Drainage Concept Report
Via Princessa Park - Soil Cement Bank Protection

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APPROVED
CITY OF SANTA CLARITA
ENGINEERING SERVICES DIVISION
SIGNATURE: A. Marreh
DATE: 6/10/2022

Prepared For:

City of Santa Clarita
23920 Valencia Blvd.
Valencia, CA 91355

Prepared By:

Pacific Advanced Civil Engineering, Inc.
17520 Newhope Street, Suite 200
Fountain Valley, CA 92708
(714) 481-7300

REGISTERED PROFESSIONAL ENGINEER
JOSE CRUZ
No. 72249
Exp. 06-30-24
CIVIL
STATE OF CALIFORNIA

Contact Person:
Jose Cruz, MS, PE
Cherise Thompson, EIT

PACE JN: B894

Table of Contents

Tables

Table of Contents

Figures

Appendices

1 Introduction

Pacific Advanced Civil Engineering, Inc. (PACE) has been retained by the City of Santa Clarita to prepare a Drainage Concept Report (DCR) for the proposed Via Princessa Park improvements located in Los Angeles County (Assessors ID 2836-002-922 & 2836-002-907 & 2864-003-923). The proposed improvements associated with the project include soil cement bank protection along the south bank of the Santa Clara River (SCR). The analysis presented in the following report will focus on the changes to the 100-yr flood water surface elevations and extents of flooding caused by the project and the design of the bank protection.

The Via Princessa project site is situated in the City of Santa Clarita, along the south bank of the Santa Clara River, west of Cordova Estates and east of the Whites Canyon Road bridge. The west side of the proposed Park will be bordered by Honby Channel, a natural drainage path that conveys flows from south of Via Princessa Rd. to the main stem of the Santa Clara River. A location map for the project site is shown on **Figure 1-1**. The proposed improvements along the south bank of the SCR consist of approximately 1,500 lineal feet (LF) of soil cement bank protection. The bank protection will be constructed as a continuous section beginning at the existing bank protection on the north edge of Cordova Estates and extending roughly 1,000 LF downstream before curving southward, following the west bank of Honby Channel for an additional 500 LF.

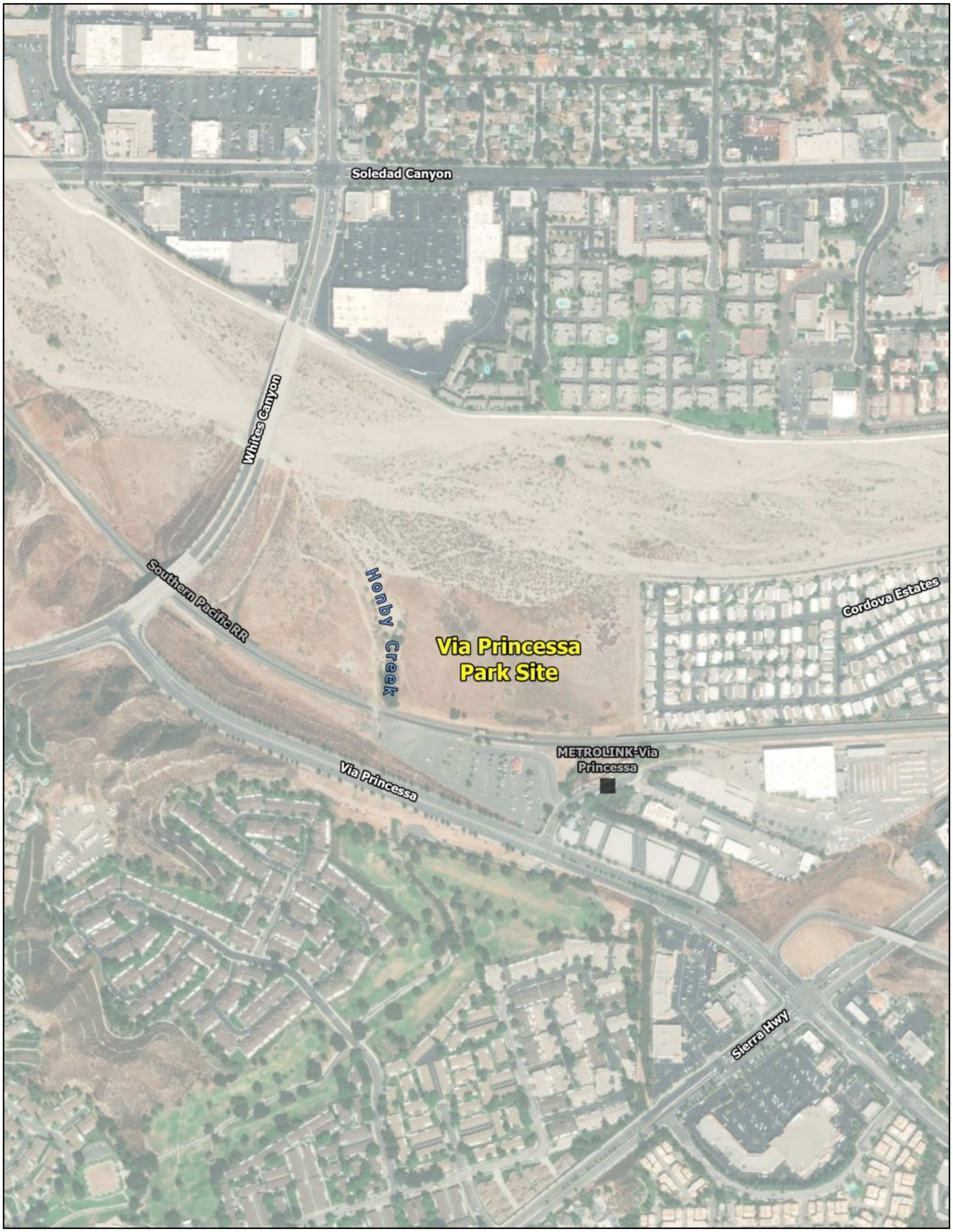
As part of this DCR, PACE performed a hydraulic analysis of the Santa Clara River in the vicinity of the Via Princessa Park project. The purpose of the hydraulic analysis is to provide design guidelines for the proposed bank protection and to evaluate potential changes to the water surface elevations or extents of flooding caused by the project.

Design of the proposed improvements along the south bank of SCR is in accordance with current City of Santa Clarita hydrology and hydraulic design criteria. All water surface elevations and topographic data presented in this report are referenced to the North American Vertical Datum of 1988 (NAVD 88). Topographic data shown on the figures was collected in 2021 by Vertex Survey, Inc. and is the same topographic data used for the HEC-RAS modeling analysis.

Hydraulic models of the Santa Clara River in the vicinity of the project site were prepared and analyzed for existing (pre-project) and proposed (post-project) conditions. **Section 3** describes these hydraulic models in detail. These results were used to evaluate the potential on- and off-site impacts of the project and to determine the appropriate design top and toe elevations for the bank protection. **Tables 4-1 and 4-2** present the results of the post-project conditions HEC-RAS model.

The post-project condition hydraulic model results were also used to determine the top and toe elevations of the proposed Via Princessa Park bank protection. An overview of the bank protection design procedure is provided in **Section 5**. The design top and toe elevations for the soil cement bank protection were based on the Q_{100} water surface elevations and velocities and are shown in **Table 5-5**.

Figure 1-1: Location Map



2 Project Hydrology

2.1 Regional SCR Hydrology

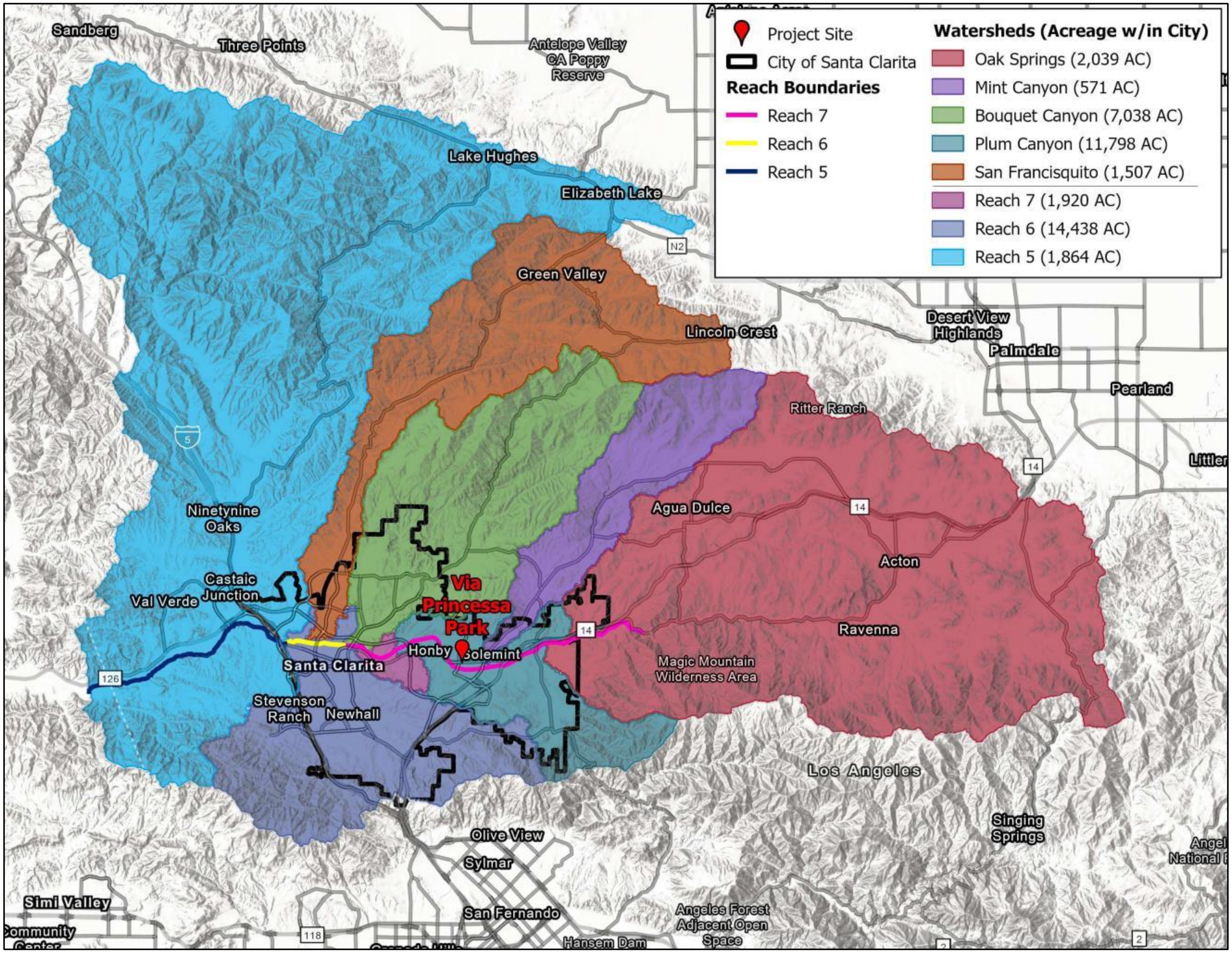
The hydrology applied to the present analysis was obtained from the latest FEMA Flood Insurance Study (FIS) 06037CV002C, dated June 2, 2021. Table 10: Summary of Discharges in the FIS lists peak discharges for a variety of storm return periods at various locations. The location applicable to the present analysis is “Santa Clara River, Approximately 4,600 feet downstream of Soledad Canyon Road.” The 100-yr flow rate from the FIS is listed in **Table 2-1** below. An excerpt of the FIS is included in **Appendix A**. The effective 100-yr floodplain, 500-yr floodplain, and 100-yr floodway are mapped on FIRM Panel No. 06037C0840G, which show that the northerly limits of the proposed project site are partially covered by the 100-yr floodplain and a majority of the project site is covered by the 500-yr floodplain (see **Appendix A)**. The proposed bank protection will be designed to protect the site improvements from the 100-yr clearwater flow rate

Table 2-1: Summary of Flow Rates

Santa Clara River, Approx. 4,600 ft. D/S of Soledad Cyn. Rd. (233 sq. mi. Drainage Area)	
Return Period	**Flow Rate (cfs)**
100-Year (Q_{100})	25,910

Figure 2-1 shows a map of the watersheds draining to the Santa Clara River. The River drains a total of 233 sq. mi. at the point approximately 4,600 ft. downstream of Soledad Canyon Road.

Figure 2-1: SCR Watershed



3 HEC-RAS Modeling

An extensive hydraulic analysis was performed to determine 100-yr flood water surface elevations and extents of flooding, as well as to design the top and toe elevations for the proposed bank protection along the Santa Clara River associated with the project. The models created for the analysis are described in the sections below.

3.1 HEC-RAS Models Developed for Via Princessa

The FEMA effective hydraulic model was obtained and used as the baseline condition model for the present analysis. Portions of the FEMA model were altered for the present analysis, including changes to manning's coefficients, supplemental topographic information, and supplemental cross-sections, as described in the sections below. Additionally, the extents of the FEMA model covered a large area which was not necessary to analyze for the proposed project. As such, the model was truncated to sections 298582 (FEMA lettered section 'BE') through 277377 (FEMA lettered section 'AR'). Mention of the "project reach" throughout this report is in reference to sections 290504 through 288766, which encompass the proposed project improvements.

From the baseline FEMA model, a total of four hydraulic models (using HEC-RAS v.6.1.0) were created for the present analysis, as summarized in **Table 3-1** below. The 100-yr models that utilized the same Manning's roughness values as the effective FEMA model (Plans 01 & 02) were created in order to determine potential changes to the effective FEMA 100-yr water surface elevations and extents of flooding. The 100-yr model with increased vegetation conditions (Plan 03) was used to set the top elevation of the soil cement bank protection. The 100-yr model with reduced vegetation conditions (Plan 04) was used to set the toe elevation of the soil cement bank protection.

Table 3-1: SCR HEC-RAS Model Descriptions

HEC-RAS File Name	Description	Purpose
Plan 01 – 100-yr Existing Condition	Existing vegetation, n=FEMA	Determine pre-project condition 100yr flood water surface elevations and flow velocities within SCR. Manning's roughness values match those shown in effective FEMA model.
Plan 02 – 100-yr Proposed Condition	Existing vegetation, n=FEMA	Determine post-project condition 100yr flood water surface elevations and flow velocities within SCR. Manning's roughness values match those shown in effective FEMA model.
Plan 03 – 100-yr Proposed Condition	**Increased vegetation, n=0.060**	**Determine post-project condition 100yr flood maximum flood elevations for design of the top of bank. The increased Manning's value of 0.06 takes future vegetation growth into account.**
Plan 04 – 100-yr Proposed Condition	**Reduced vegetation, n=0.025**	**Determine post-project condition 100yr flood maximum flow velocities for design of the toe of bank. The reduced Manning's value of 0.025 takes future vegetation reduction into account.**

Notes:
(1) HEC-RAS models for SCR included in this report are based on 2021 topography data for River Stations 290424 through 288766.

*(2) Items in **bold** are HEC-RAS models that are pertinent to the soil cement bank protection design.*

3.1.1 Boundary Conditions

All of the HEC-RAS models that were run in the sub-critical flow regime (Plans 01, 02, & 03) were assigned downstream boundary conditions. The downstream boundary condition selected for the subcritical regime was a known water surface elevation of 1281.67 at cross-section 277377 (FEMA lettered section 'AR'), which was obtained from the effective FEMA HEC-RAS model at this location. The boundary conditions are the same for pre- and post-project conditions.

The only HEC-RAS model that was not run in the sub-critical flow regime was the proposed conditions model with reduced vegetation (Plan 04). The purpose of this model was to obtain maximum velocities that could result in scour and degradation of the river bed, which is then used to establish the toe-down elevations of the bank protection. As such, this model was run in the mixed flow regime, which allows the model to solve for either sub-critical or super-critical depths. Super-critical depth solutions produce higher velocities, which are associated with greater amounts of potential scour. The upstream boundary condition used for the mixed flow regime model was normal depth, set equal to the slope at the upstream end of the model.

In an effort to verify that the boundary conditions chosen for the analysis did not have an impact on the area of interest, a sensitivity analysis was performed using the following combinations of boundary conditions:

- *Condition 1* – Normal depth was selected as the upstream boundary condition, and normal depth was selected as the downstream boundary condition. Mixed flow regime.
- *Condition 2* – Critical depth was selected as the upstream boundary condition, and normal depth was selected as the downstream boundary condition. Mixed flow regime.
- *Condition 3* – Normal depth was selected as the upstream boundary condition, and critical depth was selected as the downstream boundary condition. Mixed flow regime.
- *Condition 4* – Critical depth was selected as the upstream boundary condition, and critical depth was selected as the downstream boundary condition. Mixed flow regime.

Table 3-2 lists the water surface elevations from the models run for the four conditions discussed above. Changing the boundary conditions does not change the water surface elevation within the area of interest. Therefore, the model has been extended far enough above and below the area of interest.

Table 3-2: Comparison of HEC-RAS Hydraulic Model Boundary Conditions (Exist., Q_{100}, n=FEMA)

HEC-RAS River Station	EX Q_{100} WSE (n=FEMA)[1] (ft)	Condition 1 EX Q_{100} WSE (n=FEMA)[2] (ft)	Condition 2 EX Q_{100} WSE (n=FEMA)[3] (ft)	Condition 3 EX Q_{100} WSE (n=FEMA)[4] (ft)	Condition 4 EX Q_{100} WSE (n=FEMA)[5] (ft)
298582 BE	1465.2	1465.2	1465.2	1465.2	1465.2
298062 DD	1464.3	1464.3	1464.3	1464.3	1464.3
297469 DC	1455.9	1455.9	1455.9	1455.9	1455.9
297265 DB	1452.7	1451.8	1451.8	1451.8	1451.8
296673	1446.7	1446.7	1446.7	1446.7	1446.7
296017 BD	1439.8	1439.5	1439.5	1439.5	1439.5
295386 DA	1433.8	1433.8	1433.8	1433.8	1433.8
294750	1428.7	1428.6	1428.6	1428.6	1428.6
294327 BC	1425.3	1425.4	1425.4	1425.4	1425.4
293808 CY	1423.9	1424.2	1424.2	1424.2	1424.2
293598 CX	1418.3	1417.1	1417.1	1417.1	1417.1
293071 CW	1413.5	1413.5	1413.5	1413.5	1413.5
292356 BB	1407.0	1407.0	1407.0	1407.0	1407.0
292030 CV	1404.0	1404.0	1404.0	1404.0	1404.0
291595 CU	1400.0	1399.8	1399.8	1399.8	1399.8
291158 BA	1396.0	1396.0	1396.0	1396.0	1396.0
290724	1391.7	1391.4	1391.4	1391.4	1391.4
290504	1389.8	1389.8	1389.8	1389.8	1389.8
290198	1386.9	1386.7	1386.7	1386.7	1386.7
289893	1383.9	1383.9	1383.9	1383.9	1383.9
289667 AZ	1381.8	1381.5	1381.5	1381.5	1381.5

HEC-RAS River Station	EX Q_{100} WSE (n=FEMA)[1] (ft)	Condition 1 EX Q_{100} WSE (n=FEMA)[2] (ft)	Condition 2 EX Q_{100} WSE (n=FEMA)[3] (ft)	Condition 3 EX Q_{100} WSE (n=FEMA)[4] (ft)	Condition 4 EX Q_{100} WSE (n=FEMA)[5] (ft)
289225	1379.1	1379.4	1379.4	1379.4	1379.4
289044 CS	1379.1	1378.9	1378.9	1378.9	1378.9
288929	1378.3	1378.4	1378.4	1378.4	1378.4
288766	1375.1	1375.1	1375.1	1375.1	1375.1
288696 CR	1374.0	1374.0	1374.0	1374.0	1374.0
288160 CQ	1368.5	1368.2	1368.2	1368.2	1368.2
287582 AY	1365.0	1365.0	1365.0	1365.0	1365.0
287039 CO	1363.2	1363.3	1363.3	1363.3	1363.3
286718 CN	1356.9	1356.9	1356.9	1356.9	1356.9
286407 CM	1354.1	1354.1	1354.1	1354.1	1354.1
285935 AX	1349.2	1349.2	1349.2	1349.2	1349.2
285307 CL	1343.3	1343.3	1343.3	1343.3	1343.3
284515 AW	1336.4	1336.4	1336.4	1336.4	1336.4
283613 AV	1328.6	1328.6	1328.6	1328.6	1328.6
282827	1322.3	1322.3	1322.3	1322.3	1322.3
282470 CK	1319.3	1319.3	1319.3	1319.3	1319.3
282032 AU	1316.5	1316.5	1316.5	1316.5	1316.5
281614	1313.3	1313.3	1313.3	1313.3	1313.3
281025 CI	1309.1	1309.1	1309.1	1309.1	1309.1
280495 AT	1304.3	1304.3	1304.3	1304.3	1304.3
279819 CH	1297.8	1297.8	1297.8	1297.8	1297.8
279255 CG	1295.5	1295.5	1295.5	1295.5	1295.5
279107 AS	1293.4	1293.4	1293.4	1293.4	1293.4
278930	1292.0	1291.9	1291.9	1291.9	1291.9
277980 CE	1285.2	1285.6	1285.6	1285.7	1285.7
277377 AR	1281.7	1280.9	1280.9	1280.6	1280.6

Notes:

1. *Existing Conditions (Plan 01) – U/S Boundary Condition: None, D/S Boundary Condition: Known WSE*
2. *Condition 1 – U/S Boundary Condition: Normal Depth, D/S Boundary Condition: Normal Depth*
3. *Condition 2 – U/S Boundary Condition: Critical Depth, D/S Boundary Condition: Normal Depth*
4. *Condition 3 – U/S Boundary Condition: Normal Depth, D/S Boundary Condition: Critical Depth*
5. *Condition 4 – U/S Boundary Condition: Critical Depth, D/S Boundary Condition: Critical Depth*
6. *The limits of the project reach are indicated by the red box*

3.1.2 Topographic Data

For stations 290724 to 288766, topographic data from the 2021 aerial survey provided by Vertex Inc. was used to develop the geometry of the model. Some areas outside of project boundaries were not included in the Vertex survey data, so the topographic data included in the effective FEMA HEC-RAS model was used for any cross-section that covered area outside the 2021 survey limits. The datum referenced for both topographic data sets was the North American Vertical Datum of 1988 (NAVD 88).

3.1.3 Structures

Four major bridges cross the Santa Clara River in the vicinity of the project site and were included in the models: (1) Antelope Valley Road bridge, (2) Sierra Highway Bridge, (3) Whites Canyon Road Bridge, and (4) Soledad Canyon Road Bridge. Each of the four structures were part of the unaltered FEMA HEC-RAS model, which utilized various as-built plan sets to enter the geometric data. The only structure which was altered for the purposes of this analysis was the Whites Canyon Road bridge. Due to the added sections bounding the Whites Canyon bridge, the bridge deck stationing data had to be shifted so the openings beneath the bridge aligned more accurately with the main flow area of the river, as defined by the topographic data. The changes to the bridge deck stationing data did not affect water surface elevations.

3.1.4 Manning's Roughness Coefficients

3.1.4.1 Existing/Proposed FEMA 100-yr Flood Models (Plans 01 & 02)

Various Manning's roughness coefficients were selected for the different models, depending on the purpose. The existing and proposed 100-yr models (Plan 01 and 02), which were created to evaluate changes to the 100-yr water surface elevations and flooding extents, used roughness values matching those shown in the effective FEMA model, in order to evaluate potential changes to the 100-yr water surface elevations and extents of flooding.

3.1.4.2 Proposed 100-yr Model for Top of Bank Determination (Plan 03)

The proposed condition 100-yr model, which was created to design the top of bank (Plan 03) primarily used Manning's roughness values of 0.06, in order to evaluate maximum water surface elevations at the bank. The Manning's roughness value of 0.06 represents a future condition with more extensive vegetation growth. The water surface elevations resulting from this model were used to set the top of bank elevation of the proposed soil cement bank protection. Exceptions to the 0.06 roughness value were overbank areas in the FEMA model that had a roughness value of 0.1, which were maintained in the model used for this analysis. Additionally, a roughness value of 0.03 was utilized at the project site, which will be defined by wide grassy areas. The proposed 100-yr floodplain in this condition does not inundate the project site, so the roughness value of 0.03 had no impact on the resulting water surface elevations.

3.1.4.3 Proposed 100-yr Model for Toe of Bank Determination (Plan 04)

The proposed condition 100-yr model, which was created to design the toe of bank (Plan 04) primarily used Manning's roughness values of 0.025, in order to evaluate maximum velocities associated with the 100-yr storm. The Manning's roughness value of 0.025 represents a channel with reduced roughness due to the loss of vegetation and channel irregularity, caused by a significant storm. The velocities resulting from this model were used to set the toe of bank elevations of the proposed soil cement bank protection. Exceptions to the 0.025 roughness value were overbank areas in the FEMA model that had a roughness value of 0.1, which were maintained in the model used for this analysis. Additionally, a roughness value of 0.03 was utilized at the project site, which will be defined by wide grassy areas. The proposed 100-yr floodplain in this condition does not inundate the project site, so the roughness value of 0.03 had no impact on the resulting water surface elevations.

3.1.5 Cross-Section Spacing

Cross-sections from the effective FEMA model were maintained in the models used for the present analysis. Some additional sections were added to the model in the vicinity of the proposed Via Princessa Park and soil cement bank protection project, in order to better define the proposed improvements and quantify their impacts. The new sections added were XS 290198, 289893, 289225, 288929, and 288766. The new sections were cut using topographic data from the 2021 Vertex survey data set. Average spacing of cross-sections for the entirety of the models used in the present analysis was approximately 400 ft., while cross-sections in the vicinity of the project were spaced approximately 200 ft. apart.

3.1.6 Ineffective Flow Areas

Through the process of creating the models for the present analysis, the ineffective flow markers from the effective FEMA model were considered appropriate to use within the project reach. Ineffective flow marker locations and elevations shown in the FEMA model were not altered for the present analysis. For sections added to the model, ineffective flow markers were placed with an approach similar to that used in the FEMA model. For example, on the south bank of the SCR, adjacent to the project site, FEMA sections included ineffective flow markers at the approximate location of the top of bank. For the cross-sections added to the model, ineffective flow markers were also placed at the top of bank.

3.1.7 Levee Markers

The levee markers used in the FEMA effective HEC-RAS model were deemed appropriate to use for the present analysis. No levee marker locations or elevations were altered from the effective FEMA model. For sections added to the models used for the present analysis, levee markers were added as appropriate to the sections by interpolating the location used at adjacent sections from the FEMA models. Within the vicinity of the project site, two levees exist, according to FEMA records. Levee 1905057183, located along the south bank of the SCR, adjacent to Cordova Estates, is an accredited levee, owned and maintained by Los Angeles County Public Works (LACPW). The north bank also has a levee that is owned and maintained by LACPW, identified as 1905057135; however, this levee is not accredited. The FEMA HEC-RAS model includes levee markers along both of these banks, so those markers were not altered for the present analysis.

4 Summary of HEC-RAS Results

4.1 Pre-Project vs. Post-Project Condition (Q_{100}, n=FEMA)

Results of the hydraulic analysis for the pre- and post-project conditions modeling are summarized in **Table 4-1** for the Q_{100} flow rate and Manning's roughness values equal to those shown in the effective FEMA model. Comparison of the pre- and post-project hydraulic results indicate that the proposed improvements associated with the Via Princessa Park and soil cement bank protection will have minimal effects on the 100-yr water surface elevation and will; therefore, not require a revision of the flood insurance rate map. The results also indicate that the proposed Park site will be protected from the 100-yr flood. The pre- and post-project conditions HEC-RAS output data are included in **Appendix B**.

Although the project site is located at the fringe of the 100-yr floodplain, flow velocities along this reach of the River are in excess of 10 ft/s (n=0.025 configuration), indicating the flows have the potential to cause severe erosion along the northerly limit of the project. To prevent loss of developable land from erosion, it is recommended that soil cement bank stabilization be installed from the existing rock slope lining along Cordova Estates to the Honby Channel outlet, spanning roughly 1,500 L.F. Detailed design of the bank protection is discussed in **Section 5**.

For the south bank of the SCR which lies to the west of the Honby Channel outlet, it is not anticipated that bank protection will be needed at this time. Additional analysis will be performed during the final design phase of the project to support this conclusion, but there are several factors which indicate bank protection may not be required in this location. Primarily, the underground BMP facility to the west of Honby Creek is located in the ineffective flow area of the 100-yr flood in the SCR. As such, velocities are not anticipated to adversely affect the BMP through erosion of the bank. Additionally, the shortest distance between the underground BMP and the existing bank of the SCR is approximately 150 ft. The buried BMP lies closer to the bank of Honby Channel, set back by approximately 70 ft. This is a sizeable distance for either bank to erode and would likely take place gradually over time, if at all. Although bank protection will likely not be needed to protect the buried BMP facility, it is recommended that an erosion monitoring plan be implemented, in order to ensure that this valuable infrastructure remains in use for a long time. The monitoring plan would likely involve scour gages and erosion pins, installed in the bank of Honby Channel and/or the SCR. The gages and pins would indicate the amount and rate of bank erosion over time. If a significant amount of erosion is observed, the observations would trigger the installation of some form of bank protection, such as rip-rap, soil cement, geo-mats, vegetative reinforcement, etc. The application that might be used would depend on the type and severity of erosion observed.

Table 4-1: Pre-Project vs. Post-Project Hydraulic Analysis (Q_{100} and n=FEMA)

HEC-RAS River Station	Pre-Project Floodplain (n=FEMA)(1)		Post-Project Floodplain (n=FEMA)(2)		∆WSE 100-yr (post – pre) (ft)	∆Velocity 100-yr (post – pre) (ft/s)
	WSE 100-yr (ft)	Velocity 100-yr (ft/s)	WSE 100-yr (ft)	Velocity 100-yr (ft/s)		
298582 BE	1465.2	9.1	1465.2	9.1	0.0	0.0
298062 DD	1464.3	6.3	1464.3	6.3	0.0	0.0
297469 DC	1455.9	11.5	1455.9	11.5	0.0	0.0
297265 DB	1452.7	11.6	1452.7	11.6	0.0	0.0
296673	1446.7	11.3	1446.7	11.3	0.0	0.0
296017 BD	1439.8	10.7	1439.8	10.7	0.0	0.0
295386 DA	1433.8	10.8	1433.8	10.8	0.0	0.0
294750	1428.7	10.1	1428.7	10.1	0.0	0.0
294327 BC	1425.3	11.4	1425.3	11.4	0.0	0.0
293808 CY	1423.9	8.6	1423.9	8.6	0.0	0.0
293598 CX	1418.3	12.5	1418.3	12.5	0.0	0.0
293071 CW	1413.5	12.4	1413.5	12.4	0.0	0.0

HEC-RAS River Station	Pre-Project Floodplain (n=FEMA)(1)		Post-Project Floodplain (n=FEMA)(2)		∆WSE 100-yr (post – pre) (ft)	∆Velocity 100-yr (post – pre) (ft/s)
	WSE 100-yr (ft)	Velocity 100-yr (ft/s)	WSE 100-yr (ft)	Velocity 100-yr (ft/s)		
292356 BB	1407.0	12.2	1407.0	12.2	0.0	0.0
292030 CV	1404.0	11.9	1404.0	11.9	0.0	0.0
291595 CU	1400.0	11.3	1400.0	11.3	0.0	0.0
291158 BA	1396.0	11.1	1396.0	11.1	0.0	0.0
290724	1391.7	10.6	1391.7	10.6	0.0	0.0
290504	1389.8	10.8	1389.8	10.8	0.0	0.0
290198	1386.9	10.6	1386.9	10.5	0.0	-0.1
289893	1383.9	11.0	1383.8	11.1	0.0	0.1
289667 AZ	1381.8	11.1	1381.8	11.1	0.0	0.0
289225	1379.1	9.3	1379.2	8.7	0.0	-0.6
289044 CS	1379.1	5.5	1379.0	5.5	0.0	0.0
288929	1378.3	7.6	1378.3	7.6	0.0	0.0
288766	1375.1	10.4	1375.0	10.5	0.0	0.1
288696 CR	1374.0	11.6	1374.0	11.6	0.0	0.0
288160 CQ	1368.5	10.4	1368.5	10.4	0.0	0.0
287582 AY	1365.0	7.7	1365.0	7.7	0.0	0.0
287039 CO	1363.2	8.0	1363.2	8.0	0.0	0.0
286718 CN	1356.9	10.8	1356.9	10.8	0.0	0.0
286407 CM	1354.1	10.7	1354.1	10.7	0.0	0.0
285935 AX	1349.2	8.9	1349.2	8.9	0.0	0.0
285307 CL	1343.3	9.9	1343.3	9.9	0.0	0.0
284515 AW	1336.4	8.3	1336.4	8.3	0.0	0.0
283613 AV	1328.6	11.1	1328.6	11.1	0.0	0.0
282827	1322.3	8.6	1322.3	8.6	0.0	0.0
282470 CK	1319.3	11.1	1319.3	11.1	0.0	0.0
282032 AU	1316.5	10.1	1316.5	10.1	0.0	0.0
281614	1313.3	10.3	1313.3	10.3	0.0	0.0
281025 CI	1309.1	9.8	1309.1	9.8	0.0	0.0
280495 AT	1304.3	11.7	1304.3	11.7	0.0	0.0
279819 CH	1297.8	10.7	1297.8	10.7	0.0	0.0
279255 CG	1295.5	8.1	1295.5	8.1	0.0	0.0
279107 AS	1293.4	12.3	1293.4	12.3	0.0	0.0
278930	1292.0	12.3	1292.0	12.3	0.0	0.0
277980 CE	1285.2	12.0	1285.2	12.0	0.0	0.0
277377 AR	1281.7	11.4	1281.7	11.4	0.0	0.0

Notes:

1. *Pre-project floodplain WSEs and velocities are based on Q_{100} flow rate and n = FEMA (see **Appendix B**)*
2. *Proposed floodplain WSEs and velocities are based on Q_{100} flowrate and n = FEMA (see **Appendix B**)*
3. *Gray colored cells indicate location of soil cement improvements between RS 290504 and RS 289893*

5 Proposed Bank Top and Bank Toe Elevations

The design of the top of soil cement bank protection relied on results from the 100-yr proposed conditions model, using an increased Manning's roughness value to take future vegetation growth into account. Design toe elevations were calculated using results from the 100-yr proposed conditions model, using a decreased Manning's roughness value to take potential future vegetation reduction into account. The primary parameter used from the HEC-RAS modeling for the design of toe-down depth was velocity.

