and the Port is rail served by both BNSF and UPRR. Currently, the BNSF right-of-way (ROW) east of the entry into the Port consists of an approximately 15-foot high embankment that supports the BNSF mainline and the lead track entering the Port. The proposed project will widen this embankment to accommodate an additional track to the north of the Port lead track.

The project extents within the BNSF ROW is shown in **Figure 1** below. This report covers the portion of the project that falls within the BNSF ROW from MP 1122.39 to approximately MP 1123.



Figure 1: Site Location Map

1.3 Project Stakeholders

List design team and agency stakeholders.

1.3.1 Design Team

Owner:	Port of Stockton, Rhonda Nelson – Director, Real Estate & Port Development
Railroad:	BNSF Railway, Dionisio Martinez, Manager Public Projects
Prime Consultant/Bridge Engineer:	HDR, Inc., Matthew Archer, P.E. – Sr. Rail Engineer
Civil and Rail Engineer:	JMA Civil, Inc., Arka Ghosh, P.E. – Sr. Civil Engineer
Hydrology and Hydraulics Engineer:	(Track) JMA Civil, Inc., Arka Ghosh, P.E. – Sr. Civil Engineer
	(Bridge) HDR, Inc., Chengwen Liu, PhD, PE, SE – Structural Engineer
Geotechnical Engineer:	Kleinfelder, Nathan L. Dahlen, P.E. – Senior Project Manager
Surveyor:	Cinquini and Passarino, Inc., Jim Dickey, P.L.S. – Principal
Environmental Engineer:	Anchor QEA, LLC, Katie Chamberlin – Sr. Managing Environmental Planner

1.3.2 Agency Stakeholders

Port of Stockton

The Port of Stockton is the Owner of the project site and is responsible for leasing property to Port tenants. The Port manages all stormwater permits and works collectively with the City of Stockton to issue all building permits.

Railroad

BNSF owns and operates the main line that serves the Port of Stockton. The Central California Traction Company (CCTC) is the Port's rail operator and is jointly owned by BNSF and UPRR. Both BNSF and UPRR serve tenants at the Port. All rail design at the Port is subject to approval from CCTC with input from BNSF and UPRR.

Local Agencies

The City of Stockton has permit jurisdiction along Fresno Avenue at the proposed underpass's location.

1.4 Applicable Codes and Standards

This report and the resulting design shall comply with the following standards, including all addenda, specifications, and recommended practices.

- BNSF Main Line Track Standards
- UPRR Industry Track Standards
- Port of Stockton Drainage Design Guidelines
- Caltrans Highway Design Manual (HDM)
- USDA/SCS TR-55 Urban Hydrology for Small Watersheds, June 1986
- City of Stockton Standard Specifications and Drawings

1.5 Project Survey Datum

Ground survey was performed on 04/24/2023. The benchmark for the survey is city of Stockton benchmark number 305 stamped '10S-1' near entrance to the port of Stockton main offices. Horizontal coordinates are based on California state plane coordinate system zone #3, NAD83. Vertical datum is based on NAVD88.

1.6 Flood Hazard Analysis

The project is located at 2201 West Washington Street in Stockton, CA. The Port facility is located between MP 1123 and MP 1125 along the BNSF Stockton Subdivision. Most of the project site is in a "Zone X Other Flood Area," which indicates an area with 0.2% annual chance of flood or an area with 1% annual chance of flood with average depths of less than 1 foot or with drainage areas less than 1 square mile, as well as areas protected by levees from a 1% annual chance of flood.

The portion of the project within BNSF ROW lies in an area with reduced flood risk, as shown in the FEMA FIRM Map in **Appendix A.** A portion of the San Joaquin River is classified as a Regulatory Floodway. However, the risk of flooding is significantly reduced in the BNSF ROW due to the levee system around the San Joaquin River and Burns Cutoff maintained by the Reclamation Districts 403 and 404. The base flood elevations at the San Joaquin River vary from 10' at the north end of the Port to approximately 12.5 feet to the south at the BNSF mainline bridge.

2. Stormwater Analysis Approach

Civil3D's Storm and Sewer Analysis Package (SSA) was utilized to develop the stormwater model including the subbasins (drainage areas), storage ponds (basins), inlets, and storm drains. The widely accepted SCS TR-55 method was utilized to computing peak runoffs. The 'Hydrodynamic' mode was utilized as the link routing method to obtain the most accurate results feasible. The software utilizes Manning's Equation to compute capacities for both open channels and conduit flows. The 'Hydrodynamic' routing method in-built within the AutoCAD SSA module was selected as it is better at modeling various flow scenarios including 'surcharging' which is likely occurrence at the City Storm Drain network underneath Fresno Avenue underpass that will receive runoff from BNSF ROW. The other modes of 'Kinematic Wave' and 'Steady Flow' are not as effective in simulating

surcharge conditions. Lastly, storage curves were developed in the model based on elevation-area tables for computing retention capacity of the storage basin.

3. Existing Conditions

The Port of Stockton is divided into East and West Complex by the San Joaquin River, which is the main tributary of the project site. San Joaquin River is a major river in California, and the Port of Stockton is located on its downstream stretch before its confluence with the San Francisco Bay. Both the East and West Complex have a complex network of drains and culverts that eventually drain into the San Joaquin River.

The watershed in BNSF ROW is bound by the approximately 15-foot-high track roadbed embankment for the BNSF mainline, the Port lead track (LD01) to the south, and the adjacent Scotts Avenue roadway to the north. There are localized low points within the BNSF ROW between the track embankments and Scotts Avenue. Largely, the BNSF ROW and the adjacent roadway at the Fresno Avenue underpass drain into the City of Stockton catch basins underneath the underpass structure. As per City's field notes, the storm drain connecting the two catch basins is an 18" concrete pipe (SD-14). Another 18" concrete pipe receives runoff from the east catch basin and drains toward the City lift station at the northeast corner of the Scotts-Fresno intersection. The runoff is then pumped north from the lift station.

There is also a depression between the track embankments and the inactive BNSF spur track that acts as a retention basin. **Appendix B** shows the existing drainage map of all drainage regions described above, with illustrations. The drainage areas are also summarized below in **Table 2**.

Table 2 – Existing Drainage Areas

Drainage Area	Area (AC)	Station Range (Track LD02)	Downstream element
DA-37EX	0.77	108+71.80 to 113+80.00	Fresno West Catch Basin
DA-38EX	1.72	113+80.00 to 120+11.22	Fresno West Catch Basin
DA-39EX	0.65	120+11.22 to 122+38.25	Fresno West Catch Basin
DA-40EX	0.63	122+38.25 to 124+16.61	Fresno West Catch Basin
DA-41EX	0.31	122+58.86 to 124+16.61	Fresno West Catch Basin
DA-42EX	1.02	124+16.61 to 127+65.02	Fresno Storm Drain (SD-14)
DA-43EX	0.76	124+16.61 to 128+17.43	Fresno Storm Drain (SD-14)
DA-44EX	0.45	127+65.02 to 129+26.27	Fresno Storm Drain (SD-14)
DA-45EX	2.90	129+26.27 to 140+15.39	BNSF Detention Basin

4. Proposed Conditions

The general strategy in the BNSF ROW is to maintain existing flow patterns with the new track embankment, maintaining the existing path for runoff to sheet flow away from the tracks into the BNSF ROW. We have proposed a retaining wall to contain the track embankment from impacting adjacent Scotts Avenue underneath SR-4. The retaining wall shall have regular weep holes to convey runoff track embankment onto BNSF ROW outside the retaining wall.

There are short segments on both approaches to the proposed underpass that require V-ditches. This is because it is not feasible to lower the new track embankment below existing embankment

despite maximum ballast depth owing to the higher track profile needed at the new track to meet clearance requirements underneath Fresno Avenue. Therefore, a low spot is created between the track embankments, and the V-ditches will collect runoff and convey it to the 36" diameter culverts at the lowest flow lines. Per the BNSF's track maintenance requirements, a 36" culvert is the minimum size allowed under a main line track, and the size not governed by the expected flow through these pipes, which is minimal as shown in **Table 7**. These culverts will extend past the new track embankment and daylight into the BNSF ROW. Due to the introduction of concentrated flow with the culverts, we have proposed 3' wide trapezoidal ditches on both sides of the underpass that will receive and channelize runoff from the adjacent roadway and the BNSF culverts before flowing into the City catch basins on Fresno Avenue. Due to the steep pipe slopes and high-velocity flow through the culverts, riprap along the toe of the culverts is proposed for energy dissipation and erosion control.

Lastly, there is a short segment between the new track embankment and the reconstructed BNSF spur track. We propose a retention basin (BNSF Basin) to match the existing conditions in this area. **Table 3** below is a summary of the proposed drainage conditions. **Appendix C** shows the proposed drainage map of all drainage regions with proposed cross-sections for illustration.

Table 3: Proposed Drainage Areas

Drainage Area	Area (AC)	Station Range (Track LD02)	Downstream element
DA-37	0.59	108+71.80 to 113+35.07	Fresno West Catch Basin
DA-37A	0.27	108+71.80 to 113+35.07	Offsite within BNSF ROW
DA-38	1.38	113+35.07 to 119+12.42	Fresno West Catch Basin
DA-39	0.69	119+12.42 to 121+50.00	Fresno West Catch Basin
DA-40	0.58	121+50.00 to 124+16.61	Fresno West Basin sheet flowing into Fresno West Catch Basin
DA-40A	0.29	121+50.00 to 124+16.61	V-Ditch 1 flowing into CV-1
DA-41	0.31	122+58.86 to 124+16.61	Fresno West Catch Basin
DA-42	0.81	124+16.61 to 127+91.80	Fresno East Basin sheet flowing into SD-14
DA-42A	0.31	124+16.61 to 127+0.00	V-Ditch 2 flowing into CV-2
DA-43	0.76	124+16.61 to 128+17.43	SD-14
DA-44	0.37	127+91.80 to 129+8.37	SD-14
DA-45	2.08	129+8.37 to 137+50.63	New BNSF Retention Basin
DA-46	0.77	137+50.63 to 140+15.39	Retained

5. Hydrologic Analysis

The following sections summarize the hydrologic analysis performed to quantify the peak flows and volumes for the return periods evaluated.

5.1 Rainfall Data

Rainfall intensity data for the evaluated return periods were obtained from NOAA Atlas 14, Volume 6, Version 2 and a copy of the data is included in **Appendix D**. Precipitation data was obtained for the 2-year, 50-year, and 100-year 24-hour storms, and the values are shown in **Table 4**.

Table 4: Project Site Precipitation Data

Point Precipitation Data (inches)			
Duration	Recurrence Interval (Years)		
	2-yr	50-yr	100-yr
24-hr	1.69	3.13	3.43
Point Precipitation Frequency Estimates (inches/hour)			
5-min	1.61	3.30	3.72

5.2 Tributary Areas

The tributary areas in the BNSF ROW for the project extent can be categorized into two types.

The area west of the underpass comprise of a mix of flat terrain with self-contained low spots and sloped areas that drain toward the existing catch basins underneath Fresno Avenue.

East of the Fresno Avenue underpass, there is a depression within the BNSF ROW that naturally acts as a retention basin (BNSF Basin), formed bound by the BNSF main and Port lead track embankment and the embankment for the inactive BNSF spur track.

The primary change due to the project on all these drainage areas is the increase in impervious areas due to the addition of a new lead track and underpass structure. The existing flow patterns have been maintained to the greatest extent possible. The exception to this was the introduction of V-ditches between the existing Port lead and new lead track on both approaches to the underpass that flows through a culvert into proposed basins between Scotts Ave and the track embankments within the BNSF ROW. The ditches and culverts were added because it was not feasible to keep the top of the new track embankment lower than the existing embankment. The proposed ditches on the east and west side of Fresno Ave are intended to collect water from the BNSF right of Way into City catch basins on Fresno Avenue to avoid water retention within the BNSF right of way.

The size of the existing BNSF basin east of Fresno Avenue was reduced due to extending the embankment to accommodate a new track. However, the proposed BNSF basin is still large enough to accommodate a 100-year, 24-hour storm event as shown in subsequent sections. The existing and proposed drainage areas are illustrated in **Appendix B and C**.

5.3 Rainfall-Runoff Losses

The Civil3D SSA software was used for hydrologic calculations and to model the rainfall-runoff losses. The SCS Curve Number (CN) method was used as the rainfall loss method. The SCS CN method estimates total rainfall losses as a function of cumulative precipitation, soil type and land use. The SCS CN method requires the following inputs:

- **Curve Number (CN)**: The curve number that represents soil type and land use for the drainage area. A geotechnical report was prepared for this project by Kleinfelder, Inc., in June 2023, and an excerpt for the predominant soil type in the project area is included in **Appendix D**.

According to the referenced geotechnical report, the soil type was identified and classified accordingly. Based on this classification, typical infiltration rates were estimated to range between 0.1 and 1.0 inches per hour. Given these values, the soil was determined to belong to Hydrologic Soil Group D, as defined in USDA Table 7-1, which is provided in **Appendix D**. The land use of the project area varies but can be described as a combination of open space with good condition, impervious areas with track roadbed and roadway pavement, based on Table 2-2a of the TR-55 manual which is included in **Appendix D.** Detailed curve number calculations for all drainage areas are provided in **Table 1** of **Appendix E**.

- **Initial Abstractions (I_a, inches)**: The amount of precipitation that falls before runoff begins. Detailed Initial Abstraction calculations are provided in Table 1 of **Appendix E**.
- **Impervious Area (%)**: The percentage of directly connected impervious area, defined as any impervious surface that is either directly connected to the drainage area discharge point or flows directly into a pipe or impervious conduit to the discharge point. Detailed impervious area percentage calculations for all drainage areas are provided in **Table 1** of **Appendix E**.
- **Time of Concentration (Tc)/Lag**: Time of concentration is the time it takes run-off to travel from the hydraulically most distant point of the drainage area to the downstream element. Due to the small size of the individual drainage areas and for conservativeness, the minimum value of 5 minutes for time of concentration was selected for all drainage areas, which results in a lag time of 3 minutes based on the following formula: Lag, L (min.) = Tc X 0.6 = 5 X 0.6 = 3 min.

5.4 Runoff Data

The SCS TR55 Unit Hydrograph method determines the runoff data in SSA to transform point precipitation data into a design storm. This analysis is based on an SCS Type 1 storm, based on the project location per TR-55 Manual, Figure B-2. A copy of the rainfall distribution map is included in **Appendix D.** SSA output values for the peak run-off flow and corresponding volume for the 2-year, 50-year, and 100-year storms are included in Table 1 of **Appendix F**. **Table 5** summarizes results of the peak and total runoff volumes for each drainage area in existing and proposed conditions.

Table 5 – Existing Runoff Data

Drainage Area	100-Year 24-Hour		50-Year 24-Hour		2-Year 24-Hour	
	Total Runoff (ac-ft)	Peak Runoff (cfs)	Total Runoff (ac-ft)	Peak Runoff (cfs)	Total Runoff (ac-ft)	Peak Runoff (cfs)
Existing Condition						
DA-37EX	0.13	1.23	0.11	1.06	0.11	0.32
DA-38EX	0.27	2.58	0.24	2.21	0.24	0.62
DA-39EX	0.11	1.01	0.09	0.87	0.09	0.25
DA-40EX	0.04	0.37	0.03	0.33	0.03	0.14
DA-40EX	0.11	1.00	0.09	0.87	0.09	0.26
DA-41EX	0.05	0.48	0.04	0.41	0.04	0.12
DA-42EX	0.17	1.60	0.15	1.38	0.15	0.41
DA-43EX	0.12	1.10	0.10	0.94	0.10	0.25

Drainage Area	100-Year 24-Hour		50-Year 24-Hour		2-Year 24-Hour	
	Total Runoff (ac-ft)	Peak Runoff (cfs)	Total Runoff (ac-ft)	Peak Runoff (cfs)	Total Runoff (ac-ft)	Peak Runoff (cfs)
DA-44EX	0.06	0.59	0.05	0.50	0.05	0.12
DA-45EX	0.45	4.24	0.39	3.62	0.39	0.98
Proposed Condition						
DA-37	0.11	1.10	0.10	0.97	0.04	0.35
DA-38	0.25	2.41	0.22	2.10	0.08	0.70
DA-39	0.13	1.24	0.11	1.08	0.04	0.37
DA-40	0.10	0.94	0.09	0.81	0.03	0.25
DA-40A	0.06	0.62	0.06	0.56	0.02	0.24
DA-41	0.05	0.48	0.04	0.41	0.01	0.12
DA-42	0.14	1.36	0.12	1.17	0.04	0.38
DA-42A	0.07	0.66	0.06	0.59	0.03	0.26
DA-43	0.12	1.10	0.10	0.94	0.03	0.25
DA-44	0.07	0.64	0.06	0.56	0.02	0.18
DA-45	0.37	3.62	0.33	3.15	0.12	1.06
DA-46	0.12	1.10	0.10	0.94	0.03	0.25

6. Hydraulic Analysis

Hydraulic analysis refers to technologies for measuring, analyzing, and investigating water pressure and other aspects of water pipes. The Civil3D SSA software was used for hydraulic calculations to determine the drainage elements of basins, ditches, and pipes had adequate capacity to accommodate the design storm event per BNSF requirements. The analysis also evaluated the difference in peak flows between existing and proposed conditions. Figure 1 in **Appendix F** shows the schematic SSA project set up for both existing and proposed conditions.

6.1 Detention Basin Analysis

The existing and proposed BNSF basins between the BNSF main line embankment and the spur track embankment were modeled in SSA as a storage node. The existing and finished grade surface were rendered in CAD and elevation area tables were prepared, which were then entered into the SSA module to create storage curves for these nodes. The intent of this basin is to retain some water and release the rest into the ditch on the east side of Fresno Ave through a 24" CMP culvert. The invert of this culvert is set one foot higher than the bottom of the basin.

All practicable measures have been undertaken to achieve a balance between water retention within the BNSF right-of-way and discharge into the City's right-of-way. The basin design is governed by the following objectives:

- BNSF's stated goal to not exceed the volume of water retained in existing condition, and
- Ensuring the high water level stays lower than the top of track subgrade during a 100-year storm event.

The results for the analysis on retention storage volumes for the BNSF basin are provided below in **Table 6**. The detailed results are also shown in Table 2 of **Appendix F**.

As the result indicates, the new BNSF basin will continue to have adequate capacity to retain runoff from a 100-year event despite the existing basin's size reduction. Additionally, the maximum HGL depth of 1.67 feet attained in the proposed condition ensures that water level will stay below the top of subgrade, which is 1.75 feet above the basin flowline at the basin's shallowest point. The cross-sections shown on sheet CT-808 demonstrate the elevation differences between the basin FL and top of subgrade.

Lastly, Figure 6 in **Appendix F** shows the hydrographs for the total inflow and outflow from the BNSF basin in both existing and proposed conditions. It demonstrates that the BNSF basin retains far less water in the proposed condition than in the existing condition. This is because the total area of the basin was reduced due to addition of a new track and an outfall was provided to guard against flooding in the BNSF ROW during extreme events. The governing criterion for the new basin design was to ensure sufficient freeboard is maintained to keep high water level below top of subgrade (Rim elevation in **Table 6**).

Table 6: Results Summary for Retention Basins

Basin	Storm Event	Invert Elev. (ft.)	Rim Elev. (ft.)	Total Basin Depth (ft.)	Max HGL Depth (ft.)	Min Freeboard (ft.)	Peak Inflow (cfs)	Peak Outflow (cfs)	Retained Volume (cu. ft.)
BNSF Basin - Existing	100-yr 24-hr	3.00	8.00	5.00	1.96	3.04	4.23	0.00	19,503
	50-yr 24-hr	3.00	8.00	5.00	1.85	3.15	3.61	0.00	16,860
	2-yr 24-hr	3.00	8.00	5.00	1.13	3.87	0.97	0.00	5,483
BNSF Basin - Proposed	100-yr 24-hr	5.90	8.00	2.10	1.33	0.77	3.62	0.92	3,286
	50-yr 24-hr	5.90	8.00	2.10	1.28	0.82	3.15	0.63	3,292
	2-yr 24-hr	5.90	8.00	2.10	1.09	1.01	1.05	0.06	3,285

6.2 Storm Drain Analysis

SSA utilizes Manning's equation to calculate the capacity of the proposed underdrains and existing storm drain pipes, to confirm that they have adequate capacity for the design flow rate resulting from a 100-year design storm. The flow is calculated as follows:

$$Q = \frac{1.49}{n} * A * R^{\left(\frac{2}{3}\right)} * S^{\left(\frac{1}{2}\right)}$$

Where: Q or Q_{CAP} = Volumetric flow rate passing through the pipe in cfs.

A = Cross-sectional area of flow normal to the flow direction in ft^2

S = Hydraulic (Bottom) slope of the channel in ft/ft

n	=	Manning Roughness coefficient
R	=	Hydraulic Radius = A/P
P	=	Wetted perimeter in ft
Q_{REQ}	=	Peak flow for 100-year storm event

The proposed culverts (CV-1 & CV-2) are corrugated metal pipe (CMP), with an assumed Manning's coefficient of 0.024; the existing storm drains (SD-14, 15) across Fresno Avenue underneath the structure is 0.015. The V-ditches on either side of the bridge approaches were assumed to be a triangular cross-section with a Manning's value of 0.030. The input data for the existing and proposed storm drain conveyances (pipes, culverts, and ditches is provided in Figure 1 of **Appendix E**. The results of the pipe and open channel capacity calculations assuming full flow are presented in **Table 7 and Table 8**. The detailed SSA model results are provided in Table 3 of **Appendix F**.