5.1 Top of Bank Determination

Summary output tables containing water surface elevation results of the HEC-RAS model utilizing increased Manning's roughness value are provided in **Table 5-1** below. Modeling the proposed conditions with increased vegetation thickness ensures that the top of bank protection will continue to protect the site from 100-yr flows in the future, even if conditions in the channel change. More detailed hydraulic results are presented in **Appendix B**. The proposed bank protection must be designed to contain the design flood, meaning at or above the elevation of the 100-yr water surface. The 100-yr water surface from the proposed conditions hydraulic model are summarized for the sections intersecting the bank in **Table 5-1**. The water surface elevations for the condition which uses Manning's roughness values matching those in the effective FEMA model are also tabulated, for comparison.

Table 5-1: Calculated Top Elevations for Soil Cement Bank Protection

HEC-RAS Section	WSE for n = FEMA(1) Q_{100} (Appendix B) (ft)	WSE for n = 0.06(2) Q_{100} (Appendix B) (ft)	Design Top of Bank Elev. (ft)	Design Freeboard (TOB – WSE_{FEMA}) (ft)	Design Freeboard (TOB - $WSE_{0.06}$) (ft)
290504	1389.8	1391.1	1391.7	1.9	0.6
290198	1386.9	1388.4	1388.9	2.0	0.5
289893	1383.8	1385.1	1385.6	1.8	0.5

Notes:

*(1) Water Surface Elevation (WSE) is from the proposed condition HEC-RAS model with a Manning's roughness value (n) matching what's used in the effective FEMA model, and FEMA 100-yr flow rate of 25,910 cfs for the entire reach. See **Appendix B** for detailed results.*

*(2) Water Surface Elevation (WSE) is from the proposed condition HEC-RAS model with a Manning's roughness value (n) of 0.06 and FEMA 100yr flow rate of 25,910 cfs for entire reach. See **Appendix B** for detailed results.*

5.2 Toe of Bank Determination

The HEC-RAS analyses of the 100-yr event applying a Manning's roughness value of 0.025 was used to determine post-project condition flow velocities for the purpose of calculating the required toe-down of the bank protection. Modeling the proposed conditions with reduced vegetation thickness ensures that the toe-down of the bank protection will continue to protect the site from 100-yr flows in the future, even if conditions in the channel change. Flow velocities and other hydraulic results from the n=0.025 HEC-RAS model are included in **Appendix B**.

5.2.1 Scour Calculations

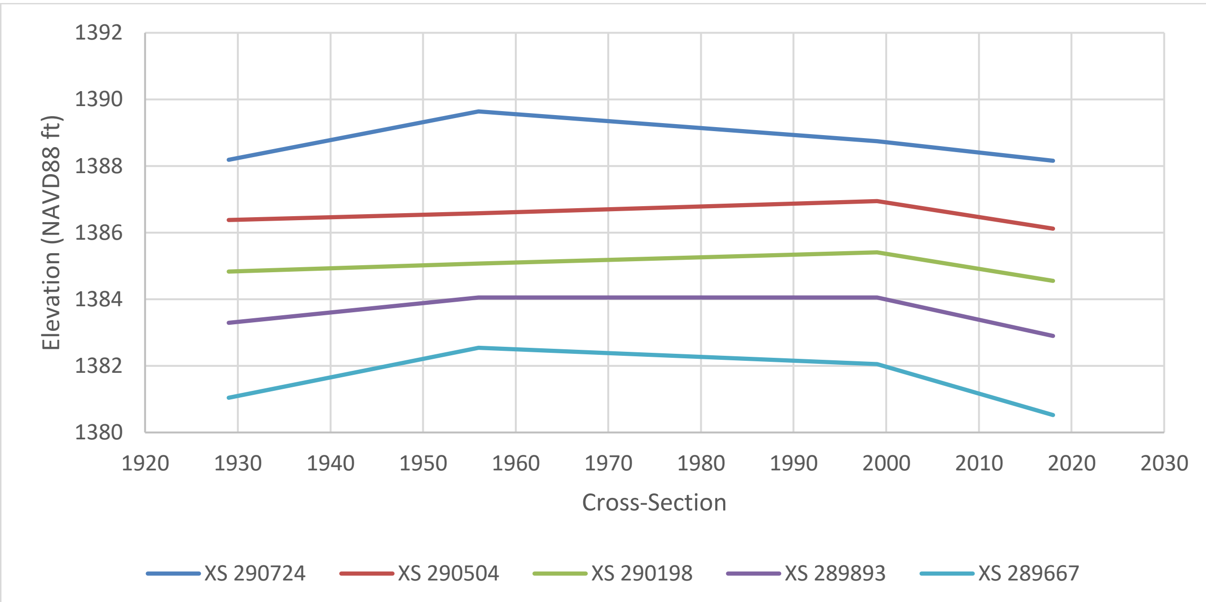
The primary failure mechanism of rigid bank protection revetments is generally scouring at the toe. The bank protection toe-down or cut-off depth must provide adequate scour protection below the earthen channel invert to account for dynamic changes in streambed elevations during storm events. The maximum scour calculated, using LA County design procedures, calls for inputs of (1) long term scour, (2) general scour, (3) local scour, (4) bend scour, (5) low-flow incisement, and (6) half of the bedform height.

Long-Term Scour:

While fluvial forces cause continual adjustments within rivers, the river bed erodes or aggrades toward the stable slope over long periods of time. This degradation is considered the long-term scour. The long-term scour was calculated by analyzing historical topography for trends in invert elevation. The historical contours dated 1897, 1929, 1956, 1999, and 2018. Contour intervals ranged from 5 ft to 50 ft. The historical map from 1897 revealed significantly lower elevations than the other four historical maps, thus the map was deemed an outlier and excluded from subsequent analyses. Historical Maps are included in **Appendix C**.

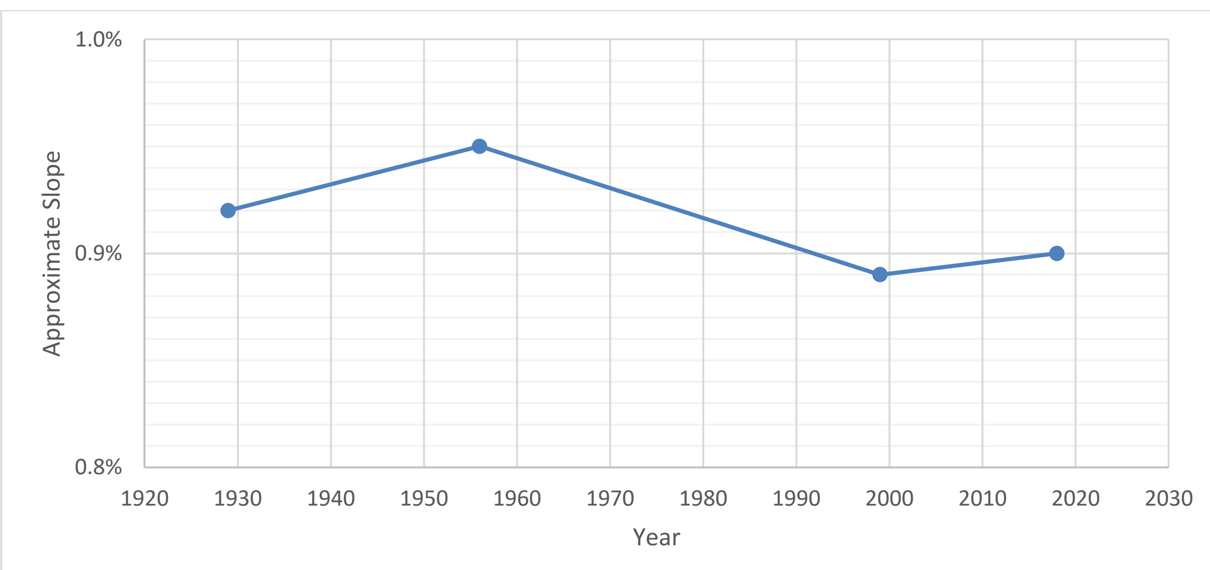
To analyze historical bed adjustment, the invert elevation at five cross-sections near the proposed soil cement bank protection was calculated for each of the historical maps. The invert elevations of the cross-sections were calculated by interpolating between contours. The invert elevations of the five cross-sections are plotted against time in **Figure 5-1**. No apparent trend in change in invert elevation was noted over time.

Figure 5-1: Historical Changes to SCR Invert over Time



The slope of the project reach was analyzed at each time interval to determine historical trends. The approximate slope is plotted over time in **Figure 5-2**. There is no apparent trend in the change of slope over time.

Figure 5-2: Historical Changes to SCR Slope Over Time



There are no persistent aggradation or degradation trends apparent in the invert elevation or slope over time, but the channel bed elevation at each cross section has fluctuated. The historical bed elevation variation was used as the long term scour component. Two methods were used to evaluate the long term variation, and the larger result at each section was taken as the long term scour value.

The first method involved determining the invert elevation at each cross-section for each of the four historical maps, and taking the difference between the maximum and minimum invert elevation as the maximum long term bed variation. The results of this method vary from 0.83 ft to 3.23 ft and are noted in the "Maximum Elevation Difference" column in **Table 5-2**.

The second method involved taking the largest historical invert variations near the upstream and the downstream ends of the proposed soil cement bank protection. These largest historical invert variations were noted at cross-sections 291158 and 289225, with values of 3.23 and 2.56 ft, respectively. The invert variation at each cross section in the bank protection area was interpolated between the invert variation values at cross-sections 291158 and 289225. The results of this analysis are displayed in the "Interpolated Maximum Elevation Difference" in **Table 5-2**.

The larger result from the two analysis methods was taken as the long-term scour component at each section. For all cross-sections, the larger value was the interpolated maximum elevation difference.

Table 5-2: Summary of Long-Term Scour in SCR

HEC-RAS Section	Max. Invert Elev. (ft)	Min. Invert Elev. (ft)	Max. Elev. Difference (ft)	Interpolated Max. Elev. Difference (ft)	Long-Term Scour (ft)
291158	1395.16	1391.93	3.23	3.23	3.23
290724	1389.64	1388.16	1.48	3.03	3.03
290504	1386.95	1386.12	0.83	2.94	2.94
290198	1385.41	1384.55	0.86	2.82	2.82
289893	1384.05	1382.90	1.15	2.71	2.71
289667	1382.54	1380.52	2.02	2.63	2.63
289225	1381.85	1379.29	2.56	2.56	2.56

Note: Gray cells represent sections where soil cement bank protection is proposed

For the present analysis, it was determined that a reach averaged long-term scour should be used for the soil cement bank protection design. The proposed bank is relatively short and, in order to eliminate frequent grade changes in the bank protection, a uniform scour value is preferred. The long term scour value, rounded to the nearest whole number, was taken at the three cross-sections that intersect the proposed soil cement bank protection. The long-term scour value was 3.0 ft.

General Scour:

For any reach, the volume of sediment deposited or eroded from the channel can be determined by observing the difference in the upstream sediment supply rate and the downstream transport rate. If the supply rate exceeds the transport rate, sediment will be deposited in the channel reach. If the supply rate is less than the transport rate, sediment will be eroded from the channel reach. If aggradation is present, it must be considered in the design of top of bank. If degradation is present, it must be considered in the design of toe of bank. This degradation due to a discrepancy in channel supply and transport rates is called 'general scour'.

General scour values were calculated using curves from the general degradation graph in **Appendix D** (Page C-3) of the LA County Sedimentation Manual. Section 290504 experiences 2.7 ft. of general scour; Section 290198 experiences 3.4 ft. of general scour; and Section 289893 experiences 2.8 ft. of general scour.

Local Scour:

Scour that occurs near flow obstructions such as bridge piers, flow contractions, or levees is described as local scour. Each of the cross-sections in the scour analysis feature bank protection, and thus local scour is expected due to bank protection. This bank scour was estimated to be 2.0 ft. The design reach did not include any bridges or sudden channel contractions, so local pier scour and contraction scour were not included in the analysis.

Bend Scour:

Curves in open channel flow lead to differential velocity gradients, which causes bend scour. The Santa Clara River in the vicinity of the project has a very gradual curve to it, but can be considered a straight reach (Radius / Top width < 0.1), so bend scour was not included in the analysis.

Low-Flow Incisement:

The Los Angeles County Sedimentation Manual states that low-flow incisement is equal to the greater of the measured low-flow depth or 2.0 ft. PACE ran the 2-yr flow rate for the Santa Clara River through the proposed conditions model, using a Manning's value of 0.06 in order to obtain the low flow depth. The 2-yr flow rate was obtained from a previous analysis, outlined in the report titled "Santa Clarita River Enhancement and Management Plan – Flood Protection Report", dated June 1996. The resulting depths modeled using the 2-yr flow rate (900 cfs) were at or below 2.0 ft., thus the low-flow incisement was set at 2.0 ft. for all sections intersecting the proposed bank protection.

Bedform Height:

Dunes and antidunes, known as bedforms, commonly develop in channels. The bedform height is defined as the height difference between the crest and trough of the bedform. The LACDPW Sedimentation Manual includes half of the bedform height in total scour calculations to represent the difference between the mean bed elevation and the trough elevation.

The Sedimentation Manual defines the bedform height based on velocity, using the following equation:

$$h = 0.027\text{V}^2$$

where,

h = bedform height (ft)

V = mean flow velocity (ft/s)

HEC-RAS model provided velocities at each cross-section, which were used to calculate the bedform height. The bedform height at section 290504 was 3.8; section 290198 was 4.0; and section 289893 was 4.0.

5.2.2 Results

Table 5-3 below summarizes each of the scour components used to calculate Total Scour (i.e. Toe Down). The detailed scour calculations are provided in **Appendix D**. The calculated minimum toe of bank elevations are summarized in **Table 5-4**.

Table 5-3: Summary of Scour Components

HEC-RAS Section	Long-Term Scour (ft)	General Scour (ft)	Local Scour (ft)	Bend Scour (ft)	Low-Flow Incisement (ft)	Half Bedform Height (ft)	Total Scour (ft)
290504	3.0	2.7	2.0	0.0	2.0	1.9	11.5
290198	3.0	3.4	2.0	0.0	2.0	2.0	12.5
289893	3.0	2.8	2.0	0.0	2.0	2.0	11.8

Table 5-4: Calculated Toe Elevations for Soil Cement Bank Protection

HEC-RAS Section	Maximum Channel Invert(1) (Appendix B) (ft)	Toe-Down(2) (Appendix D) (ft)	Design Toe Elevation (ft)
290504	1384.0	11.5	1372.5
290198	1382.0	12.5	1369.5
289893	1379.0	11.8	1367.2

Notes:

*(1) Minimum Channel Invert is from the pre-project condition HEC-RAS model, which is included in **Appendix E**.*

*(2) Toe-Down calculations are included in **Appendix D**.*

5.3 Summary of Top and Toe Bank Elevations

The values obtained from the freeboard analysis and the total scour calculations were used to design the top and toe elevations of the proposed soil cement bank protection. **Table 5-5** below summarizes the calculated top and toe elevations for each HEC-RAS section that intersects the proposed bank.

Table 5-5: Proposed Top and Toe Elevations for Soil Cement Bank Protection

HEC-RAS Section	Bank Station	Design Toe Elevation (ft)	Design Top Elevation (ft)	Proposed Bank Height (ft)
End Bank Protection	25+37.37	1373.8	1396.4	22.6
290504	23+63.24	1372.5	1391.7	19.2
290198	19+96.58	1369.5	1388.9	19.4
289893	16+16.53	1367.2	1385.6	18.3
Begin Bank Protection	10+00.00	1366.5	1390.2	23.7

The profiles for the bank top and toe are shown on **Figure 5-3**. Locations of grade breaks were selected to ensure the top of bank met or exceeded the freeboard requirements.

SHEET	JOB	TITLE
5-3	VIA PRINCESSA PARK SANTA CLARITA, CA	SOIL CEMENT BANK PROTECTION PLAN AND PROFILE

JOB NO. BB94

PACE Advanced Water Engineering
17520 Newhope Street, Suite 200 | Fountain Valley, CA 92708
P: (714) 481-7300 | www.pacewater.com

PREPARED BY: PACE
PROJECT ENGINEER: JOSE CRUZ
DRAWN: B.P. SCALE: AS SHOWN
DESIGNED: J.C.
CHECKED: J.C. DATE: 14.06.2022

REGISTERED PROFESSIONAL ENGINEER JOSE CRUZ No. 72249 Exp. 06-30-22 CIVIL STATE OF CALIFORNIA

NO	BY	DATE	REVISIONS	DATE	APP.

6 Soil Cement Bank Protection

6.1 Bank Protection Project Description

The proposed bank protection will consist of conventional soil cement bank protection to provide the appropriate level of freeboard and scour protection for all storm events up to the 100yr storm (Q_{100}). The following criteria was considered when designing the bank protection:

1. Flood control stability;
2. Durability of bank protection;
3. Safety concerns regarding access to and from the channel;
4. Bank protection maintenance;
5. Environmental compatibility with the native area and aesthetics;
6. Constructability; and
7. Cost of construction.

The purpose of the proposed bank protection is to provide erosion and flood control protection. The soil cement bank protection will be completely buried with soil backfill sloped at 3H:1V over the soil cement face. The excavation required to construct the bank protection will be backfilled and returned to existing grade or slightly lower to facilitate vegetation regrowth. Soil cement bank protection is constructed as a monolithic and homogenous structure consisting of approximately 90% native soils and 10% cement. The typical section consists of 8-foot wide and 6- to 12-inch thick layers of soil cement. Each layer of soil cement is set back from the edge of the previous layer, at a 1.5H:1V slope. The entire section varies in total height based on varying freeboard, flow depth and toe-down requirements.

The proposed soil cement bank protection addresses the above design criteria as follows:

1. Soil cement provides a stable riverbank protection material, in terms of both surface erosion and structural stability. Analysis of site soils will be performed to determine if they are suitable for use in soil cement. If unsuitable, off-site soils will be used.
2. The soil cement bank protection will be completely buried with a 3:1 slope soil backfill. Due to transitions from proposed soil cement bank protection (buried condition) to existing rip-rap bank protection (exposed conditions), some soil cement areas will be exposed.

6.2 Soil Cement Bank Protection Design Elements

This section describes design elements related to the proposed soil cement bank protection system along SCR associated with the development project. The proposed improvements along SCR consist of a total of approximately 1,500 lineal feet (LF) of bank protection.

6.2.1 Soil Cement Connections

At the upstream end of the project, the Via Princessa Park bank soil cement will tie into the existing bank protection adjacent to Cordova Estates, between HEC-RAS River Stations 290724 and 290504. On the downstream end, the proposed bank soil cement protection will tie into the Honby Channel culvert outlet (Between HEC-RAS River Station 289893 and 289667).

As part of the proposed project improvements, the Honby Channel will be extended and grouted/loose rock will line portions of the bank and channel invert, in order to protect against scour. The proposed soil cement bank protection will be designed to tie-in to the proposed bank lining at Honby Channel.

6.2.2 Storm Drain Penetrations

There will not be any storm drains penetrations through the soil cement bank protection.

6.2.4 *Maintenance Access Road*

The bank protection incorporates a 20-foot wide multi-purpose trail/access road that follows the alignment of the bank protection. The maintenance road is located directly above the uppermost layer of soil cement. Runoff from the maintenance road will be directed towards the proposed development and will be treated prior to being discharged to the storm drain system.

6.2.5 *Horizontal and Vertical Scour Gauges*

In order to measure abrasion of the soil cement, several scour gauges will be incorporated into the bank protection system. There are two ways that scour gauges are installed, either they are core drilled horizontally into the soil cement banks after completion of the project or installed concurrently during soil cement construction. If scour gauges are core drilled, they will be filled in with grout to secure scour gauge inside soil cement bank. In addition, vertical scour gauges are also installed adjacent to the toe alignment along the river bottom. The vertical scour gauges will be used to measure scour or degradation of the river bottom in the event of any significant storm event.

6.3 Material Suitability

The following soil cement material suitability analysis excerpts were taken from various ACI and PCA publications referenced in **Section 9.**

The erosion and overtopping of river banks by floodwaters is a significant flood concern in the southwest. In order to protect valuable land, bridges, and buildings from such erosion, many communities have found that stabilized soil, in the form of soil cement, meets the criteria of cost-effectiveness, performance, functional life, and aesthetics.

The American Concrete Institute (ACI 116R) defines soil cement as “a mixture of soil and measured amounts of Portland Cement and water compacted to a high density.” Soil cement can be further defined as a material produced by blending, compacting, and curing a mixture of soil/aggregate, Portland Cement, possibly admixtures including pozzolans, and water, to form a hardened material with specific engineering properties. The soil/aggregate particles are bonded by cement paste, but unlike concrete, the individual particle is not completely coated with cement paste.

A wide variety of soils can be used to make durable soil cement. In fact, most soils in Southern California are suitable for use with soil cement. Ideally, sand to silty sand with the highest dry unit weight possible should be used to make soil cement, as this material is more likely to be well graded. For maximum economy and most efficient construction, the Portland Cement Association (PCA) recommends the following soil gradation:

Sieve Size	% Passing
3/4”	80% - 100%
#4	60% - 90%
#40	30% - 50%
#200	5% - 25%

The Plasticity Index (PI) of the fines should not exceed 8.

The following is the soil classification, cement content for the borrow area/earthwork and groundwater levels as stated in the geotechnical report dated March 30, 2022, prepared by R.T. Frankian & Associates (full geotechnical report included in **Appendix F**):

6.3.1 *Soil Classification*

The ideal material calls for a well-graded sand with some gravels and fine sands, and no or minimal clays. The geotechnical investigation identified the upper surficial soils at the site as having silty sands and sandy silts that were relatively moist and moderately dense. Beneath the surficial layer were alternating layers of clean sands and silty sands that were found to be dense. Most of the native on-site soils are expected to be suitable as aggregate for the soil cement mix.

6.3.3 Cement Content

An efficient mix utilizes the minimum cement content necessary to reach the specified design strengths. Based on strength and durability relationships developed by the Portland Cement Association, the minimum requirement for compressive strength at 7-day is 750 psi. A cement content of 8% to 10%, by weight, is anticipated based on several projects within the vicinity. The final cement content will be based on testing results from the actual base material stockpile.

6.3.4 Aggregate Location

It is assumed that on-site soils will be suitable for soil cement production, but future geotechnical investigations will be conducted to confirm this. Based on a myriad of tests performed by PCA, the ideal base material for soil cement, in general, is well-graded sand with some gravel and some fines. The soils that are extracted from the trench excavations typically are well graded sands and therefore used for the soil cement mix.

6.3.5 Groundwater Levels

No groundwater was encountered during Frankian's geotechnical investigations; however, the presence or absence of groundwater should be verified prior to the start of construction. Any dewatering activities (if necessary) that take place during construction will be limited to the area from the soil cement grading daylight line to a maximum of 15 feet towards the River. The contractor may request in writing an extension of the area for dewatering, except that in no case shall any dewatering or construction activities take place within the United States Army Corps of Engineers (ACOE) or California Department of Fish and Wildlife (CDFW) resource area without prior authorization.

Any groundwater data should not be assumed to be accurate during the period of construction. The contractor is responsible for obtaining and reviewing copies of the project geotechnical report and should independently determine groundwater levels and appropriate dewatering efforts necessary to prepare excavation for soil cement construction.

7 Conclusion

The purpose of this report is to present the results of the hydraulic analysis in order to provide design guidelines for the proposed bank protection measures and to evaluate potential changes to water surface elevations or extents of flooding caused by the Via Princessa Park and soil cement bank protection project. The results of the 100-yr floodplain analysis indicate that the project will have minimal impacts to the 100-yr water surface elevations and flooding extents; therefore, a map revision will not be needed for the project. Additionally, the results indicate that the proposed bank protection will protect the site from the 100-yr storm, both from inundation and scour.

8 Bibliography

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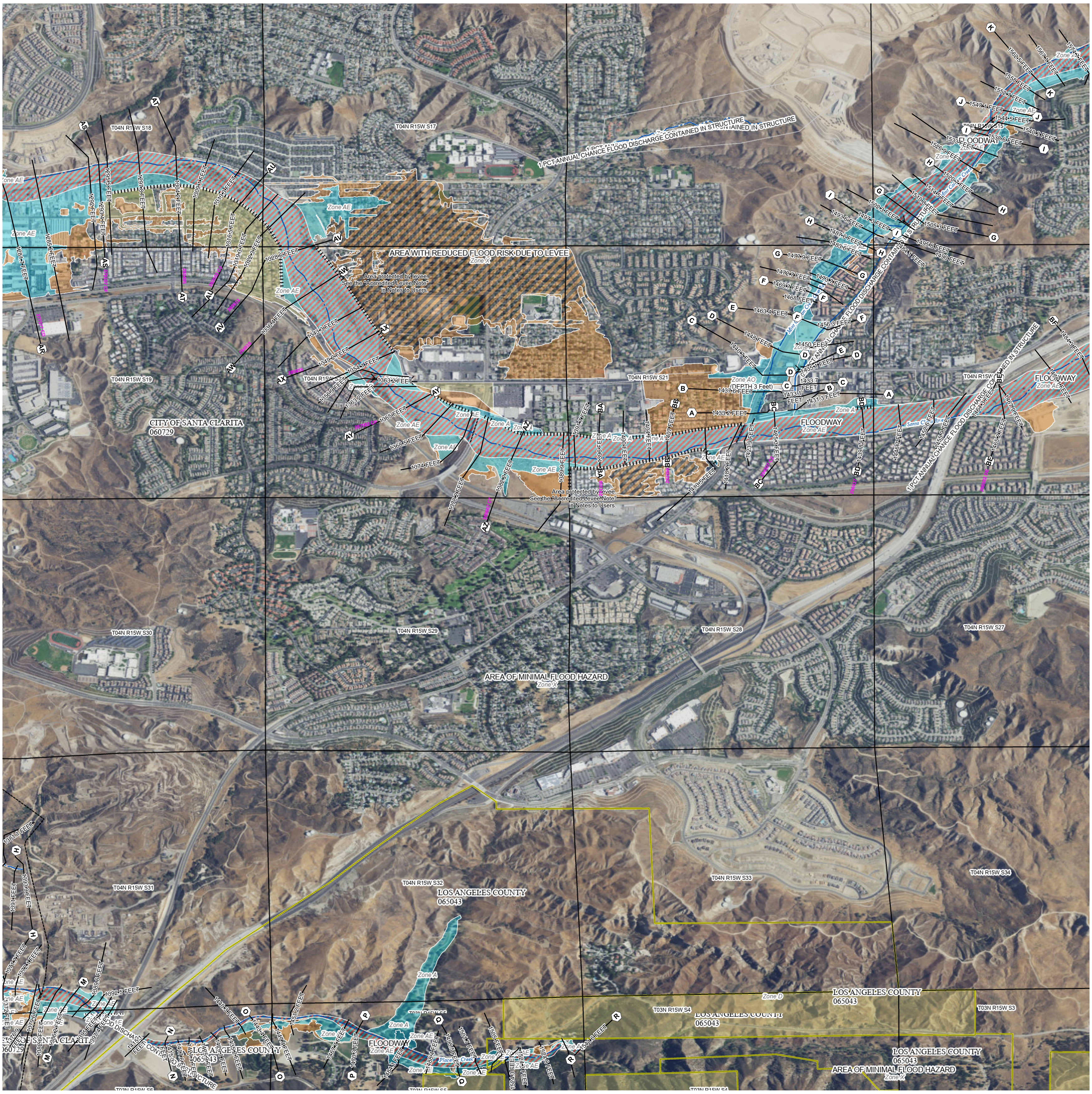
"State-of-the-Art Report on Soil Cement" (230.1R-90), American Concrete Institute.

Appendix A

PACE
Advanced Water Engineering

Appendix A – FEMA FIRM & FIS

118°30'W 34°26'28.19"N



118°26'14.19"W 34°22'16.84"N

FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR DRAFT 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	(B) 20.2 Cross Sections with 1% Annual Chance
	17.5 Water Surface Elevation
	(8) Coastal Transect
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature
	513 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 https://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

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 the United States Geological Survey (USGS). The basemap shown is the USGS National Map: Orthoimagery. Last refreshed October, 2020.

This map was exported from FEMA's National Flood Hazard Layer (NFHL) on **12/9/2021 2:26 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.

ACCREDITED LEVEE SYSTEM: Check with your local community to obtain more information, such as the estimated level of protection provided (which may exceed the 1-percent-annual-chance level) and Emergency Action Plan, on the levee system(s) shown as providing protection for areas on this panel. To mitigate flood risk in residual risk areas, property owners and residents are encouraged to consider flood insurance and floodproofing or other protective measures. For more information on flood insurance, interested parties should visit http://www.fema.gov/national-flood-insurance-program.

SCALE

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

N

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

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

Meters 0 105 210 420 630 840

FEMA

National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP

PANEL **840** OF **2204**

Panel Contains:

COMMUNITY	NUMBER	PANEL
CITY OF SANTA CLARITA	060729	0840
LOS ANGELES COUNTY	065043	0840

MAP NUMBER
06037C0840G
EFFECTIVE DATE
June 02, 2021

FLOOD INSURANCE STUDY

FEDERAL EMERGENCY MANAGEMENT AGENCY

VOLUME 1 OF 9

LOS ANGELES COUNTY, CALIFORNIA

AND INCORPORATED AREAS

COMMUNITY NAME	NUMBER	COMMUNITY NAME	NUMBER
AGOURA HILLS, CITY OF	065072	COMMERCE, CITY OF	060110
ALHAMBRA, CITY OF*	060095	COMPTON, CITY OF	060111
ARCADIA, CITY OF*	065014	COVINA, CITY OF*	065024
ARTESIA, CITY OF*	060097	CUDAHY, CITY OF	060657
AVALON, CITY OF	060098	CULVER CITY, CITY OF	060114
AZUSA, CITY OF	065015	DIAMOND BAR, CITY OF	060741
BALDWIN PARK, CITY OF*	060100	DOWNEY, CITY OF	060645
BELL, CITY OF*	060101	DUARTE, CITY OF*	065026
BELL GARDENS, CITY OF	060656	EL MONTE, CITY OF*	060658
BELLFLOWER, CITY OF	060102	EL SEGUNDO, CITY OF	060118
BEVERLY HILLS, CITY OF*	060655	GARDENA, CITY OF	060119
BRADBURY, CITY OF*	065017	GLENDALE, CITY OF	065030
BURBANK, CITY OF	065018	GLENDORA, CITY OF*	065031
CALABASAS, CITY OF	060749	HAWAIIAN GARDENS, CITY OF*	065032
CARSON, CITY OF	060107	HAWTHORNE, CITY OF*	060123
CERRITOS, CITY OF	060108	HERMOSA BEACH, CITY OF	060124
CLAREMONT, CITY OF*	060109	HIDDEN HILLS, CITY OF	060125

*No Special Flood Hazard Areas Identified

REVISED: June 2, 2021

FLOOD INSURANCE STUDY NUMBER

06037CV001F

Version Number 2.3.3.2

COMMUNITY NAME	NUMBER	COMMUNITY NAME	NUMBER
HUNTINGTON PARK, CITY OF*	060126	PICO RIVERA, CITY OF	060148
INDUSTRY, CITY OF*	065035	POMONA, CITY OF*	060149
INGLEWOOD, CITY OF*	065036	RANCHO PALOS VERDES, CITY OF	060464
IRWINDALE, CITY OF*	060129	REDONDO BEACH, CITY OF	060150
LA CANADA FLINTRIDGE, CITY OF*	060669	ROLLING HILLS, CITY OF*	060151
LA HABRA HEIGHTS, CITY OF*	060701	ROLLING HILLS ESTATES, CITY OF*	065054
LA MIRADA, CITY OF	060131	ROSEMEAD, CITY OF*	060153
LA PUENTE*, CITY OF	065039	SAN DIMAS, CITY OF	060154
LA VERNE, CITY OF	060133	SAN FERNANDO, CITY OF	060628
LAKEWOOD, CITY OF	060130	SAN GABRIEL, CITY OF*	065055
LANCASTER, CITY OF	060672	SAN MARINO, CITY OF*	065057
LAWNDALE, CITY OF*	060134	SANTA CLARITA, CITY OF	060729
LOMITA, CITY OF*	060135	SANTA FE SPRINGS, CITY OF	060158
LONG BEACH, CITY OF	060136	SANTA MONICA, CITY OF	060159
LOS ANGELES, CITY OF	060137	SIERRA MADRE, CITY OF*	065059
LOS ANGELES COUNTY UNINCORPORATED AREAS	065043	SIGNAL HILL, CITY OF*	060161
LYNWOOD, CITY OF	060635	SOUTH EL MONTE, CITY OF*	060162
MALIBU, CITY OF	060745	SOUTH GATE, CITY OF	060163
MANHATTAN BEACH, CITY OF	060138	SOUTH PASADENA, CITY OF*	065061
MAYWOOD, CITY OF*	060651	TEMPLE CITY, CITY OF*	060653
MONROVIA, CITY OF*	065046	TORRANCE, CITY OF	060165
MONTEBELLO, CITY OF	060141	VERNON, CITY OF*	060166
MONTEREY PARK, CITY OF*	065047	WALNUT, CITY OF*	065069
NORWALK, CITY OF	060652	WEST COVINA, CITY OF	060666
PALMDALE, CITY OF	060144	WEST HOLLYWOOD, CITY OF*	060720
PALOS VERDES ESTATES, CITY OF	060145	WESTLAKE VILLAGE, CITY OF	060744
PARAMOUNT, CITY OF	065049	WHITTIER, CITY OF	060169
PASADENA, CITY OF*	065050		

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REVISED: June 2, 2021

FEMA

FLOOD INSURANCE STUDY NUMBER

06037CV001F

Version Number 2.3.3.2

TABLE OF CONTENTS
Volume 1

Figures

Tables

Page

Volume 2

Figures

Tables

Volume 3

Tables

Volume 4

Tables

Volume 5

Exhibits

Volume 6

Exhibits

Volume 7
<u>Exhibits</u>

Volume 8
<u>Exhibits</u>

Volume 9

Exhibits

Published Separately

FLOOD INSURANCE STUDY REPORT
LOS ANGELES COUNTY, CALIFORNIA

SECTION 1.0 – INTRODUCTION

1.1 The National Flood Insurance Program

The National Flood Insurance Program (NFIP) is a voluntary Federal program that enables property owners in participating communities to purchase insurance protection against losses from flooding. This insurance is designed to provide an insurance alternative to disaster assistance to meet the escalating costs of repairing damage to buildings and their contents caused by floods.