Table 7 – Pipe Capacity Summary

Conveyance	Tributary Areas	Storm Event	Peak Flow (cfs)	Design Capacity (cfs)	Max Flow/Design Flow Ratio
Existing Condition					
Ex. SD-14	DA-37 EX to DA-41 EX	100-Year 24-Hour	6.26	9.71	0.64
		50-Year 24-Hour	5.39	9.71	0.55
		2-Year 24-Hour	1.56	9.71	0.16
Ex. SD-15	DA-37 EX to DA-44 EX	100-Year 24-Hour	9.36	10.38	0.90
		50-Year 24-Hour	8.08	10.38	0.78
		2-Year 24-Hour	2.29	10.38	0.22
Proposed Condition					
Ex. SD-14	DA-38 to DA-41	100-Year 24-Hour	4.35	9.71	0.45
		50-Year 24-Hour	3.73	9.71	0.38
		2-Year 24-Hour	0.99	9.71	0.10
Ex. SD-15	DA-38 to DA-45	100-Year 24-Hour	6.55	10.38	0.63
		50-Year 24-Hour	5.44	10.38	0.52
		2-Year 24-Hour	1.41	10.38	0.14
CV-1	DA-40A	100-Year 24-Hour	0.59	224.29	0.00
		50-Year 24-Hour	0.52	224.29	0.00
		2-Year 24-Hour	0.22	224.29	0.00
CV-2	DA-42A	100-Year 24-Hour	0.62	199.03	0.00
		50-Year 24-Hour	0.55	199.03	0.00
		2-Year 24-Hour	0.23	199.03	0.00
BNSF CV	DA-45	100-Year 24-Hour	3.61	19.61	0.18
		50-Year 24-Hour	3.15	19.61	0.16
		2-Year 24-Hour	1.05	19.61	0.05

Table 8: Open Channel Capacity Summary

Conveyance	Tributary Areas	Storm Event	Peak Flow (cfs)	Design Capacity (cfs)	Max Flow/Design Flow Ratio
Proposed Condition					
V-Ditch 1	DA-40A	100-Year 24-Hour	0.59	32.68	0.02
		50-Year 24-Hour	0.52	32.68	0.02
		2-Year 24-Hour	0.22	32.68	0.01
V-Ditch 2	DA-42A	100-Year 24-Hour	0.62	7.59	0.08
		50-Year 24-Hour	0.55	7.59	0.07
		2-Year 24-Hour	0.23	7.59	0.03
Ditch_Fresno_E	DA-38 to DA-40A	100-Year 24-Hour	4.06	22.22	0.36
		50-Year 24-Hour	3.52	22.22	0.15
		2-Year 24-Hour	1.15	22.22	0.05
Ditch_Fresno_W	DA-42 to DA-45	100-Year 24-Hour	3.55	13.67	0.43
		50-Year 24-Hour	3.03	13.67	0.21
		2-Year 24-Hour	0.89	13.67	0.06

The model predicts that the existing 18" City storm drains, SD-14 and SD-15 have adequate design capacity to accommodate 100-year 24-hour storms in existing and proposed conditions. The peak flows decrease during the proposed condition despite the increased impervious area. This could be most likely due to the attenuation of flow achieved by creating a high point due to the new track, resulting in a longer flow path for a portion of the runoff that gets captured by the V-ditches between tracks and conveyed back through culverts.

The profile plot for the 100-year storm in Figures 2 in **Appendix F** demonstrate peak flow condition through the City storm drains. Figures 3, 4, and 5 show the 100-year peak flow during proposed conditions. The HGL value stays within the crown of the pipes. Therefore, the model does not report any capacity or surcharge condition. The EGL value for the 100-year storm however, exceeds the pipes and approximately gets close to the rim elevation of the catch basins as shown in Figure 3.

The proposed culverts and V-ditches have adequate capacity to convey a 100-year storm. The 36" culverts are over-designed to accommodate BNSF's need for bigger pipes for maintenance purposes. Figures 4 and 5 in **Appendix F** show the profile plot for the runoff flow through the V-ditches and culverts on the west and east side of the underpass respectively at the time of peak flow for the 100-year storm.

In addition to the storm drains, the capacity of the existing inlets was also evaluated. **Table 8** below summarizes the SSA results for the two inlets either side of Fresno Avenue underneath structure. Detailed results are also presented in Table 4 of **Appendix F**.

Table 8: Drainage Inlet Results Summary

Inlet Structure	Max Depth	Storm Event	Peak Flow (cfs)	Gutter Water Depth (ft)	Time of Max Depth (hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min.)
Existing Conditions							
Fresno East	6.15	100-Year 24-Hour	3.28	0.44	10:00	0.00	0.00
		50-Year 24-Hour	2.81	0.41	10:00	0.00	0.00
		2-Year 24-Hour	0.77	0.21	10:00	0.00	0.00
Fresno West	6.50	100-Year 24-Hour	6.28	0.65	10:00	0.00	0.00
		50-Year 24-Hour	5.40	0.59	10:00	0.00	0.00
		2-Year 24-Hour	1.56	0.29	10:00	0.00	0.00
Proposed Conditions							
Fresno East	6.15	100-Year 24-Hour	1.10	0.25	10:14	0.00	0.00
		50-Year 24-Hour	0.93	0.23	10:14	0.00	0.00
		2-Year 24-Hour	0.24	0.14	10:02	0.00	0.00
Fresno West	6.50	100-Year 24-Hour	0.48	0.15	10:11	0.00	0.00
		50-Year 24-Hour	0.41	0.15	10:11	0.00	0.00
		2-Year 24-Hour	0.12	0.14	10:02	0.00	0.00

The model reports that both the City catch basins operate within capacity and do not experience flooding in either the existing or proposed condition. The peak flows through the inlets are reduced during the proposed condition, which is beneficial since this junction was identified as likely flooded in the City's 2023 Stormwater Master Plan, as shown in Appendix D.

According to the referenced geotechnical report, the soil type was identified, and based on this classification, typical infiltration rate is estimated to be 0.1 in/hr (0.2 ft/day) which will be used for drawdown calculation for the proposed ditches/basins based on the existing soil type. The results of the drawdown calculations for the 100-year storm event are presented in **Table 9**.

Table 9 - Drawdown Calculation Results Proposed Ditches

Ditch/Basin Name	Storage Depth 100-Year	Drawdown Time (Days) 100-Year
V-Ditch 1	0.29	1.45
V-Ditch 2	0.32	1.6
Ditch_Fresno_E	0.37	1.85
Ditch_Fresno_W	0.37	1.85
BNSF Basin	1.33	6.65

Formulas:

- Storage Depth = High Water Elevation – Bottom Elevation
- Drainage Time = Storage Depth / Infiltration Rate

List of Attachments

Attachment A: **FEMA Map**

Attachment B: **Existing Drainage Map**

Attachment C: **Proposed Drainage Map**

Attachment D: **Hydrologic Data**

Attachment E: **SSA Input Data**

Attachment F: **SSA Model Results**

APPENDIX A

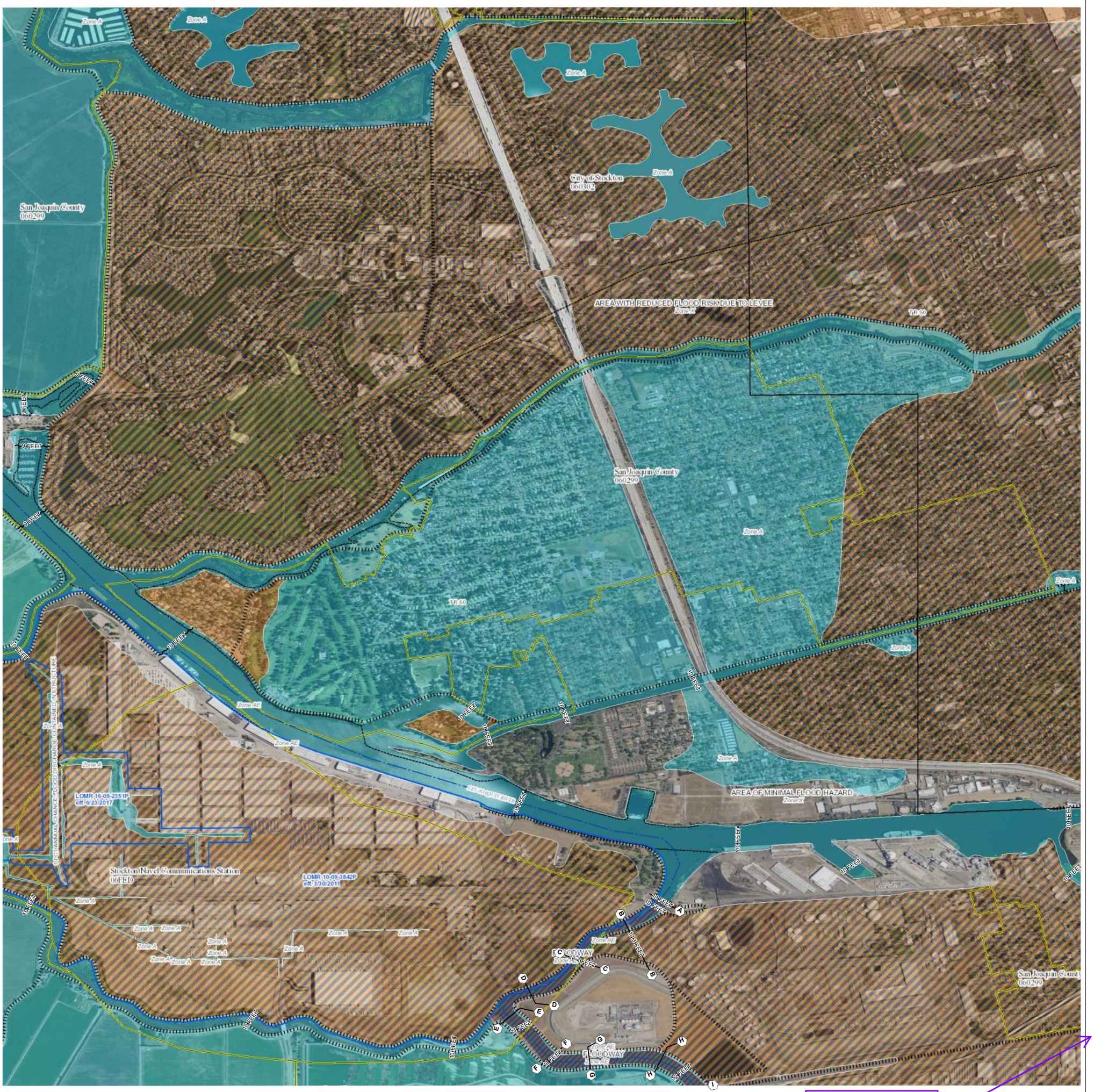
FEMA Map



JMA CIVIL

38°0'13.37"N

121°22'31.03"W



Project site is east of here, still Zone X.

USGS The National Map: Orthoimagery. Data refreshed April, 2019.

37°56'1.73"N

121°18'44.06"W

FLOOD HAZARD INFORMATION

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

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

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

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

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

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

NOTES TO USERS

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

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates refer to the Flood Insurance Study Report for this jurisdiction.

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

Basemap information shown on this FIRM was provided in digital format by USDA, Farm Service Agency (FSA). This information was derived from NAIP, dated April 11, 2018.

This map was exported from FEMA's National Flood Hazard Layer (NFHL) on **6/9/2020 5:23:16 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time. For additional information, please see the Flood Hazard Mapping Updates Overview Fact Sheet at https://www.fema.gov/media-library/assets/documents/118418

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

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date.

ATTENTION: The levee, dike, or other structure that impacts flood hazards inside this boundary has not been shown to comply with Section 65.10 of the NFIP Regulations. As such, this FIRM panel will be revised at a later date to update the flood hazard information associated with this structure. The flood hazard data inside this boundary on the FIRM panel has been republished from the previous effective (historic) FIRM for this area, after being converted from NGVD 29 to NAVD 88.

SCALE

N

Map Projection:
GCS, Geodetic Reference System 1980;
Vertical Datum: NAVD88
For information about the specific vertical datum for elevation features, datum conversions, or vertical monuments used to create this map please see the Flood Insurance Study(FIS) Report for your community at https://msc.fema.gov

1 inch = 1,000 feet 1:12,000

0 500 1,000 2,000 3,000 4,000 Feet

0 105 210 420 630 840 Meters

FEMA National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP

SAN JOAQUIN COUNTY, CALIFORNIA AND INCORPORATED AREAS

PANEL 455 OF 835

Panel Contains:

COMMUNITY	NUMBER	PANEL
STOCKTON NAVEL COMMUNICATIONS STATION CALIFORNIA	06FED	0455
CITY OF STOCKTON CALIFORNIA	060302	0455
SAN JOAQUIN COUNTY CALIFORNIA	060299	0455

MAP NUMBER
06077C0455F
EFFECTIVE DATE
10/16/2009

Figure A-3: Stockton FEMA Flood Insurance Rate Map 2009

APPENDIX B

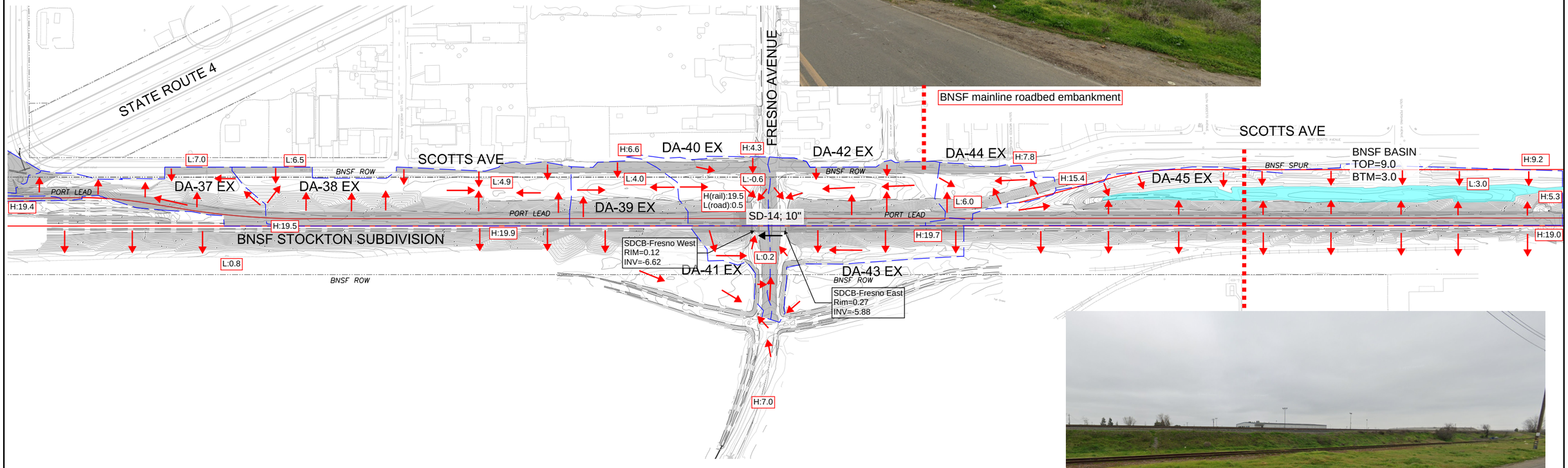
Existing Drainage Map



JMA CIVIL



BNSF mainline roadbed embankment





Grade difference and low spot between BNSF mainline and spur track

DIRECTION OF PIPE FLOW

DIRECTION OF FLOW

DRAINAGE AREA BOUNDARIES

IMPERVIOUS SURFACE

EX. DRAINAGE FEATURES

0 100 200 300
SCALE FEET
1" = 100'

SUBCONSULTANT:	SUBCONSULTANT:	PRIME CONSULTANT:	PROFESSIONAL SEAL:	ISSUE:	REVISIONS:	
	JMA CIVIL 383 4th Street, Ste. 201 Oakland, CA 94607 T: 925.400.4356 www.jmacivil.com	HDR 2379 Gateway Oaks, Ste. 200 Sacramento, CA 95833 T: 916.679.8700 www.hdrinc.com		60% DESIGN NOT FOR CONSTRUCTION - 04/19/2024	MARK / DATE / DESCRIPTION A / 07/25/2023 / 30% DESIGN	

PORT OF STOCKTON
RAIL CAPACITY IMPROVEMENTS

2201 W. WASHINGTON STREET
STOCKTON, CA 95203

SHEET TITLE:
EX. DRAINAGE AREAS
BNSF ROW

PROJ NO: 21273	SHEET NO. EX-001
SCALE: AS NOTED	
DATE: 07/25/2023	
DESIGNED BY: AG	SHEET 1 OF 1

IF THIS DRAWING IS LESS THAN 22" X 34" IT IS A REDUCED SIZE DRAWING

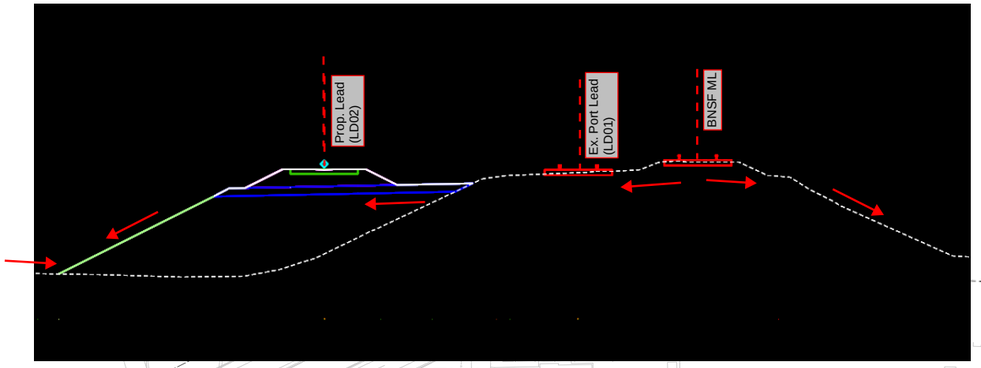
aghosh - 4/13/2024 - 1134458 AM - pw://JMA-PW-APP.jmacivil.com:JMA-PW/Documents/Projects/21273-HDRPoS/Rail/Exhibits/Ex Drainage Areas/Drainage Exhibit - BNSF ROW.dgn

APPENDIX C

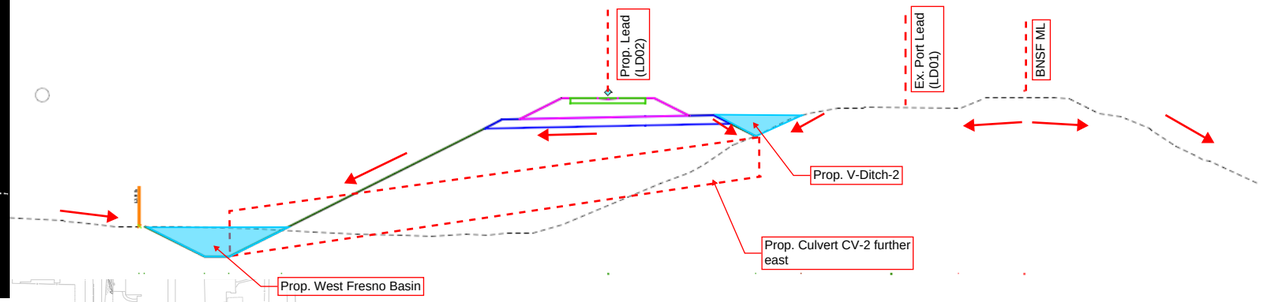
Proposed Drainage Map



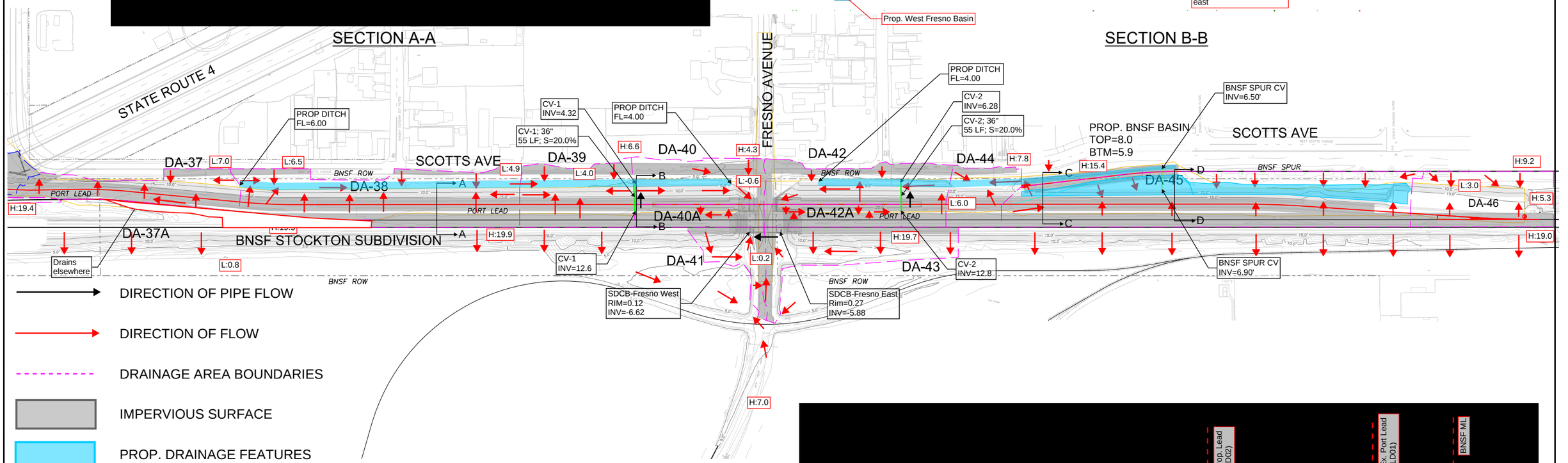
JMA CIVIL



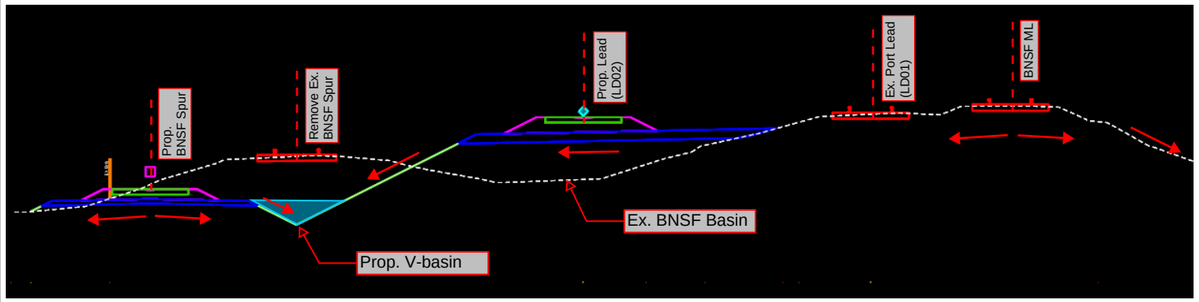
SECTION A-A

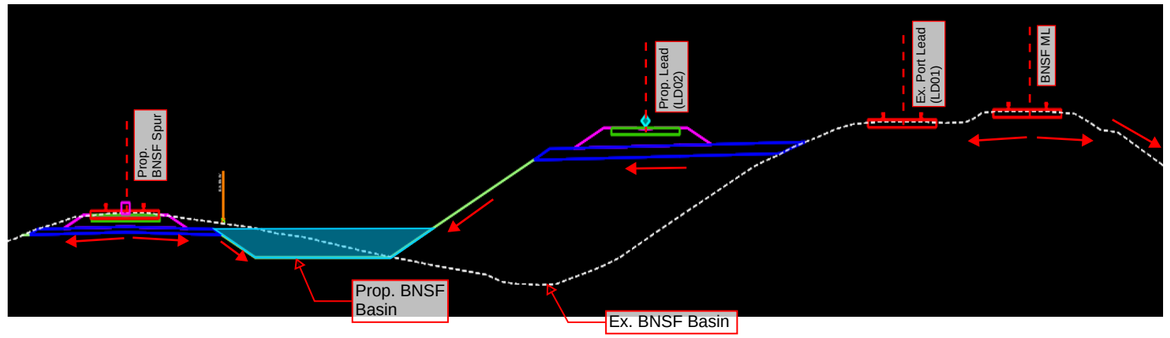


SECTION B-B



SECTION C-C





SECTION D-D

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SCALE FEET
1" = 100'

SUBCONSULTANT:	SUBCONSULTANT:	PRIME CONSULTANT:
	JMA CIVIL 383 4th Street, Ste. 201 Oakland, CA 94607 T: 925.400.4356 www.jmacivil.com	HDR 2379 Gateway Oaks, Ste. 200 Sacramento, CA 95833 T: 916.679.8700 www.hdrinc.com

PROFESSIONAL SEAL:

ISSUE: 60% DESIGN NOT FOR CONSTRUCTION - 04/19/2024

REVISIONS:

MARK	DATE	DESCRIPTION
B	08/30/2024	60% DESIGN
A	07/25/2023	30% DESIGN

PORT OF STOCKTON
RAIL & BRIDGE IMPROVEMENTS

2201 W. WASHINGTON STREET
STOCKTON, CA 95203

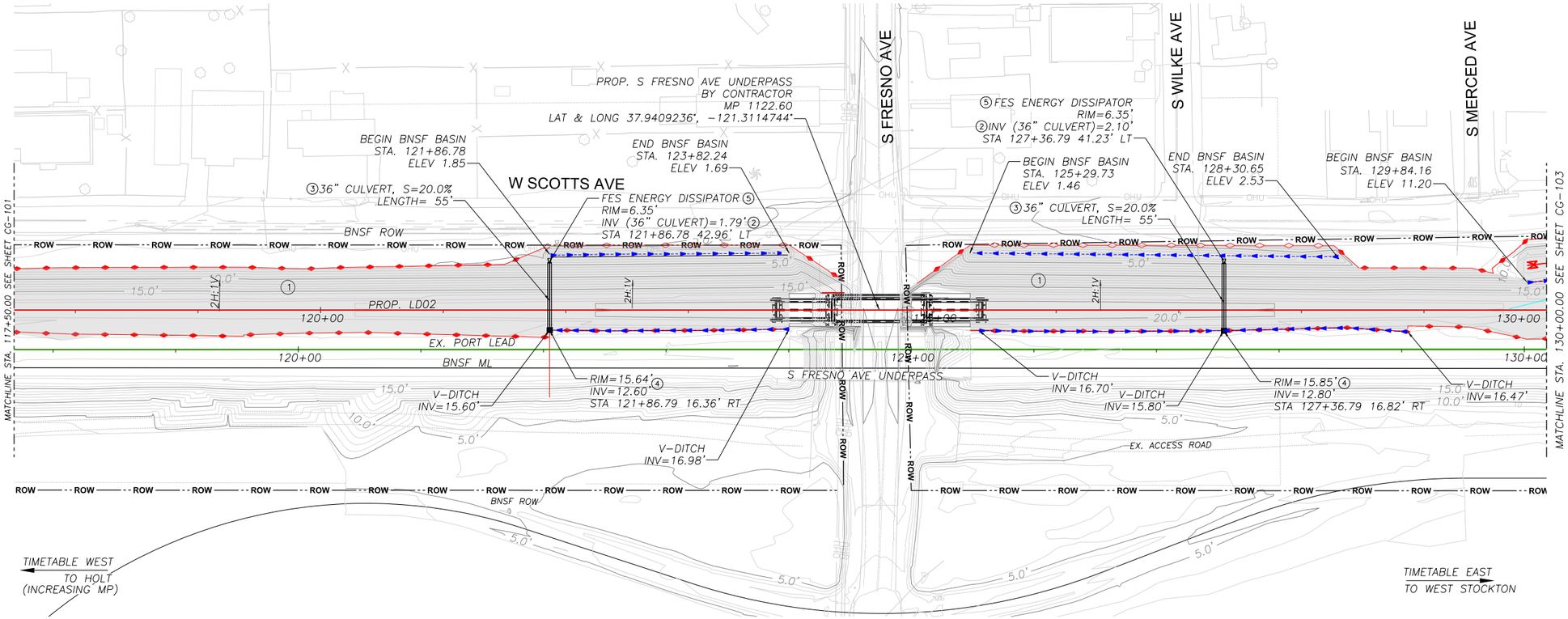
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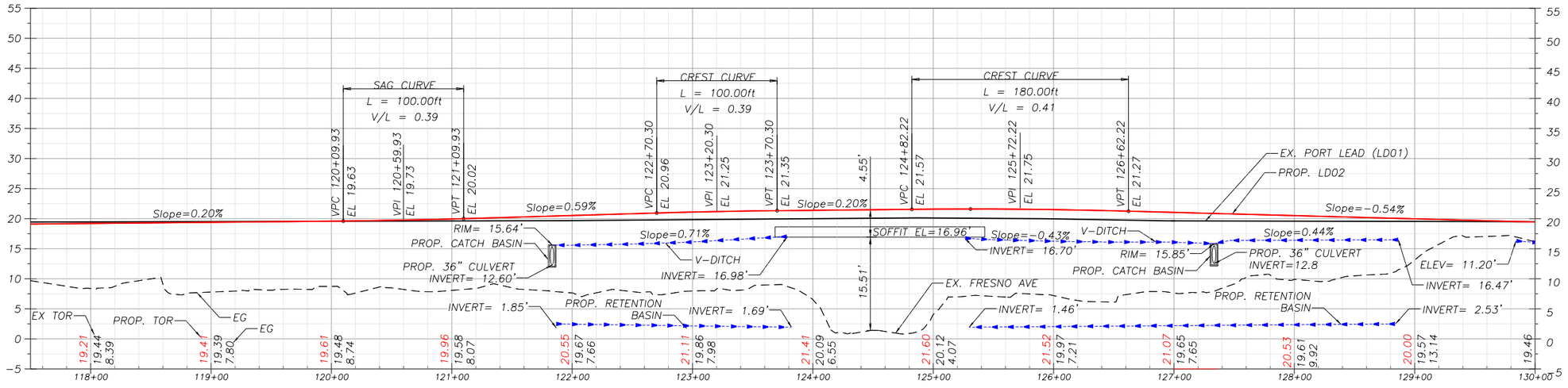
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DATE: 08/30/2024
DESIGNED BY: AG

SHEET NO. EX-001
SHEET 1 1

IF THIS DRAWING IS LESS THAN 22" X 34" IT IS A REDUCED SIZE DRAWING

aghosh 1/10/2025 - 4:48:38 PM - pw://JMA-PW-APP-jmadrive.com:JMA-PW/Documents/Projects/21273-HDRPoSRail/Exhibits/Prop Drainage Areas/Drainage Exhibit Prop- BNSF ROW.dgn



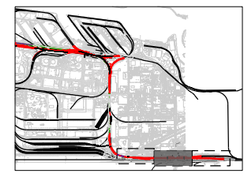


DESIGN NOTE:

1. OVERHEAD UTILITIES ARE NOT SHOWN ON PLANS FOR CLARITY.
2. GRADING SHALL NOT EXTEND WITHIN 10' OF EXISTING ADJACENT TRACK CENTERLINE.

SHEET NOTES:

1. REFER TO DETAIL 4 ON SHEET CT-501 FOR ROADBED KEY-IN DETAILS.
2. PROVIDE RIPRAP PER DETAIL 5 ON SHEET CT-502.
3. PROVIDE CULVERT PER DETAIL 3 ON SHEET CT-502.
4. PROVIDE CATCH BASIN PER DETAIL 4 ON SHEET CT-502.
5. PROVIDE FES ENERGY DISSIPATOR PER DETAIL 7 ON SHEET CT-502.



0 10 20 30
VERTICAL SCALE FEET
1" = 10'
0 50 100 150
HORIZONTAL SCALE FEET
1" = 50'

REV	DATE	DESCRIPTION	BY	SUB	APP
C	11/27/24	90% DESIGN SUBMITTAL			
B	04/19/24	60% DESIGN SUBMITTAL			
A	08/11/23	30% DESIGN SUBMITTAL			

Information is confidential on all plans, drawings, specifications, and/or information furnished here in shall remain the property of the Burlington Northern Santa Fe Railway and shall be held confidential and shall not be used for any purpose not provided for in agreements with the Burlington Northern Santa Fe Railway

DESIGNED BY A. GHOSH
DRAWN BY H.SADIQ
CHECKED BY A. RIEGER
APPROVED BY J. MARSHALL
DATE 11/17/24

BNSF RAILWAY
JMA civil
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Oakland, CA 94607
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2379 Gateway Oaks, Ste. 200
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www.hdrinc.com

PORT OF STOCKTON
RAIL AND BRIDGE IMPROVEMENTS
STOCKTON SUBDIVISION MP 1122.587
2201 W. WASHINGTON STREET
STOCKTON, CA 95203

LD02 GRADING AND DRAINAGE SHEET

CONTRACT NO. 60657603
DRAWING NO. CG-102
REVISION C
SHEET NO.
SCALE AS NOTED

CG-101 to CG-103 LD02 P&P.dgn
$controlled$
BY: aghosh
TIME: 4:24:18 PM
$TODAY$
WORK ELEMENT
PHYSICAL ENTITY
CONTRACT DESIGNATOR
LINE ITEM
COST ELEMENT
PROJECT NUMBER

APPENDIX D

Hydrologic Data



JMA CIVIL

NOAA Atlas 14, Volume 6, Version 2
Location name: Stockton, California, USA*
Latitude: 37.95°, Longitude: -121.2667°
Elevation: 23.43 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.107 (0.095-0.121)	0.134 (0.119-0.152)	0.170 (0.151-0.194)	0.200 (0.175-0.231)	0.242 (0.203-0.293)	0.275 (0.224-0.342)	0.310 (0.244-0.397)	0.346 (0.263-0.460)	0.396 (0.285-0.555)	0.436 (0.300-0.639)
10-min	0.153 (0.136-0.174)	0.192 (0.171-0.218)	0.244 (0.216-0.279)	0.287 (0.251-0.332)	0.347 (0.291-0.419)	0.395 (0.321-0.490)	0.444 (0.350-0.569)	0.496 (0.376-0.659)	0.567 (0.408-0.796)	0.624 (0.430-0.916)
15-min	0.185 (0.165-0.211)	0.232 (0.206-0.264)	0.295 (0.261-0.337)	0.347 (0.304-0.401)	0.420 (0.352-0.507)	0.477 (0.389-0.593)	0.537 (0.423-0.688)	0.599 (0.455-0.797)	0.686 (0.494-0.963)	0.755 (0.520-1.11)
30-min	0.251 (0.223-0.285)	0.314 (0.279-0.358)	0.399 (0.353-0.456)	0.470 (0.412-0.543)	0.569 (0.476-0.687)	0.646 (0.526-0.802)	0.727 (0.573-0.932)	0.812 (0.616-1.08)	0.929 (0.669-1.30)	1.02 (0.704-1.50)
60-min	0.350 (0.311-0.397)	0.438 (0.389-0.498)	0.556 (0.492-0.635)	0.655 (0.573-0.756)	0.792 (0.663-0.957)	0.900 (0.733-1.12)	1.01 (0.798-1.30)	1.13 (0.859-1.50)	1.29 (0.931-1.82)	1.42 (0.981-2.09)
2-hr	0.489 (0.435-0.555)	0.583 (0.518-0.664)	0.716 (0.634-0.818)	0.832 (0.728-0.960)	1.00 (0.837-1.21)	1.14 (0.928-1.42)	1.29 (1.02-1.66)	1.46 (1.11-1.94)	1.70 (1.22-2.38)	1.90 (1.31-2.78)
3-hr	0.577 (0.513-0.656)	0.680 (0.604-0.773)	0.826 (0.731-0.943)	0.954 (0.835-1.10)	1.14 (0.957-1.38)	1.30 (1.06-1.62)	1.48 (1.16-1.89)	1.67 (1.26-2.22)	1.95 (1.40-2.73)	2.18 (1.50-3.20)
6-hr	0.775 (0.690-0.881)	0.907 (0.805-1.03)	1.09 (0.967-1.25)	1.25 (1.10-1.45)	1.49 (1.25-1.80)	1.69 (1.37-2.09)	1.90 (1.50-2.43)	2.13 (1.62-2.83)	2.47 (1.78-3.46)	2.75 (1.90-4.04)
12-hr	1.00 (0.893-1.14)	1.20 (1.07-1.37)	1.47 (1.30-1.68)	1.69 (1.48-1.95)	1.99 (1.66-2.40)	2.22 (1.81-2.75)	2.46 (1.94-3.15)	2.70 (2.05-3.60)	3.04 (2.19-4.27)	3.31 (2.28-4.85)
24-hr	1.37 (1.23-1.55)	1.69 (1.52-1.91)	2.10 (1.88-2.38)	2.41 (2.15-2.76)	2.83 (2.45-3.33)	3.13 (2.67-3.75)	3.43 (2.86-4.20)	3.73 (3.03-4.67)	4.11 (3.22-5.35)	4.39 (3.34-5.90)
2-day	1.73 (1.56-1.95)	2.13 (1.92-2.41)	2.63 (2.37-2.99)	3.03 (2.70-3.46)	3.53 (3.06-4.16)	3.90 (3.32-4.68)	4.26 (3.55-5.22)	4.62 (3.76-5.79)	5.08 (3.98-6.61)	5.41 (4.12-7.26)
3-day	1.98 (1.79-2.24)	2.43 (2.19-2.75)	2.99 (2.69-3.40)	3.43 (3.06-3.92)	4.00 (3.47-4.71)	4.42 (3.76-5.30)	4.83 (4.02-5.91)	5.23 (4.25-6.56)	5.75 (4.51-7.48)	6.13 (4.66-8.23)
4-day	2.18 (1.97-2.47)	2.68 (2.41-3.03)	3.29 (2.96-3.73)	3.77 (3.37-4.31)	4.39 (3.81-5.17)	4.85 (4.13-5.81)	5.30 (4.42-6.49)	5.74 (4.67-7.20)	6.31 (4.95-8.22)	6.74 (5.12-9.04)
7-day	2.60 (2.35-2.95)	3.19 (2.87-3.61)	3.92 (3.53-4.45)	4.49 (4.01-5.14)	5.24 (4.54-6.16)	5.78 (4.93-6.93)	6.32 (5.27-7.73)	6.85 (5.57-8.59)	7.53 (5.90-9.80)	8.04 (6.11-10.8)
10-day	2.91 (2.63-3.29)	3.57 (3.22-4.05)	4.40 (3.96-5.00)	5.05 (4.51-5.77)	5.88 (5.10-6.92)	6.49 (5.53-7.78)	7.09 (5.91-8.67)	7.67 (6.24-9.63)	8.43 (6.61-11.0)	8.99 (6.84-12.1)
20-day	3.78 (3.41-4.28)	4.71 (4.24-5.33)	5.84 (5.25-6.63)	6.70 (5.98-7.66)	7.80 (6.76-9.17)	8.58 (7.30-10.3)	9.32 (7.77-11.4)	10.0 (8.17-12.6)	11.0 (8.59-14.3)	11.6 (8.84-15.6)
30-day	4.47 (4.03-5.06)	5.62 (5.07-6.37)	7.00 (6.30-7.95)	8.04 (7.18-9.19)	9.33 (8.09-11.0)	10.2 (8.71-12.3)	11.1 (9.24-13.6)	11.9 (9.67-14.9)	12.9 (10.1-16.8)	13.6 (10.4-18.3)
45-day	5.54 (5.00-6.27)	7.05 (6.35-7.98)	8.81 (7.92-10.0)	10.1 (9.03-11.6)	11.7 (10.1-13.8)	12.8 (10.9-15.3)	13.8 (11.5-16.9)	14.7 (12.0-18.5)	15.9 (12.4-20.6)	16.6 (12.7-22.3)
60-day	6.56 (5.91-7.42)	8.39 (7.56-9.50)	10.5 (9.44-11.9)	12.0 (10.7-13.8)	13.9 (12.0-16.3)	15.1 (12.9-18.1)	16.2 (13.5-19.9)	17.3 (14.1-21.7)	18.5 (14.5-24.1)	19.4 (14.7-26.0)

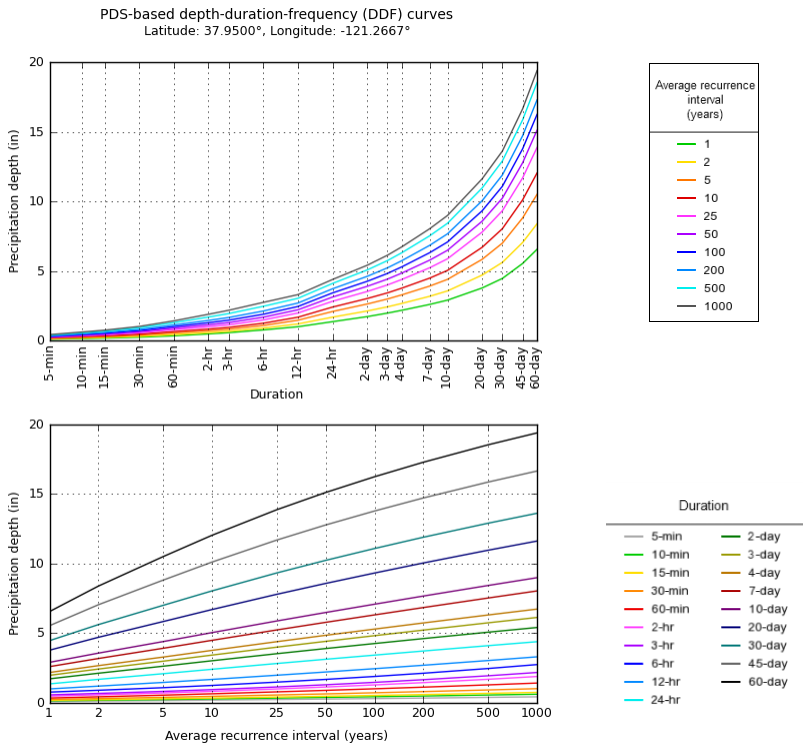
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

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.