For decades, the national response to flood disasters was generally limited to constructing flood-control works such as dams, levees, sea-walls, and the like, and providing disaster relief to flood victims. This approach did not reduce losses nor did it discourage unwise development. In some instances, it may have actually encouraged additional development. To compound the problem, the public generally could not buy flood coverage from insurance companies, and building techniques to reduce flood damage were often overlooked.

In the face of mounting flood losses and escalating costs of disaster relief to the general taxpayers, the U.S. Congress created the NFIP. The intent was to reduce future flood damage through community floodplain management ordinances, and provide protection for property owners against potential losses through an insurance mechanism that requires a premium to be paid for the protection.

The U.S. Congress established the NFIP on August 1, 1968, with the passage of the National Flood Insurance Act of 1968. The NFIP was broadened and modified with the passage of the Flood Disaster Protection Act of 1973 and other legislative measures. It was further modified by the National Flood Insurance Reform Act of 1994 and the Flood Insurance Reform Act of 2004. The NFIP is administered by the Federal Emergency Management Agency (FEMA), which is a component of the Department of Homeland Security (DHS).

Participation in the NFIP is based on an agreement between local communities and the Federal Government. If a community adopts and enforces floodplain management regulations to reduce future flood risks to new construction and substantially improved structures in Special Flood Hazard Areas (SFHAs), the Federal Government will make flood insurance available within the community as a financial protection against flood losses. The community's floodplain management regulations must meet or exceed criteria established in accordance with Title 44 Code of Federal Regulations (CFR) Part 60.3, *Criteria for land Management and Use*.

SFHAs are delineated on the community's Flood Insurance Rate Maps (FIRMs). Under the NFIP, buildings that were built before the flood hazard was identified on the community's FIRMs are generally referred to as "Pre-FIRM" buildings. When the NFIP was created, the U.S. Congress recognized that insurance for Pre-FIRM buildings would be prohibitively expensive if the premiums were not subsidized by the Federal Government. Congress also recognized that most of these floodprone buildings were built by individuals who did not have sufficient knowledge of the flood hazard to make informed decisions. The NFIP requires that full actuarial rates reflecting the complete flood risk be charged on all buildings constructed or substantially improved on or after

Table 1: Listing of NFIP Jurisdictions, continued

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Pomona, City of[1]	060149	18070106 18070203	06037C1725F 06037C1750F	
Rancho Palos Verdes, City of[1]	060464	18070104 18070106	06037C1917H 06037C1918H 06037C1919H 06037C1940F 06037C1943G 06037C2006G 06037C2007G 06037C2026G 06037C2027G 06037C2031G	
Redondo Beach, City of	060150	18070104 18070106	06037C1769G, 06037C1790F, 06037C1907G, 06037C1909G, 06037C1928F, 06037C1930F	
Rolling Hills, City of[1]	060151	18070104 18070106	06037C1940F 06037C2026G 06037C2027G	
Rolling Hills Estates, City of[1]	065054	18070104 18070106	06037C1919H 06037C1940F	
Rosemead, City of[1]	060153	18070105	06037C1665F 06037C1675F[2]	
San Dimas, City of	060154	18070106	06037C1440F 06037C1445F 06037C1725F	
San Fernando, City of[1]	060628	18070105	06037C1075G	
San Gabriel, City of[1]	065055	18070105	06037C1675F[2]	
San Marino, City of[1]	065057	18070105	06037C1375F 06037C1400F 06037C1635F[2] 06037C1675F[2]	
Santa Clarita, City of	060729	18070102 18070105	06037C0805G 06037C0810G 06037C0815G 06037C0816G 06037C0817G 06037C0818G 06037C0819G 06037C0830G 06037C0835G 06037C0840G 06037C0845G 06037C1030F 06037C1031G 06037C1032G 06037C1034F 06037C1051G 06037C1075G	

Table 2: Flooding Sources Included in this FIS Report, continued

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
San Martinez Chiquito Canyon	Los Angeles County	Confluence with Santa Clara River	Approximately 2000 feet upstream of San Martinez Road	18070102	4.0	—	N	AE	2015
San Martinez Grande Canyon Creek	Los Angeles County	Confluence with Santa Clara River	1.8 miles above State Route 126	18070102	2.0	—	N	AE	2015
San Pedro Bay	City of Long Beach	—	—	18070104	1.0	—	N	AE	1991
Sand Canyon Creek	Los Angeles County, City of Santa Clarita	Confluence with Santa Clara River	0.4 miles upstream of Coyote Canyon Creek	18070102	4.2	—	N	AE, AO	2010
Santa Clara River	Los Angeles County, City of Santa Clarita	At Los Angeles—Ventura County Boundary	Approximately 1.4 miles upstream of Lang Station Road	18070102	22.8	—	Y	AE	2015
Santa Clara River	Los Angeles County	Approximately 12 miles upstream of Lang Station Road	0.3 miles upstream of confluence of Soledad Canyon Creek	18070102	7.5	—	Y	A, AE	2015
Santa Clara River Overflow	Los Angeles County	Confluence with Santa Clara River	Approximately 1700 feet upstream of the confluence of Santa Clara River	18070102	0.3	—	N	AE	2015
Santa Maria Canyon	Los Angeles County	—	—	18070104	0.7	—	N	A, AE	1979
Santa Susana Creek	City of Los Angeles	—	—	18070105	2.9	—	N	AE	1979
Santa Susana Pass Wash	City of Los Angeles	—	—	18070105	0.9	—	N	A, AE	1979

Table 3: Flood Zone Designations by Community, continued

Community	Flood Zone(s)
Redondo Beach, City of	AE, VE, X
Rolling Hills, City of	D, X
Rolling Hills Estates, City of	X
Rosemead, City of	D, X
San Dimas, City of	AE, D, X
San Fernando, City of	X
San Gabriel, City of	X
San Marino, City of	X
Santa Clarita, City of	A, AE, AH, AO, D, X
Santa Fe Springs, City of	AE, AH, X
Santa Monica, City of	AE, D, VE, X
Sierra Madre, City of	D, X
Signal Hill, City of	X
South El Monte, City of	X
South Gate, City of	A, X
South Pasadena, City of	X
Temple City, City of	X
Torrance, City of	A, AE, AH, V, VE, X
Vernon, City of	X
Walnut, City of	D, X
West Covina, City of	A, D, X
West Hollywood, City of	X
Westlake Village, City of	A, AE, X
Whittier, City of	A, AE, AO, D, X

3.2 Coastal Barrier Resources System

This section is not applicable to this Flood Risk Project.

Table 9 : Levees

Community	Flooding Source	Levee Location	Levee Owner	USACE Levee	Levee ID	Covered Under PL84-99 Program?	FIRM Panel(s)
Bell, City of	Los Angeles River	Left Bank	USACE, LA District	Yes	1901057931	Yes	06037C1810F
Bell, City of	Los Angeles River	Right Bank	USACE, LA District	Yes	1901057921	Yes	06037C1810F
Bell Gardens, City of	Rio Hondo Channel	Right Bank	County of Los Angeles	Yes	1901057060	Yes	06037C1664F
Carson, City of	Compton Creek	Left Bank	County of Los Angeles	Yes	1901057139	Yes	06037C1815F
Carson, City of	Compton Creek	Right Bank	County of Los Angeles	Yes	1901057158	Yes	06037C1815F
Carson, City of	Dominguez Channel	Left Bank	County of Los Angeles	Yes	1901057016	No	06037C1935F
Carson, City of	Dominguez Channel	Right Bank	County of Los Angeles	Yes	1901057114	No	06037C1935F
Carson, City of	Dominguez Channel	Left Bank	County of Los Angeles	Yes	1901057202	No	06037C1935F
Carson, City of	Dominguez Channel	Right Bank	County of Los Angeles	Yes	1901057132	No	06037C1935F
Long Beach, City of	Los Angeles River	Right Bank	County of Los Angeles	Yes	1901057176	Yes	06037C1962F
Los Angeles County, Unincorporated Areas	Violin Canyon Creek	Right Bank	County of Los Angeles	Yes	1904057151	No	06037C0575F 06037C0600G 06037C0805G
Montebello, City of	Rio Hondo Channel	Right Bank	County of Los Angeles	Yes	1901057052	Yes	06037C1664F
Santa Clarita, City of	Bouquet Canyon Creek	Left Bank	County of Los Angeles	Yes	1901057140	No	06037C0810G 06037C0817G
Santa Clarita, City of	Bouquet Canyon Creek	Right Bank	County of Los Angeles	Yes	1905057909	No	06037C0810G 06037C0817G
Santa Clarita, City of	Santa Clara River	Left Bank	County of Los Angeles	Yes	1901057092	No	06037C0818G
Santa Clarita, City of	Santa Clara River	Right Bank	County of Los Angeles	Yes	1901057115	No	06037C0840G

Table 9: Levees , continued

Community	Flooding Source	Levee Location	Levee Owner	USACE Levee	Levee ID	Covered Under PL84-99 Program?	FIRM Panel(s)
Santa Clarita, City of	Santa Clara River	Left Bank	County of Los Angeles	Yes	1905081017	No	06037C0816G
Santa Clarita, City of	Santa Clara River	Right Bank	County of Los Angeles	Yes	1901057135	No	06037C0840G
Santa Clarita, City of	Santa Clara River	Right Bank	County of Los Angeles	Yes	1905057199	No	06037C0818G
Santa Clarita, City of	Santa Clara River	Right Bank	County of Los Angeles	Yes	1901057906	No	06037C0840G
Santa Clarita, City of	San Francisquito Canyon Creek	Right Bank	County of Los Angeles	Yes	1905057008	No	06037C0815G
South Gate, City of	Los Angeles River	Left Bank	County of Los Angeles	Yes	1901057053	Yes	06037C1815F
South Gate, City of	Los Angeles River	Right Bank	County of Los Angeles	Yes	1901057054	Yes	06037C1815F
South Gate, City of	Los Angeles River	Left Bank	USACE, LA District	Yes	1901057064	Yes	06037C1810F
Long Beach, City of	Coyote Creek	Right Bank	USACE, LA District	Yes	1901057050	Yes	06037C1990F
Santa Clarita, City of	Santa Clara River	Right Bank	USACE, LA District	No	1901057908	Unknown	06037C0840G
Long Beach, City of	San Gabriel River	Right Bank	USACE, LA District	Yes	1901057051	Yes	06037C1990F
Santa Clarita, City of	Bouquet Canyon Creek	Right Bank	USACE, LA District	No	1901057909	Unknown	06037C0810G 06037C0817G
Santa Clarita, City of	Santa Clara River	Left Bank	USACE, LA District	No	1901057183	No	06037C0840G
Santa Clarita, City of	Santa Clara River	Left Bank	USACE, LA District	No	1901057911	Unknown	06037C0840G
Santa Clarita, City of	South Fork Santa Clara River	Left Bank	USACE, LA District	No	1901058269	No	06037C0818G
Santa Clarita, City of	South Fork Santa Clara River	Left Bank	USACE, LA District	No	1905057092	No	06037C0818G

FLOOD INSURANCE STUDY

FEDERAL EMERGENCY MANAGEMENT AGENCY

VOLUME 2 OF 9

LOS ANGELES COUNTY, CALIFORNIA

AND INCORPORATED AREAS

COMMUNITY NAME	NUMBER	COMMUNITY NAME	NUMBER
AGOURA HILLS, CITY OF	065072	COMMERCE, CITY OF	060110
ALHAMBRA, CITY OF*	060095	COMPTON, CITY OF	060111
ARCADIA, CITY OF*	065014	COVINA, CITY OF*	065024
ARTESIA, CITY OF*	060097	CUDAHY, CITY OF	060657
AVALON, CITY OF	060098	CULVER CITY, CITY OF	060114
AZUSA, CITY OF	065015	DIAMOND BAR, CITY OF	060741
BALDWIN PARK, CITY OF*	060100	DOWNEY, CITY OF	060645
BELL, CITY OF*	060101	DUARTE, CITY OF*	065026
BELL GARDENS, CITY OF	060656	EL MONTE, CITY OF*	060658
BELLFLOWER, CITY OF	060102	EL SEGUNDO, CITY OF	060118
BEVERLY HILLS, CITY OF*	060655	GARDENA, CITY OF	060119
BRADBURY, CITY OF*	065017	GLENDALE, CITY OF	065030
BURBANK, CITY OF	065018	GLENDORA, CITY OF*	065031
CALABASAS, CITY OF	060749	HAWAIIAN GARDENS, CITY OF*	065032
CARSON, CITY OF	060107	HAWTHORNE, CITY OF*	060123
CERRITOS, CITY OF	060108	HERMOSA BEACH, CITY OF	060124
CLAREMONT, CITY OF*	060109	HIDDEN HILLS, CITY OF	060125

*No Special Flood Hazard Areas Identified

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06037CV002F

Version Number 2.3.3.2

COMMUNITY NAME	NUMBER	COMMUNITY NAME	NUMBER
HUNTINGTON PARK, CITY OF*	060126	PICO RIVERA, CITY OF	060148
INDUSTRY, CITY OF*	065035	POMONA, CITY OF*	060149
INGLEWOOD, CITY OF*	065036	RANCHO PALOS VERDES, CITY OF	060464
IRWINDALE, CITY OF*	060129	REDONDO BEACH, CITY OF	060150
LA CANADA FLINTRIDGE, CITY OF*	060669	ROLLING HILLS, CITY OF*	060151
LA HABRA HEIGHTS, CITY OF*	060701	ROLLING HILLS ESTATES, CITY OF*	065054
LA MIRADA, CITY OF	060131	ROSEMEAD, CITY OF*	060153
LA PUENTE*, CITY OF	065039	SAN DIMAS, CITY OF	060154
LA VERNE, CITY OF	060133	SAN FERNANDO, CITY OF	060628
LAKEWOOD, CITY OF	060130	SAN GABRIEL, CITY OF*	065055
LANCASTER, CITY OF	060672	SAN MARINO, CITY OF*	065057
LAWNDALE, CITY OF*	060134	SANTA CLARITA, CITY OF	060729
LOMITA, CITY OF*	060135	SANTA FE SPRINGS, CITY OF	060158
LONG BEACH, CITY OF	060136	SANTA MONICA, CITY OF	060159
LOS ANGELES, CITY OF	060137	SIERRA MADRE, CITY OF*	065059
LOS ANGELES COUNTY UNINCORPORATED AREAS	065043	SIGNAL HILL, CITY OF*	060161
LYNWOOD, CITY OF	060635	SOUTH EL MONTE, CITY OF*	060162
MALIBU, CITY OF	060745	SOUTH GATE, CITY OF	060163
MANHATTAN BEACH, CITY OF	060138	SOUTH PASADENA, CITY OF*	065061
MAYWOOD, CITY OF*	060651	TEMPLE CITY, CITY OF*	060653
MONROVIA, CITY OF*	065046	TORRANCE, CITY OF	060165
MONTEBELLO, CITY OF	060141	VERNON, CITY OF*	060166
MONTEREY PARK, CITY OF*	065047	WALNUT, CITY OF*	065069
NORWALK, CITY OF	060652	WEST COVINA, CITY OF	060666
PALMDALE, CITY OF	060144	WEST HOLLYWOOD, CITY OF*	060720
PALOS VERDES ESTATES, CITY OF	060145	WESTLAKE VILLAGE, CITY OF	060744
PARAMOUNT, CITY OF	065049	WHITTIER, CITY OF	060169
PASADENA, CITY OF*	065050		

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REVISED: June 2, 2021

FLOOD INSURANCE STUDY NUMBER

06037CV002F

Version Number 2.3.3.2

Table 10: Summary of Discharges, continued

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)					
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance Existing	1% Annual Chance Future	0.2% Annual Chance
Santa Clara River	Approximately 8,000 feet upstream of confluence of Castaic Creek	418	13,250	*	35,860	50,270	*	78,040
Santa Clara River	Approximately 650 feet downstream of The Old Road	412	13,120	*	35,690	49,990	*	77,430
Santa Clara River	Upstream of confluence of San Francisquito Canyon Creek	357	9,790	*	28,790	41,560	*	65,810
Santa Clara River	Upstream of confluence of South Fork Santa Clara River	312	7,460	*	23,120	33,890	*	53,570
Santa Clara River	Upstream of confluence of Bouquet Canyon Creek	239	5,400	*	17,620	26,210	*	41,080
Santa Clara River	Approximately 4,600 feet downstream of Soledad Canyon Road	233	5,290	*	17,390	25,910	*	40,550
Santa Clara River	Upstream of confluence of Mint Canyon Creek	195	4,140	*	14,320	21,690	*	33,990
Santa Clara River	At Sand Canyon Road	179	3,840	*	12,810	19,500	*	30,490
Santa Clara River	Approximately 4,800 feet downstream of Lang Station Road	171	3,770	*	12,370	18,730	*	29,130
Santa Clara River	Approximately 1,600 feet upstream of Bootlegger Canyon	85.0	2,260	*	6,450	9,600	*	14,690
Santa Clara River	Approximately 500 feet upstream of confluence of Arraste	76.3	1,550	*	4,780	7,440	*	11,760

Table 13: Summary of Hydrologic and Hydraulic Analyses, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Complete	Flood Zone on	Special Considerations
San Martinez Chiquito Canyon	Confluence with Santa Clara River	Approximately 2000 feet upstream of San Martinez Road	US EPA Hydrologic Simulation Program – FORTRAN (HSPF)	HEC-RAS 4.1	7/21/2015	AE	
San Martinez Grande Canyon Creek	Confluence with Santa Clara River	1.8 miles above State Route 126	US EPA Hydrologic Simulation Program – FORTRAN (HSPF)	HEC-RAS 4.1	7/21/2015	AE	
San Pedro Bay	—	—	Regional Regression Equations	HEC-2	—	AE	
Sand Canyon Creek	Confluence with Santa Clara River	0.4 miles upstream of Coyote Canyon Creek	HEC-1	HEC-RAS 4.1	02/01/2010	AE	
Santa Clara River	At Los Angeles—Ventura County Boundary	Approximately 1.4 miles upstream of Lang Station Road	HEC-1	HEC-RAS 4.1	7/21/2015	AE w/ Floodway	
Santa Clara River	Approximately 12 miles upstream of Lang Station Road	Confluence of Aliso Canyon Creek	HEC-1	HEC-RAS 4.1	03/13/2014	AE w/ Floodway	

Table 14: Roughness Coefficients, continued

Flooding Source	Channel "n"	Overbank "n"
North Overflow	0.014-0.050	0.014-0.050
Oak Springs Canyon	0.040	0.040-0.070
Oak Springs Canyon Overflow	0.070	0.070
Old Topanga Canyon	0.030	0.050
Overflow Area of Lockheed Drain Channel	0.030-0.040	0.030-0.040
Overflow Area of Lockheed Storm Drain	0.014-0.050	0.014-0.050
Palo Comando Creek	0.030	0.050
Pico Canyon	0.015-0.040	0.040-0.130
Placerita Creek	0.020-0.040	0.040-0.130
Placerita Creek Overflow	0.130	0.050-0.130
Plum Canyon	0.015	0.016-0.030
Potrero Canyon	0.040-0.060	0.040-0.060
Potrero Canyon Overflow	0.060	0.060
Quigley Canyon Creek	0.035-0.060	0.048-0.063
Railroad Canyon	0.035-0.045	0.100
Railroad Canyon Left Overbank	0.028-0.032	0.100
Ramirez Canyon	0.030	0.050
Rio Hondo Left Overbank Path 3	0.050-0.150	0.050-0.150
Rio Hondo Left Overbank Path 5	0.050-0.150	0.050-0.150
Rio Hondo Left Overbank Path 6	0.050-0.150	0.050-0.150
Rustic Canyon	0.035-0.065	0.030-0.065
San Francisquito Canyon Creek	0.038	0.042
San Martinez Chiquito Canyon	0.016-0.040	0.050-0.100
San Martinez Grande Canyon Creek	0.040-0.070	0.040-0.070
Sand Canyon Creek	0.020-0.130	0.050-0.130
Santa Clara River	0.032-0.040	0.010-0.100
Santa Clara River Overflow	0.032	0.036
Santa Maria Canyon	0.030	0.050
Soledad Canyon	0.015-0.040	0.050-0.070
South Fork Santa Clara River	0.020-0.050	0.05-0.100
South Fork Santa Clara River Tributary	0.020-0.050	0.05-0.100

Table 19: Results of Alluvial Fan Analyses

Flooding Source	Location From (apex)	Location To (toe)	1% Annual Chance Peak Flow at Fan Apex (cfs)	Flood Zones and Depths (ft)	Minimum Velocity (fps)	Maximum Velocity (fps)
Agua Dulce Canyon Creek	*	*	*	AO 1’, A	*	*
Amargosa Creek	*	*	*	AO 1’	*	*
Anaverde Creek	*	*	*	AO 1’	*	*
Big Tujunga Wash	*	*	*	AO 3’, A	*	*
Boquet Canyon Creek	*	*	*	AO1-3’	*	*
Browns Creek	*	*	*	AO 2’	*	*
Coyote Canyon Creek	*	*	*	AO 1’, A	*	*
Deer Canyon	*	*	*	AO 3’	*	*
Dry Canyon Creek	*	*	*	AO 2’	*	*
Escondido Canyon	*	*	*	AO 1-2’, A	*	*
Gorman Canyon Creek	*	*	*	AO 1’, A	*	*
Haskell Canyon	*	*	*	AO 2-3’	*	*
Little Tujunga Wash	*	*	*	AO 2’, A	*	*
New Hall Creek	*	*	*	AO 1’	*	*
Oak Springs Canyon	*	*	*	AO 1-2’, A	*	*
Pacoima Wash	*	*	*	AO 3’, A	*	*
Railroad Canyon	*	*	*	AO 1’, A	*	*
Ritter Ridge	*	*	*	AO 1’	*	*
Sand Canyon Creek	*	*	*	AO 1’	*	*
Santa Clara River	*	*	*	AO 1-3', A	*	*

FLOOD INSURANCE STUDY

FEDERAL EMERGENCY MANAGEMENT AGENCY

VOLUME 3 OF 9

LOS ANGELES COUNTY, CALIFORNIA

AND INCORPORATED AREAS

COMMUNITY NAME	NUMBER	COMMUNITY NAME	NUMBER
AGOURA HILLS, CITY OF	065072	COMMERCE, CITY OF	060110
ALHAMBRA, CITY OF*	060095	COMPTON, CITY OF	060111
ARCADIA, CITY OF*	065014	COVINA, CITY OF*	065024
ARTESIA, CITY OF*	060097	CUDAHY, CITY OF	060657
AVALON, CITY OF	060098	CULVER CITY, CITY OF	060114
AZUSA, CITY OF	065015	DIAMOND BAR, CITY OF	060741
BALDWIN PARK, CITY OF*	060100	DOWNEY, CITY OF	060645
BELL, CITY OF*	060101	DUARTE, CITY OF*	065026
BELL GARDENS, CITY OF	060656	EL MONTE, CITY OF*	060658
BELLFLOWER, CITY OF	060102	EL SEGUNDO, CITY OF	060118
BEVERLY HILLS, CITY OF*	060655	GARDENA, CITY OF	060119
BRADBURY, CITY OF*	065017	GLENDALE, CITY OF	065030
BURBANK, CITY OF	065018	GLENDORA, CITY OF*	065031
CALABASAS, CITY OF	060749	HAWAIIAN GARDENS, CITY OF*	065032
CARSON, CITY OF	060107	HAWTHORNE, CITY OF*	060123
CERRITOS, CITY OF	060108	HERMOSA BEACH, CITY OF	060124
CLAREMONT, CITY OF*	060109	HIDDEN HILLS, CITY OF	060125

*No Special Flood Hazard Areas Identified

REVISED: June 2, 2021

FEMA

FLOOD INSURANCE STUDY NUMBER

06037CV003F

Version Number 2.3.3.2

COMMUNITY NAME	NUMBER	COMMUNITY NAME	NUMBER
HUNTINGTON PARK, CITY OF*	060126	PICO RIVERA, CITY OF	060148
INDUSTRY, CITY OF*	065035	POMONA, CITY OF*	060149
INGLEWOOD, CITY OF*	065036	RANCHO PALOS VERDES, CITY OF	060464
IRWINDALE, CITY OF*	060129	REDONDO BEACH, CITY OF	060150
LA CANADA FLINTRIDGE, CITY OF*	060669	ROLLING HILLS, CITY OF*	060151
LA HABRA HEIGHTS, CITY OF*	060701	ROLLING HILLS ESTATES, CITY OF*	065054
LA MIRADA, CITY OF	060131	ROSEMEAD, CITY OF*	060153
LA PUENTE*, CITY OF	065039	SAN DIMAS, CITY OF	060154
LA VERNE, CITY OF	060133	SAN FERNANDO, CITY OF	060628
LAKEWOOD, CITY OF	060130	SAN GABRIEL, CITY OF*	065055
LANCASTER, CITY OF	060672	SAN MARINO, CITY OF*	065057
LAWNDALE, CITY OF*	060134	SANTA CLARITA, CITY OF	060729
LOMITA, CITY OF*	060135	SANTA FE SPRINGS, CITY OF	060158
LONG BEACH, CITY OF	060136	SANTA MONICA, CITY OF	060159
LOS ANGELES, CITY OF	060137	SIERRA MADRE, CITY OF*	065059
LOS ANGELES COUNTY UNINCORPORATED AREAS	065043	SIGNAL HILL, CITY OF*	060161
LYNWOOD, CITY OF	060635	SOUTH EL MONTE, CITY OF*	060162
MALIBU, CITY OF	060745	SOUTH GATE, CITY OF	060163
MANHATTAN BEACH, CITY OF	060138	SOUTH PASADENA, CITY OF*	065061
MAYWOOD, CITY OF*	060651	TEMPLE CITY, CITY OF*	060653
MONROVIA, CITY OF*	065046	TORRANCE, CITY OF	060165
MONTEBELLO, CITY OF	060141	VERNON, CITY OF*	060166
MONTEREY PARK, CITY OF*	065047	WALNUT, CITY OF*	065069
NORWALK, CITY OF	060652	WEST COVINA, CITY OF	060666
PALMDALE, CITY OF	060144	WEST HOLLYWOOD, CITY OF*	060720
PALOS VERDES ESTATES, CITY OF	060145	WESTLAKE VILLAGE, CITY OF	060744
PARAMOUNT, CITY OF	065049	WHITTIER, CITY OF	060169
PASADENA, CITY OF*	065050		

*No Special Flood Hazard Areas Identified

REVISED: June 2, 2021

FEMA

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Version Number 2.3.3.2

Table 23: Summary of Topographic Elevation Data used in Mapping

Community	Flooding Source	Source for Topographic Elevation Data			
		Description	Scale	Contour Interval	Citation
Los Angeles County and Incorporated Areas	All studied streams within this FIS report	LiDAR	1:100	2 ft	Los Angeles Region Imagery Acquisition Consortium (LAR-IAC)
El Segundo, City of; Hermosa Beach, City of; Long Beach, City of; Los Angeles, City of; Los Angeles County, Unincorporated Areas; Malibu, City of; Manhattan Beach, City of; Palos Verdes Estates, City of; Rancho Palos Verdes, City of; Redondo Beach, City of; Santa Monica, City of; Torrance, City of	Pacific Ocean	LiDAR OPC/ USGS 2009-2011 & BATHY NOAA	N/A	2 ft	USGS, 2009-2011

BFEs shown at cross sections on the FIRM represent the 1% annual chance water surface elevations shown on the Flood Profiles and in the Floodway Data tables in the FIS Report . Rounded whole -foot elevations may be shown on the FIRM in coastal areas, areas of ponding, and other areas with static base flood elevations.

Table 24: Floodway Data, continued

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	207,726	1223	5,733	11.6	833.0	833.0	833.2	0.2
B	209,501	959	6,793	9.8	844.0	844.0	844.0	0.0
C	210,587	1348	7,091	9.4	848.7	848.7	848.7	0.0
D	212,272	1240	7,166	9.3	857.3	857.3	857.7	0.4
E	213,280	1050	7,642	8.7	864.5	864.5	865.2	0.7
F	214,526	665	5,083	13.1	870.4	870.4	871.0	0.6
G	215,675	671	7,005	9.5	879.5	879.5	879.8	0.3
H	217,269	1097	6,533	10.2	883.9	883.9	884.2	0.3
I	218,493	778	5,349	12.5	889.9	889.9	890.2	0.3
J	220,308	660	4,739	14.1	900.1	900.1	900.1	0.0
K	222,073	813	5,560	12.0	911.3	911.3	911.5	0.2
L	223,286	831	7,473	8.9	916.9	916.9	917.4	0.5
M	224,864	846	6,321	10.5	925.7	925.7	925.7	0.0
N	226,652	497	4,705	14.2	934.6	934.6	934.6	0.0
O	227,982	696	9,195	7.2	946.5	946.5	946.5	0.0
P	230,167	1206	7,808	8.5	949.3	949.3	949.4	0.1
Q	231,459	677	3,948	12.8	957.2	957.2	957.5	0.3
R	233,694	1080	5,054	10.0	969.3	969.3	970.1	0.8
S	235,405	1011	5,477	9.2	980.6	980.6	980.9	0.3
T	237,277	531	3,893	12.9	990.3	990.3	990.5	0.2
U	238,750	695	4,944	10.2	998.0	998.0	998.1	0.1
V	240,838	791	5,361	9.4	1,007.9	1,007.9	1, 008.0	0.1
W	243,054	618	4,075	12.3	1,020.7	1,020.7	1,020.9	0.2
X	244,918	512	5,206	9.7	1,033.9	1,033.9	1,034.1	0.2
Y	246,184	305	2,893	17.4	1,044.6	1,044.6	1,044.6	0.0
Z	247,789	384	4,945	10.1	1,056.4	1,056.4	1,056.4	0.0

[1] Feet above mouth at Pacific Ocean

TABLE 24

FEDERAL EMERGENCY MANAGEMENT AGENCY

LOS ANGELES COUNTY, CALIFORNIA

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: SANTA CLARA RIVER

Table 24: Floodway Data, continued

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
AA	249,448	326	3,061	16.3	1,066.0	1,066.0	1,066.4	0.4
AB	250,339	361	6,593	7.6	1,078.1	1,078.1	1,078.1	0.0
AC	256,333	984	6,695	7.5	1,081.3	1,081.3	1,081.3	0.0
AD	255,132	785	5,243	7.9	1,096.4	1,096.4	1,096.6	0.2
AE	256,422	721	4,516	9.2	1,105.3	1,105.3	1,105.3	0.0
AF	257,835	1181	6,208	6.7	1,111.9	1,111.9	1,111.9	0.0
AG	259,228	451	2,586	13.1	1,122.8	1,122.8	1,123.0	0.2
AH	260,732	540	2,808	12.1	1,135.4	1,135.4	1,135.4	0.0
AI	262,728	653	2,569	10.2	1,152.0	1,152.0	1,152.0	0.0
AJ	263,987	678	4,649	5.6	1,165.9	1,165.9	1,165.9	0.0
AK	265,479	645	2,413	10.9	1,175.3	1,175.3	1,175.7	0.4
AL	267,152	627	2,651	9.9	1,190.5	1,190.5	1,190.6	0.1
AM	269,009	922	2,779	9.4	1,205.4	1,205.4	1,205.4	0.0
AN	270,595	809	3,108	8.4	1,220.9	1,220.9	1,220.9	0.0
AO	272,264	787	3,303	7.9	1,233.7	1,233.7	1,234.1	0.4
AP	274,071	1274	3,070	8.5	1,249.0	1,249.0	1,249.1	0.1
AQ	276,329	674	3,322	7.9	1,269.8	1,269.8	1,270.5	0.7
AR	277,377	473	3,050	8.6	1,281.7	1,281.7	1,281.7	0.0
AS	279,107	399	2,332	11.2	1,293.4	1,293.4	1,293.9	0.5
AT	280,495	436	2,341	11.2	1,304.2	1,304.2	1,304.7	0.5
AU	282,032	535	2,718	9.6	1,316.5	1,316.5	1,316.5	0.0
AV	283,613	616	2,357	11.0	1,328.6	1,328.6	1,328.6	0.0
AW	284,515	893	3,031	8.6	1,336.4	1,336.4	1,336.5	0.1
AX	285,935	869	2,893	9.0	1,349.2	1,349.2	1,349.2	0.0
AY	287,582	677	3,451	7.5	1,365.0	1,365.0	1,365.1	0.1
AZ	289,667	522	2,233	11.6	1,382.2	1,382.2	1,383.0	0.8

[1] Feet above mouth at Pacific Ocean

TABLE 24	FEDERAL EMERGENCY MANAGEMENT AGENCY LOS ANGELES COUNTY, CALIFORNIA AND INCORPORATED AREAS	FLOODWAY DATA FLOODING SOURCE: SANTA CLARA RIVER

Table 24: Floodway Data, continued

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
BA	291,158	615	2,345	11.1	1,396.0	1,396.0	1,396.0	0.0
BB	292,356	459	2,125	12.2	1,407.0	1,407.0	1,407.1	0.1
BC	294,327	464	2,306	11.2	1,425.3	1,425.3	1,425.4	0.1
BD	296,017	541	2,044	10.6	1,439.8	1,439.8	1,439.9	0.1
BE	298,582	592	2,431	8.9	1,465.2	1,465.2	1,465.2	0.0
BF	300,339	832	2,096	10.4	1,484.3	1,484.3	1,484.4	0.1
BG	302,539	728	2,095	10.4	1,506.3	1,506.3	1,506.3	0.0
BH	303,917	375	2,727	8.0	1,518.2	1,518.2	1,518.2	0.0
BI	305,997	363	1,646	11.9	1,536.9	1,536.9	1,536.9	0.0
BJ	307,229	457	1,722	11.3	1,547.8	1,547.8	1,548.0	0.2
BK	308,499	294	1,886	10.3	1,558.3	1,558.3	1,559.3	1.0
BL	309,701	450	1,568	12.4	1,572.0	1,572.0	1,572.0	0.0
BM	310,789	179	1,907	10.2	1,579.5	1,579.5	1,580.5	1.0
BN	311,968	495	1,286	15.2	1,590.4	1,590.4	1,590.5	0.1
BO	313,366	472	3,691	5.3	1,598.9	1,598.9	1,599.3	0.4
BP	314,917	345	2,826	6.9	1,604.2	1,604.2	1,605.1	0.9
BQ	316,595	98	1,570	11.9	1,612.9	1,612.9	1,613.6	0.7
BR	317,637	251	1,033	18.1	1,624.9	1,624.9	1,625.0	0.1
BS	318,765	305	2,121	8.8	1,631.6	1,631.6	1,632.5	0.9
BT	320,949	399	2,622	7.1	1,667.5	1,667.5	1,668.2	0.7
BU	322,310	157	1,725	10.9	1,674.1	1,674.1	1,675.0	0.9
BV	323,563	356	1,133	15.1	1,692.1	1,692.1	1,692.1	0.0
BW	324,830	166	1,513	11.3	1,705.8	1,705.8	1,706.0	0.2
BX	325,864	90	1,277	14.7	1,722.8	1,722.8	1,723.0	0.2
BY	327,062	191	995	18.8	1,742.3	1,742.3	1,742.4	0.1
BZ	327,955		1,738	10.8	1,754.5	1,754.5	1,754.7	0.2

[1] Feet above mouth at Pacific Ocean

TABLE 24

FEDERAL EMERGENCY MANAGEMENT AGENCY

LOS ANGELES COUNTY, CALIFORNIA

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: SANTA CLARA RIVER

Table 24: Floodway Data, continued

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
CA	384,541	194	1,137	8.5	2,513.1	2,513.1	2,513.1	0.0
CB	385,337	181	1,067	9.0	2,524.6	2,524.6	2,525.4	0.8
CC	385,939	140	820	11.7	2,535.8	2,535.8	2,535.8	0.0
CD	386,895	191	938	10.2	2,551.0	2,551.0	2,551.0	0.0
CE	387,619	119	706	13.6	2,561.9	2,561.9	2,561.9	0.0
CF	388,131	162	1,097	6.8	2,572.6	2,572.6	2,573.4	0.8
CG	389,210	172	677	11.0	2,590.3	2,590.3	2,590.3	0.0
CH	389,523	116	592	12.6	2,595.0	2,595.0	2,595.6	0.6
CI	389,943	141	669	11.1	2,610.1	2,610.1	2,611.0	0.9
CJ	390,256	138	624	11.9	2,615.3	2,615.3	2,616.0	0.7
CK	390,918	358	1,061	7.0	2,623.3	2,623.3	2,624.3	1.0
CL	392,093	181	699	10.6	2,641.4	2,641.4	2,642.1	0.7
CM	392,901	159	699	10.7	2,652.7	2,652.7	2,653.0	0.3
CN	393,451	347	1,350	5.5	2,662.0	2,662.0	2,662.5	0.5
CO	393,519	257	809	9.2	2,662.0	2,662.0	2,662.9	0.9
CP	394,929	236	779	9.6	2,680.6	2,680.6	2,681.1	0.5
CQ	395,864	140	633	11.8	2,692.5	2,692.5	2,693.5	1.0
CR	397,082	232	578	9.0	2,709.8	2,709.8	2,710.6	0.8
CS	398,092	331	649	8.0	2,724.2	2,724.2	2,724.7	0.5
CT	399,243	226	584	8.9	2,739.7	2,739.7	2,739.8	0.1
CU	400,786	365	687	7.6	2,757.4	2,757.4	2,757.4	0.0
CV	402,290	190	545	9.6	2,776.0	2,776.0	2,776.1	0.1
CW	403,917	270	606	8.6	2,795.5	2,795.5	2,795.6	0.1
CX	405,540	115	459	11.4	2,813.8	2,813.8	2,813.8	0.0
CY	407,100	155	509	10.2	2,833.0	2,833.0	2,833.0	0.0

[1] Feet above mouth at Pacific Ocean

TABLE 24

FEDERAL EMERGENCY MANAGEMENT AGENCY

LOS ANGELES COUNTY, CALIFORNIA

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: SANTA CLARA RIVER

FLOOD INSURANCE STUDY

FEDERAL EMERGENCY MANAGEMENT AGENCY

VOLUME 8 OF 9

LOS ANGELES COUNTY, CALIFORNIA

AND INCORPORATED AREAS

COMMUNITY NAME	NUMBER	COMMUNITY NAME	NUMBER
AGOURA HILLS, CITY OF	065072	COMMERCE, CITY OF	060110
ALHAMBRA, CITY OF*	060095	COMPTON, CITY OF	060111
ARCADIA, CITY OF*	065014	COVINA, CITY OF*	065024
ARTESIA, CITY OF*	060097	CUDAHY, CITY OF	060657
AVALON, CITY OF	060098	CULVER CITY, CITY OF	060114
AZUSA, CITY OF	065015	DIAMOND BAR, CITY OF	060741
BALDWIN PARK, CITY OF*	060100	DOWNEY, CITY OF	060645
BELL, CITY OF*	060101	DUARTE, CITY OF*	065026
BELL GARDENS, CITY OF	060656	EL MONTE, CITY OF*	060658
BELLFLOWER, CITY OF	060102	EL SEGUNDO, CITY OF	060118
BEVERLY HILLS, CITY OF*	060655	GARDENA, CITY OF	060119
BRADBURY, CITY OF*	065017	GLENDALE, CITY OF	065030
BURBANK, CITY OF	065018	GLENDORA, CITY OF*	065031
CALABASAS, CITY OF	060749	HAWAIIAN GARDENS, CITY OF*	065032
CARSON, CITY OF	060107	HAWTHORNE, CITY OF*	060123
CERRITOS, CITY OF	060108	HERMOSA BEACH, CITY OF	060124
CLAREMONT, CITY OF*	060109	HIDDEN HILLS, CITY OF	060125

*No Special Flood Hazard Areas Identified

REVISED: June 2, 2021

FLOOD INSURANCE STUDY NUMBER

06037CV008F

Version Number 2.3.3.2

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COMMUNITY NAME	NUMBER	COMMUNITY NAME	NUMBER
HUNTINGTON PARK, CITY OF*	060126	PICO RIVERA, CITY OF	060148
INDUSTRY, CITY OF*	065035	POMONA, CITY OF*	060149
INGLEWOOD, CITY OF*	065036	RANCHO PALOS VERDES, CITY OF	060464
IRWINDALE, CITY OF*	060129	REDONDO BEACH, CITY OF	060150
LA CANADA FLINTRIDGE, CITY OF*	060669	ROLLING HILLS, CITY OF*	060151
LA HABRA HEIGHTS, CITY OF*	060701	ROLLING HILLS ESTATES, CITY OF*	065054
LA MIRADA, CITY OF	060131	ROSEMEAD, CITY OF*	060153
LA PUENTE*, CITY OF	065039	SAN DIMAS, CITY OF	060154
LA VERNE, CITY OF	060133	SAN FERNANDO, CITY OF	060628
LAKEWOOD, CITY OF	060130	SAN GABRIEL, CITY OF*	065055
LANCASTER, CITY OF	060672	SAN MARINO, CITY OF*	065057
LAWNDALE, CITY OF*	060134	SANTA CLARITA, CITY OF	060729
LOMITA, CITY OF*	060135	SANTA FE SPRINGS, CITY OF	060158
LONG BEACH, CITY OF	060136	SANTA MONICA, CITY OF	060159
LOS ANGELES, CITY OF	060137	SIERRA MADRE, CITY OF*	065059
LOS ANGELES COUNTY UNINCORPORATED AREAS	065043	SIGNAL HILL, CITY OF*	060161
LYNWOOD, CITY OF	060635	SOUTH EL MONTE, CITY OF*	060162
MALIBU, CITY OF	060745	SOUTH GATE, CITY OF	060163
MANHATTAN BEACH, CITY OF	060138	SOUTH PASADENA, CITY OF*	065061
MAYWOOD, CITY OF*	060651	TEMPLE CITY, CITY OF*	060653
MONROVIA, CITY OF*	065046	TORRANCE, CITY OF	060165
MONTEBELLO, CITY OF	060141	VERNON, CITY OF*	060166
MONTEREY PARK, CITY OF*	065047	WALNUT, CITY OF*	065069
NORWALK, CITY OF	060652	WEST COVINA, CITY OF	060666
PALMDALE, CITY OF	060144	WEST HOLLYWOOD, CITY OF*	060720
PALOS VERDES ESTATES, CITY OF	060145	WESTLAKE VILLAGE, CITY OF	060744
PARAMOUNT, CITY OF	065049	WHITTIER, CITY OF	060169
PASADENA, CITY OF*	065050		

*No Special Flood Hazard Areas Identified

REVISED: June 2, 2021

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06037CV008F

Version Number 2.3.3.2

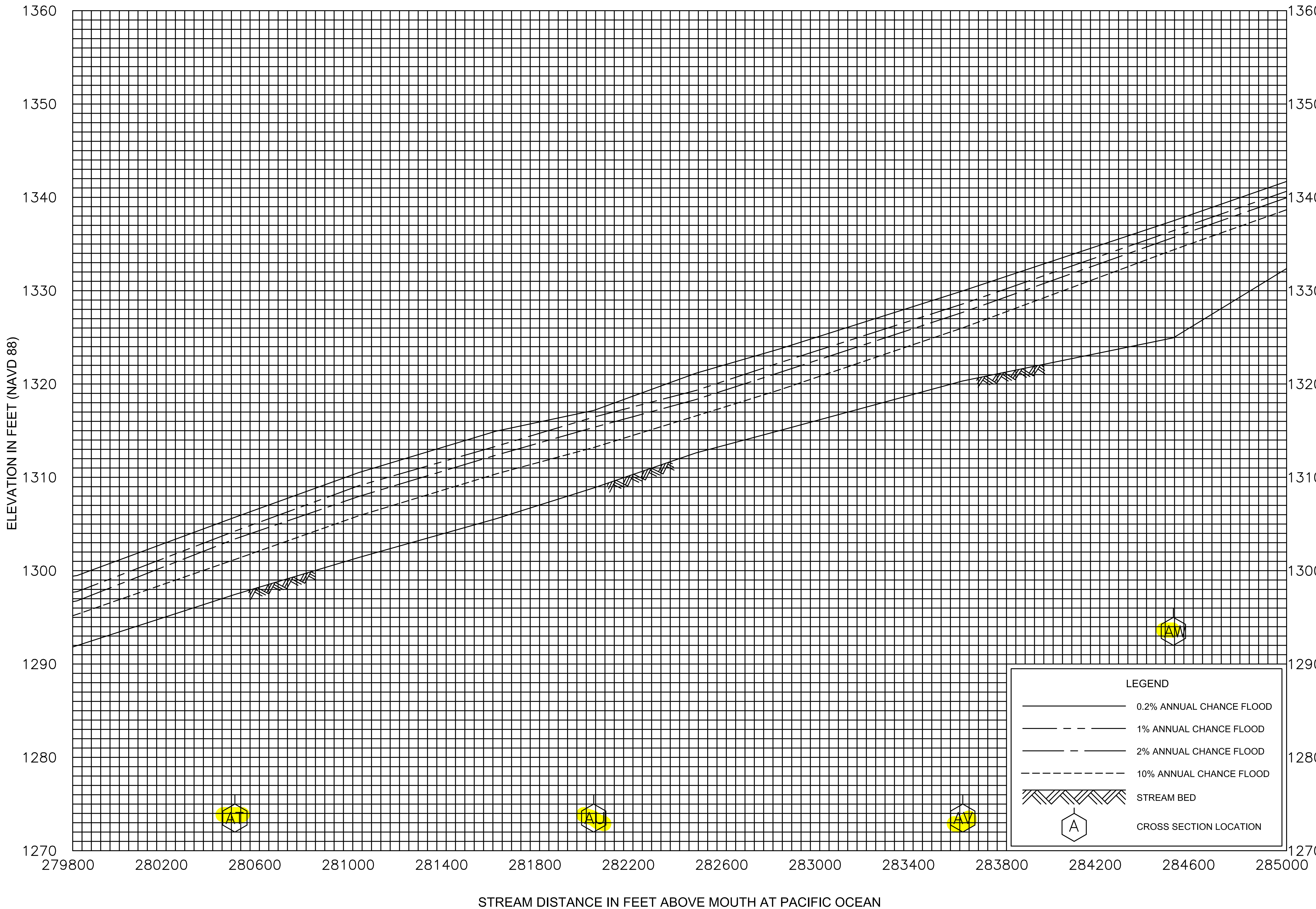
FLOOD PROFILES

SANTA CLARA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

LOS ANGELES COUNTY, CA

AND INCORPORATED AREAS



FLOOD PROFILES

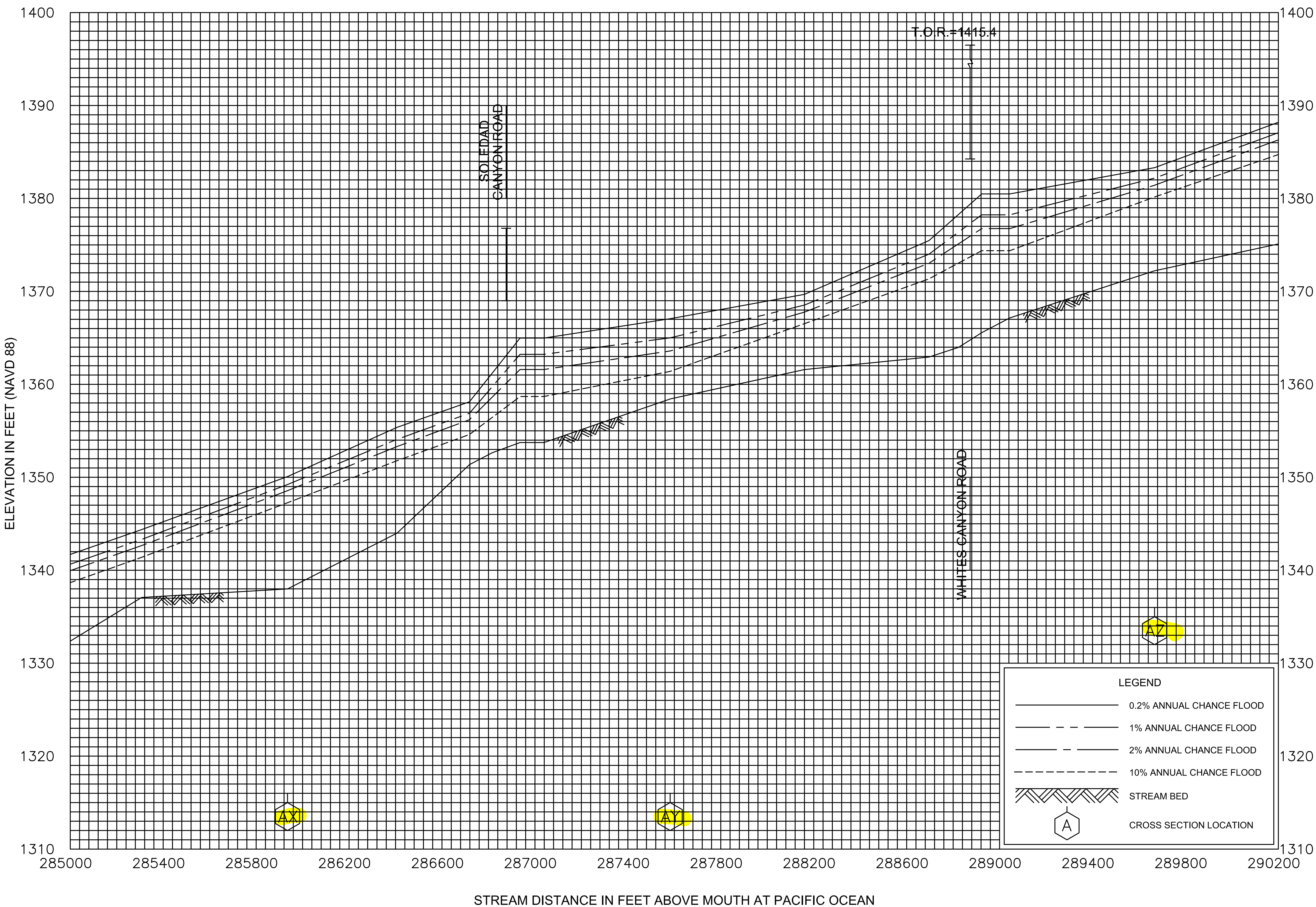
SANTA CLARA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