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PF graphical



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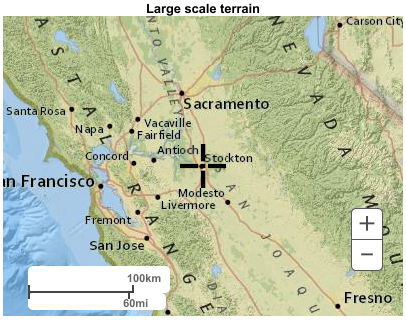
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Maps & aerials

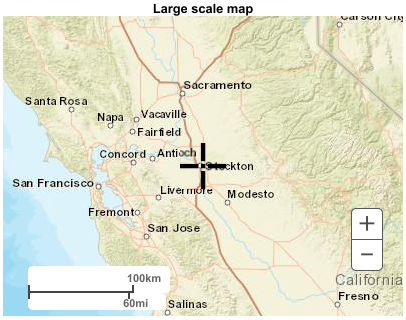
Small scale terrain



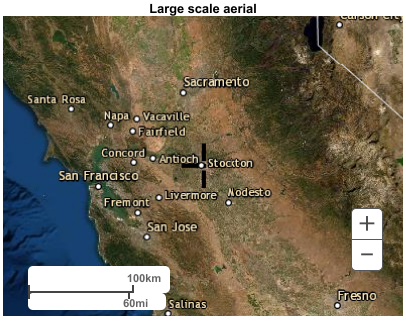
Large scale terrain



Large scale map



Large scale aerial



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Questions?: HDSC.Questions@noaa.gov

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Location name: Stockton, California, USA*
Latitude: 37.95°, Longitude: -121.2667°
Elevation: 23.43 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	1.28 (1.14-1.45)	1.61 (1.43-1.82)	2.04 (1.81-2.33)	2.40 (2.10-2.77)	2.90 (2.44-3.52)	3.30 (2.69-4.10)	3.72 (2.93-4.76)	4.15 (3.16-5.52)	4.75 (3.42-6.66)	5.23 (3.60-7.67)
10-min	0.918 (0.816-1.04)	1.15 (1.03-1.31)	1.46 (1.30-1.67)	1.72 (1.51-1.99)	2.08 (1.75-2.51)	2.37 (1.93-2.94)	2.66 (2.10-3.41)	2.98 (2.26-3.95)	3.40 (2.45-4.78)	3.74 (2.58-5.50)
15-min	0.740 (0.660-0.844)	0.928 (0.824-1.06)	1.18 (1.04-1.35)	1.39 (1.22-1.60)	1.68 (1.41-2.03)	1.91 (1.56-2.37)	2.15 (1.69-2.75)	2.40 (1.82-3.19)	2.74 (1.98-3.85)	3.02 (2.08-4.43)
30-min	0.502 (0.446-0.570)	0.628 (0.558-0.716)	0.798 (0.706-0.912)	0.940 (0.824-1.09)	1.14 (0.952-1.37)	1.29 (1.05-1.60)	1.45 (1.15-1.86)	1.62 (1.23-2.16)	1.86 (1.34-2.61)	2.04 (1.41-3.00)
60-min	0.350 (0.311-0.397)	0.438 (0.389-0.498)	0.556 (0.492-0.635)	0.655 (0.573-0.756)	0.792 (0.663-0.957)	0.900 (0.733-1.12)	1.01 (0.798-1.30)	1.13 (0.859-1.50)	1.29 (0.931-1.82)	1.42 (0.981-2.09)
2-hr	0.244 (0.218-0.278)	0.292 (0.259-0.332)	0.358 (0.317-0.409)	0.416 (0.364-0.480)	0.500 (0.418-0.604)	0.570 (0.464-0.708)	0.646 (0.508-0.828)	0.728 (0.553-0.968)	0.848 (0.610-1.19)	0.948 (0.653-1.39)
3-hr	0.192 (0.171-0.218)	0.226 (0.201-0.257)	0.275 (0.243-0.314)	0.318 (0.278-0.367)	0.381 (0.319-0.460)	0.434 (0.353-0.538)	0.491 (0.387-0.630)	0.555 (0.421-0.738)	0.648 (0.467-0.910)	0.727 (0.500-1.07)
6-hr	0.129 (0.115-0.147)	0.151 (0.134-0.172)	0.182 (0.161-0.208)	0.209 (0.183-0.242)	0.249 (0.208-0.301)	0.282 (0.229-0.350)	0.317 (0.250-0.406)	0.356 (0.270-0.473)	0.412 (0.297-0.578)	0.459 (0.316-0.674)
12-hr	0.083 (0.074-0.095)	0.100 (0.089-0.114)	0.122 (0.108-0.139)	0.140 (0.123-0.162)	0.165 (0.138-0.199)	0.184 (0.150-0.228)	0.204 (0.161-0.261)	0.224 (0.170-0.298)	0.252 (0.182-0.354)	0.274 (0.189-0.403)
24-hr	0.057 (0.051-0.064)	0.070 (0.063-0.080)	0.087 (0.079-0.099)	0.101 (0.090-0.115)	0.118 (0.102-0.139)	0.131 (0.111-0.156)	0.143 (0.119-0.175)	0.155 (0.126-0.195)	0.171 (0.134-0.223)	0.183 (0.139-0.246)
2-day	0.036 (0.032-0.041)	0.044 (0.040-0.050)	0.055 (0.049-0.062)	0.063 (0.056-0.072)	0.074 (0.064-0.087)	0.081 (0.069-0.097)	0.089 (0.074-0.109)	0.096 (0.078-0.121)	0.106 (0.083-0.138)	0.113 (0.086-0.151)
3-day	0.028 (0.025-0.031)	0.034 (0.030-0.038)	0.042 (0.037-0.047)	0.048 (0.043-0.054)	0.056 (0.048-0.065)	0.061 (0.052-0.074)	0.067 (0.056-0.082)	0.073 (0.059-0.091)	0.080 (0.063-0.104)	0.085 (0.065-0.114)
4-day	0.023 (0.021-0.026)	0.028 (0.025-0.032)	0.034 (0.031-0.039)	0.039 (0.035-0.045)	0.046 (0.040-0.054)	0.051 (0.043-0.061)	0.055 (0.046-0.068)	0.060 (0.049-0.075)	0.066 (0.052-0.086)	0.070 (0.053-0.094)
7-day	0.015 (0.014-0.018)	0.019 (0.017-0.021)	0.023 (0.021-0.026)	0.027 (0.024-0.031)	0.031 (0.027-0.037)	0.034 (0.029-0.041)	0.038 (0.031-0.046)	0.041 (0.033-0.051)	0.045 (0.035-0.058)	0.048 (0.036-0.064)
10-day	0.012 (0.011-0.014)	0.015 (0.013-0.017)	0.018 (0.016-0.021)	0.021 (0.019-0.024)	0.025 (0.021-0.029)	0.027 (0.023-0.032)	0.030 (0.025-0.036)	0.032 (0.026-0.040)	0.035 (0.028-0.046)	0.037 (0.028-0.050)
20-day	0.008 (0.007-0.009)	0.010 (0.009-0.011)	0.012 (0.011-0.014)	0.014 (0.012-0.016)	0.016 (0.014-0.019)	0.018 (0.015-0.021)	0.019 (0.016-0.024)	0.021 (0.017-0.026)	0.023 (0.018-0.030)	0.024 (0.018-0.032)
30-day	0.006 (0.006-0.007)	0.008 (0.007-0.009)	0.010 (0.009-0.011)	0.011 (0.010-0.013)	0.013 (0.011-0.015)	0.014 (0.012-0.017)	0.015 (0.013-0.019)	0.017 (0.013-0.021)	0.018 (0.014-0.023)	0.019 (0.014-0.025)
45-day	0.005 (0.005-0.006)	0.007 (0.006-0.007)	0.008 (0.007-0.009)	0.009 (0.008-0.011)	0.011 (0.009-0.013)	0.012 (0.010-0.014)	0.013 (0.011-0.016)	0.014 (0.011-0.017)	0.015 (0.012-0.019)	0.015 (0.012-0.021)
60-day	0.005 (0.004-0.005)	0.006 (0.005-0.007)	0.007 (0.007-0.008)	0.008 (0.007-0.010)	0.010 (0.008-0.011)	0.010 (0.009-0.013)	0.011 (0.009-0.014)	0.012 (0.010-0.015)	0.013 (0.010-0.017)	0.013 (0.010-0.018)

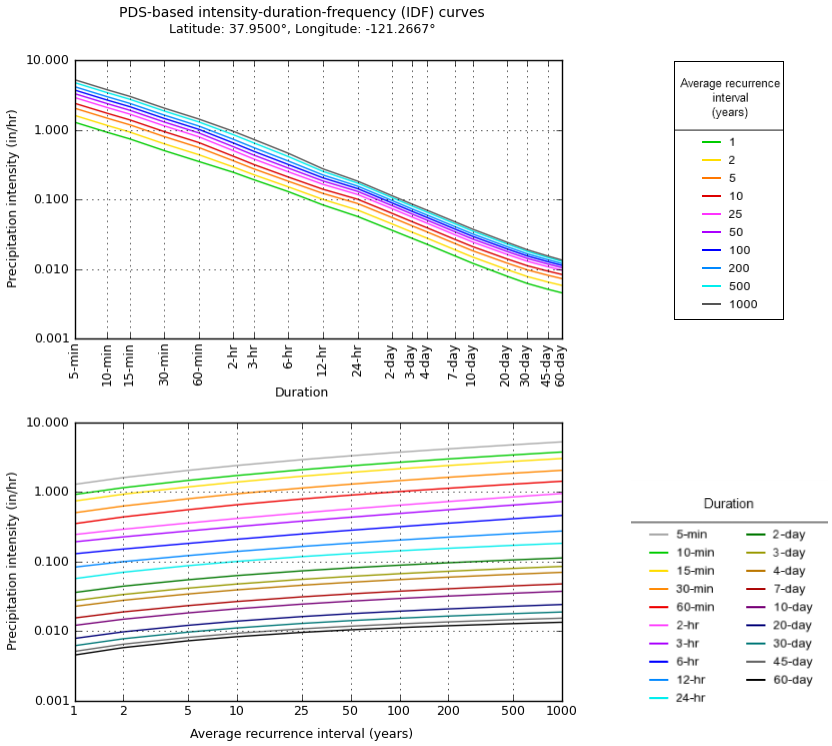
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

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.

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PF graphical



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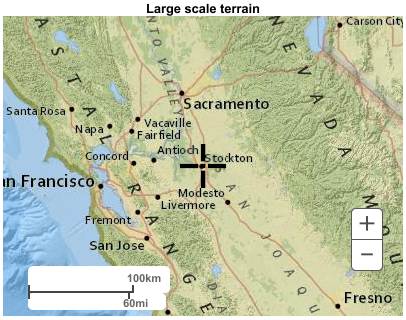
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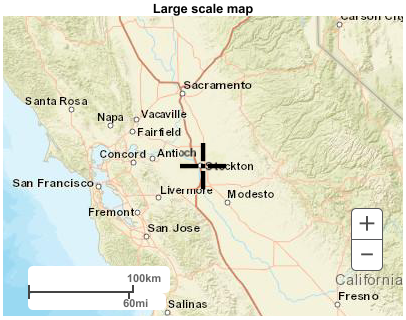
Small scale terrain



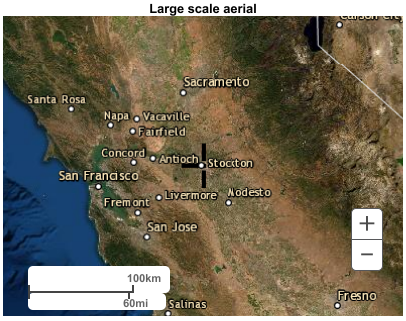
Large scale terrain



Large scale map



Large scale aerial

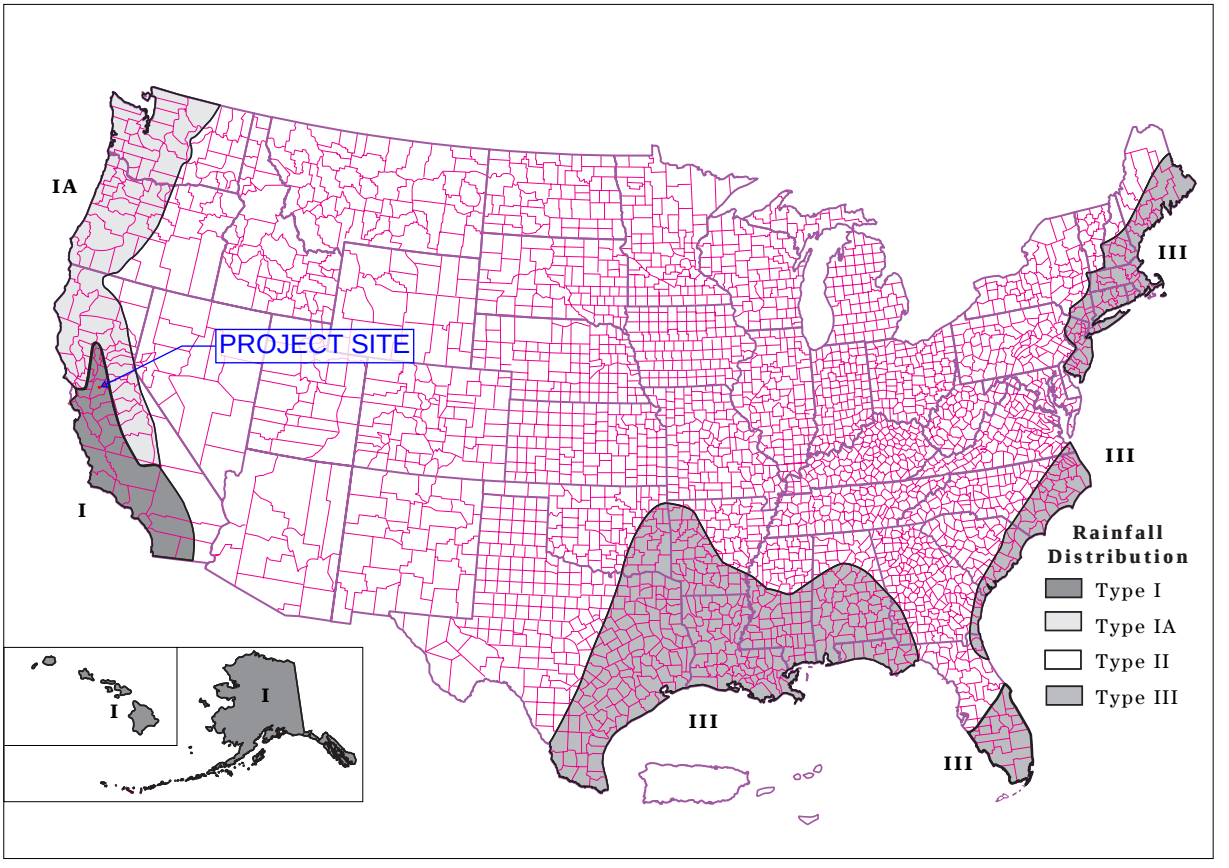


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Figure B-2 Approximate geographic boundaries for NRCS (SCS) rainfall distributions



Rainfall data sources

This section lists the most current 24-hour rainfall data published by the National Weather Service (NWS) for various parts of the country. Because NWS Technical Paper 40 (TP-40) is out of print, the 24-hour rainfall maps for areas east of the 105th meridian are included here as figures B-3 through B-8. For the area generally west of the 105th meridian, TP-40 has been superseded by NOAA Atlas 2, the Precipitation-Frequency Atlas of the Western United States, published by the National Ocean and Atmospheric Administration.

East of 105th meridian

Hershfield, D.M. 1961. Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 40. Washington, DC. 155 p.

West of 105th meridian

Miller, J.F., R.H. Frederick, and R.J. Tracey. 1973. Precipitation-frequency atlas of the Western United States. Vol. I Montana; Vol. II, Wyoming; Vol III, Colorado; Vol. IV, New Mexico; Vol V, Idaho; Vol. VI, Utah; Vol. VII, Nevada; Vol. VIII, Arizona; Vol. IX, Washington; Vol. X, Oregon; Vol. XI, California. U.S. Dept. of Commerce, National Weather Service, NOAA Atlas 2. Silver Spring, MD.

Alaska

Miller, John F. 1963. Probable maximum precipitation and rainfall-frequency data for Alaska for areas to 400 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. of Commerce, Weather Bur. Tech. Pap. No. 47. Washington, DC. 69 p.

Hawaii

Weather Bureau. 1962. Rainfall-frequency atlas of the Hawaiian Islands for areas to 200 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 43. Washington, DC. 60 p.

Puerto Rico and Virgin Islands

Weather Bureau. 1961. Generalized estimates of probable maximum precipitation and rainfall-frequency data for Puerto Rico and Virgin Islands for areas to 400 square miles, durations to 24 hours, and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 42. Washington, DC. 94 P.

- **Artificial Fill (map symbol af) –** Unconsolidated sand and silt with lesser amounts of gravel and clay hydraulically emplaced from dredging of the San Joaquin River. Artificial fill may include organic materials.

- **Holocene Dos Palos Alluvium (map symbol Qdp) –** Unweathered, unconsolidated deposits of arkosic gravel, sand, silt, and clay covering the floodbasin of the lower San Joaquin River.

- **Late Pleistocene Modesto Formation (map symbol Qm) –** Represents glacial outwash from the core of Sierra Nevada and lesser local (not Sierran) sediment sources. Consists predominantly of sand and silt with lesser amounts of gravel and clay.

The Riverbank Formation is not exposed at the surface along the alignment but is interpreted to be located at a depth of about 45 to 60 feet below ground surface based on a significant increase in density and the presence of sandier deposits. The Riverbank Formation is described as follows:

- **Late Pleistocene Riverbank Formation (map symbol Qr) –** Arkosic sand forming terraces topographically at or above Modesto Formation level. Represents glacial outwash from core of Sierra Nevada and lesser locally sourced sediments.

A geologic map of the alignment, based on Wagner, et al. (1991) is presented on Figure 2.

3.3 EARTH MATERIALS

The following description provides a general summary of the subsurface conditions encountered during the field exploration and further validated by the laboratory testing program. For a more thorough description of the actual conditions encountered at specific boring locations, refer to the log of borings in Appendix A. All soils have been classified according to the Unified Soil Classification System (ASTM D2487).

Subsurface soils encountered during our investigation primarily consisted of soft to stiff clay, clay with sand, sandy clay, stiff to very stiff silt, loose to medium dense silty sands, clayey sands, poorly graded sands and soft to stiff cohesive soils in the upper 8 to 13 feet underlain by similar soils that are medium dense to dense and stiff to hard plus poorly graded sand with silt at depth below 40 ft.

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Table 2-2a Runoff curve numbers for urban areas [1/]

Cover description: Cover type and hydrologic condition	Average percent impervious area [2/]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3/]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4/]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5/]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

BNSF ROW

Assumed for all impervious areas at Port including tracks and roadway

1 Average runoff condition, and $I_a = 0.2S$.

2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Appendix A Hydrologic Soil Groups

Soils are classified into hydrologic soil groups (HSG's) to indicate the minimum rate of infiltration obtained for bare soil after prolonged wetting. The HSG's, which are A, B, C, and D, are one element used in determining runoff curve numbers (see chapter 2). For the convenience of TR-55 users, exhibit A-1 lists the HSG classification of United States soils.

The infiltration rate is the rate at which water enters the soil at the soil surface. It is controlled by surface conditions. HSG also indicates the transmission rate—the rate at which the water moves within the soil. This rate is controlled by the soil profile. Approximate numerical ranges for transmission rates shown in the HSG definitions were first published by Musgrave (USDA 1955). The four groups are defined by SCS soil scientists as follows:

Group A soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sand or gravel and have a high rate of water transmission (greater than 0.30 in/hr).

Group B soils have moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (0.15-0.30 in/hr).

Group C soils have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine texture. These soils have a low rate of water transmission (0.05-0.15 in/hr).

Group D soils have high runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0-0.05 in/hr).

In exhibit A-1, some of the listed soils have an added modifier; for example, "Abrazo, gravelly." This refers to a gravelly phase of the Abrazo series that is found in SCS soil map legends.

Disturbed soil profiles

As a result of urbanization, the soil profile may be considerably altered and the listed group classification may no longer apply. In these circumstances, use the following to determine HSG according to the texture of the new surface soil, provided that significant compaction has not occurred (Brakensiek and Rawls 1983).