LOS ANGELES COUNTY, CA

AND INCORPORATED AREAS

323P



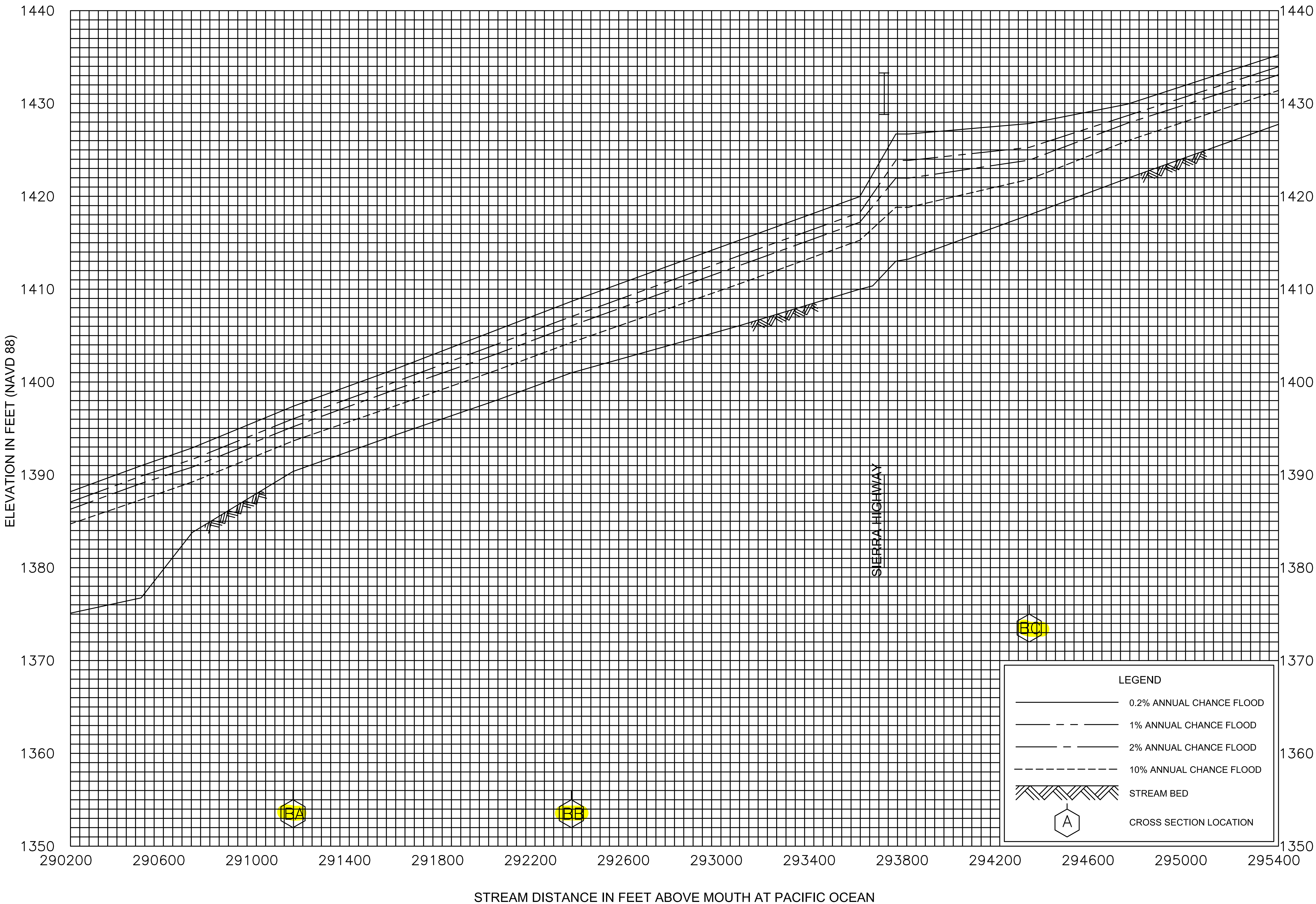
FLOOD PROFILES

SANTA CLARA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

LOS ANGELES COUNTY, CA

AND INCORPORATED AREAS



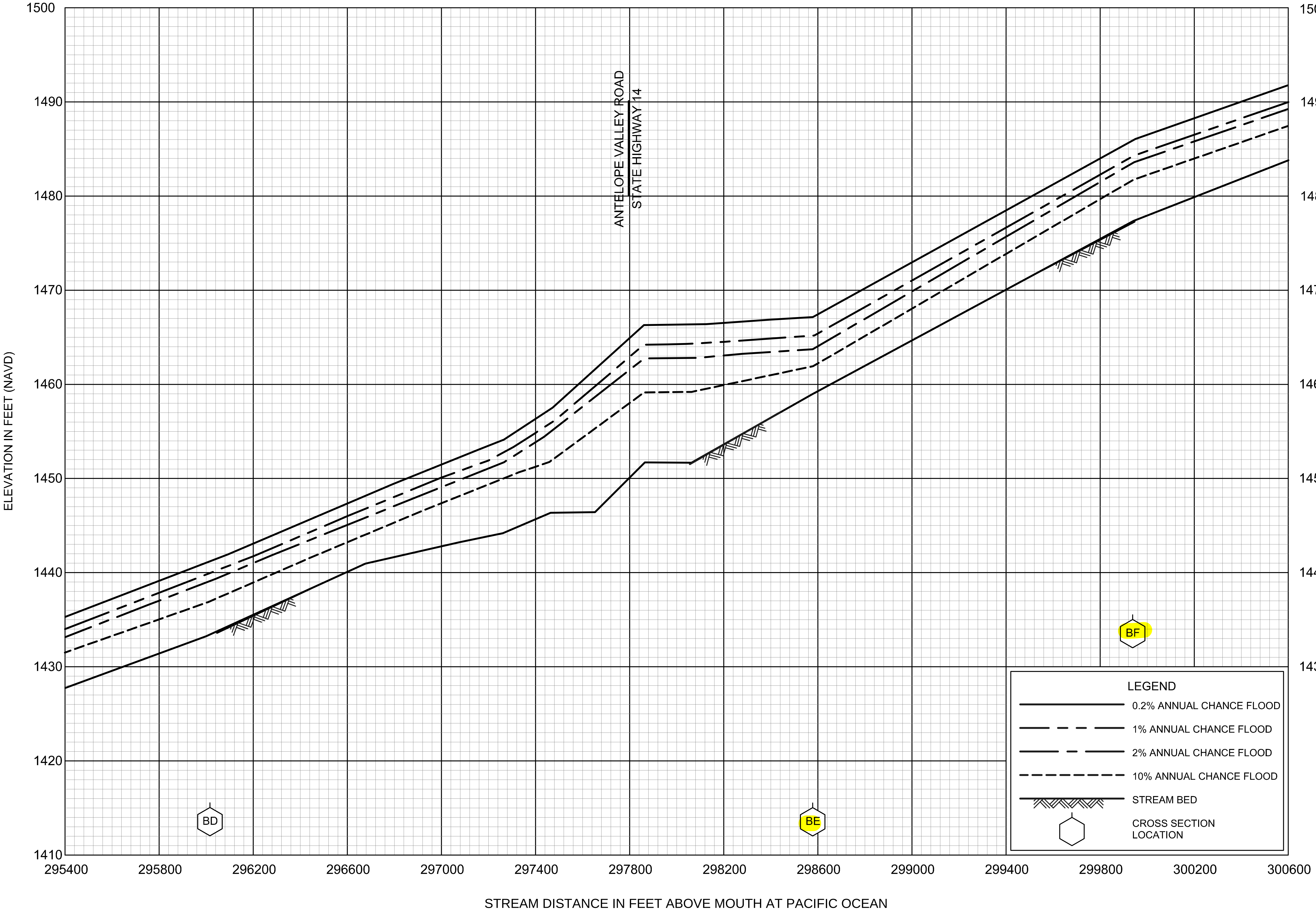
FLOOD PROFILES

SANTA CLARA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

LOS ANGELES COUNTY, CA

AND INCORPORATED AREAS



FLOOD PROFILES

SANTA CLARA RIVER

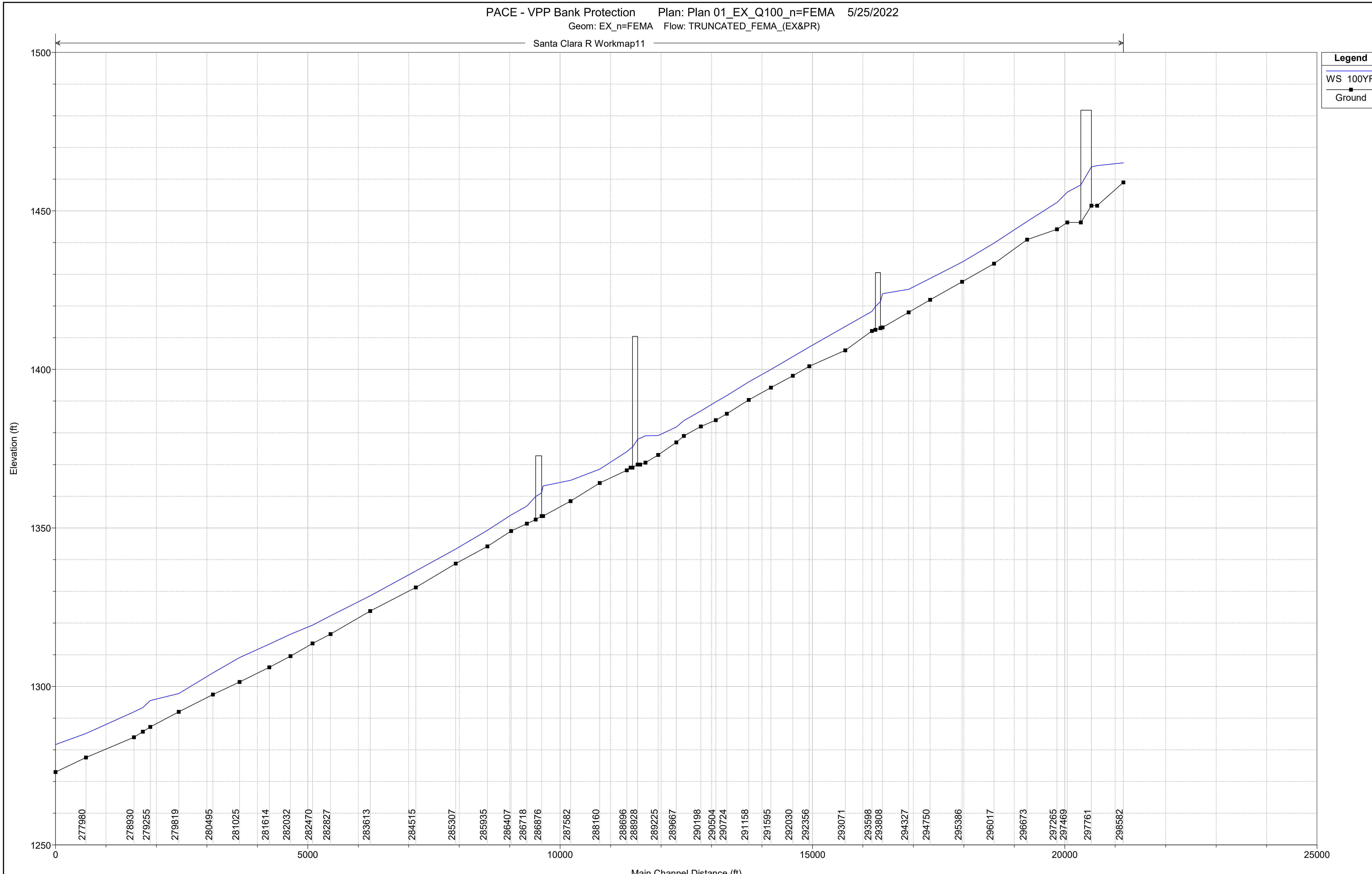
FEDERAL EMERGENCY MANAGEMENT AGENCY

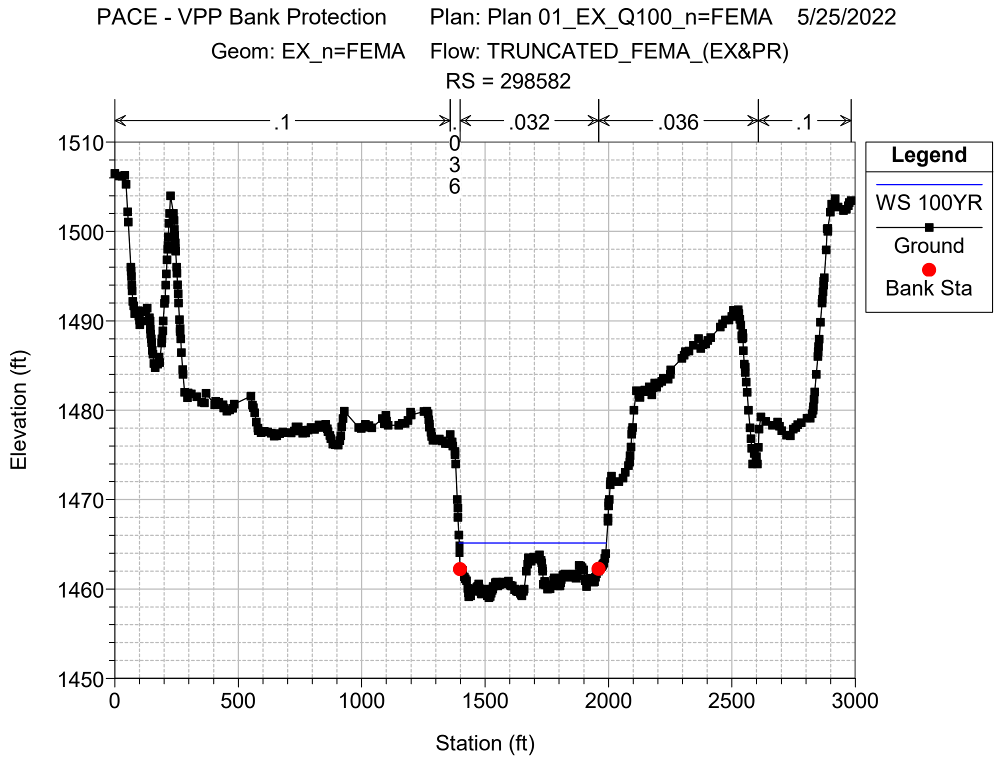
LOS ANGELES COUNTY, CA

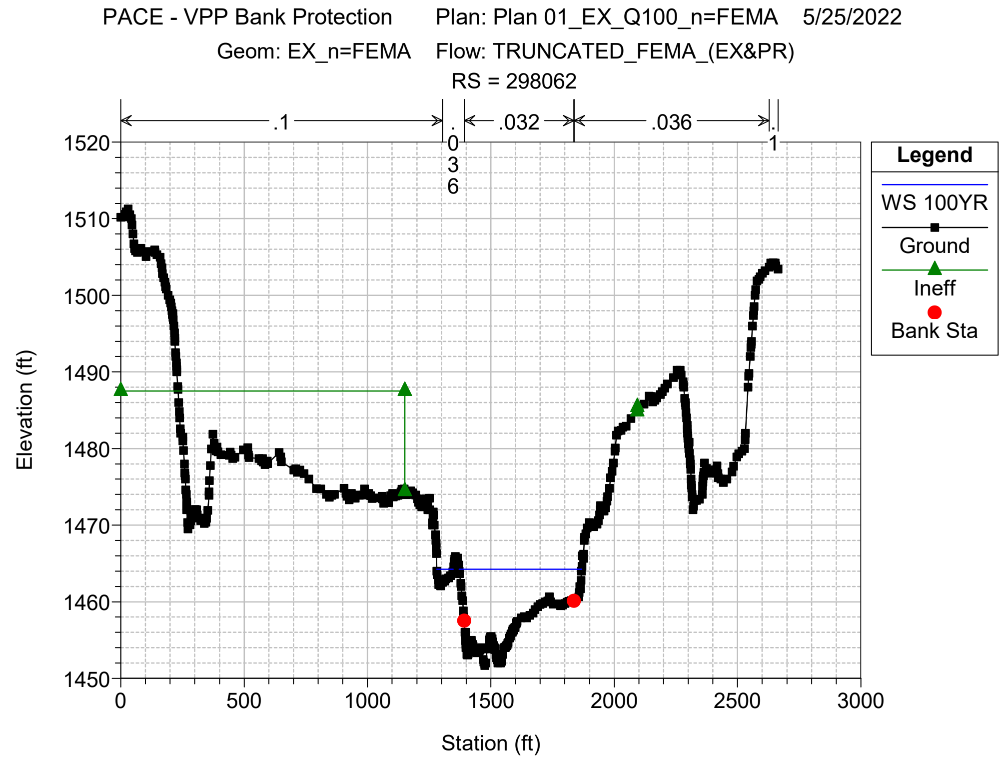
AND INCORPORATED AREAS

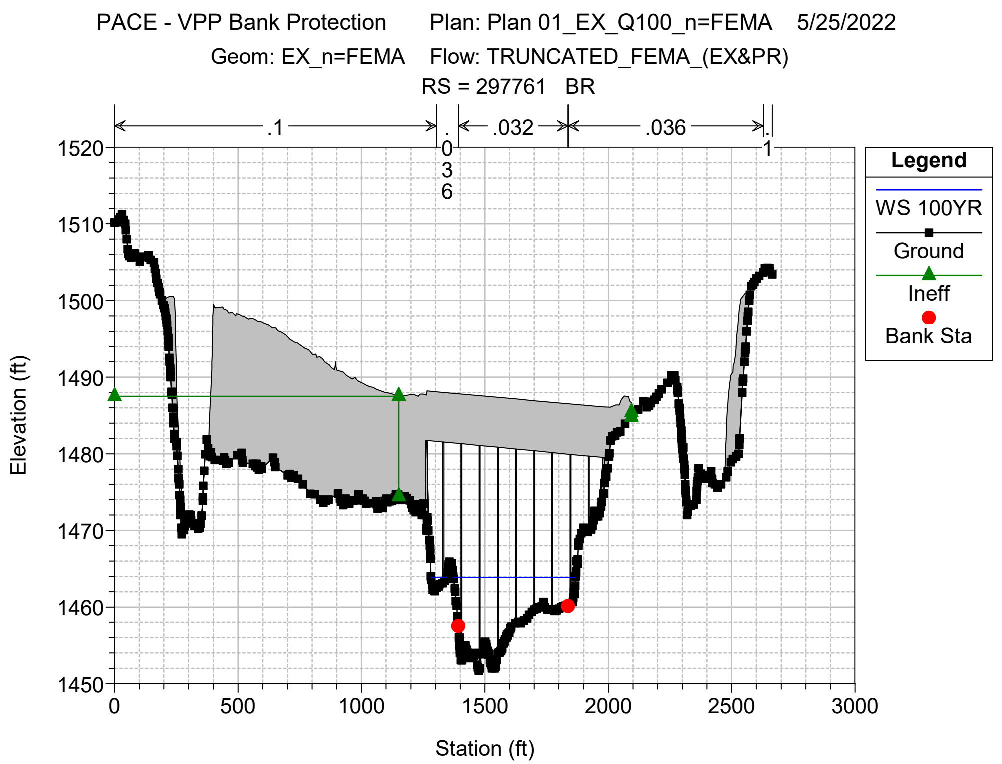
PACE
Advanced Water Engineering

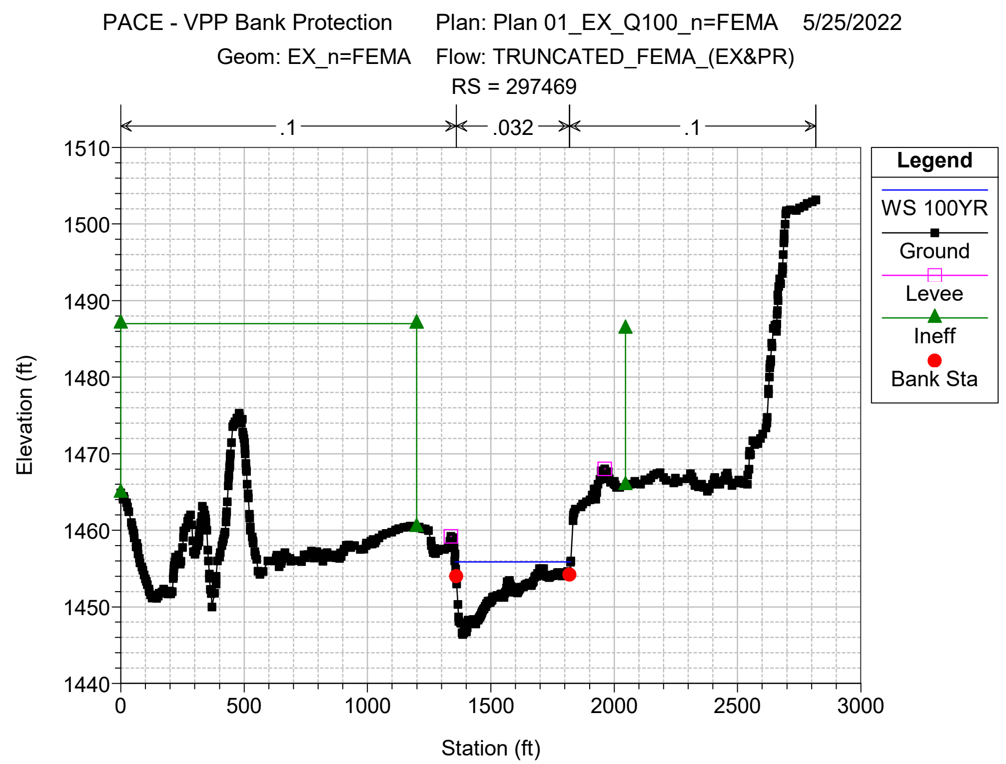
Appendix B – HEC-RAS Model Results

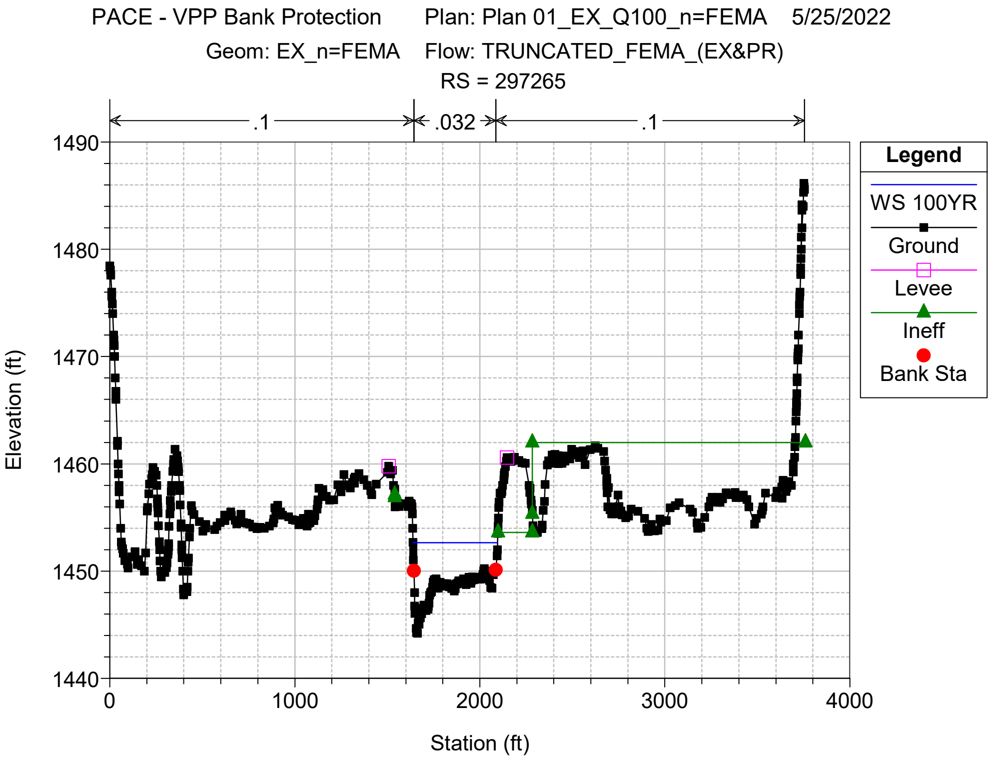

PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
Santa Clara R Workmap11
Legend
WS 100YR
Ground
Elevation (ft)
Main Channel Distance (ft)
1250
1300
1350
1400
1450
1500
0
5000
10000
15000
20000
25000
277980
278930
279255
279819
280495
281025
281614
282032
282470
282827
283613
284515
285307
285935
286407
286718
286876
287582
288160
288696
288928
289225
289667
290198
290504
290724
291158
291595
292030
292356
293071
293598
293808
294327
294750
295386
296017
296673
297265
297469
297761
298582

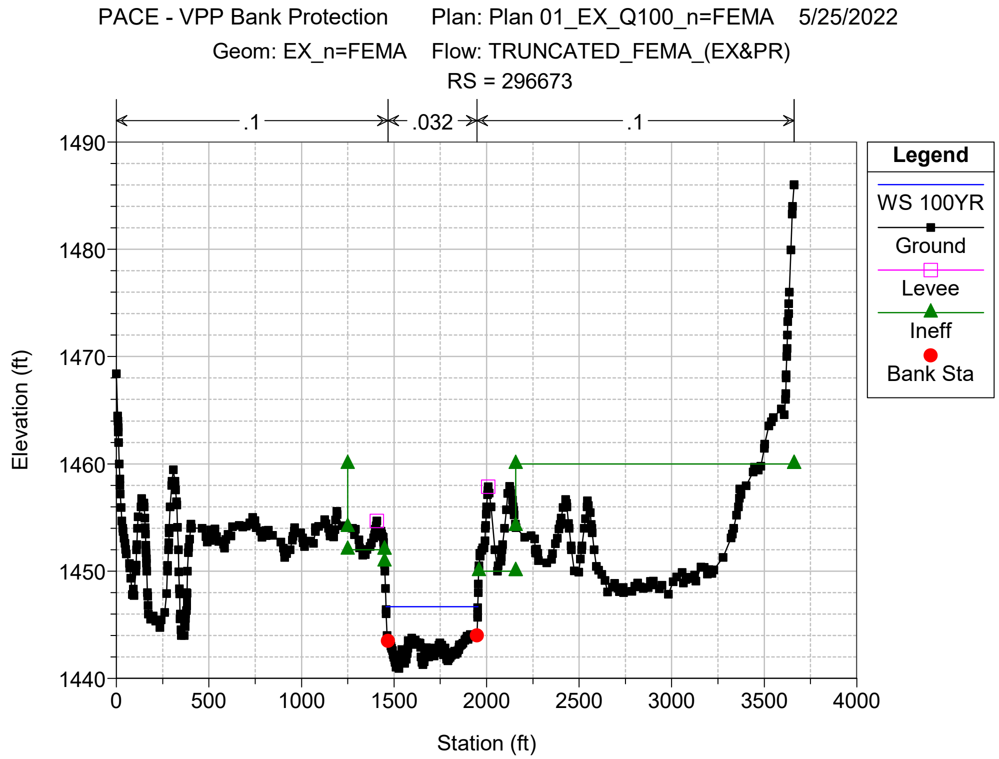

PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 298582
.1
.036
.032
.036
.1
Legend
WS 100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1450
1460
1470
1480
1490
1500
1510
0
500
1000
1500
2000
2500
3000

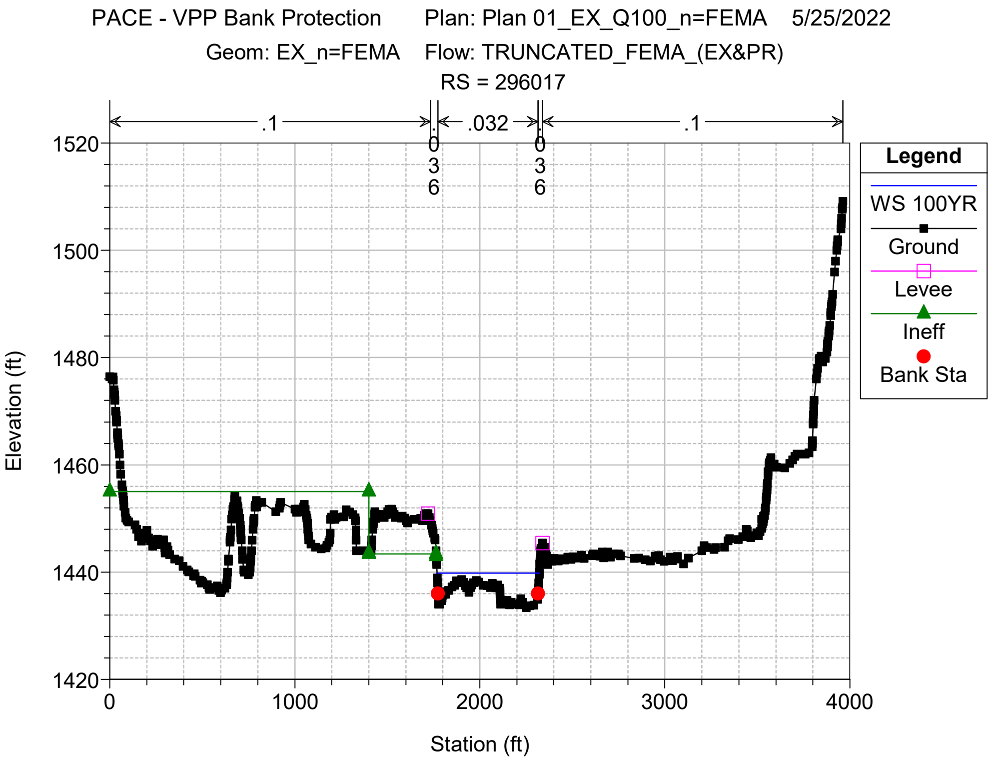

PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 298062
.1
.036
.032
.036
.1
Legend
WS 100YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1450
1460
1470
1480
1490
1500
1510
1520
0
500
1000
1500
2000
2500
3000

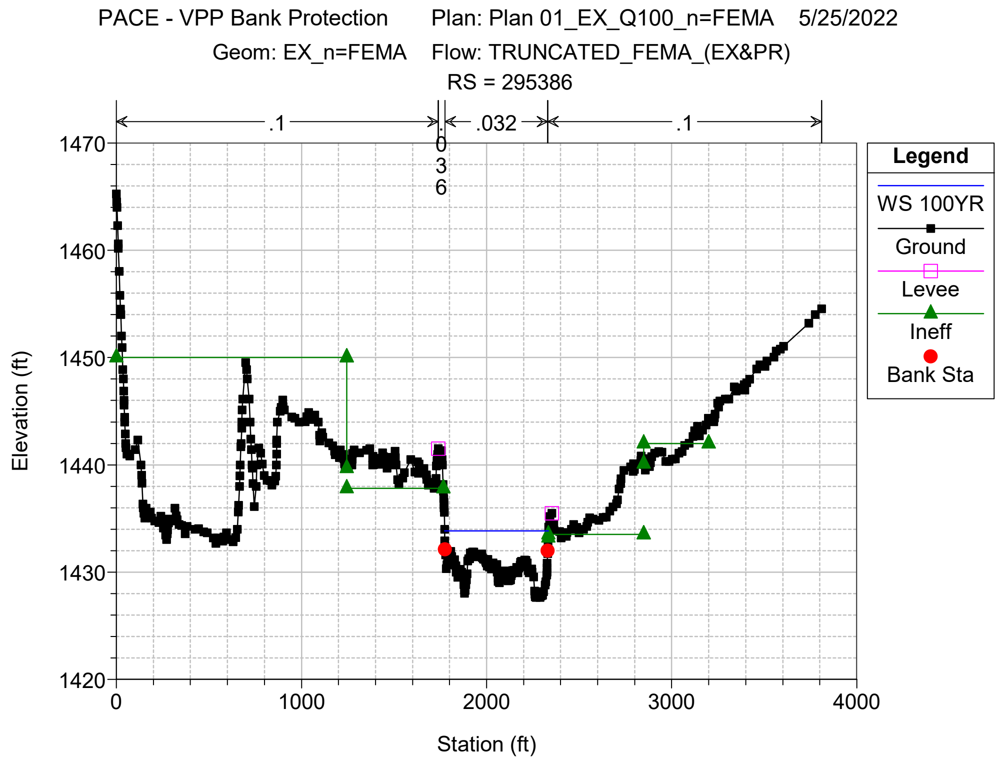

PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 297761 BR
.1
.036
.032
.036
.1
Legend
WS 100YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1450
1460
1470
1480
1490
1500
1510
1520
0
500
1000
1500
2000
2500
3000

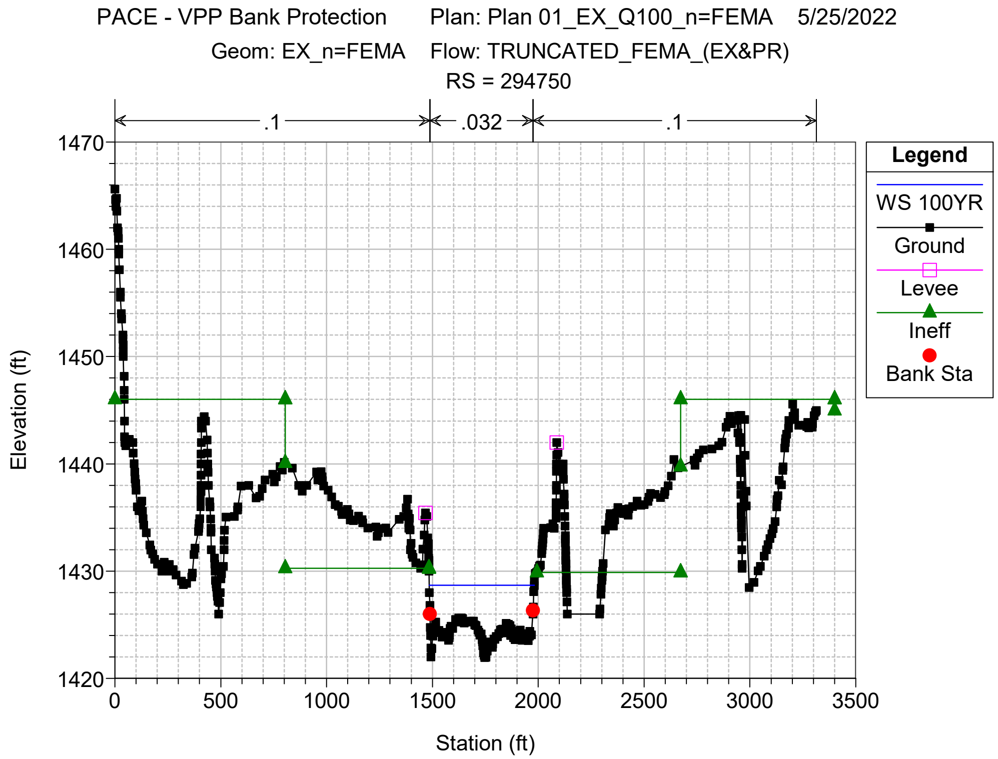
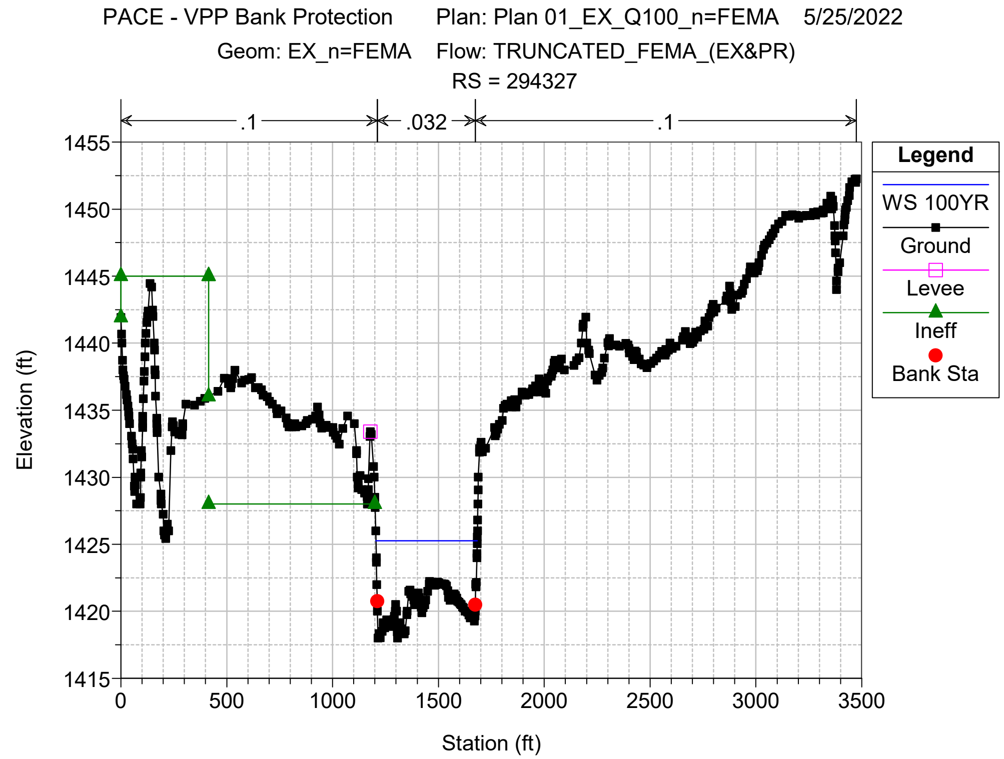
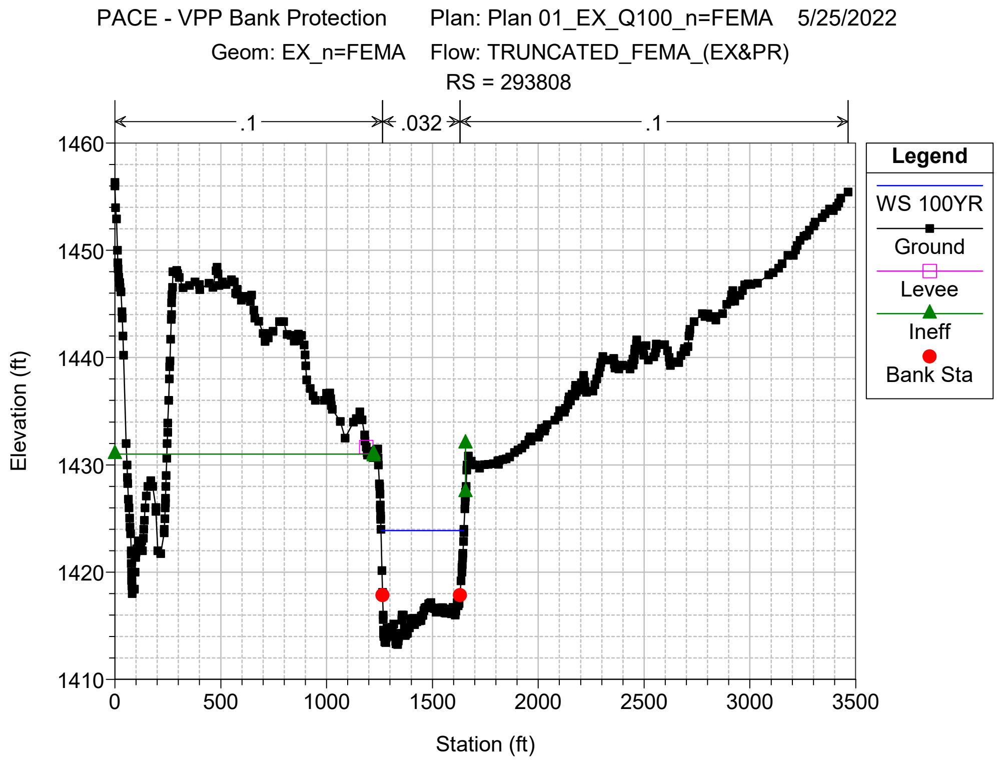
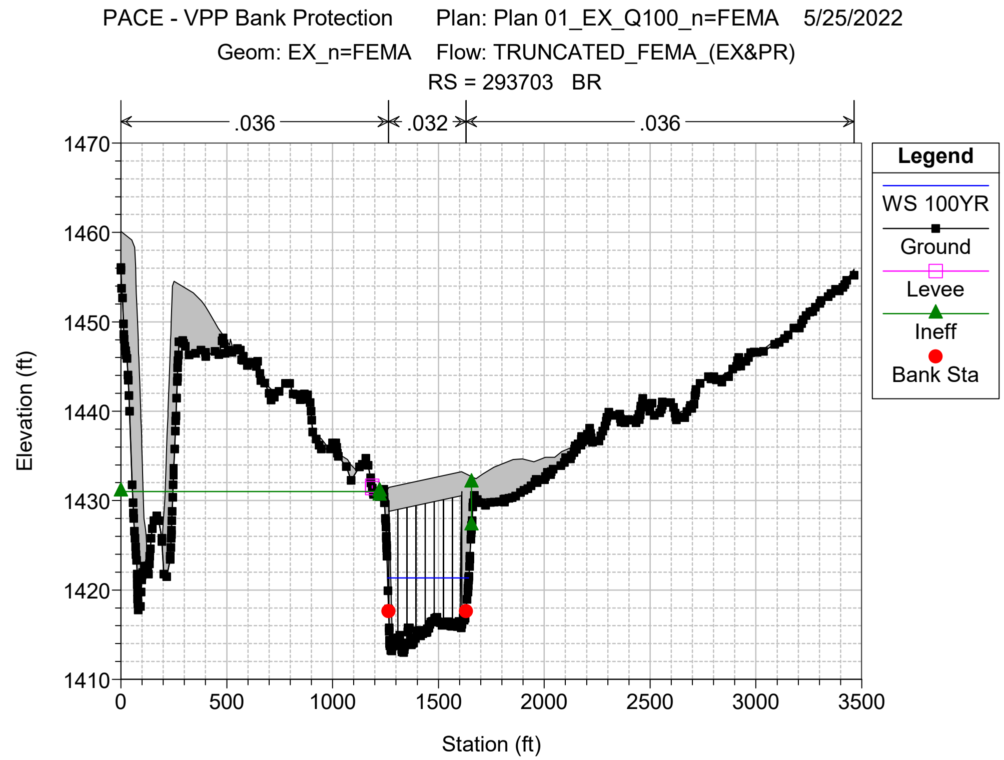

PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 297469
.1
.032
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1440
1450
1460
1470
1480
1490
1500
1510
0
500
1000
1500
2000
2500
3000

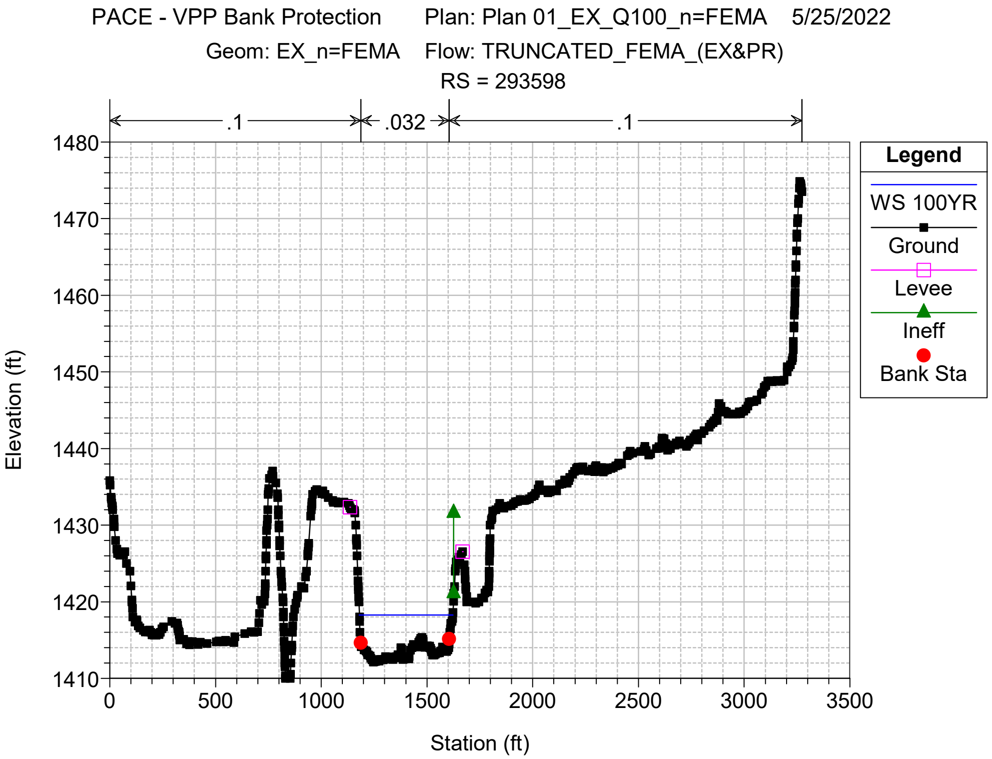

PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 297265
.1
.032
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1490
1480
1470
1460
1450
1440
0
1000
2000
3000
4000

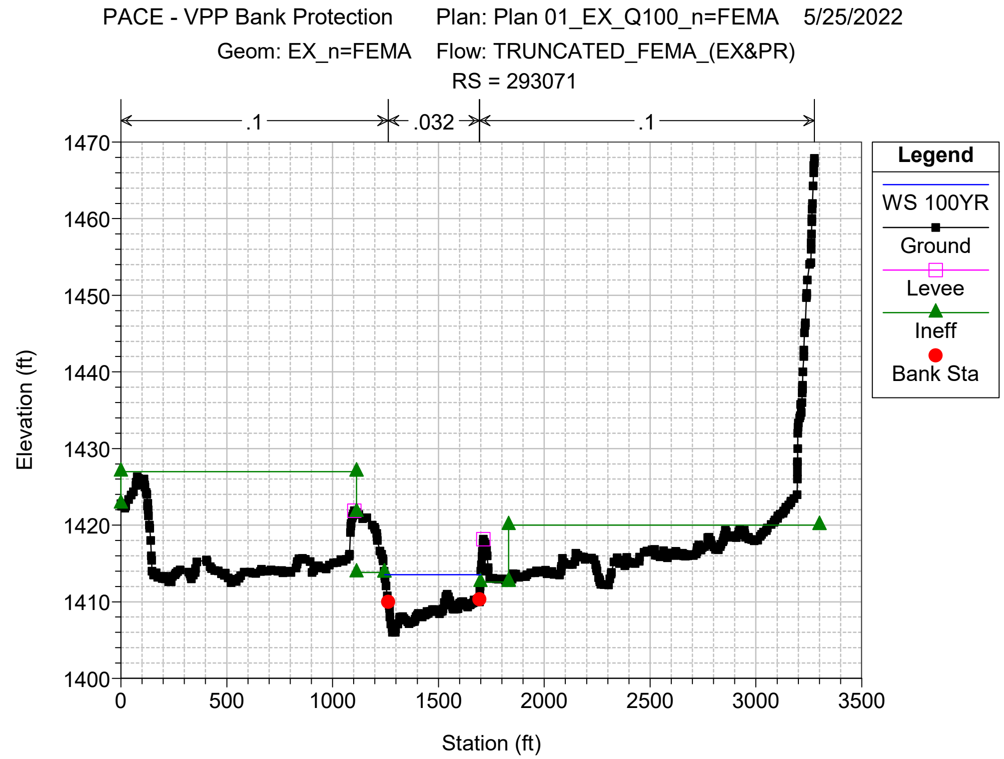

PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 296673
.1
.032
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1490
1480
1470
1460
1450
1440
0
500
1000
1500
2000
2500
3000
3500
4000