HSG	*Soil textures*
A	Sand, loamy sand, or sandy loam
B	Silt loam or loam
C	Sandy clay loam
D	Clay loam, silty clay loam, sandy clay, silty clay, or clay

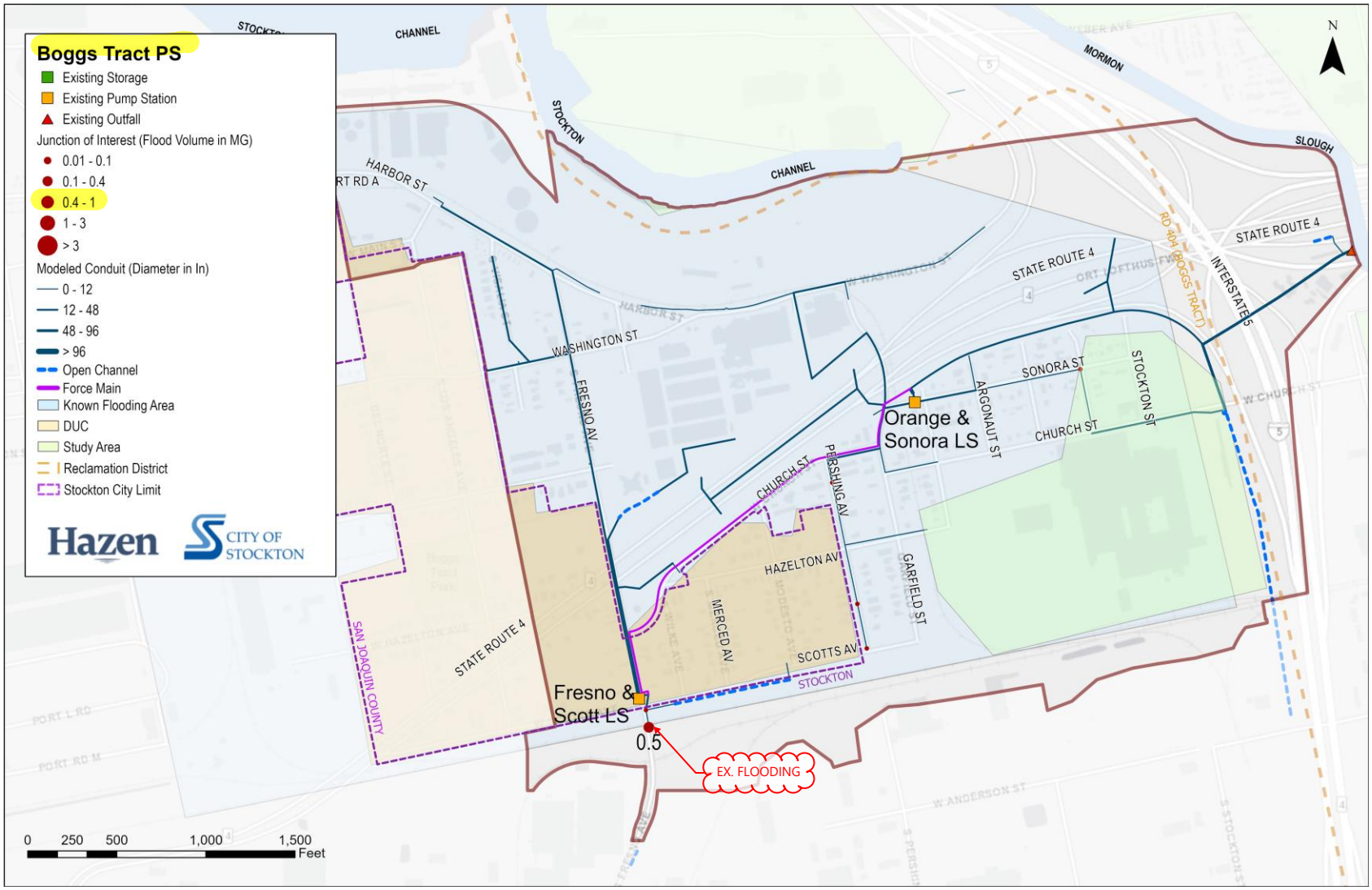
Drainage and group D soils

Some soils in the list are in group D because of a high water table that creates a drainage problem. Once these soils are effectively drained, they are placed in a different group. For example, Ackerman soil is classified as A/D. This indicates that the drained Ackerman soil is in group A and the undrained soil is in group D.

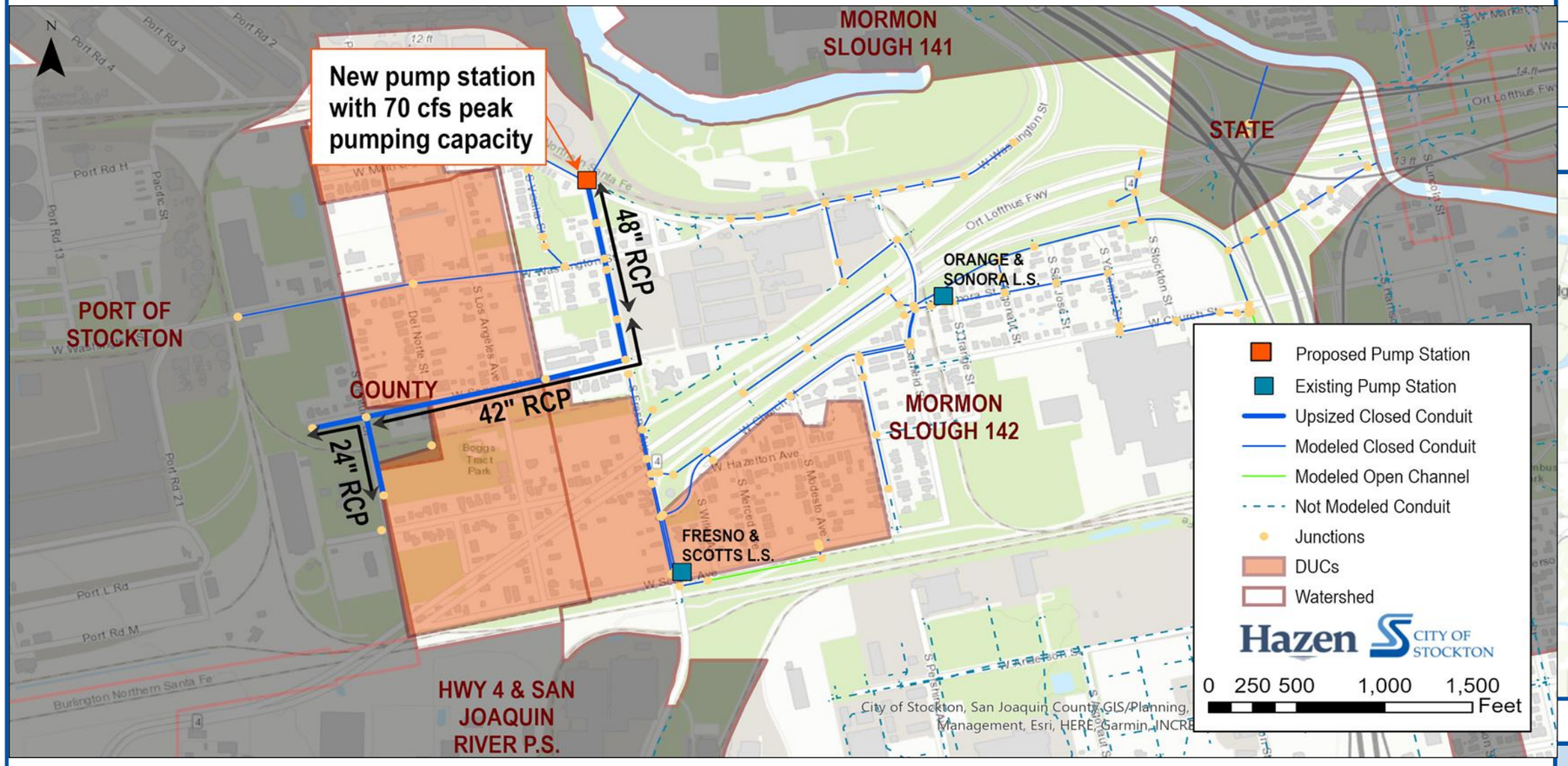
APPENDIX 19.A
Manning's Roughness Coefficient[a,b]
(design use)

channel material	n
plastic (PVC and ABS)	0.009
clean, uncoated cast iron	0.013–0.015
clean, coated cast iron	0.012–0.014
dirty, tuberculated cast iron	0.015–0.035
riveted steel	0.015–0.017
lock-bar and welded steel pipe	0.012–0.013
galvanized iron	0.015–0.017
brass and glass	0.009–0.013
wood stave	
small diameter	0.011–0.012
large diameter	0.012–0.013
concrete	
average value used	0.013
typical commercial, ball and spigot rubber gasketed end connections	
– full (pressurized and wet)	0.010
– partially full	0.0085
with rough joints	0.016–0.017
dry mix, rough forms	0.015–0.016
wet mix, steel forms	0.012–0.014
very smooth, finished	0.011–0.012
vitrified sewer	0.013–0.015
common-clay drainage tile	0.012–0.014
asbestos	0.011
planed timber (flume)	0.012 (0.010–0.014)
canvas	0.012
unplaned timber (flume)	0.013 (0.011–0.015)
brick	0.016
rubble masonry	0.017
smooth earth	0.018
firm gravel	0.023
corrugated metal pipe (CMP)	0.022–0.033
natural channels, good condition	0.025
rip rap	0.035
natural channels with stones and weeds	0.035
very poor natural channels	0.060

[a]compiled from various sources
[b]Values outside these ranges have been observed, but these values are typical.


Boggs Tract PS
Existing Storage
Existing Pump Station
Existing Outfall
Junction of Interest (Flood Volume in MG)
0.01 - 0.1
0.1 - 0.4
0.4 - 1
1 - 3
> 3
Modeled Conduit (Diameter in In)
0 - 12
12 - 48
48 - 96
> 96
Open Channel
Force Main
Known Flooding Area
DUC
Study Area
Reclamation District
Stockton City Limit
Hazen
CITY OF STOCKTON
N
CHANNEL
STOCKTON
MORMON
SLOUGH
HARBOR ST
WASHINGTON ST
STATE ROUTE 4
INTERSTATE 5
RD 404 (BOGGS TRACT)
FRESNO AV
CHURCH ST
PERSHING AV
ARGONAUT ST
SONORA ST
STOCKTON ST
Orange & Sonora LS
HAZELTON AV
MERCED AV
GARFIELD ST
SCOTTS AV
SAN JOAQUIN COUNTY
Fresno & Scott LS
0.5
EX. FLOODING
0 250 500 1,000 1,500 Feet

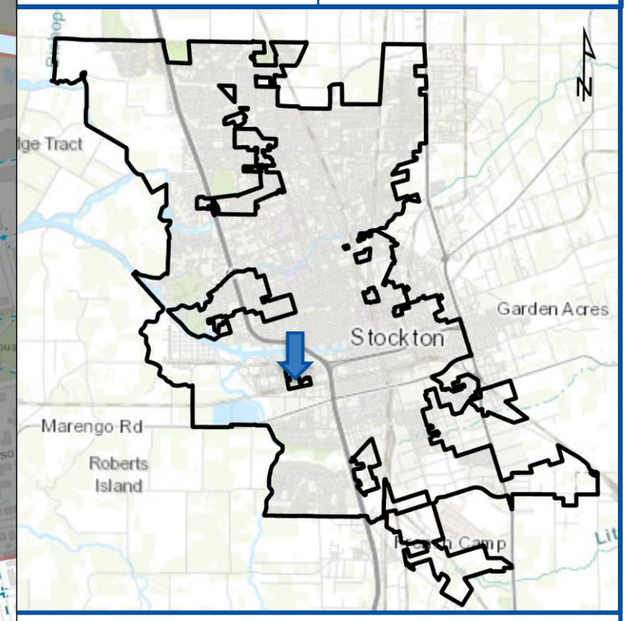
Boggs Tract



Stockton Stormwater Master Plan

CITY OF STOCKTON | Hazen

January 2022



Existing Conditions

The Boggs Tract community, located West of Fresno Ave, does not have sufficient drainage and frequently floods. The primary goal of this plan is to provide drainage relief to this community. The Fresno & Scott Lift Station (LS), which is adjacent to Boggs Tract, manages runoff from a portion of the watershed north of the Crosstown Freeway, this LS is undersized and frequently causes upstream flooding. The watershed's only outfall is into Mormon Slough through a gravity pipe under I-5.

Proposed Improvement

The Fresno & Scott LS does not have capacity to accommodate runoff form Boggs Tract, upsizing this pump also requires upsizing the downstream forcemain and the gravity pipe crossing I-5. The recommendation is to install a pump station at Harbor St which discharges into a new outfall into the Port of Stockton. New storm drains along Washington St and Sonora St will route runoff to the new pump station, additional local grading and drainage will be needed to required to collect local drainage. As a result of the project, the Fresno & Scott LS will receive less runoff which will improve its operation.

Site Information

Drainage Basin: Boggs Tract
Receiving Water: Port of Stockton

Concern Area Characteristics			
Known Concern Area	Yes	**Traffic Impacts**	High
Extent of Concerns	High	**Support for Future Dev.**	Low
Flooding Frequency	High	**Data Confidence**	High

Conceptual Level Estimates

Construction Cost: $ 17,144,585
Estimated O&M: High
Co-Benefits:
- Service to DUC

Overall Priority: High

Improvement Typologies

New Pump Station

Upsized Conveyance

Conceptual Design – Not for Construction

APPENDIX E

SSA Input Data



JMA CIVIL

Port of Stockton Double Lead Track Project

Table 1 - SSA Input Values - Existing and Proposed Drainage Areas

Construction Phase	Drainage Area	Area A (AC)	Impervious Area B (AC)	Pervious Area C (AC)	% Impervious Area =B/A X 100%	Area, A (Mi^2) =A X 0.0015625	Impervious SCS Curve Number D (CN)	Pervious SCS Curve Number E (CN)	Weight Average CN F=((B X D)+(C X E))/A	Initial Abstraction Ia (inch) =0.2 X ((1000/F)-10)	Time of Concentration, Assumed Tc (min)	Lag, L (min.) =Tc x 0.6
Existing	DA-37 Ex	0.77	0.33	0.44	42.9%	0.0012	93	80	86	0.3	5	3
Existing	DA-38 Ex	1.72	0.56	1.16	32.6%	0.0027	93	80	84	0.4	5	3
Existing	DA-39 Ex	0.65	0.24	0.41	37.0%	0.0010	93	80	85	0.4	5	3
Existing	DA-40 Ex	0.63	0.27	0.36	42.7%	0.0010	93	80	86	0.3	5	3
Existing	DA-41 Ex	0.31	0.12	0.19	38.7%	0.0005	93	80	85	0.4	5	3
Existing	DA-42 Ex	1.02	0.41	0.61	40.5%	0.0016	93	80	85	0.3	5	3
Existing	DA-43 Ex	0.76	0.20	0.56	26.3%	0.0012	93	80	83	0.4	5	3
Existing	DA-44 Ex	0.45	0.06	0.39	13.3%	0.0007	93	80	82	0.4	5	3
Existing	DA-45 Ex	2.90	0.83	2.07	28.6%	0.0045	93	80	84	0.4	5	3
Proposed	DA-37	0.59	0.42	0.17	70.8%	0.0009	93	80	89	0.2	5	3
Proposed	DA-38	1.38	0.79	0.59	57.2%	0.0022	93	80	87	0.3	5	3
Proposed	DA-39	0.69	0.43	0.26	61.9%	0.0011	93	80	88	0.3	5	3
Proposed	DA-40	0.58	0.26	0.32	44.5%	0.0009	93	80	86	0.3	5	3
Proposed	DA-40A	0.29	0.29	0.00	100.0%	0.0005	93	80	93	0.2	5	3
Proposed	DA-41	0.31	0.12	0.19	38.7%	0.0005	93	80	85	0.4	5	3
Proposed	DA-42	0.81	0.40	0.41	49.9%	0.0013	93	80	86	0.3	5	3
Proposed	DA-42A	0.31	0.31	0.00	100.0%	0.0005	93	80	93	0.2	5	3
Proposed	DA-43	0.76	0.20	0.56	26.3%	0.0012	93	80	83	0.4	5	3
Proposed	DA-44	0.37	0.20	0.17	55.1%	0.0006	93	80	87	0.3	5	3
Proposed	DA-45	2.08	1.19	0.89	57.4%	0.0033	93	80	87	0.3	5	3
Proposed	DA-46	0.77	0.20	0.57	25.5%	0.0012	93	80	83	0.4	5	3

Port of Stockton Double Lead Track Project
Table 2 - Existing & Proposed Storage Volume Analysis

EXISTING STORAGE ELEMENTS

Node: BNSF Basin

ELEV	DEPTH (FT)	AREA (SF)	AREA (AC)	DISCHARGE	STORAGE (AC-FT)	NOTES
3.00	0.00	1306.80	0.03	0.00	0.00	
4.00	1.00	7405.20	0.17	0.00	0.10	
5.00	2.00	24829.20	0.57	0.00	0.47	
6.00	3.00	38768.40	0.89	0.00	1.20	
7.00	4.00	40510.80	0.93	0.00	2.11	
8.00	5.00	41817.60	0.96	0.00	3.06	Basin Rim/Top of Subgrade
					3.06	**TOTAL STORAGE**

PROPOSED STORAGE ELEMENTS

Node: Proposed BNSF Basin

ELEV	DEPTH (FT)	AREA (SF)	AREA (AC)	DISCHARGE	STORAGE (AC-FT)	NOTES
5.50	0.00	3049.20	0.07	0.00	0.00	
6.00	0.50	6098.40	0.14	0.00	0.05	
6.50	1.00	12545.28	0.29	0.00	0.16	
7.00	1.50	3920.40	0.09	0.00	0.25	
7.50	2.00	4356.00	0.10	0.00	0.30	
8.00	2.50	4791.60	0.11	0.00	0.35	
8.50	3.00	5227.20	0.12	0.00	0.41	Basin Rim/Top of Subgrade
					0.41	**TOTAL STORAGE**



THIS MAP FOR CITY USE ONLY

The information is based on the most current information available to the City of Stockton Geographic Information System Division. The information is not intended to replace engineering, financial or primary records research.

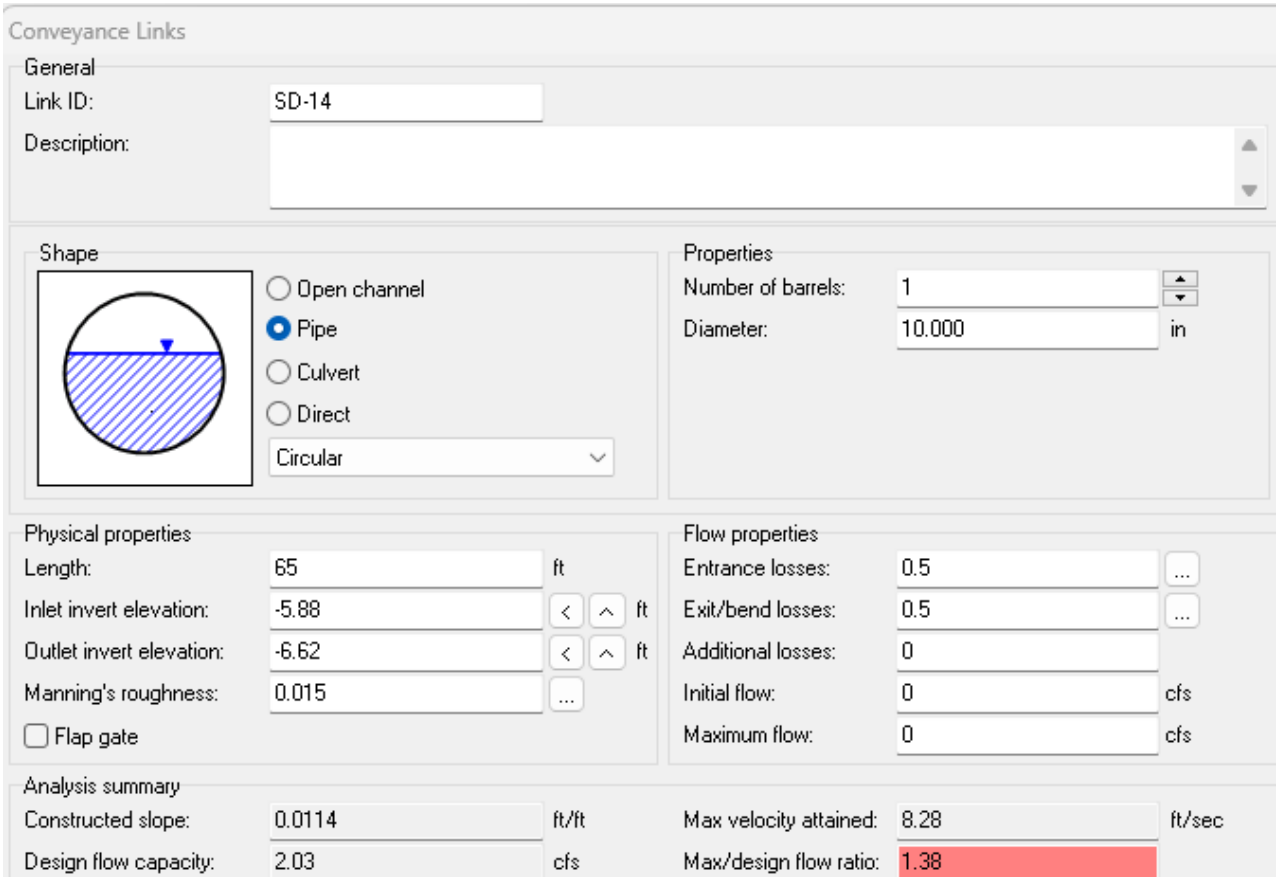
STORM - MAY 2022

0 100 200 400 600 800 Feet

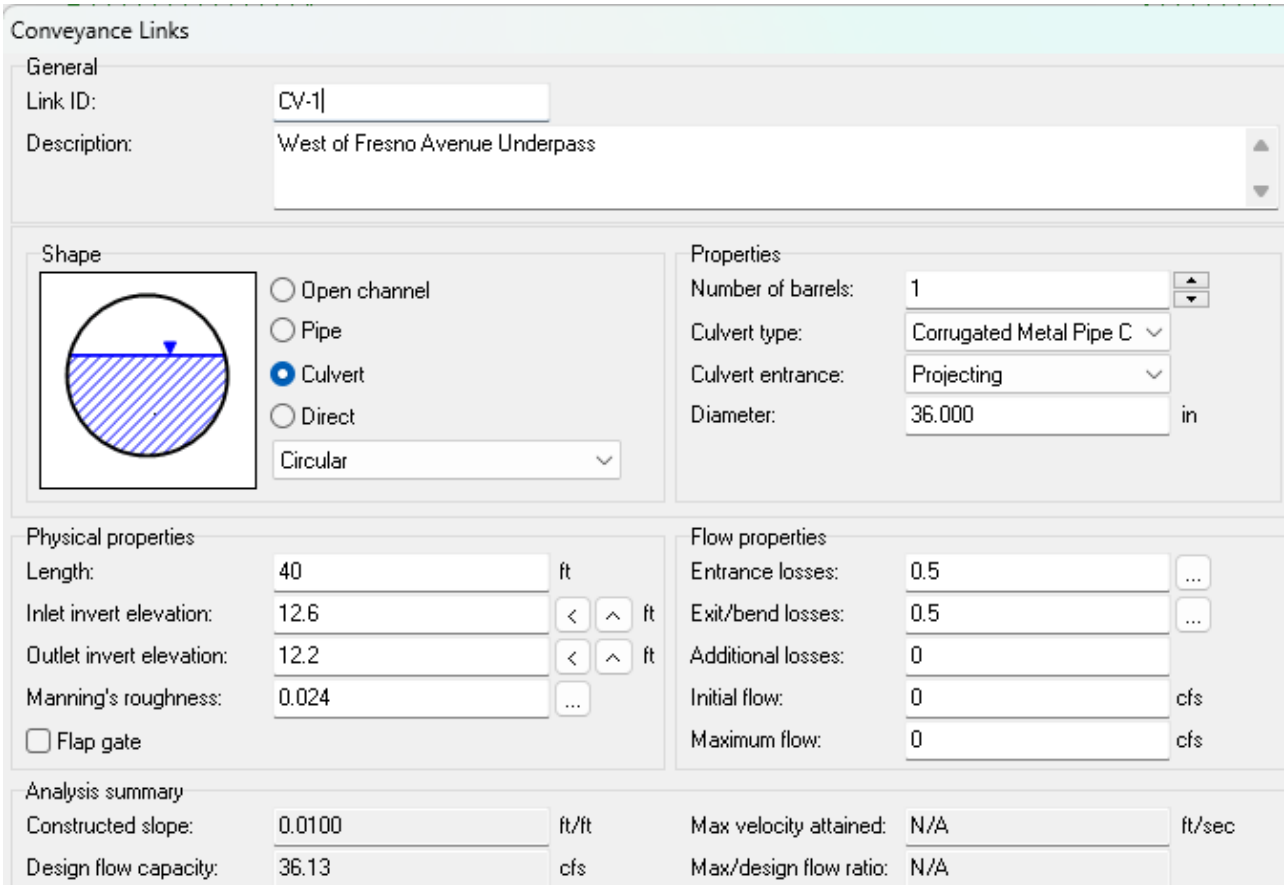
35K

Port of Stockton Double Lead Track Project
Figure 1 - Storm Drain/Culverts/Ditches Input Data