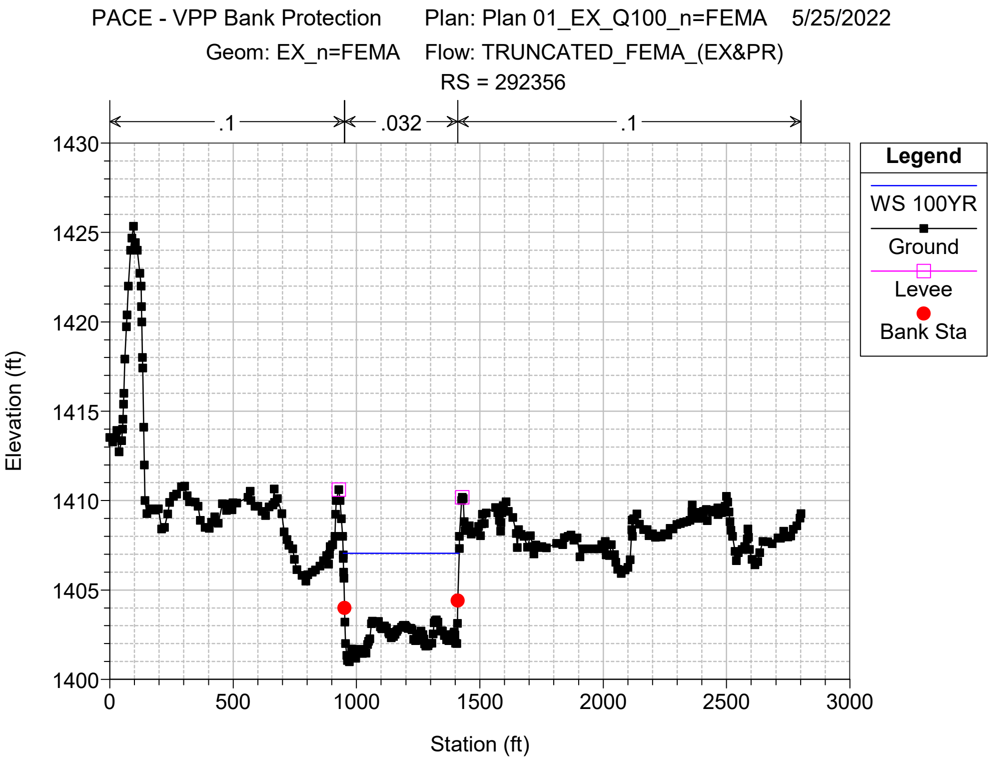

PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 296017
.1
.032
.1
0
3
6
0
3
6
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1520
1500
1480
1460
1440
1420
0
1000
2000
3000
4000

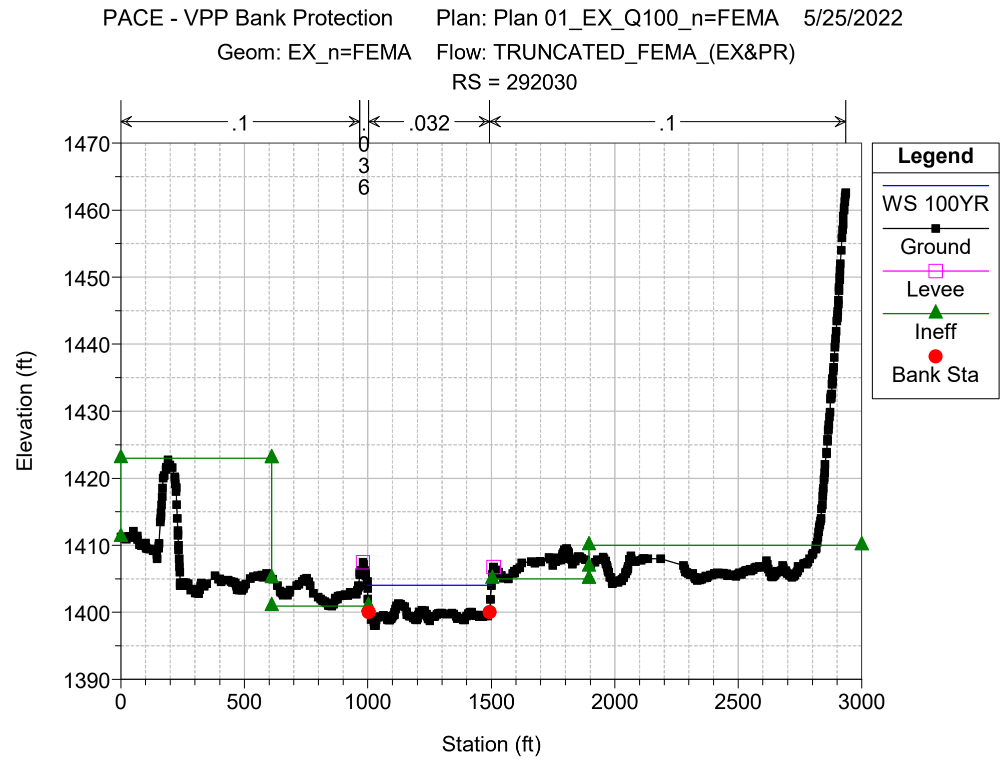

PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 295386
.1
.032
.1
0
3
6
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1470
1460
1450
1440
1430
1420
0
1000
2000
3000
4000


PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA
5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 294750
.1
.032
.1
1470
1460
1450
1440
1430
1420
Elevation (ft)
0
500
1000
1500
2000
2500
3000
3500
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA
5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 294327
.1
.032
.1
1455
1450
1445
1440
1435
1430
1425
1420
1415
Elevation (ft)
0
500
1000
1500
2000
2500
3000
3500
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA
5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 293808
.1
.032
.1
1460
1450
1440
1430
1420
1410
Elevation (ft)
0
500
1000
1500
2000
2500
3000
3500
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA
5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 293703 BR
.036
.032
.036
1470
1460
1450
1440
1430
1420
1410
Elevation (ft)
0
500
1000
1500
2000
2500
3000
3500
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

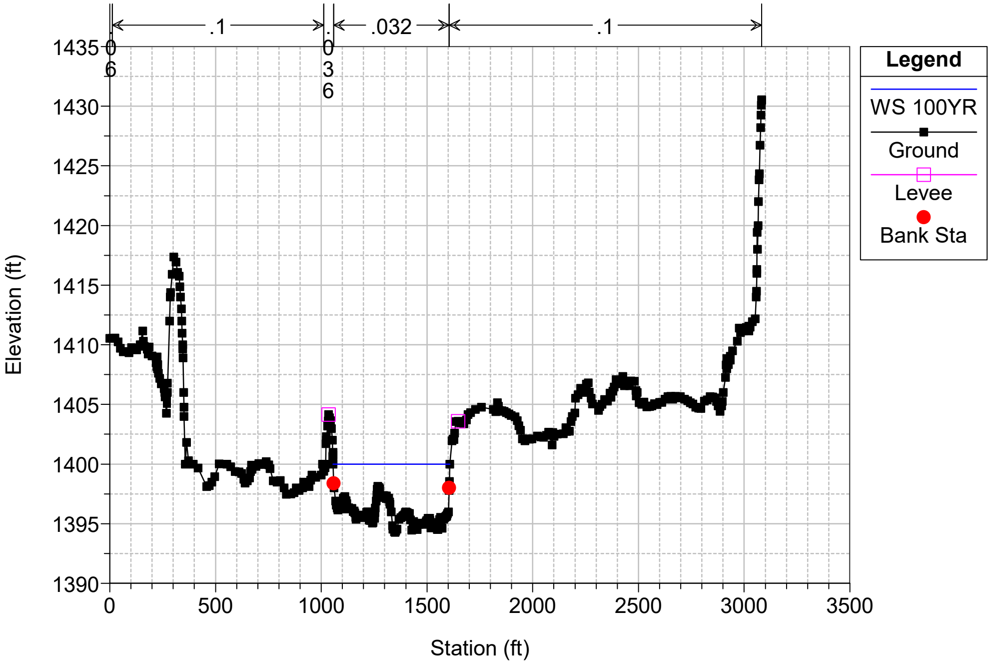

PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 293598
.1
.032
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1480
1470
1460
1450
1440
1430
1420
1410
0
500
1000
1500
2000
2500
3000
3500


PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 293071
.1
.032
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1470
1460
1450
1440
1430
1420
1410
1400
0
500
1000
1500
2000
2500
3000
3500

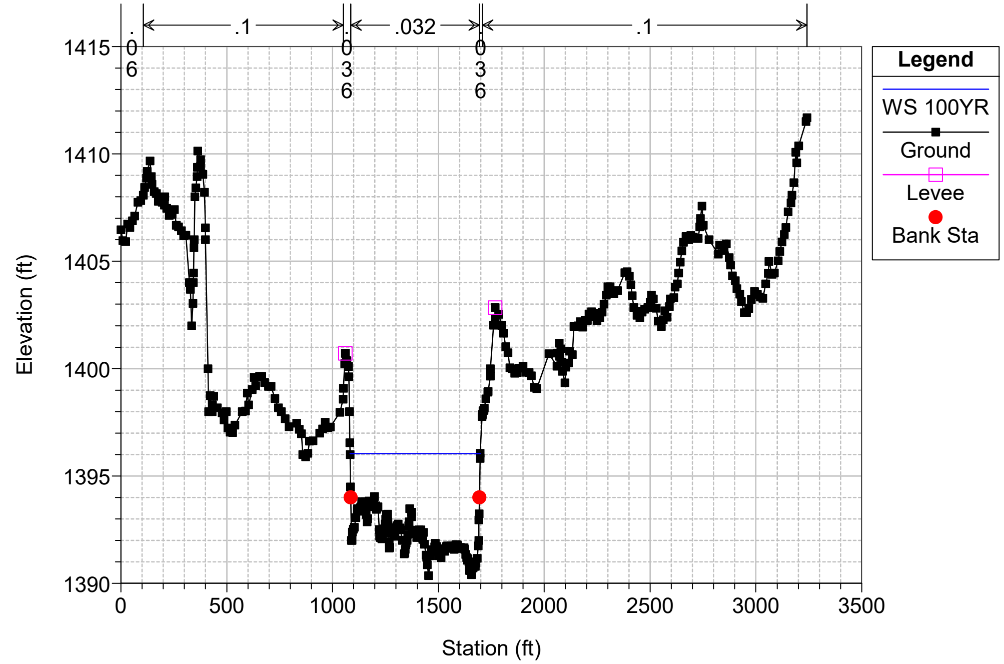

PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 292356
.1
.032
.1
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
1430
1425
1420
1415
1410
1405
1400
0
500
1000
1500
2000
2500
3000


PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 292030
.1
0
3
6
.032
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1470
1460
1450
1440
1430
1420
1410
1400
1390
0
500
1000
1500
2000
2500
3000

PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 291595



PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 291158



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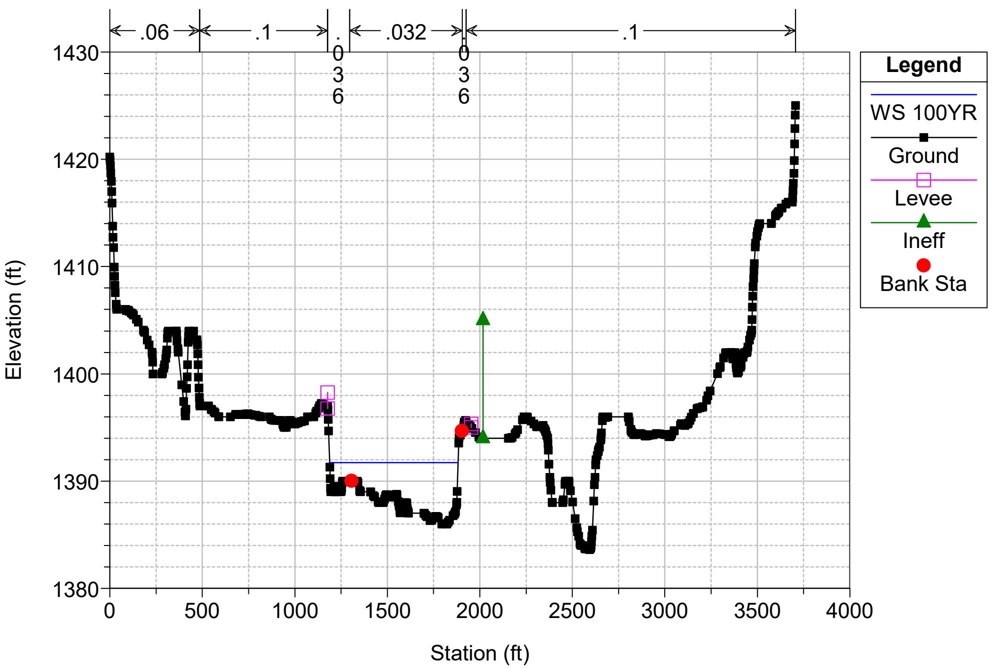
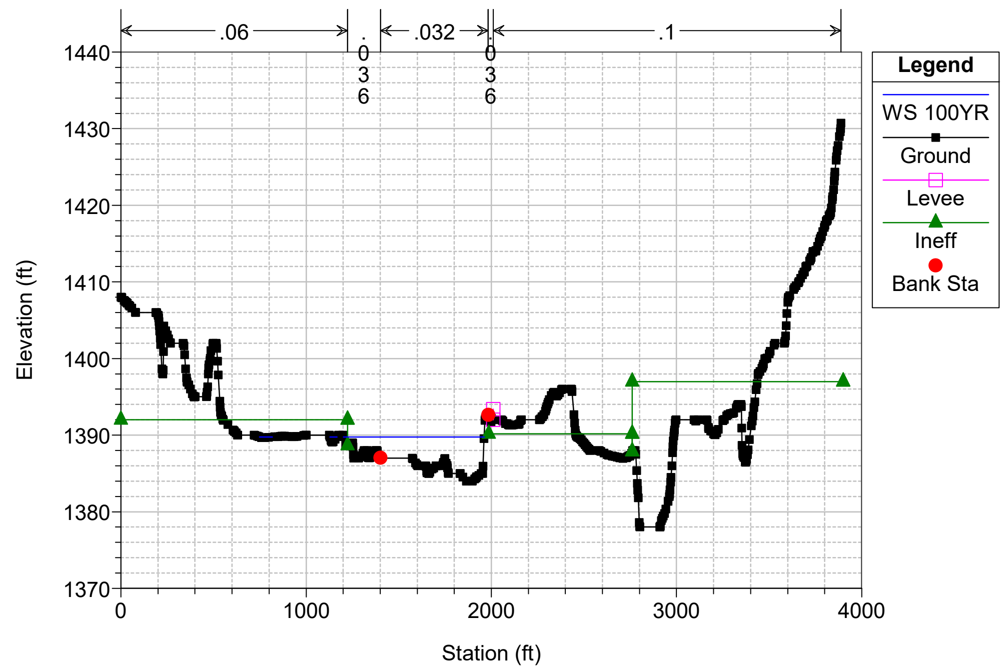
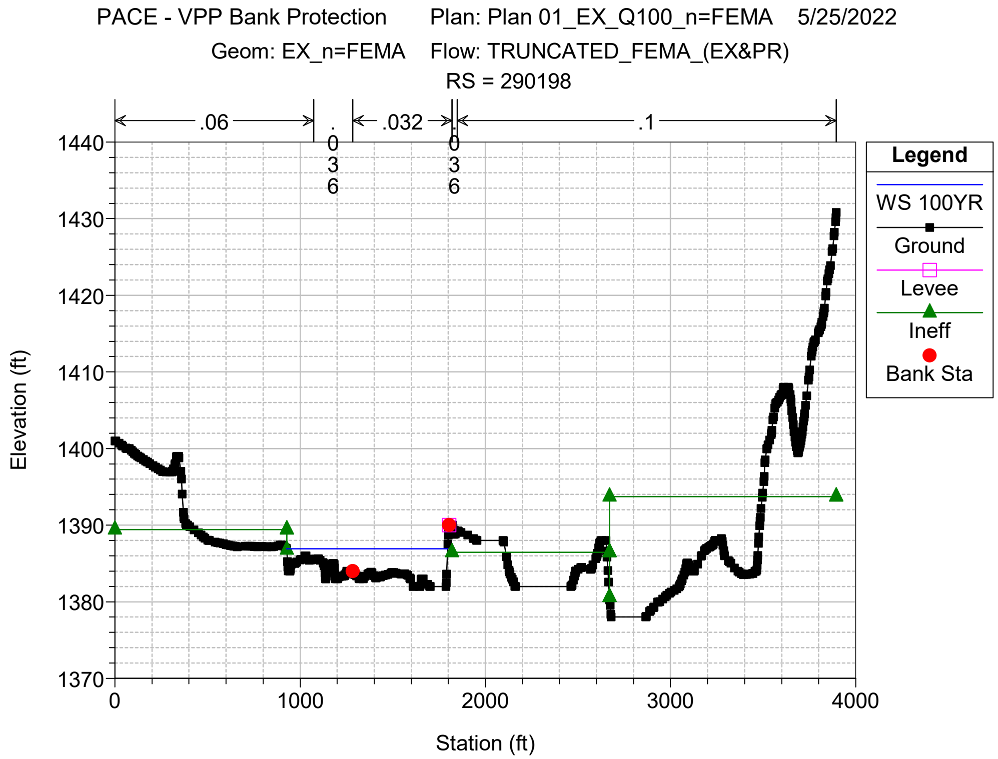
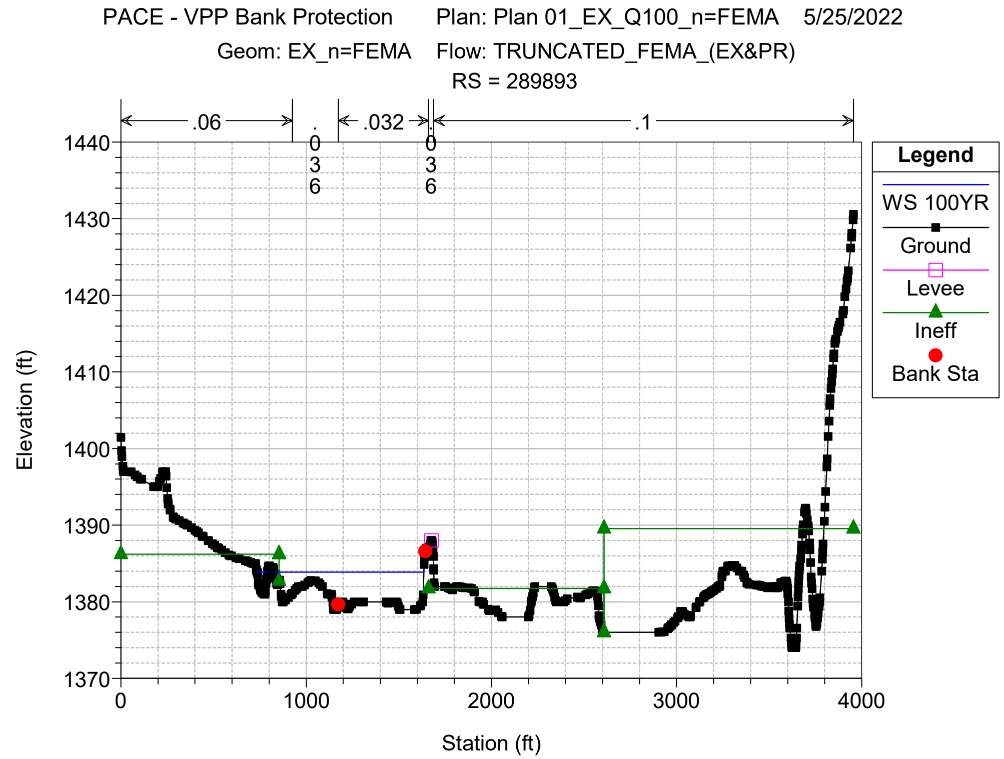
RS = 290724

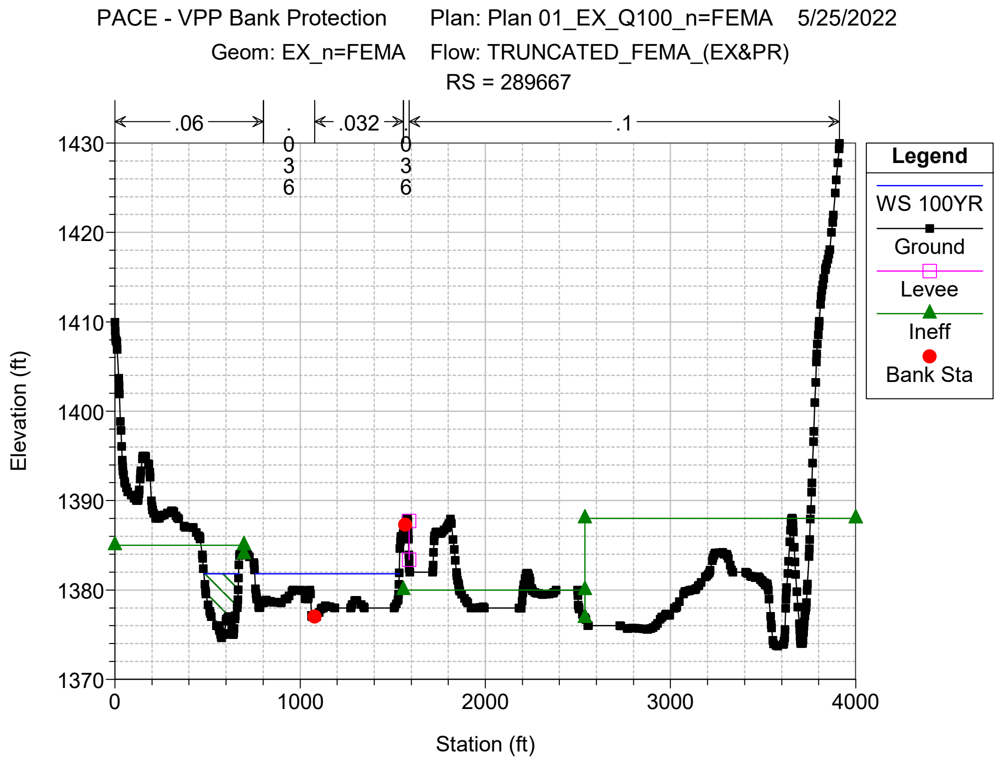


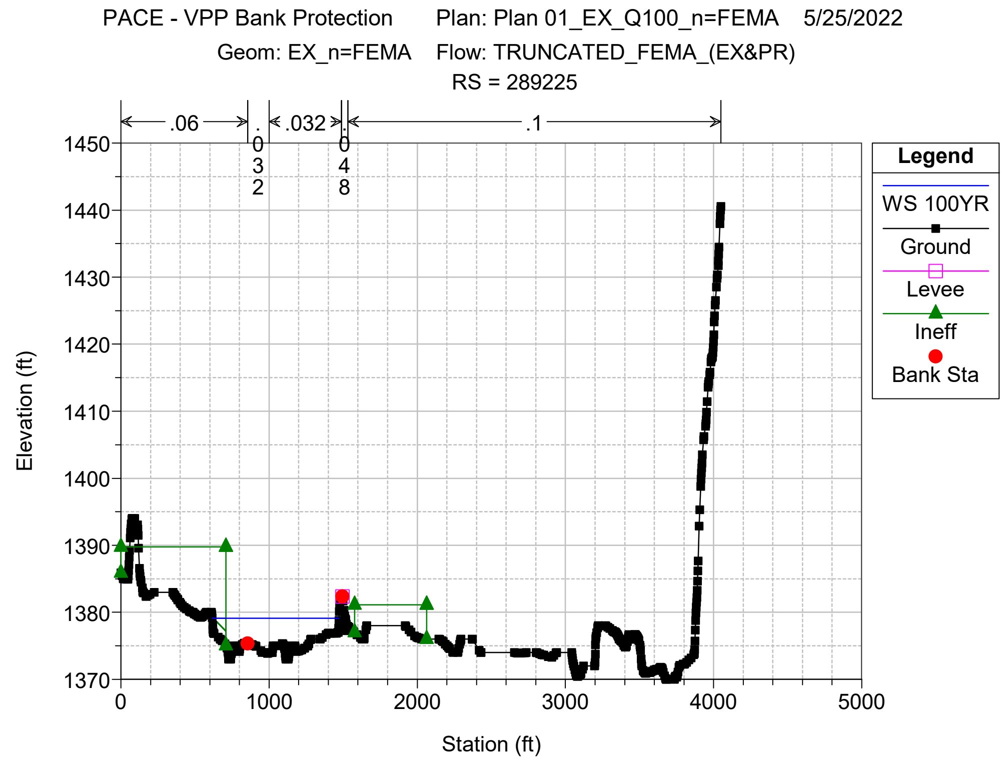
PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 290504




PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA
5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 290198
.06
.036
.032
.036
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1440
1430
1420
1410
1400
1390
1380
1370
0
1000
2000
3000
4000


PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA
5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 289893
.06
.036
.032
.036
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1440
1430
1420
1410
1400
1390
1380
1370
0
1000
2000
3000
4000


PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA
5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 289667
.06
.036
.032
.036
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1430
1420
1410
1400
1390
1380
1370
0
1000
2000
3000
4000


PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA
5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 289225
.06
.032
.032
.048
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
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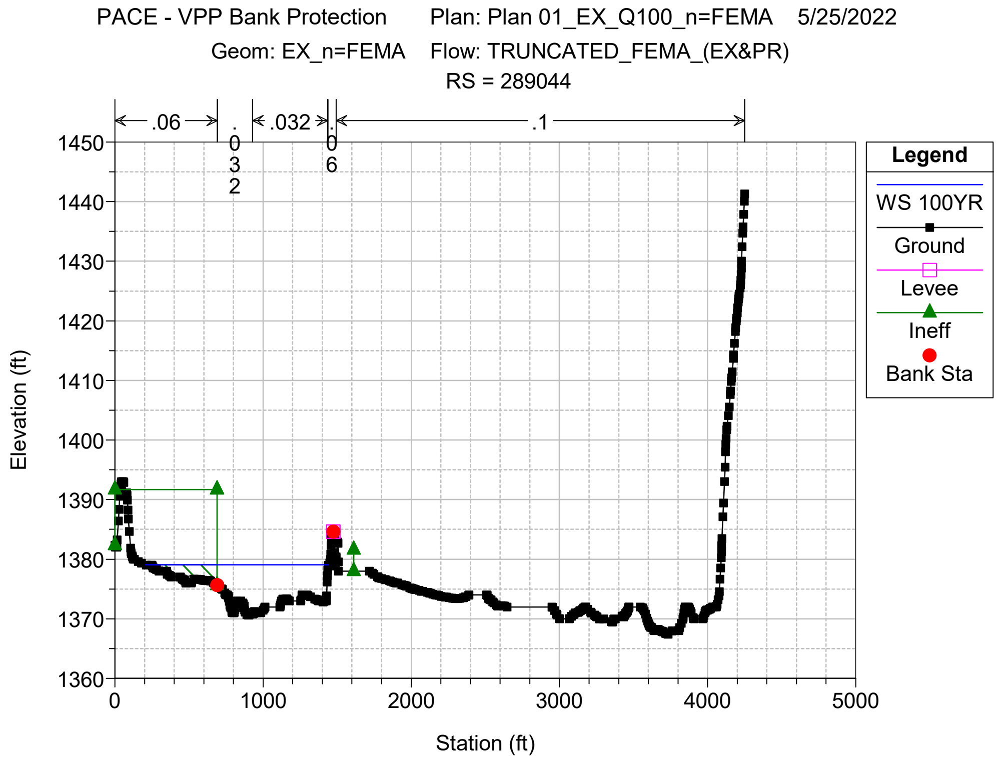
1440
1430
1420
1410
1400
1390
1380
1370
0
1000
2000
3000
4000
5000


PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
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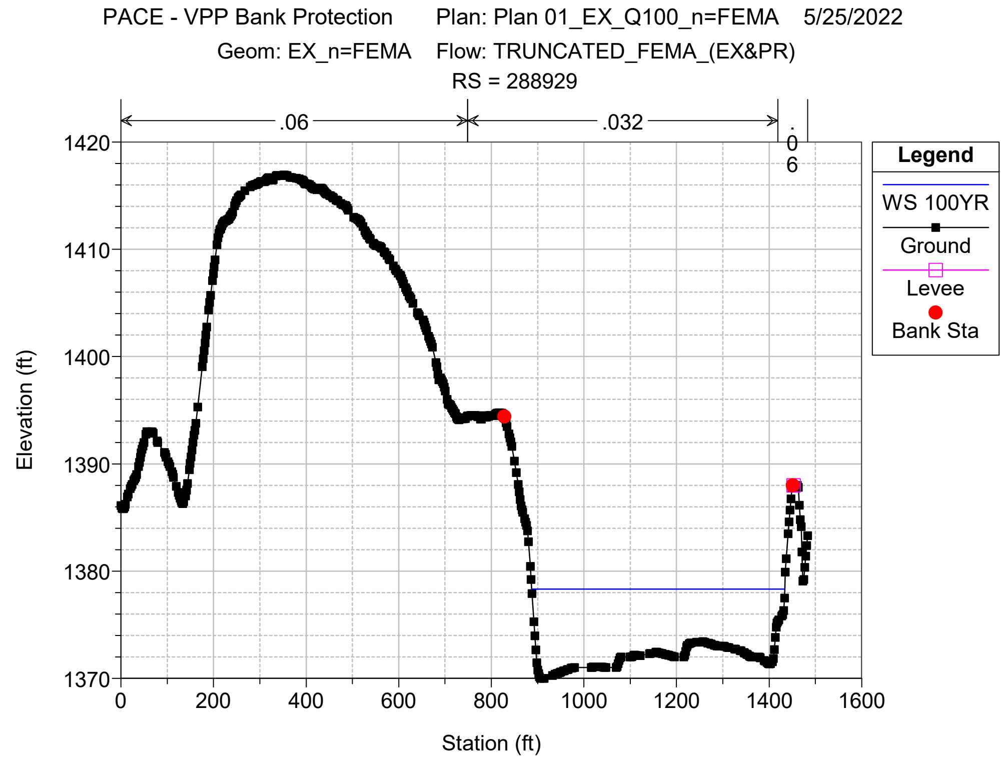
.06
.032
.032
.06
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1360
1370
1380
1390
1400
1410
1420
1430
1440
1450
0
1000
2000
3000
4000
5000


PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 288929
.06
.032
.06
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
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1390
1400
1410
1420
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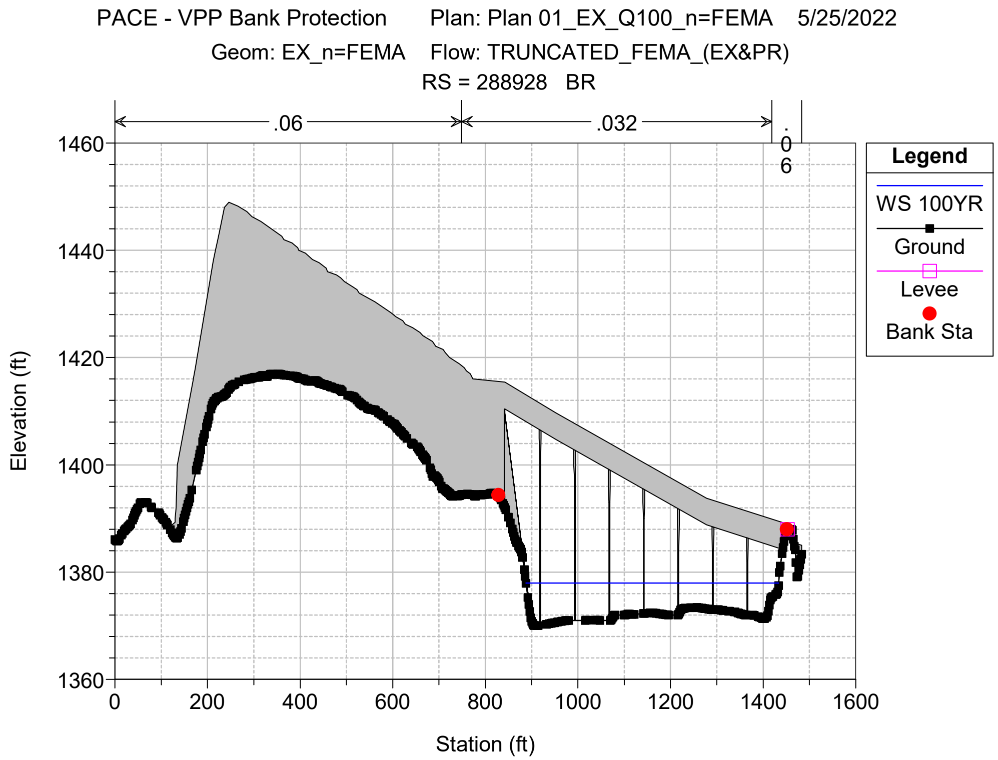
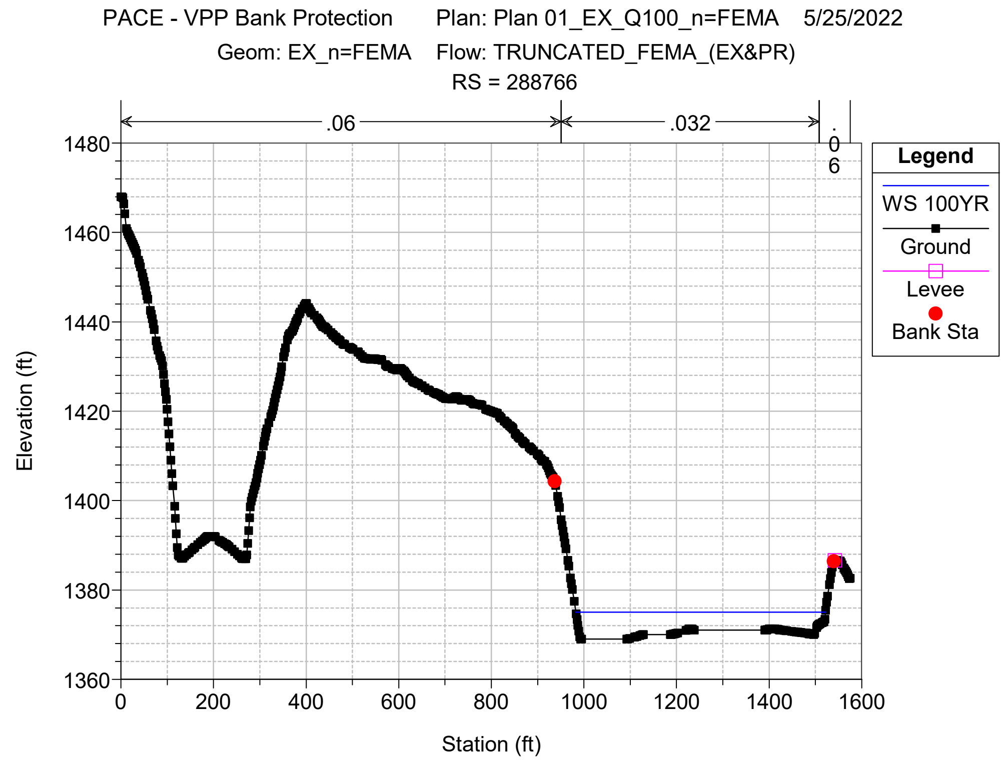
200
400
600
800
1000
1200
1400
1600


PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 288928 BR
.06
.032
.06
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
1360
1380
1400
1420
1440
1460
0
200
400
600
800
1000
1200
1400
1600


PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
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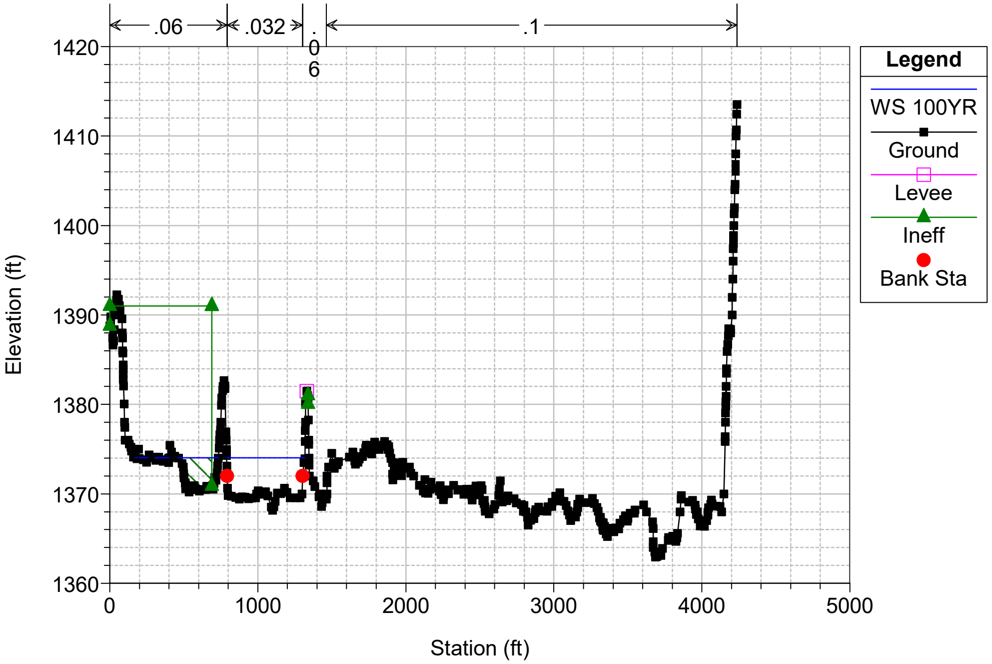
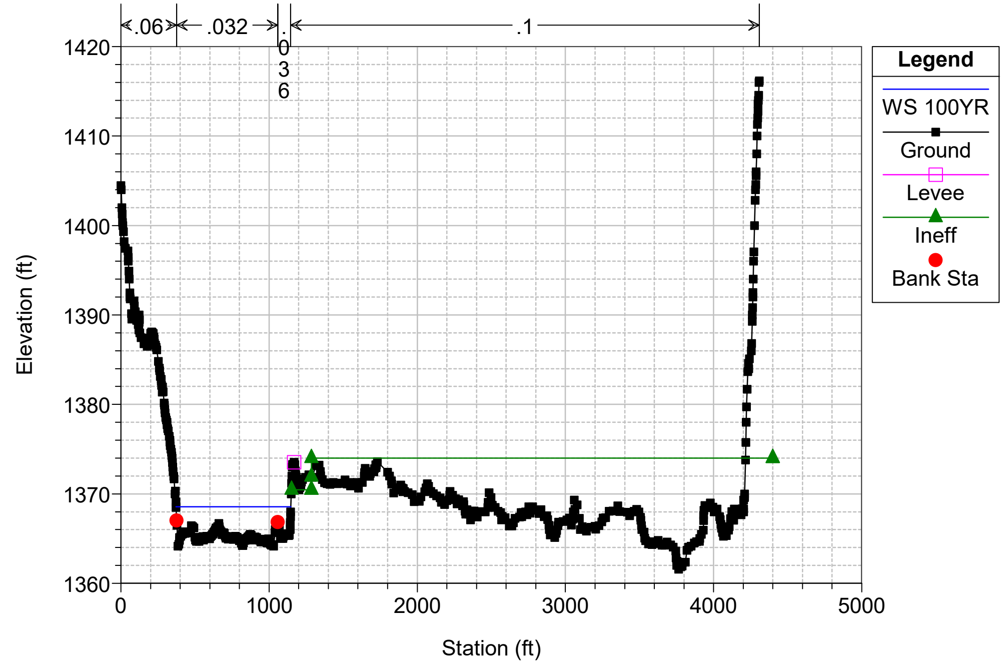
.06
.032
.06
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
1360
1380
1400
1420
1440
1460
1480
0
200
400
600
800
1000
1200
1400
1600

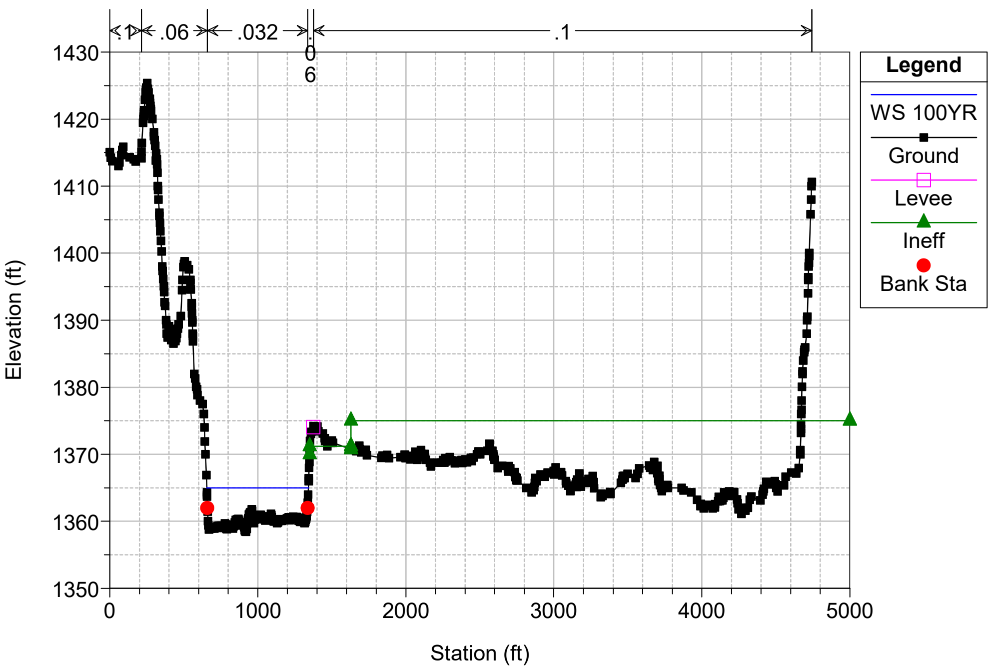
PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 288696



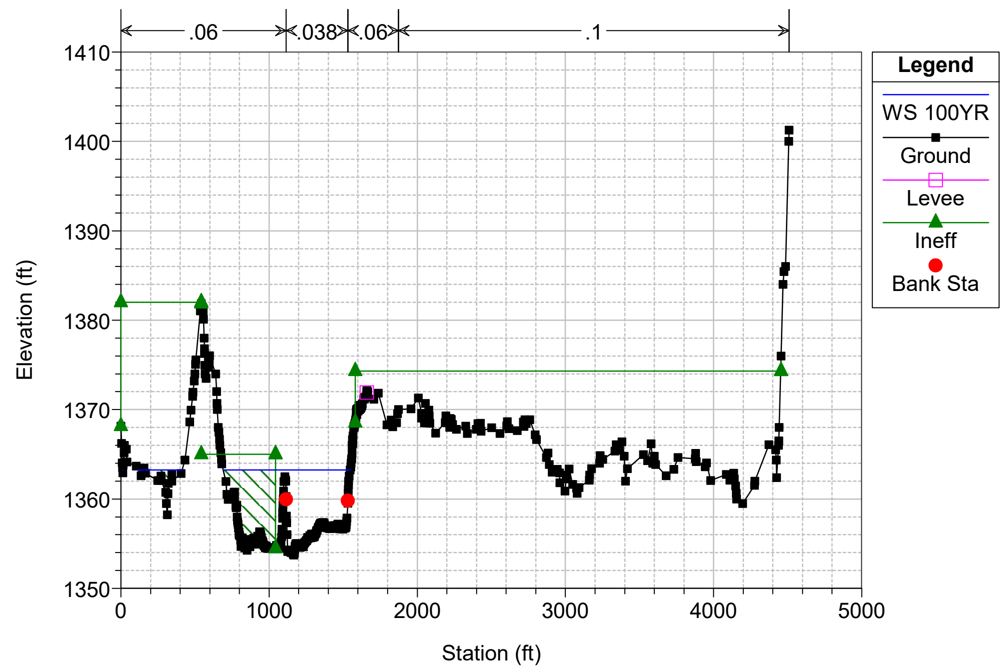
PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 288160



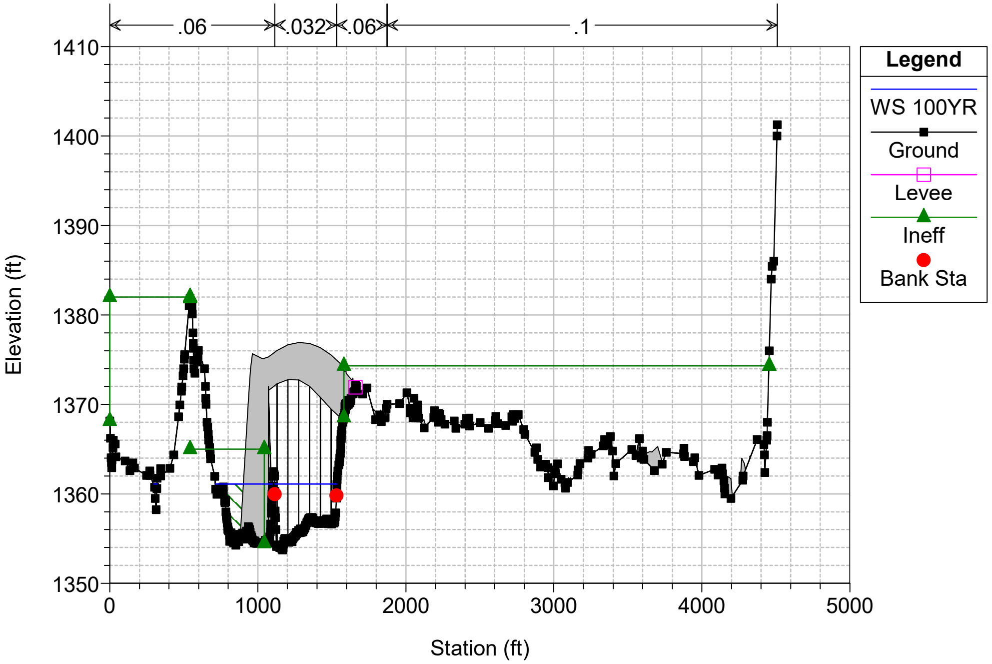
PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 287582



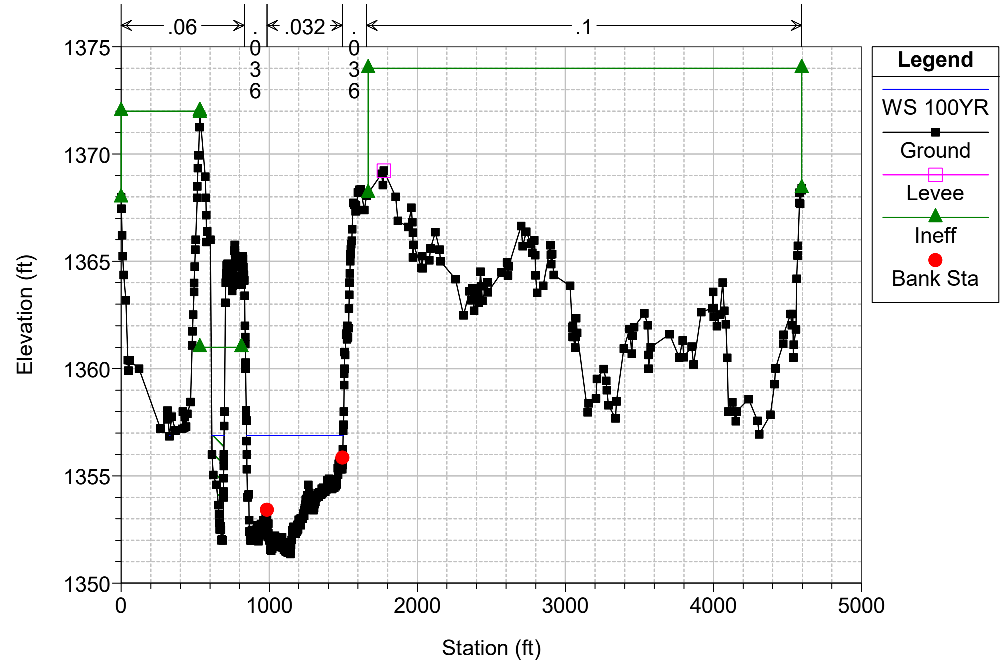
PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 287039



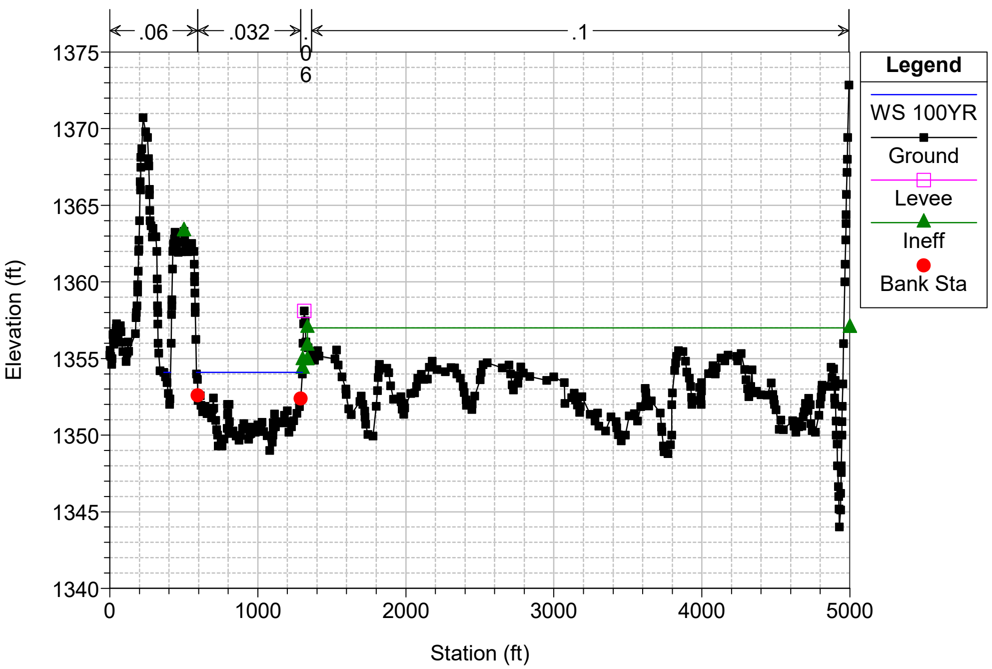
PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 286876 BR



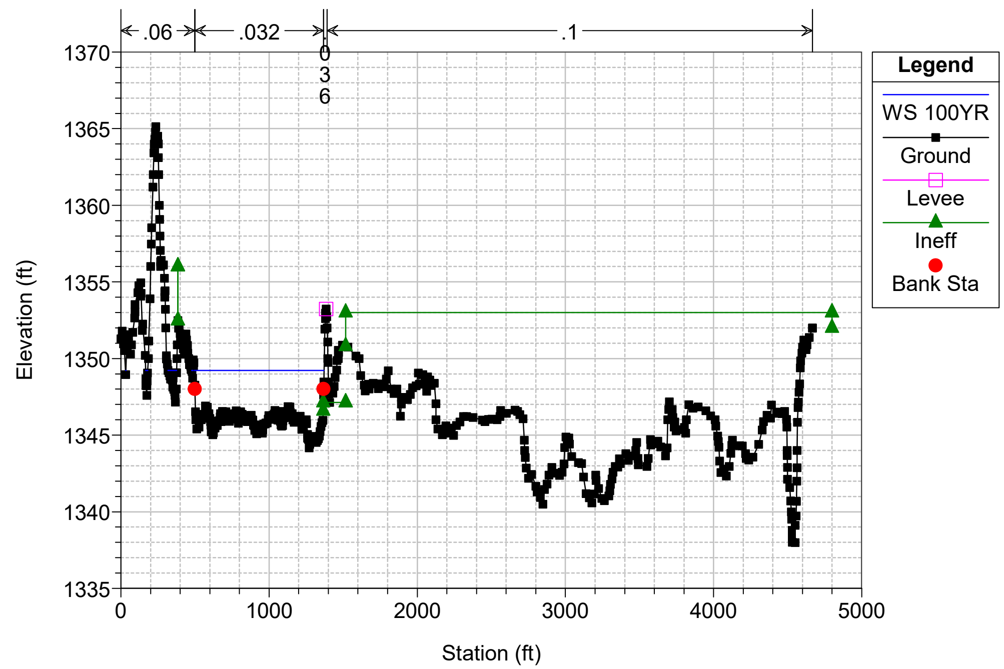
PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 286718

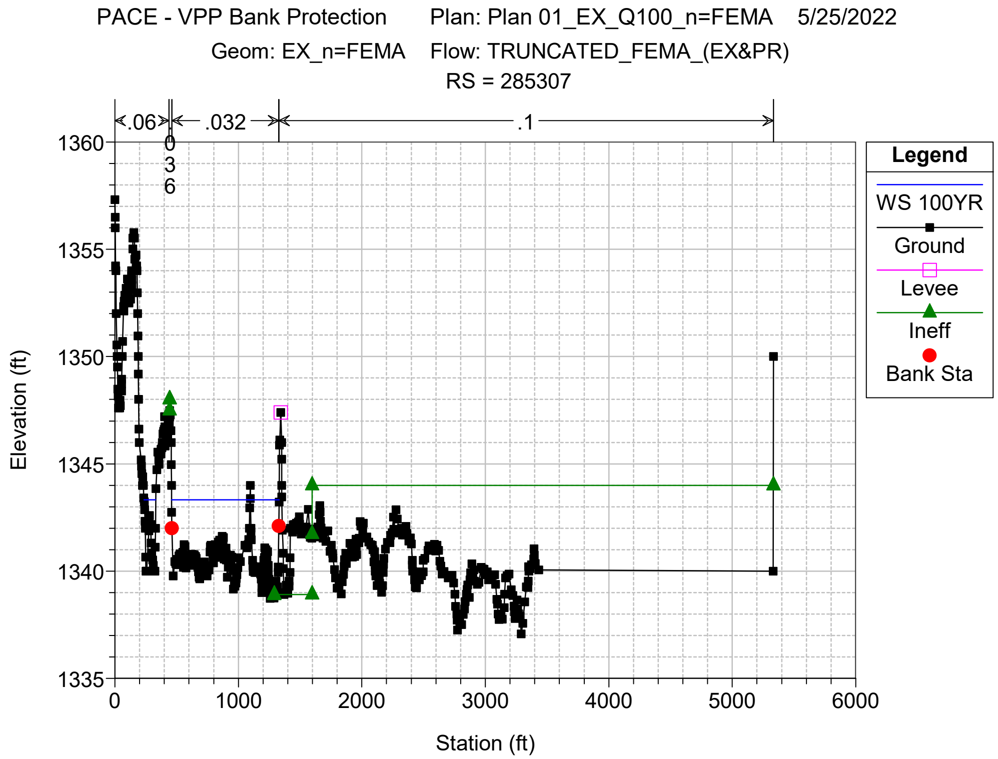


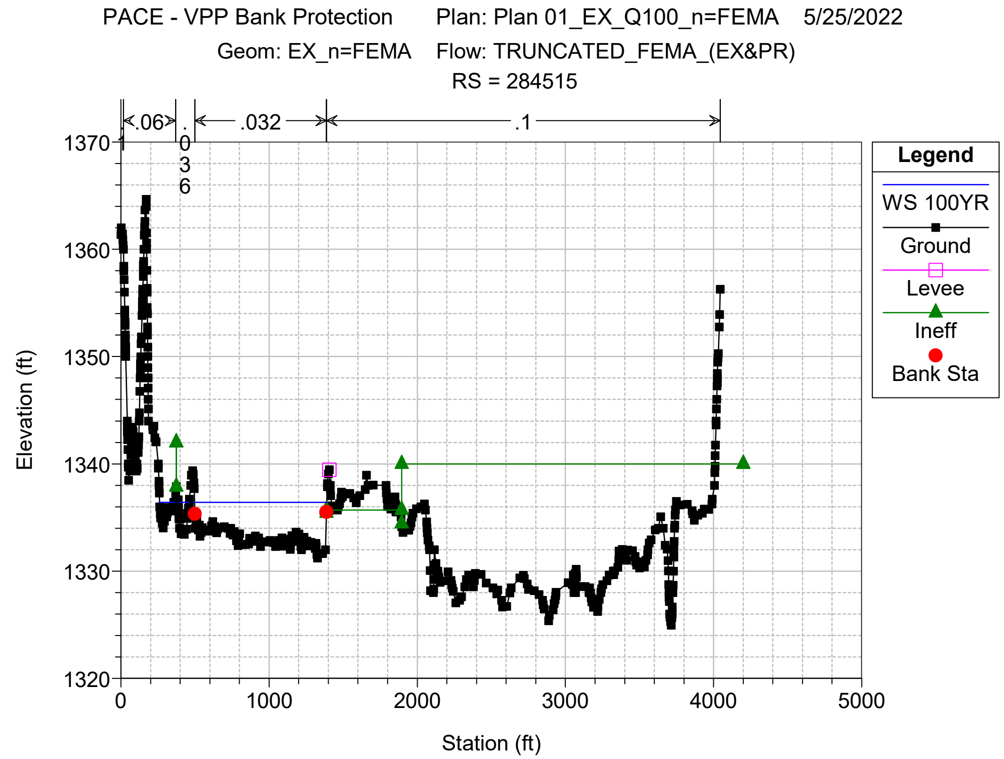
PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 286407

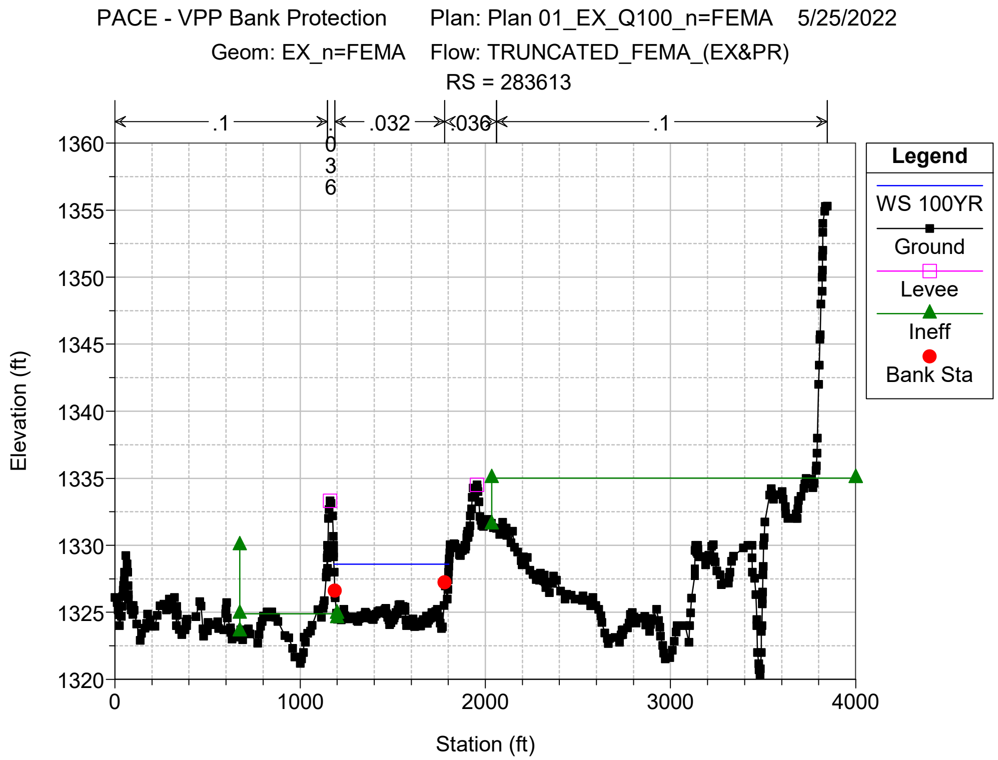


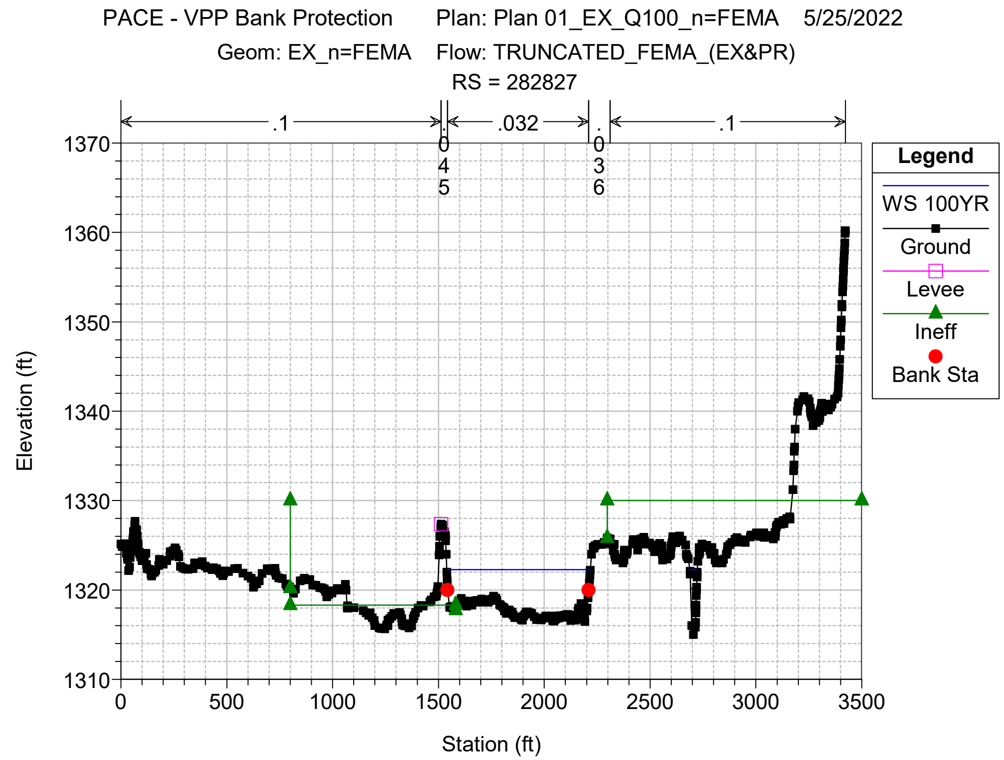
PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 285935

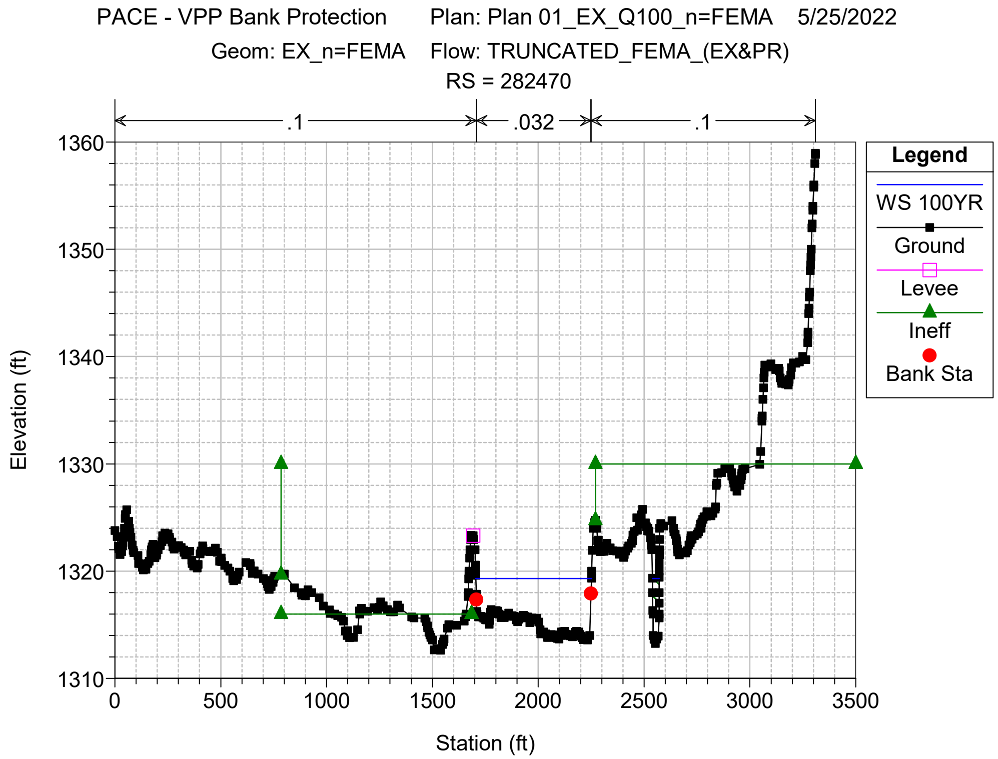


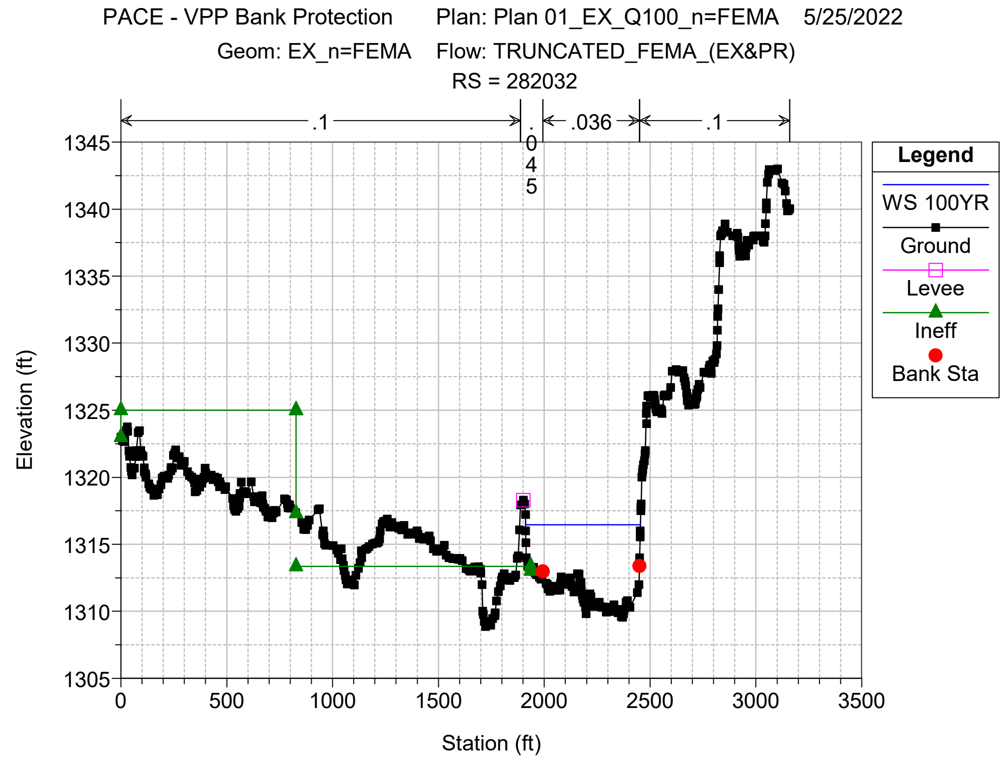

PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 285307
.06
036
.032
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1335
1340
1345
1350
1355
1360
0
1000
2000
3000
4000
5000
6000