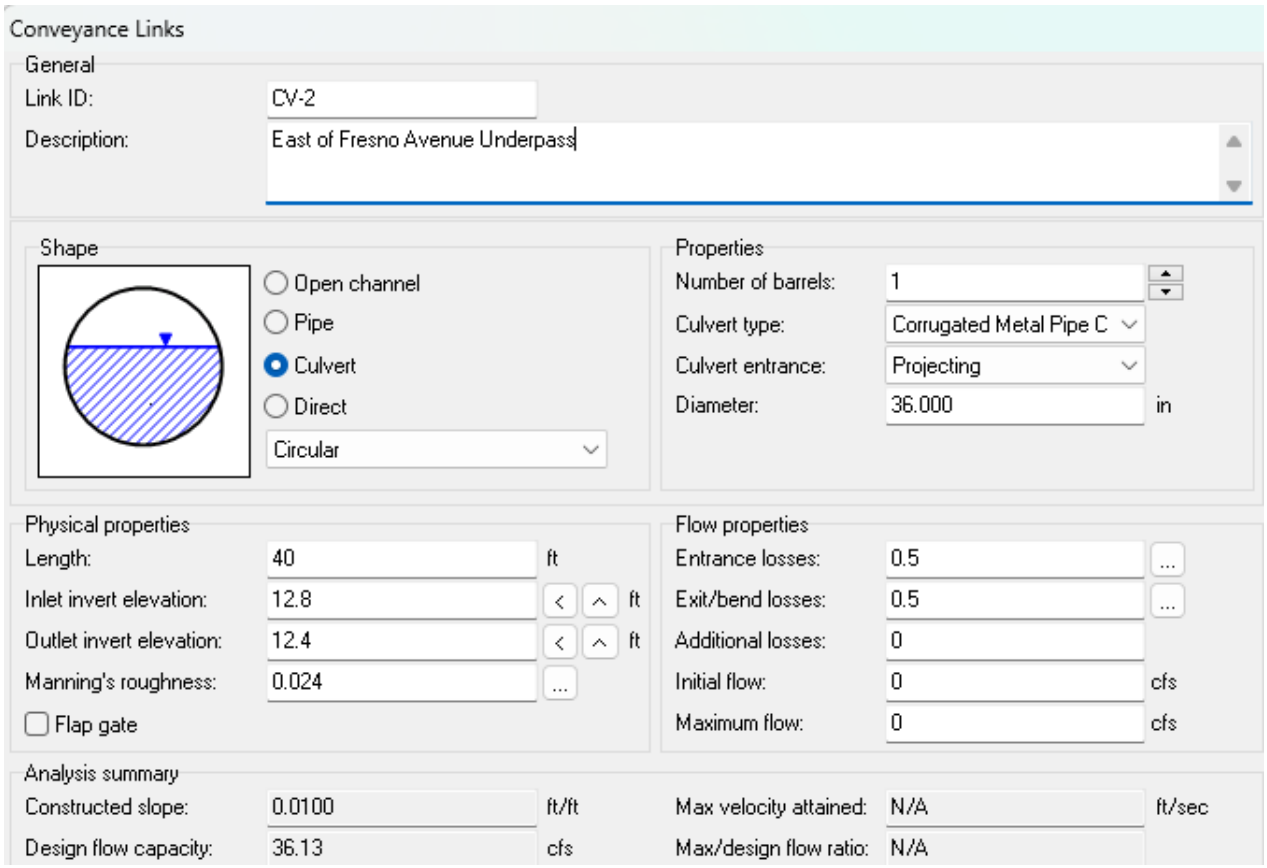
EXISTING

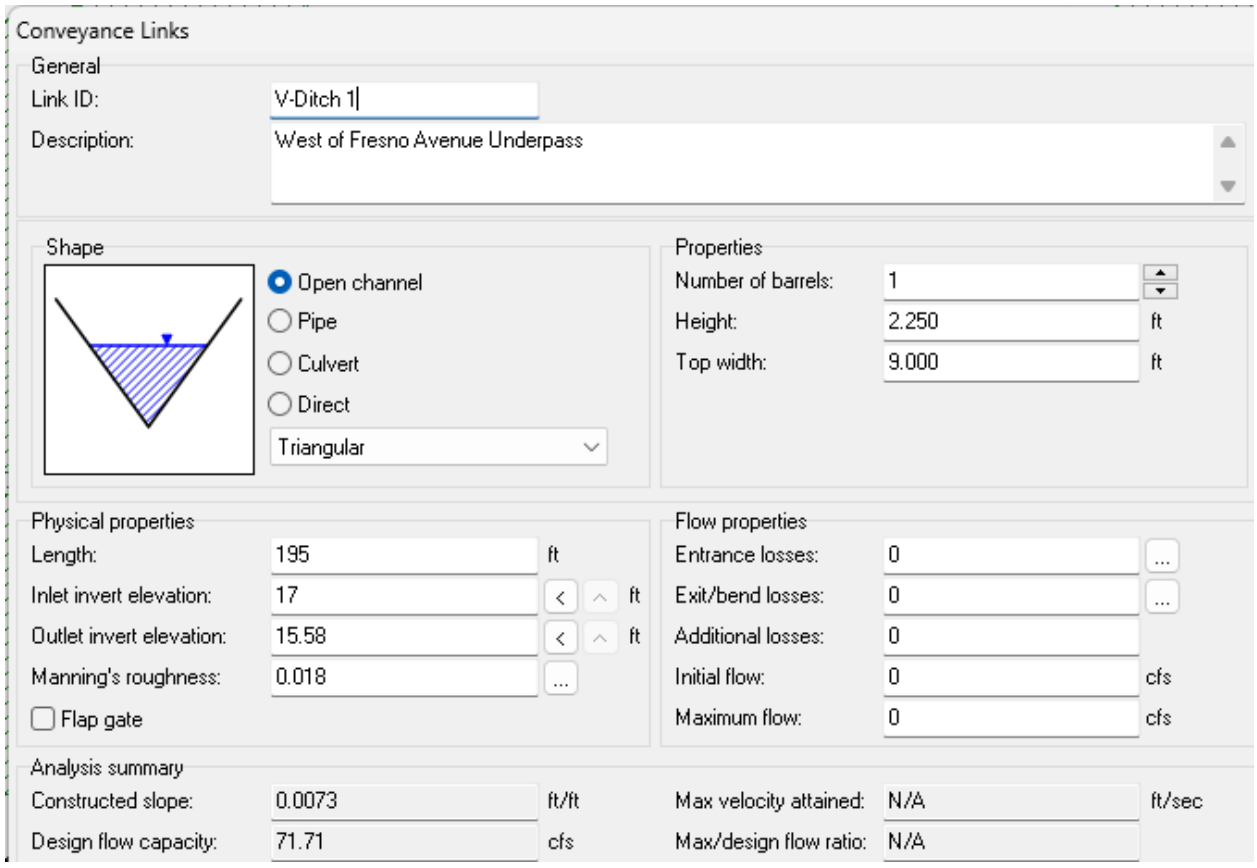


PROPOSED



Port of Stockton Double Lead Track Project
Figure 1 (Cont'd) - Storm Drain/Culverts/Ditches Input Data
PROPOSED

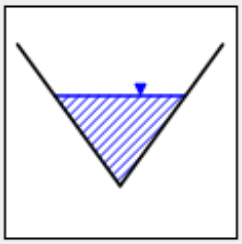




Port of Stockton Double Lead Track Project
Figure 1 (Cont'd) - Storm Drain/Culverts/Ditches Input Data
PROPOSED

Conveyance Links

General
Link ID: V-Ditch 2
Description: East of Fresno Avenue Underpass

Shape

Open channel
Pipe
Culvert
Direct
Triangular

Properties
Number of barrels: 1
Height: 1.500 ft
Top width: 5.750 ft

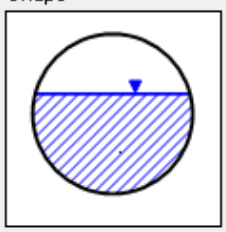
Physical properties
Length: 210 ft
Inlet invert elevation: 16.75 ft
Outlet invert elevation: 15.75 ft
Manning's roughness: 0.018
Flap gate

Flow properties
Entrance losses: 0
Exit/bend losses: 0
Additional losses: 0
Initial flow: 0 cfs
Maximum flow: 0 cfs

Analysis summary
Constructed slope: 0.0048 ft/ft
Design flow capacity: 18.79 cfs
Max velocity attained: N/A ft/sec
Max/design flow ratio: N/A

Conveyance Links

General
Link ID: SD-15
Description:

Shape

Open channel
Pipe
Culvert
Direct
Circular

Properties
Number of barrels: 1
Diameter: 18.000 in

Physical properties
Length: 160 ft
Inlet invert elevation: -6.62 ft
Outlet invert elevation: -8.7 ft
Manning's roughness: 0.015
Flap gate

Flow properties
Entrance losses: 0.5
Exit/bend losses: 0.5
Additional losses: 0
Initial flow: 0 cfs
Maximum flow: 0 cfs

Analysis summary
Constructed slope: 0.0130 ft/ft
Design flow capacity: 10.38 cfs
Max velocity attained: N/A ft/sec
Max/design flow ratio: N/A

Port of Stockton Double Lead Track Project
Figure 2 - Existing Conditions Inlets Input Data

Inlets

General specifications

Inlet ID:	Fresno East	
Inlet manufacturer:	FHWA HEC-22 Generic	
Manufacturer part number:	N/A	
Number of inlets:	1	
Inlet type:	Grate Inlet - Rectangular	
Inlet location:	On Sag	
Combination inlet type:	Curb Opening & Grate	
Curb opening and grate type:	Equal Length Inlet	

Description

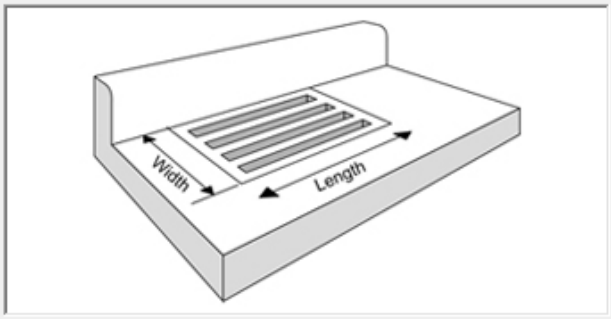
Grate specifications

Grate type:	Parallel Bar P-1-7/8-4	
Grate length:	24.00	in
Grate width:	16.00	in

Physical properties

Catchbasin invert elevation:	-5.88	ft
Inlet rim elevation:	0.27	ft
Ponded area:	0	ft²
Initial water surface elevation:	-5.88	ft
External inflows:	NO	...
Grate clogging factor:	0	%
Roadway/gutter bypass link:	*	

Inlet illustration



Roadway & gutter specifications

Roadway longitudinal slope:		ft/ft
Roadway cross slope:	0.01	ft/ft
Roadway Manning's:	0.013	...
Gutter cross slope:	0.062	ft/ft
Gutter width:	2.00	ft

Analysis summary

Peak flow during analysis:	2.31	cfs
Peak flow intercepted by inlet:	N/A	cfs
Peak flow bypassing inlet:	N/A	cfs
Inlet efficiency during peak flow:	N/A	%

Inlets

General specifications

Inlet ID:	Fresno West	
Inlet manufacturer:	FHWA HEC-22 Generic	
Manufacturer part number:	N/A	
Number of inlets:	1	
Inlet type:	Grate Inlet - Rectangular	
Inlet location:	On Sag	
Combination inlet type:	Curb Opening & Grate	
Curb opening and grate type:	Equal Length Inlet	

Description

Delete
Show
Report
More>>

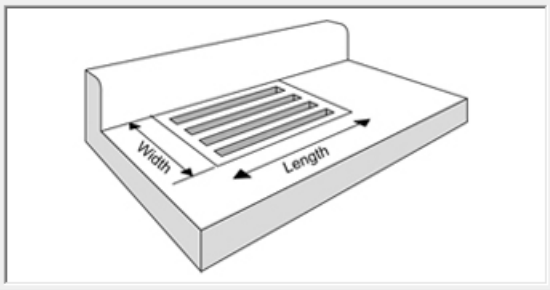
Grate specifications

Grate type:	Parallel Bar P-1-7/8-4	
Grate length:	24.00	in
Grate width:	16.00	in

Physical properties

Catchbasin invert elevation:	-6.62	ft
Inlet rim elevation:	-0.12	ft
Ponded area:	0	ft²
Initial water surface elevation:	-6.62	ft
External inflows:	NO	...
Grate clogging factor:	0	%
Roadway/gutter bypass link:	*	

Inlet illustration



Roadway & gutter specifications

Roadway longitudinal slope:		ft/ft
Roadway cross slope:	0.01	ft/ft
Roadway Manning's:	0.013	...
Gutter cross slope:	0.062	ft/ft
Gutter width:	2.00	ft

Analysis summary

Peak flow during analysis:	1.27	cfs
Peak flow intercepted by inlet:	N/A	cfs
Peak flow bypassing inlet:	N/A	cfs
Inlet efficiency during peak flow:	N/A	%

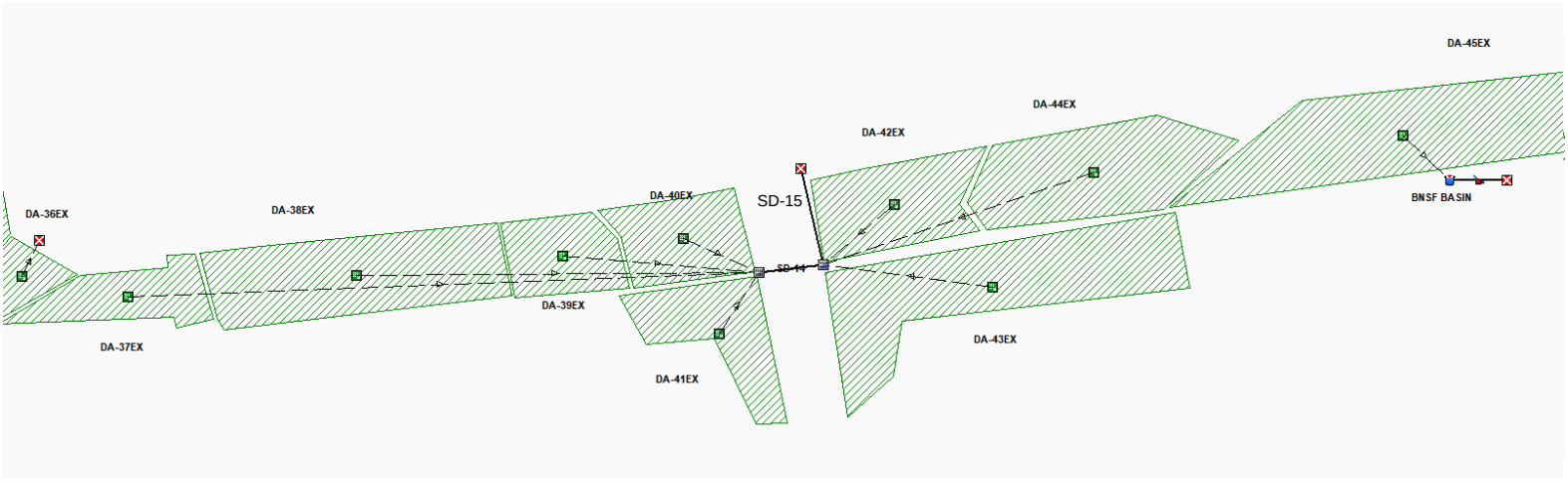
APPENDIX F

SSA Model Results

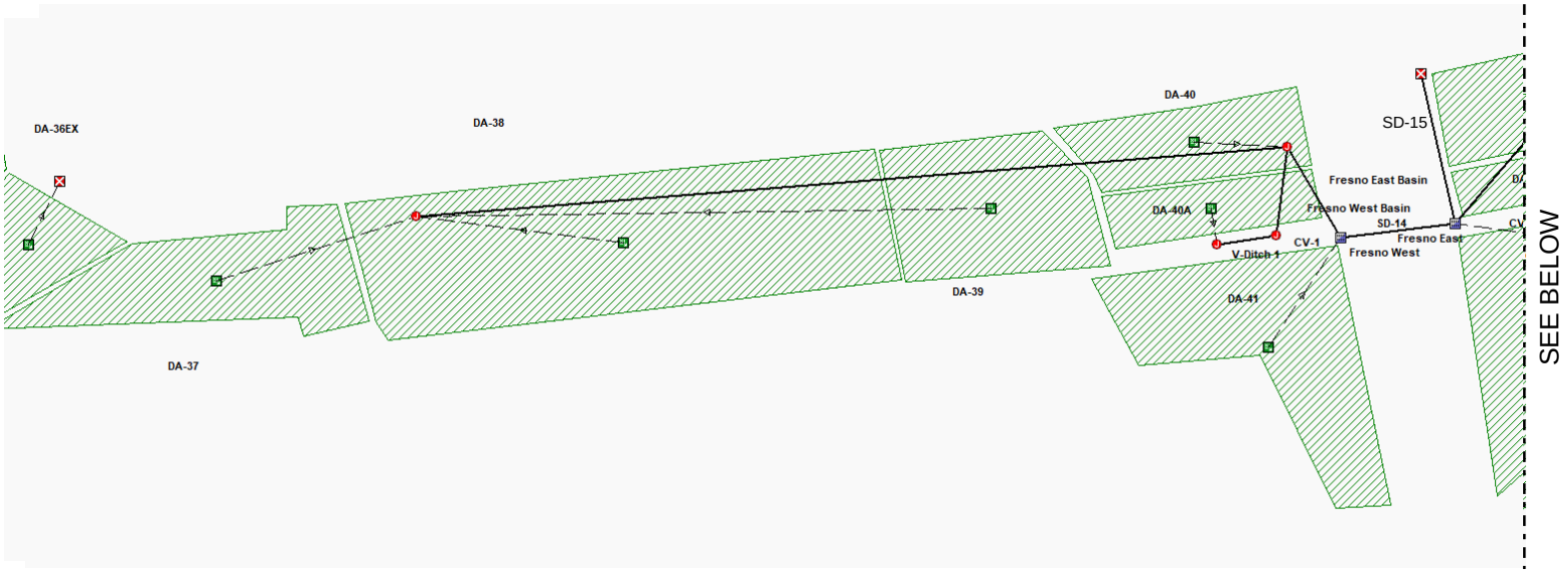


FIGURE 1: Civil3D SSA Model Setup

EXISTING CONDITION



PROPOSED CONDITION



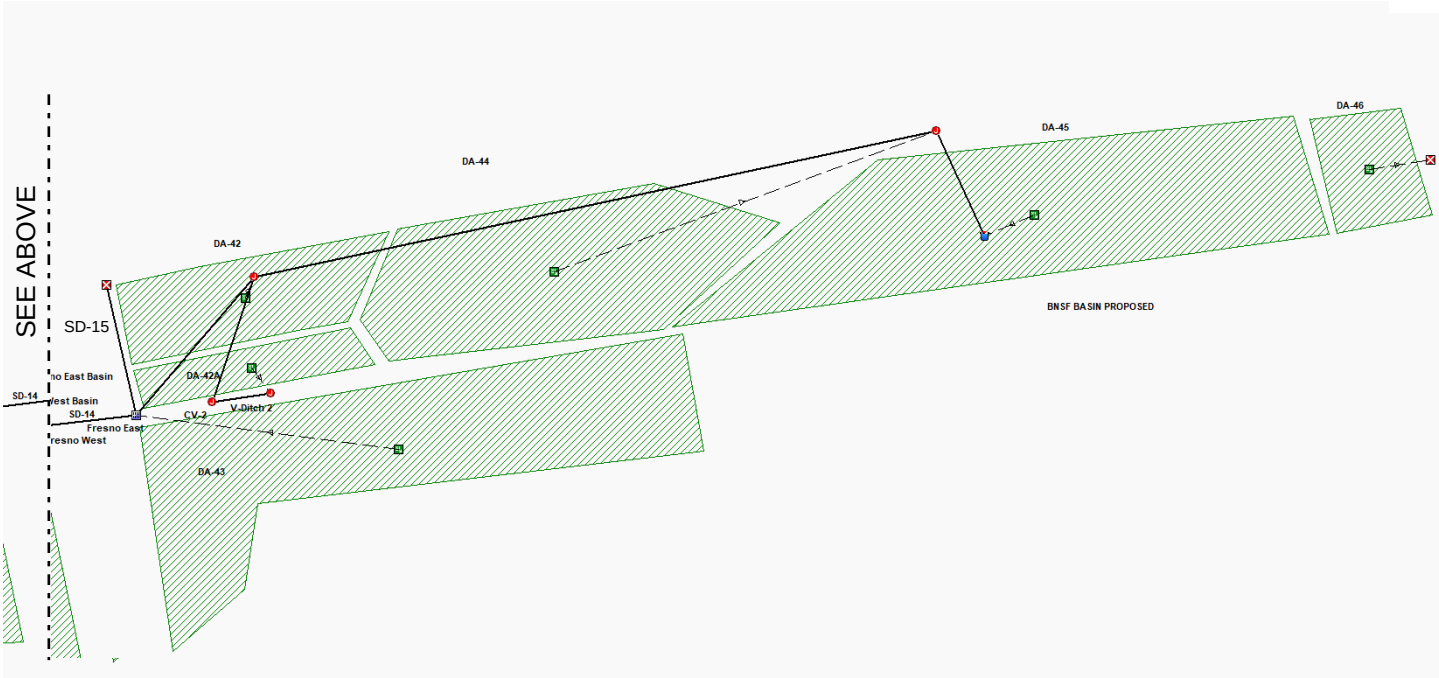


Table 1: Peak Runoff and Discharge Volume Analysis

S. No.	Drainage Area	Area	Weighted Curve Number	100-Year 24-Hour			50-Year 24-Hour			2-Year 24-Hour		
				Total Precipitation	Total Runoff	Peak Runoff	Total Precipitation	Total Runoff	Peak Runoff	Total Precipitation	Total Runoff	Peak Runoff
		(acres)		(inches)	(ac-ft)	(cfs)	(inches)	(ac-ft)	(cfs)	(inches)	(ac-ft)	(cfs)
Existing Conditions												
1	DA-37EX	0.77	85.58	3.43	0.13	1.23	3.13	0.11	1.06	1.69	0.11	0.32
2	DA-38EX	1.72	84.24	3.43	0.27	2.58	3.13	0.24	2.21	1.69	0.24	0.62
3	DA-39EX	0.65	84.81	3.43	0.11	1.01	3.13	0.09	0.87	1.69	0.09	0.25
4	DA-40EX	0.63	85.55	3.43	0.11	1.00	3.13	0.09	0.87	1.69	0.09	0.26
5	DA-41EX	0.31	85.03	3.43	0.05	0.48	3.13	0.04	0.41	1.69	0.04	0.12
6	DA-42EX	1.02	85.27	3.43	0.17	1.60	3.13	0.15	1.38	1.69	0.15	0.41
7	DA-43EX	0.76	83.42	3.43	0.12	1.10	3.13	0.10	0.94	1.69	0.10	0.25
8	DA-44EX	0.45	81.73	3.43	0.06	0.59	3.13	0.05	0.50	1.69	0.05	0.12
9	DA-45EX	2.90	83.72	3.43	0.45	4.24	3.13	0.39	3.62	1.69	0.39	0.98
Proposed Conditions												
1	DA-37	0.59	89.20	3.43	0.11	1.10	3.13	0.10	0.97	1.69	0.04	0.35
2	DA-38	1.38	87.44	3.43	0.25	2.41	3.13	0.22	2.10	1.69	0.08	0.70
3	DA-39	0.69	88.05	3.43	0.13	1.24	3.13	0.11	1.08	1.69	0.04	0.37
4	DA-40	0.58	85.79	3.43	0.10	0.94	3.13	0.09	0.81	1.69	0.03	0.25
5	DA-40A	0.29	93.00	3.43	0.06	0.62	3.13	0.06	0.56	1.69	0.02	0.24
6	DA-41	0.31	85.03	3.43	0.05	0.48	3.13	0.04	0.41	1.69	0.01	0.12
7	DA-42	0.81	86.49	3.43	0.14	1.36	3.13	0.12	1.17	1.69	0.04	0.38
8	DA-42A	0.31	93.00	3.43	0.07	0.66	3.13	0.06	0.59	1.69	0.03	0.26
9	DA-43	0.76	83.42	3.43	0.12	1.10	3.13	0.10	0.94	1.69	0.03	0.25
10	DA-44	0.37	87.16	3.43	0.07	0.64	3.13	0.06	0.56	1.69	0.02	0.18
11	DA-45	2.08	87.46	3.43	0.37	3.62	3.13	0.33	3.15	1.69	0.12	1.06
12	DA-46	0.77	83.31	3.43	0.12	1.10	3.13	0.10	0.94	1.69	0.03	0.25

Table 2: Storage Volume Analysis

S. No.	Basin	Storm Event	Invert Elev. (ft)	Rim Elev. (ft)	Total Basin Depth (ft)	Initial Water Depth (ft)	Peak Inflow (cfs)	Peak Outflow (cfs)	Max HGL Elev. (ft)	Max HGL Depth (ft)	Min Freeboard (ft)	Time of Max HGL (days hh:mm)
1	BNSF Basin - Existing	100-year 24-hour	3.00	8.00	5.00	0.00	4.23	0.00	4.96	1.96	3.04	1 00:20
2	BNSF Basin - Existing	50-year 24-hour	3.00	8.00	5.00	0.00	3.61	0.00	4.85	1.85	3.15	1 00:20
3	BNSF Basin - Existing	2-year 24-hour	3.00	8.00	5.00	0.00	0.97	0.00	4.13	1.13	3.87	1 00:15
4	BNSF Basin - Proposed	100-year 24-hour	5.90	8.00	2.10	0.00	3.62	0.92	7.23	1.33	0.77	0 10:14
5	BNSF Basin - Proposed	50-year 24-hour	5.90	8.00	2.10	0.00	3.15	0.63	7.18	1.28	0.82	0 10:27
6	BNSF Basin - Proposed	2-year 24-hour	5.90	8.00	2.10	0.00	1.05	0.06	6.99	1.09	1.01	0 18:06

Table 3: Pipe and Ditch Flow Analysis

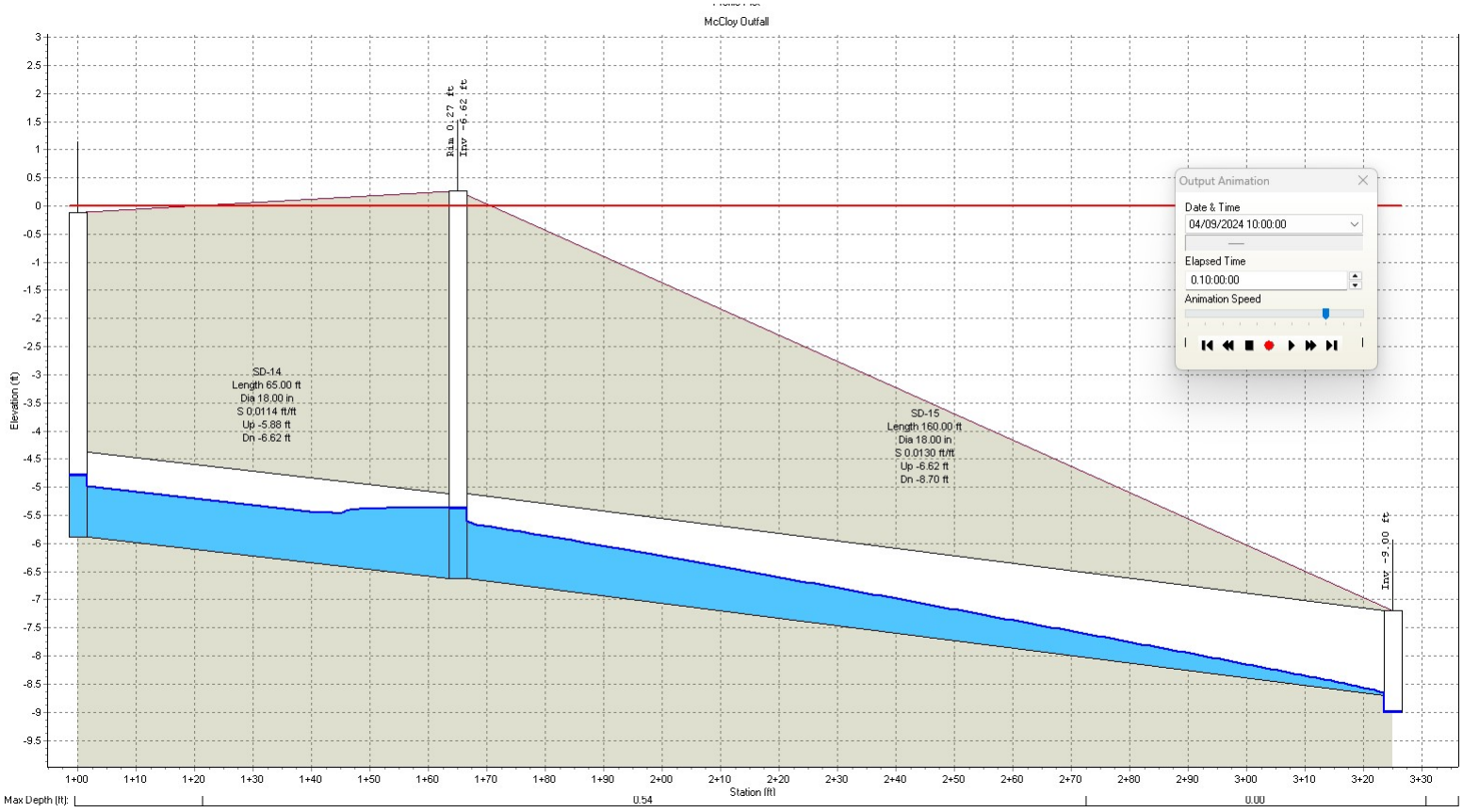
S. No.	Storm Drain	Length (ft)	Inlet Elev. (ft)	Outlet Elev. (ft)	Total Drop (ft)	Slope (%)	Cross-Section	Pipe Dia. (inches)	Manning's	Entrance Losses	Storm Event	Peak Flow (cfs)	Time of Peak Occurrence (days hh:mm)	Max Flow Velocity (ft/sec)	Max Flow Depth (ft)	Max EGL (ft)	Design Capacity (cfs)	Max Flow/Design Flow Ratio	Max Flow Depth/Total Depth
Existing Condition																			
1	Ex. SD-14	65.00	-5.88	-6.62	0.74	1.1	CIRCULAR	18.0	0.0150	0.5000	100-Year 24-Hour	6.26	0 10:00	4.20	1.17	1.44	9.71	0.64	0.79
2		65.00	-5.88	-6.62	0.74	1.1	CIRCULAR	18.0	0.0150	0.5000	50-Year 24-Hour	5.39	0 10:00	4.16	1.02	1.29	9.71	0.55	0.69
3		65.00	-5.88	-6.62	0.74	1.1	CIRCULAR	18.0	0.0150	0.5000	2-Year 24-Hour	1.56	0 10:10	3.31	0.46	0.63	9.71	0.16	0.31
1	Ex. SD-15	160.00	-6.62	-8.70	2.08	1.3	CIRCULAR	18.0	0.0150	0.5000	100-Year 24-Hour	9.36	0 10:00	6.19	1.17	1.76	10.38	0.90	0.80
2		160.00	-6.62	-8.70	2.08	1.3	CIRCULAR	18.0	0.0150	0.5000	50-Year 24-Hour	8.08	0 10:00	6.10	1.03	1.61	10.38	0.78	0.70
3		160.00	-6.62	-8.70	2.08	1.3	CIRCULAR	18.0	0.0150	0.5000	2-Year 24-Hour	2.29	0 10:10	4.56	0.48	0.80	10.38	0.22	0.33
Proposed Condition																			
1	Ex. SD-14	65.00	-5.88	-6.62	0.74	1.1	CIRCULAR	18.0	0.0150	0.5000	100-Year 24-Hour	4.35	0 10:11	4.08	0.87	1.13	9.71	0.45	0.59
2		65.00	-5.88	-6.62	0.74	1.1	CIRCULAR	18.0	0.0150	0.5000	50-Year 24-Hour	3.73	0 10:11	4.00	0.78	1.03	9.71	0.38	0.52
3		65.00	-5.88	-6.62	0.74	1.1	CIRCULAR	18.0	0.0150	0.5000	2-Year 24-Hour	0.99	0 10:17	3.00	0.36	0.50	9.71	0.10	0.24
1	Ex. SD-15	160.00	-6.62	-8.70	2.08	1.3	CIRCULAR	18.0	0.0150	0.5000	100-Year 24-Hour	6.55	0 10:14	5.86	0.91	1.44	10.38	0.63	0.60
2		160.00	-6.62	-8.70	2.08	1.3	CIRCULAR	18.0	0.0150	0.5000	50-Year 24-Hour	5.44	0 10:14	5.64	0.80	1.29	10.38	0.52	0.54
3		160.00	-6.62	-8.70	2.08	1.3	CIRCULAR	18.0	0.0150	0.5000	2-Year 24-Hour	1.41	0 10:19	4.00	0.38	0.63	10.38	0.14	0.25
4	CV-1	55.00	12.60	1.79	10.81	10.0	CIRCULAR	36.0	0.0240	0.5000	100-Year 24-Hour	0.59	0 10:01	1.75	1.52	1.57	36.13	0.02	0.51
5		55.00	12.60	1.79	10.81	10.0	CIRCULAR	36.0	0.0240	0.5000	50-Year 24-Hour	0.53	0 10:01	1.70	1.52	1.56	36.13	0.01	0.51
6		55.00	12.60	1.79	10.81	10.0	CIRCULAR	36.0	0.0240	0.5000	2-Year 24-Hour	0.22	0 10:02	1.48	0.88	0.91	36.13	0.01	0.29
7	CV-2	55.00	12.80	2.10	10.70	10.0	CIRCULAR	36.0	0.0240	0.5000	100-Year 24-Hour	0.62	0 10:01	1.54	1.48	1.52	36.13	0.02	0.49
8		55.00	12.80	2.10	10.70	10.0	CIRCULAR	36.0	0.0240	0.5000	50-Year 24-Hour	0.55	0 10:01	1.53	1.47	1.51	36.13	0.02	0.49
9		55.00	12.80	2.10	10.70	10.0	CIRCULAR	36.0	0.0240	0.5000	2-Year 24-Hour	0.23	0 10:02	1.58	0.87	0.91	36.13	0.01	0.29
10	BNSF CV	40.00	6.90	6.50	0.40	1.0	CIRCULAR	24.0	0.0150	0.5000	100-Year 24-Hour	0.92	0 10:14	4.03	0.25	0.50	19.61	0.05	0.13
11		40.00	6.90	6.50	0.40	1.0	CIRCULAR	24.0	0.0150	0.5000	50-Year 24-Hour	0.63	0 10:28	3.68	0.21	0.42	19.61	0.03	0.10
12		40.00	6.90	6.50	0.40	1.0	CIRCULAR	24.0	0.0150	0.5000	2-Year 24-Hour	0.06	0 18:06	2.05	0.06	0.13	19.61	0.00	0.03

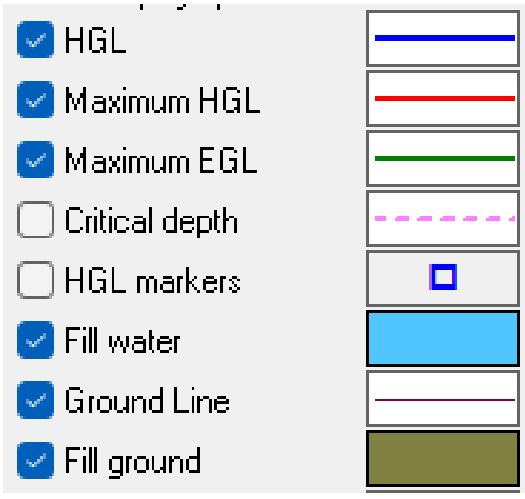
S. No.	Element	Length (ft)	Inlet Elev.(ft)	Outlet Elev (ft)	Total Drop(ft)	Slope (%)	Channel Type	Height (ft)	Top Width(ft)	Manning's	Peak Flow(cfs)	Time of Peak Occurence(days hh:mm)	Max Flow Velocity (ft/sec)	Max Flow Depth (ft)	Design Capacity (cfs)	Max Flow / Design Flow	Max Flow Depth/Total Depth
Proposed Condition																	
1	V-Ditch 1	195.00	17.00	15.58	1.42	0.7300	Triangular	2.250	9.00	0.0180	0.59	0 10:01	2.22	0.36	71.63	0.01	0.16
2		195.00	17.00	15.58	1.42	0.7300	Triangular	2.250	9.00	0.0180	0.53	0 10:01	2.16	0.34	71.63	0.01	0.16
3		195.00	17.00	15.58	1.42	0.7300	Triangular	2.250	9.00	0.0180	0.22	0 10:01	1.76	0.25	71.63	0.00	0.11
4	V-Ditch 2	210.00	16.75	15.75	1.00	0.4800	Triangular	1.500	5.75	0.0180	0.62	0 10:01	2.02	0.39	18.72	0.03	0.27
5		210.00	16.75	15.75	1.00	0.4800	Triangular	1.500	5.75	0.0180	0.56	0 10:01	1.96	0.38	18.72	0.03	0.26
6		210.00	16.75	15.75	1.00	0.4800	Triangular	1.500	5.75	0.0180	0.23	0 10:02	1.58	0.27	18.72	0.01	0.19

Table 4: Inlet Analysis

S. No.	Inlet Structure	Inlet Location	Invert Elev. (ft)	Rim Elev. (ft)	Max Depth (ft)	Initial Water Depth (ft)	Road Cross-Slope (ft/ft)	Manning's	Storm Event	Peak Flow (cfs)	Allowable Spread (ft)	Max Gutter Spread (ft)	Max Gutter Water Depth (ft)	Time of Max Depth (days hh:mm)	Total Flooded Volume (ac-inches)	Total Time Flooded (minutes)
Existing Conditions																
1	Fresno East	On Sag	-6.62	0.27	6.89	0.00	0.0100	0.0130	100-Year 24-Hour	3.28	7.00	31.76	0.44	0 10:00	0.00	0.00
2									50-Year 24-Hour	2.81	7.00	28.00	0.41	0 10:00	0.00	0.00
3									2-Year 24-Hour	0.77	7.00	8.14	0.21	0 10:00	0.00	0.00
4	Fresno West	On Sag	-5.88	-0.12	5.76	0.00	0.0100	0.0130	100-Year 24-Hour	6.28	7.00	52.36	0.65	0 10:00	0.00	0.00
5									50-Year 24-Hour	5.40	7.00	46.73	0.59	0 10:00	0.00	0.00
6									2-Year 24-Hour	1.56	7.00	16.88	0.29	0 10:00	0.00	0.00
Proposed Conditions																
1	Fresno East	On Sag	-6.62	0.27	6.89	0.00	0.0100	0.0130	100-Year 24-Hour	1.10	7.00	12.01	0.25	0 10:14	0.00	0.00
2									50-Year 24-Hour	0.93	7.00	10.16	0.23	0 10:14	0.00	0.00
3									2-Year 24-Hour	0.24	7.00	1.75	0.14	0 10:02	0.00	0.00
4	Fresno West	On Sag	-5.88	-0.12	5.76	0.00	0.0100	0.0130	100-Year 24-Hour	0.48	7.00	2.36	0.15	0 10:11	0.00	0.00
5									50-Year 24-Hour	0.41	7.00	2.20	0.15	0 10:11	0.00	0.00
6									2-Year 24-Hour	0.12	7.00	1.34	0.14	0 10:02	0.00	0.00

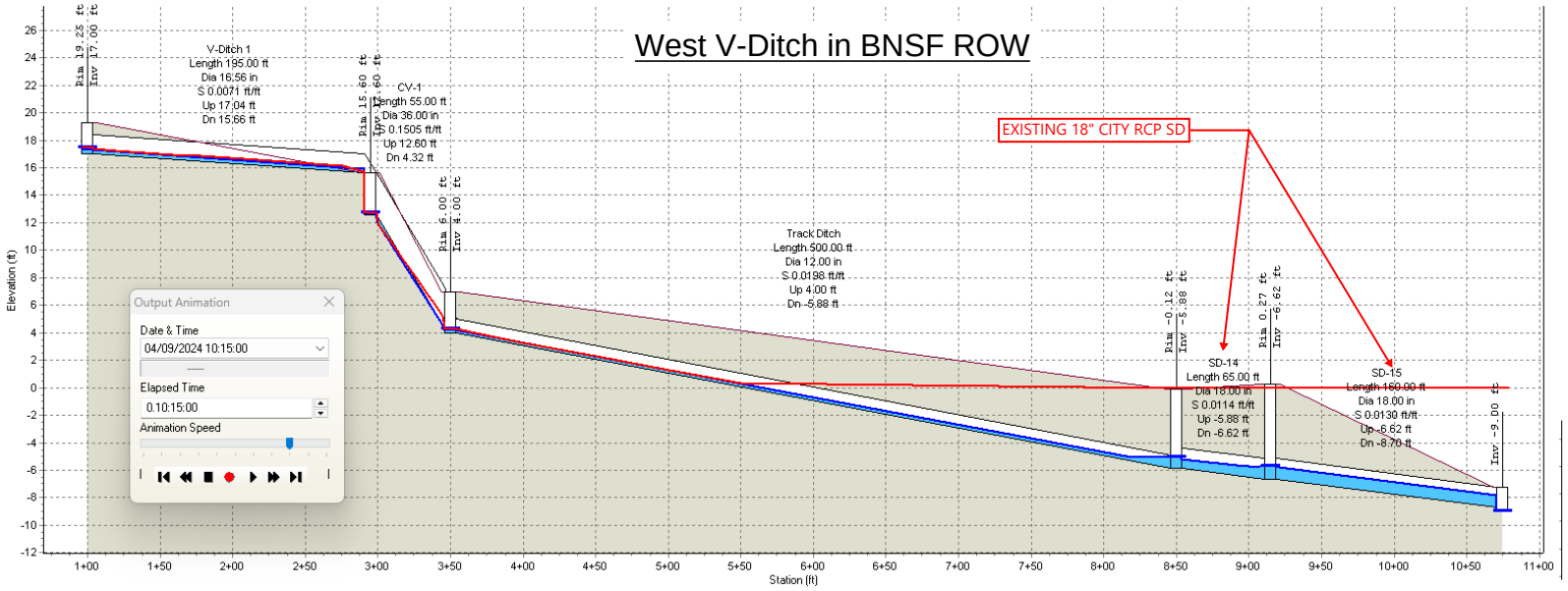
Figure 2: 100-year Storm Profile Plot at Time of Peak Flow
Through Existing SD-14 & SD-15 in Existing Condition

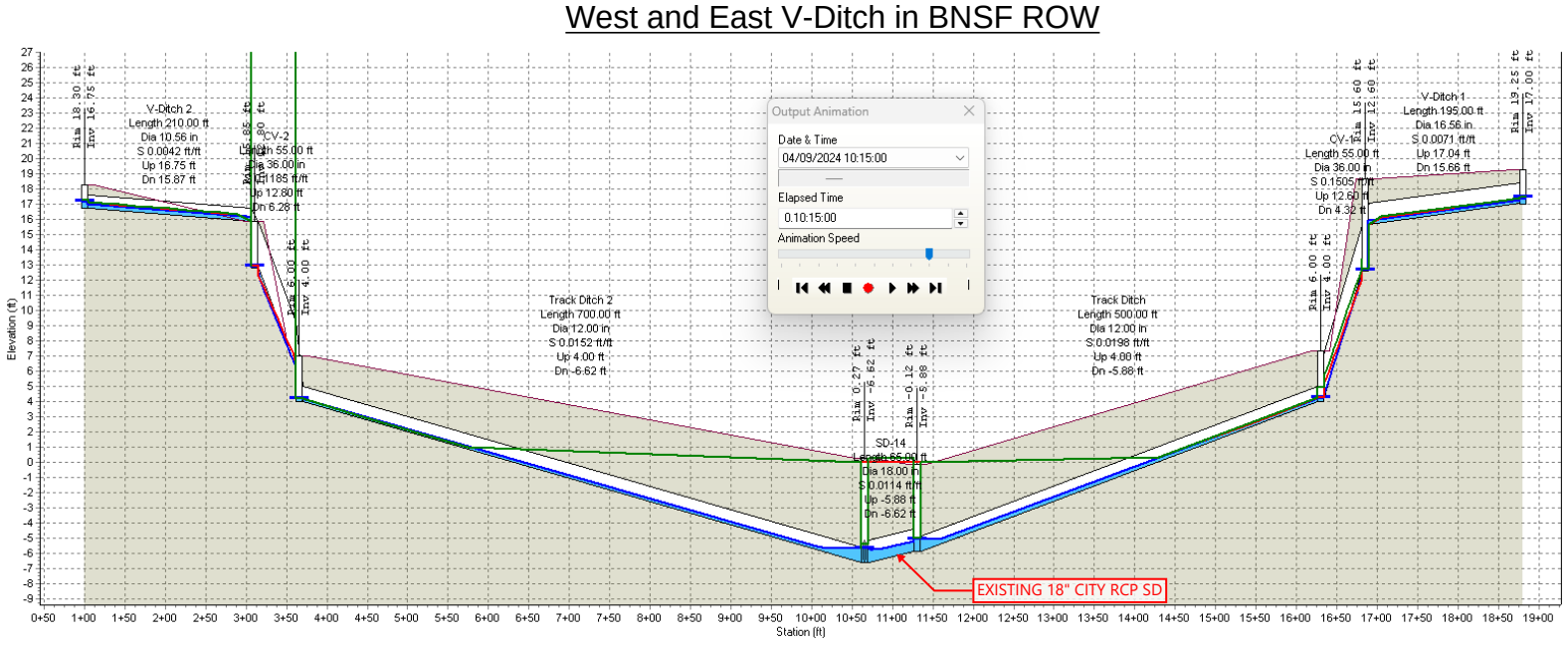


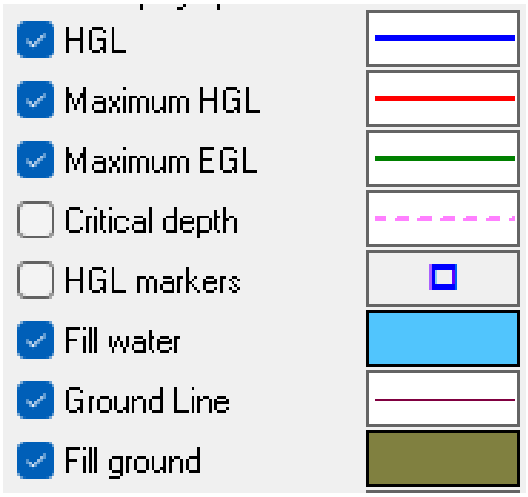


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Figure 3: 100-Year Flow through West and East V-Ditch into City SD system in Proposed Condition

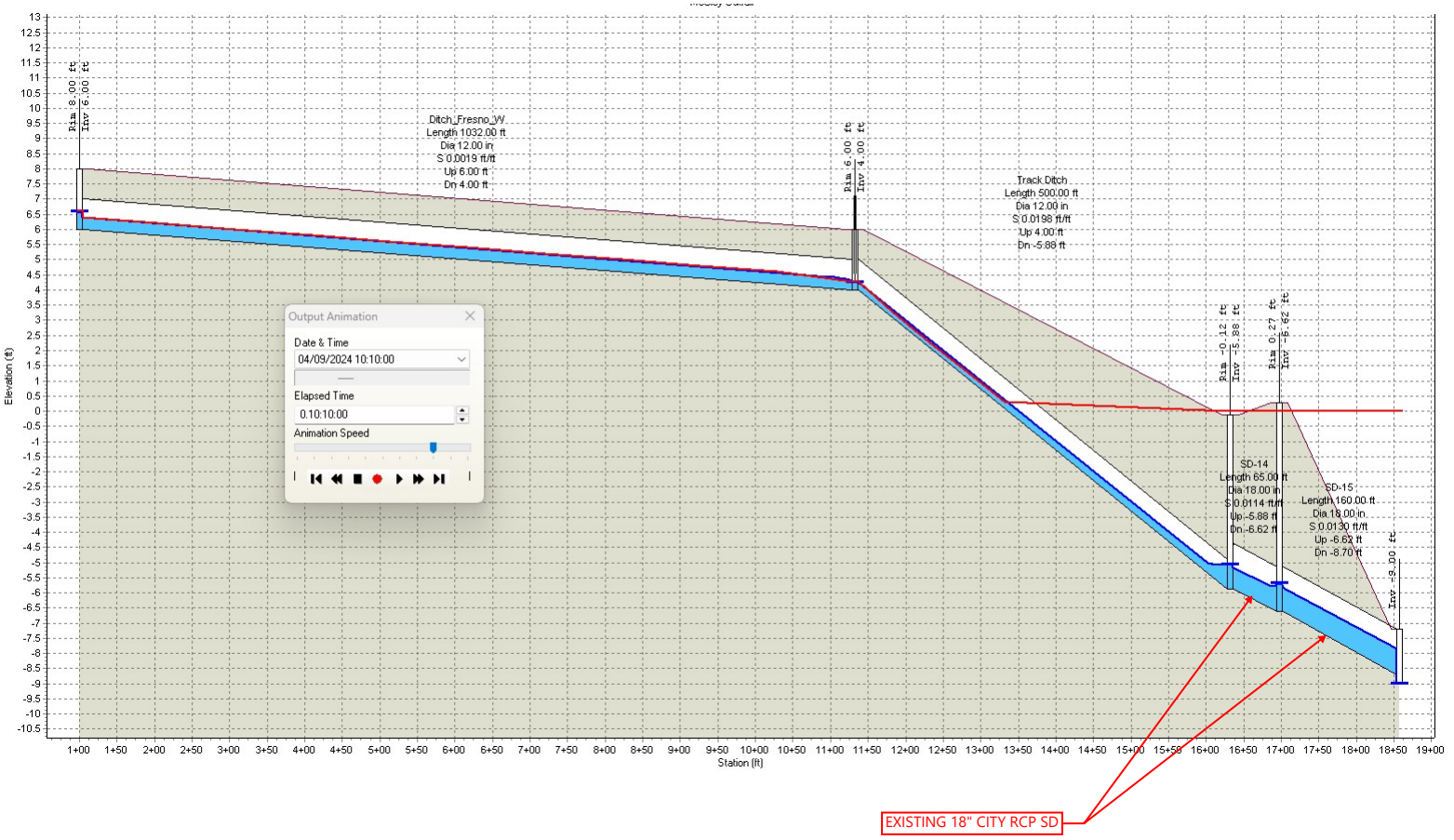






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Figure 4: 100-year Storm Profile Plot at Time of Peak Flow
Through V-Ditch 1 and CV-1



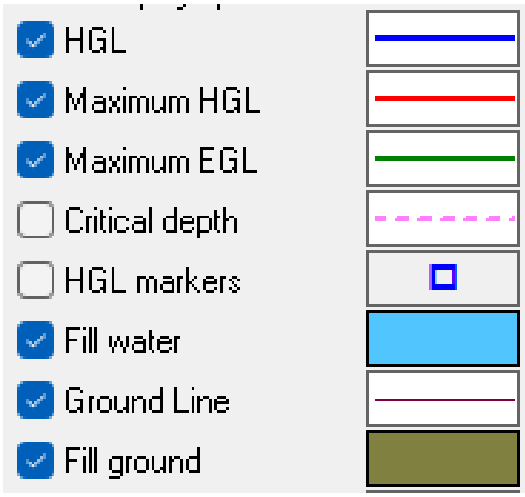
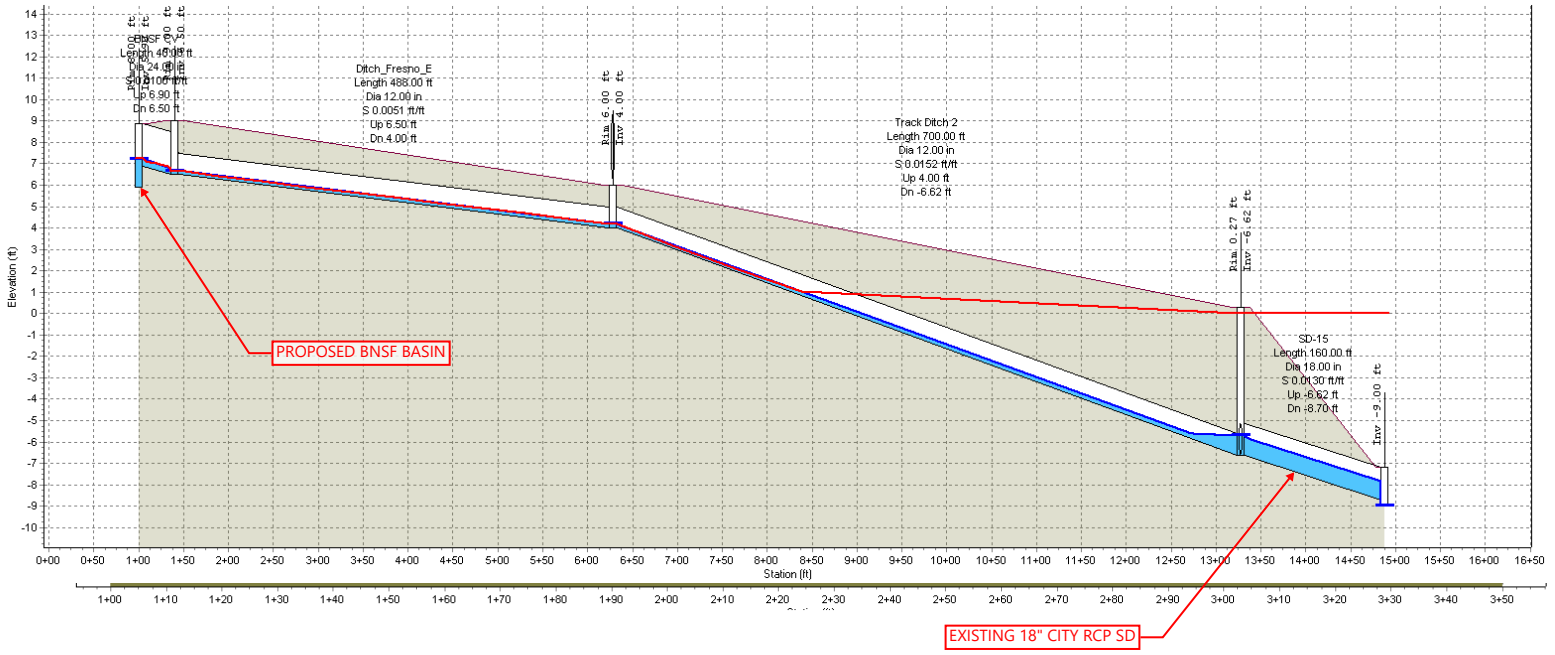
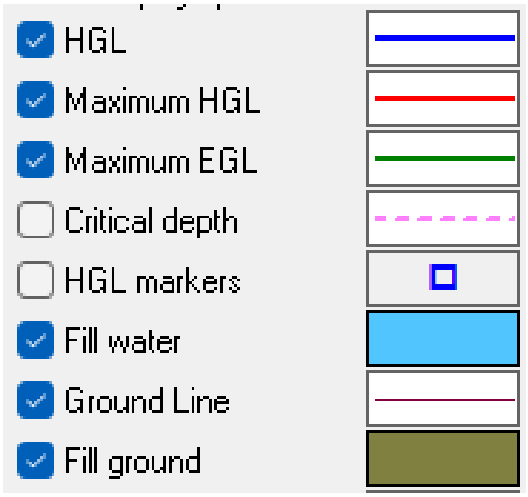


Figure 5: 100-year Storm Profile Plot at Time of Peak Flow
Through V-Ditch 2 and CV-2

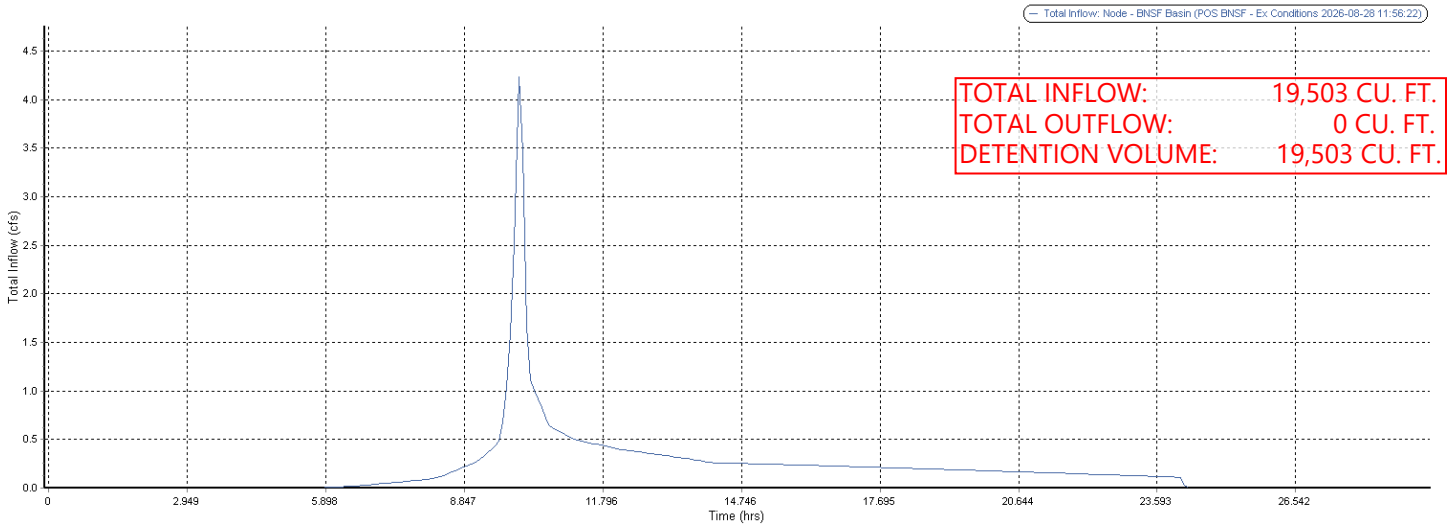




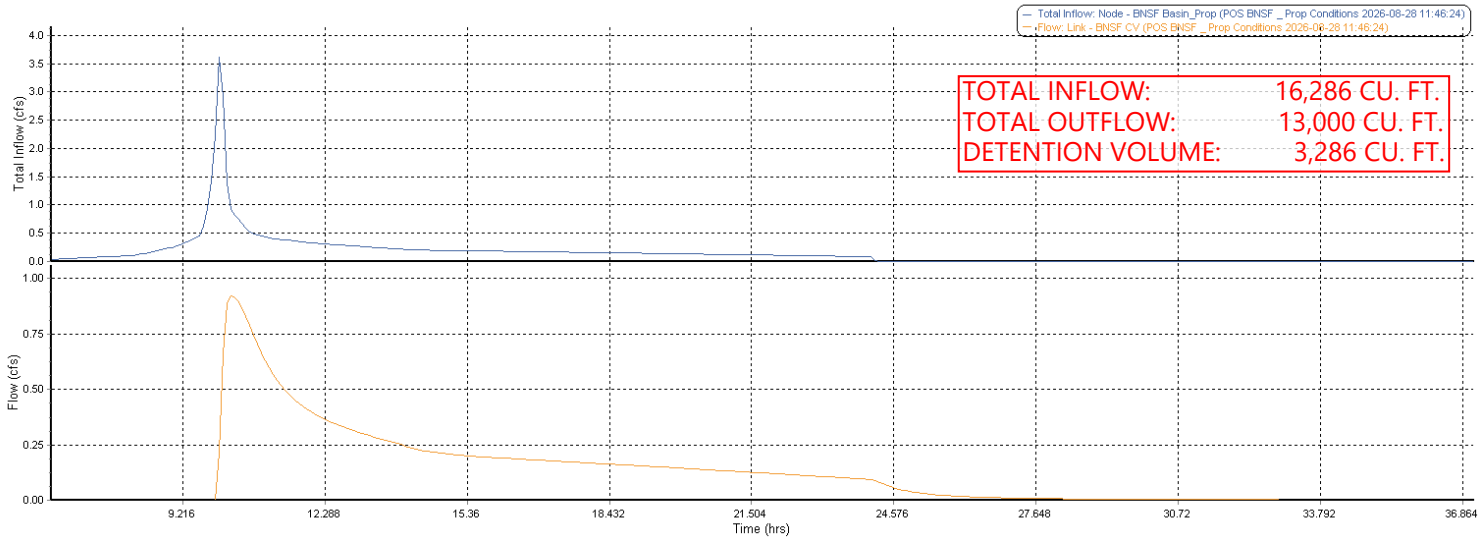
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Figure 6: 100-Year Hydrograph Analysis - BNSF Basin

EXISTING CONDITION



PROPOSED CONDITION



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