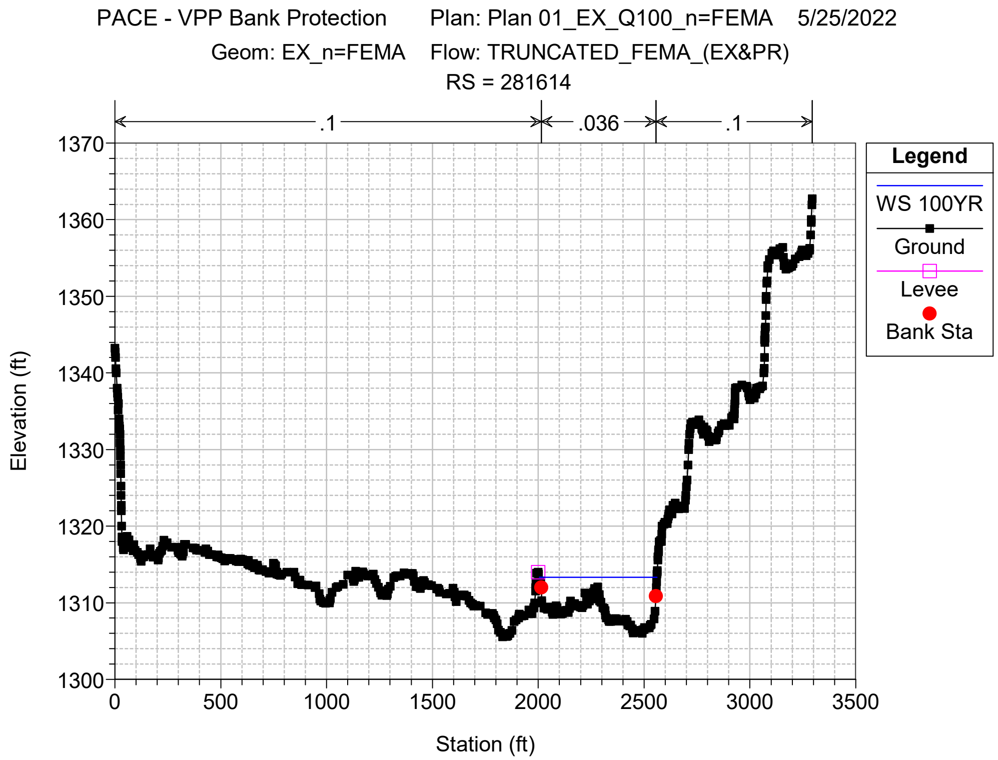

PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 284515
.06
.036
.032
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1320
1330
1340
1350
1360
1370
0
1000
2000
3000
4000
5000

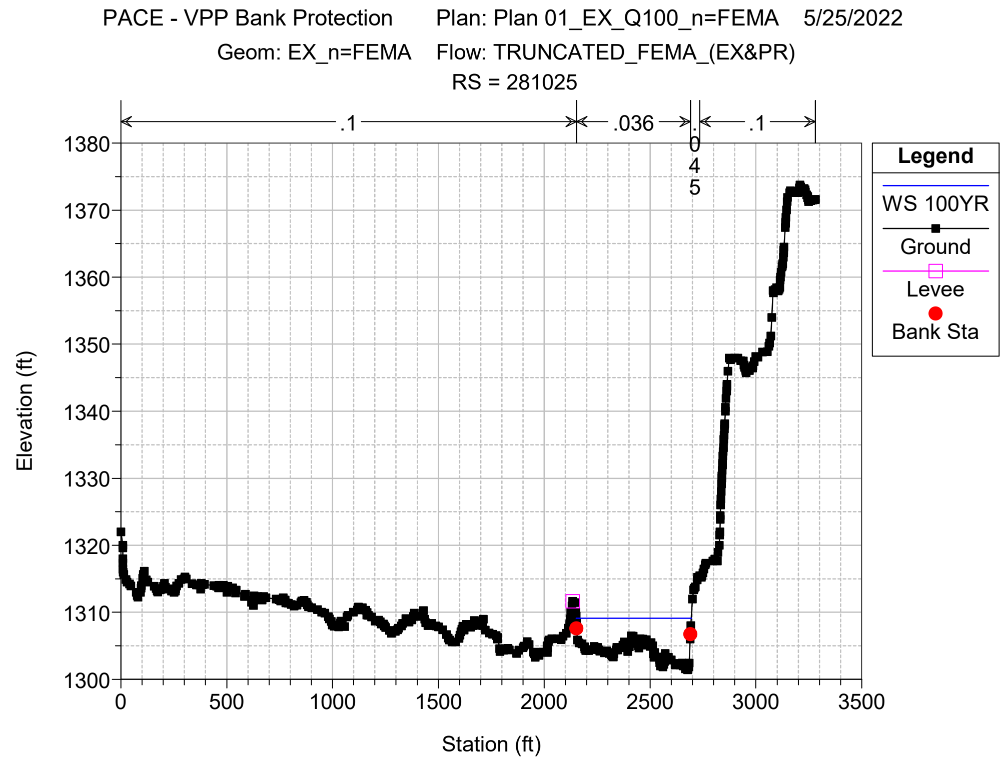

PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 283613
.1
036
.032
.036
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1320
1325
1330
1335
1340
1345
1350
1355
1360
0
1000
2000
3000
4000

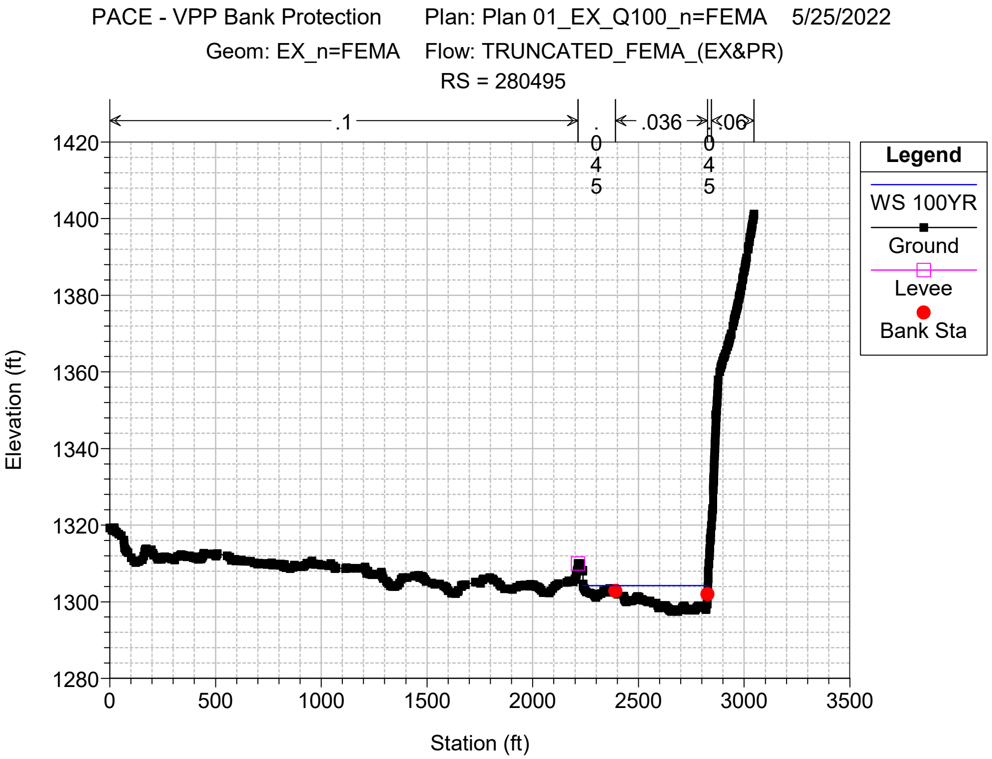

PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 282827
.1
045
.032
.036
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1310
1320
1330
1340
1350
1360
1370
0
500
1000
1500
2000
2500
3000
3500

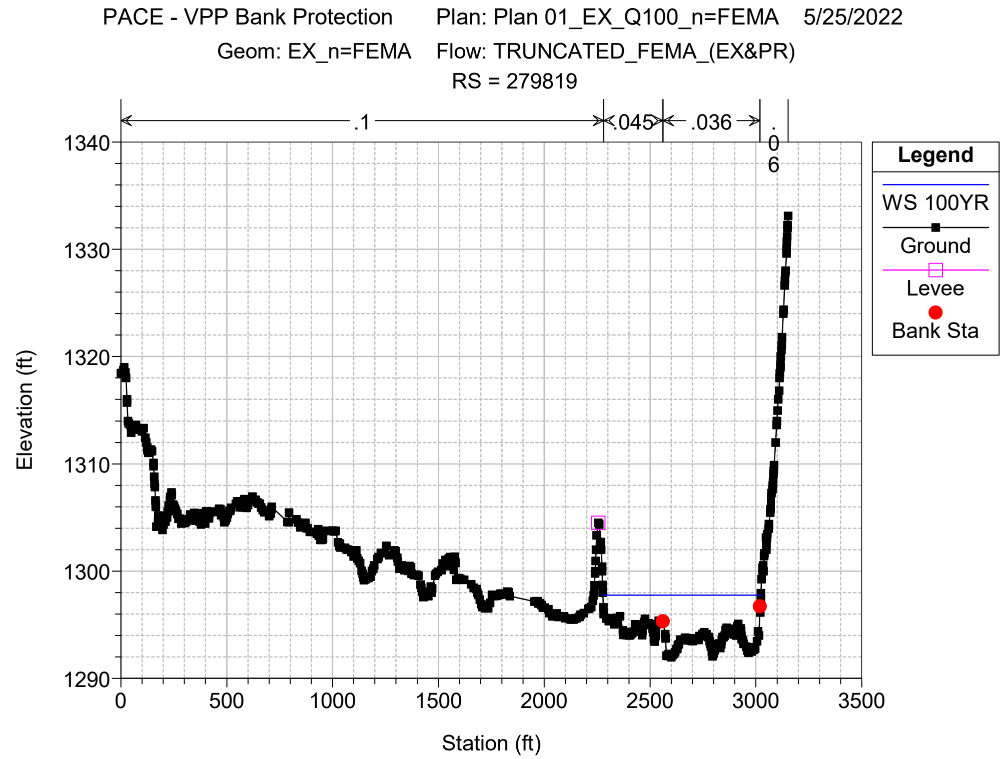

PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA
5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 282470
.1
.032
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

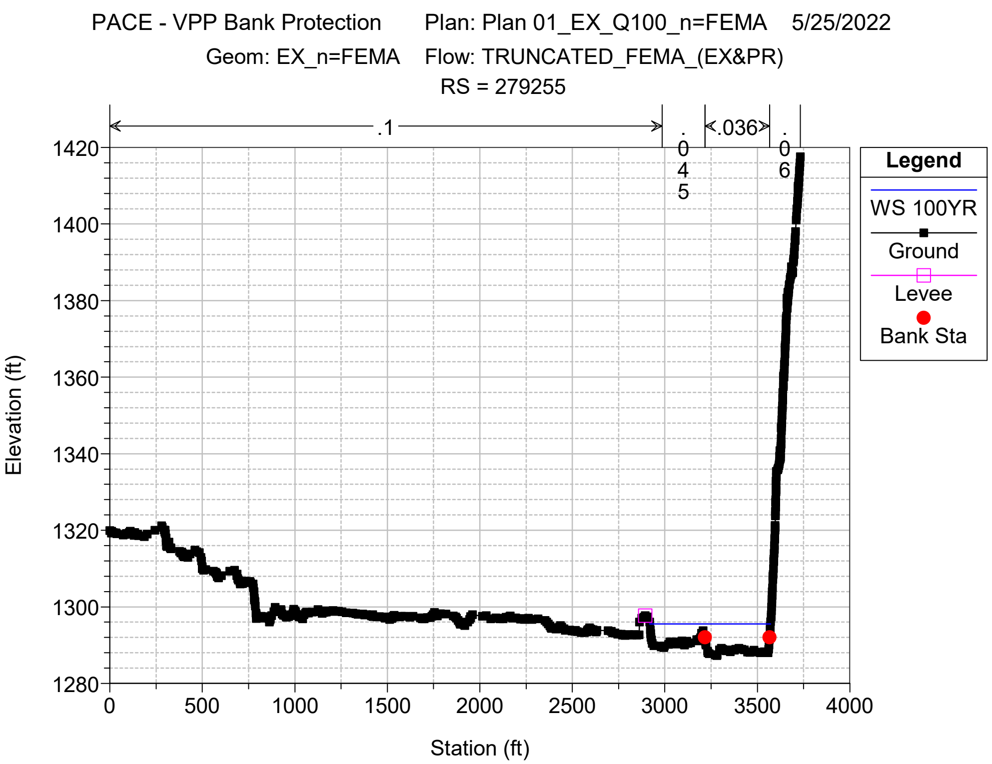

PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA
5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 282032
.1
.045
.036
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

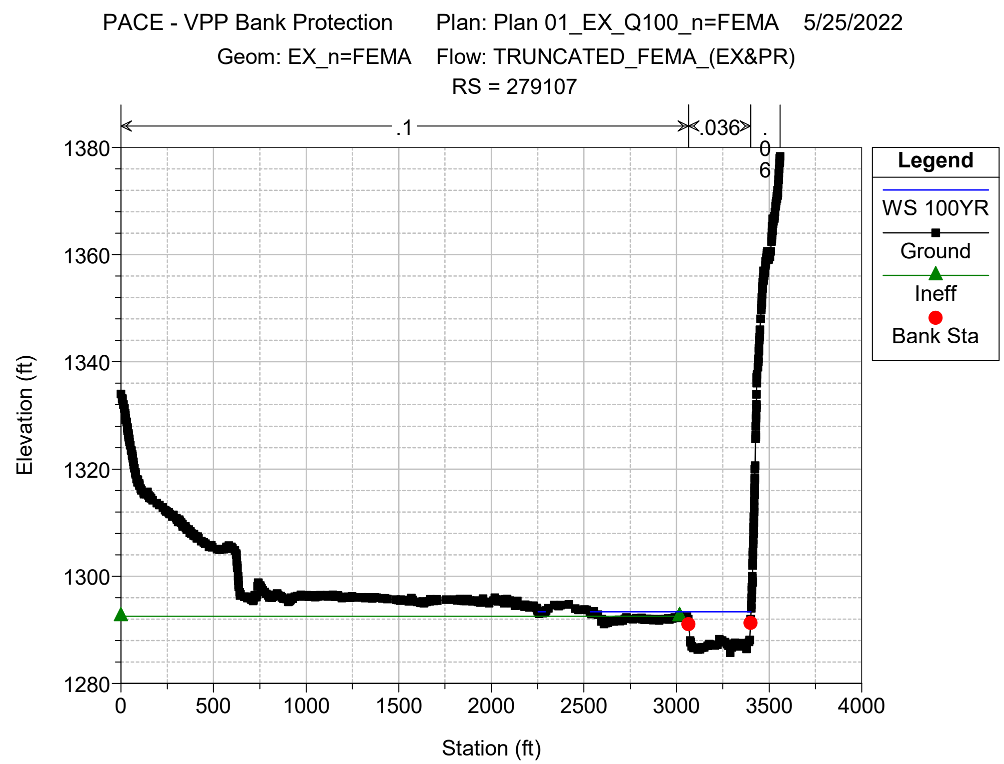

PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA
5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 281614
.1
.036
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Bank Sta

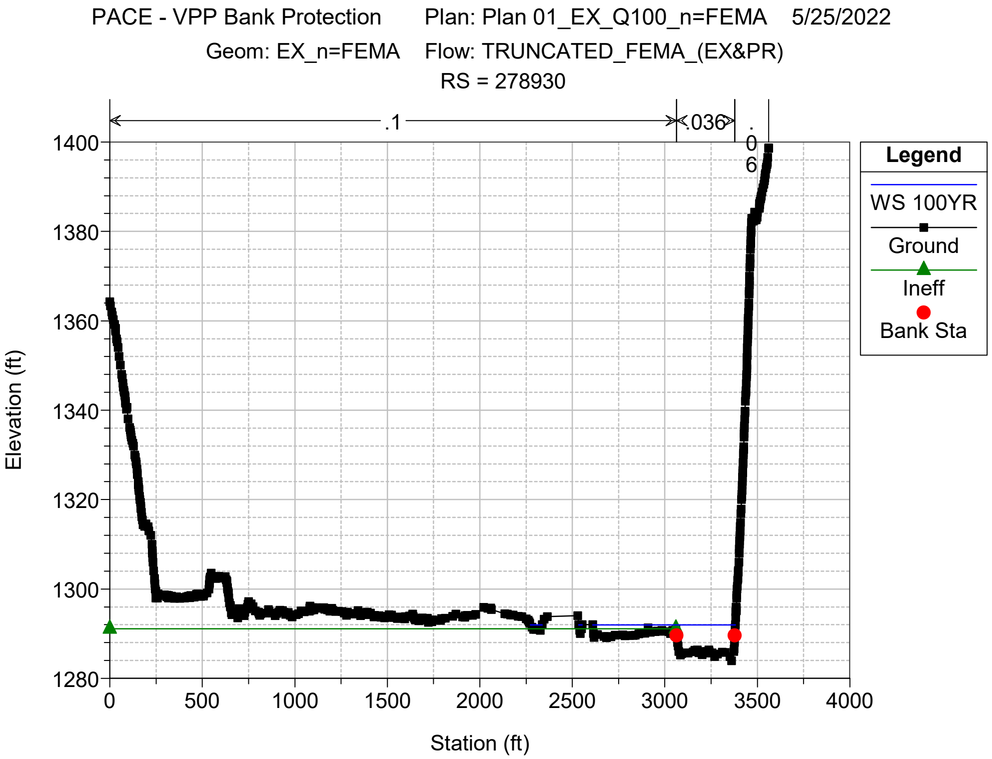

PACE - VPP Bank Protection
Plan: Plan 01_EX_Q100_n=FEMA
5/25/2022
Geom: EX_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 281025
.1
.036
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Bank Sta

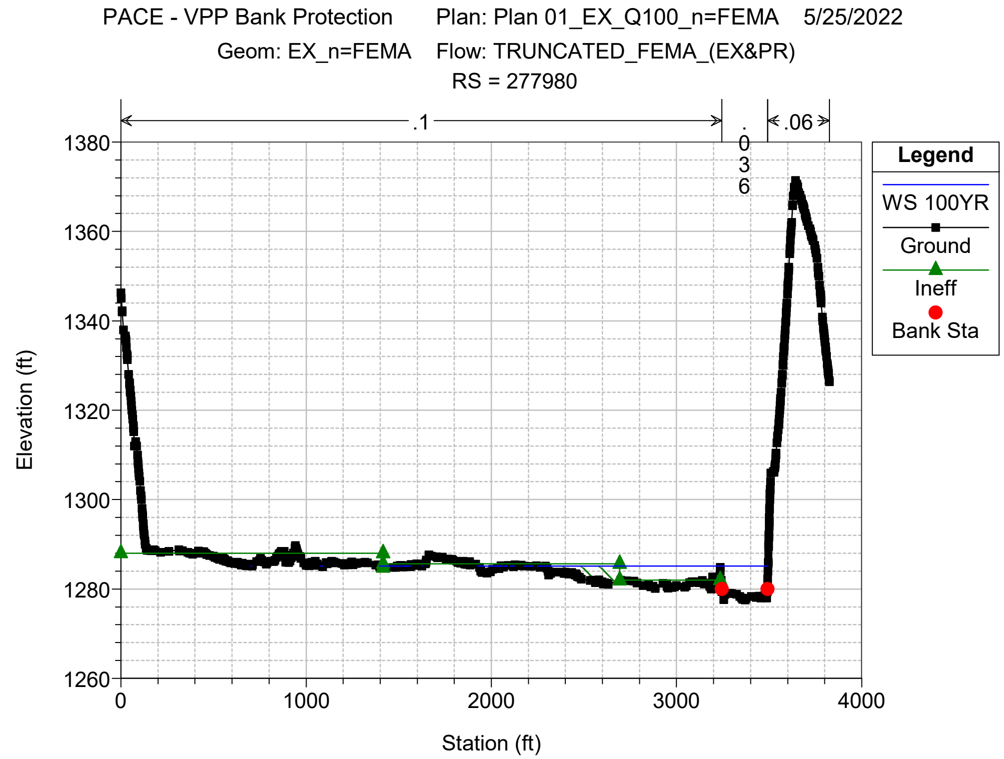

PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 280495
.1
.045
.036
.045
.06
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

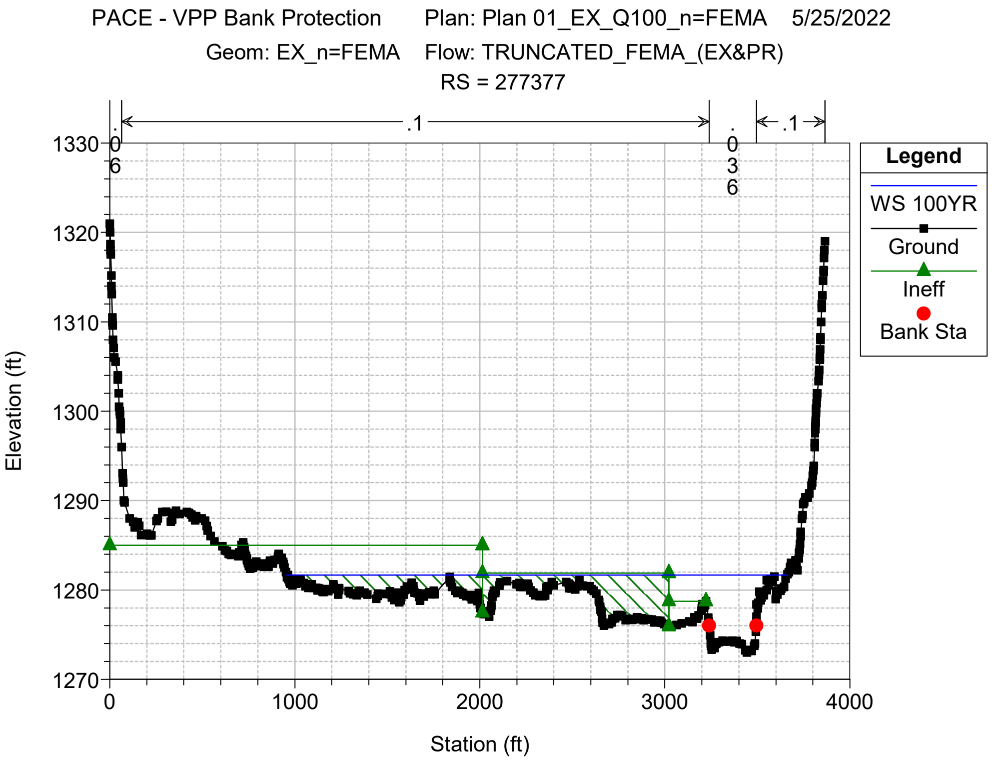

PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 279819
.1
.045
.036
.06
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 279255
.1
.045
.036
.06
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 279107
.1
.036
.06
Legend
WS 100YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

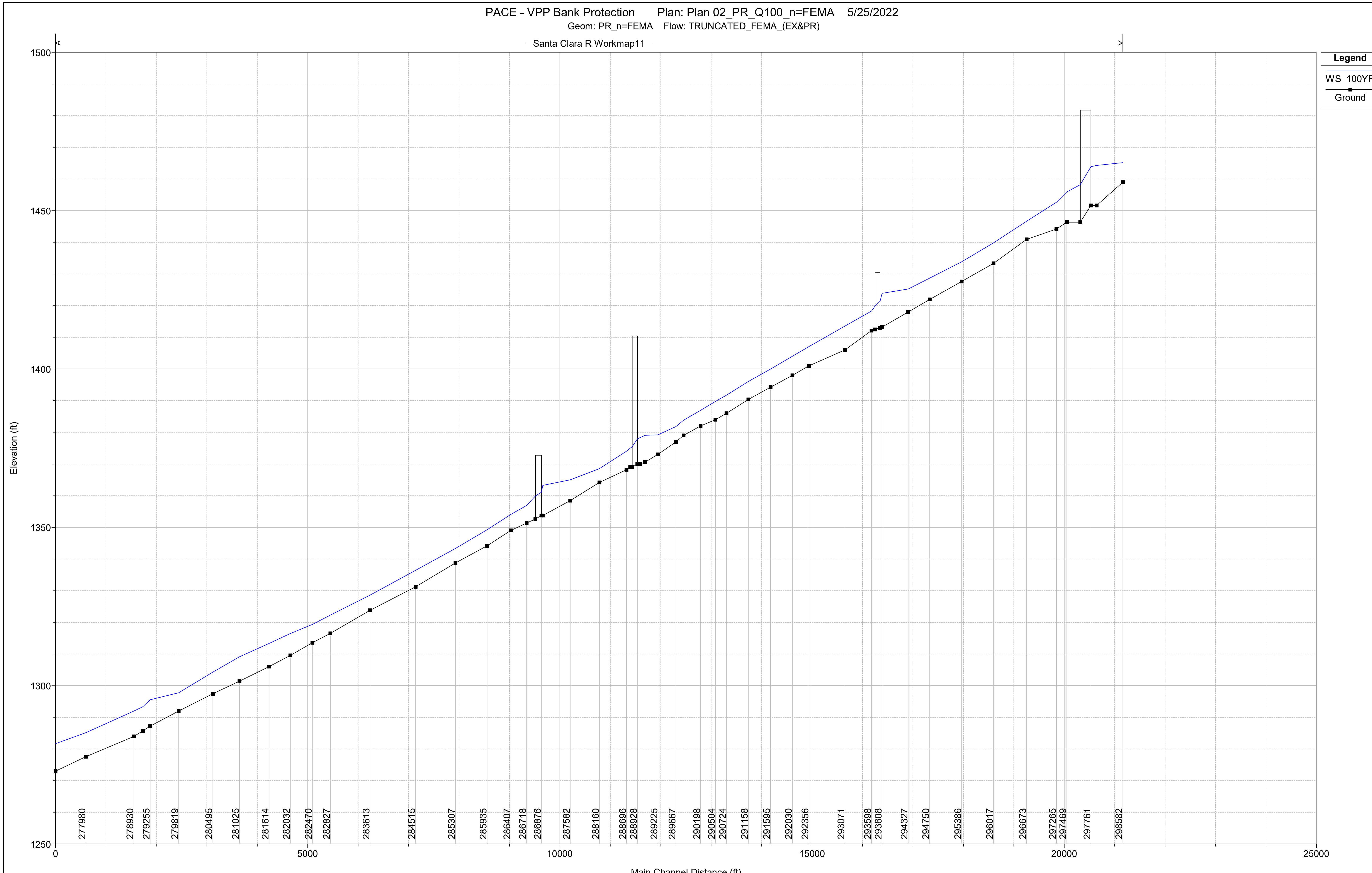

PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 278930
.1
.036
.06
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Ineff
Bank Sta

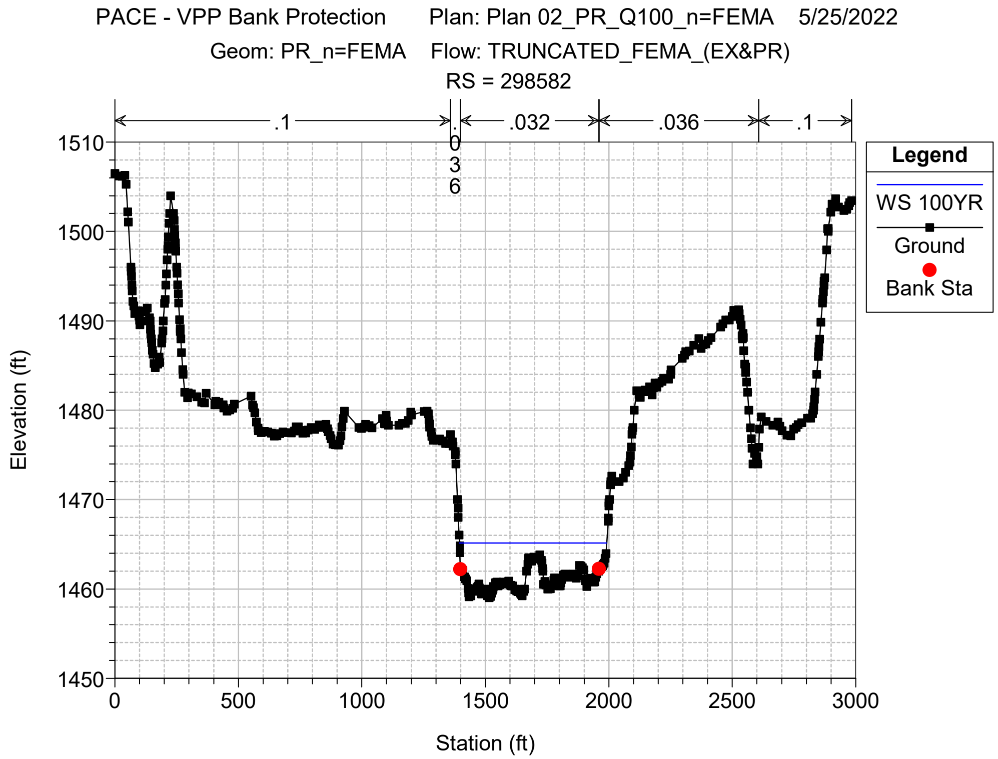

PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 277980
.1
.036
.06
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Ineff
Bank Sta


PACE - VPP Bank Protection Plan: Plan 01_EX_Q100_n=FEMA 5/25/2022
Geom: EX_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 277377
.06
.1
.036
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Ineff
Bank Sta

HEC-RAS Plan: Plan 01 River: Santa Clara R Reach: Workmap11 Profile: 100YR

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Workmap11	298582 BE	100YR	21690.00	1459.01	1465.15		1466.41	0.005694	9.08	2422.86	596.34	0.78
Workmap11	298062 DD	100YR	21690.00	1451.65	1464.26	1460.97	1464.87	0.001285	6.33	3583.86	562.69	0.41
Workmap11	297761		Bridge									
Workmap11	297469 DC	100YR	21690.00	1446.37	1455.89	1455.89	1457.95	0.009437	11.51	1890.74	466.71	1.00
Workmap11	297265 DB	100YR	21690.00	1444.21	1452.65	1452.65	1454.74	0.009216	11.60	1888.74	456.81	1.00
Workmap11	296673	100YR	21690.00	1440.93	1446.68	1446.68	1448.66	0.009431	11.30	1942.53	495.96	1.00
Workmap11	296017 BD	100YR	21690.00	1433.35	1439.82	1439.76	1441.58	0.009104	10.65	2047.07	552.60	0.97
Workmap11	295386 DA	100YR	21690.00	1427.63	1433.84	1433.84	1435.64	0.009692	10.76	2020.43	561.28	1.00
Workmap11	294750	100YR	21690.00	1421.94	1428.69	1428.26	1430.28	0.006657	10.13	2152.18	495.27	0.85
Workmap11	294327 BC	100YR	25910.00	1418.00	1425.27	1424.98	1427.28	0.007290	11.38	2305.70	478.78	0.91
Workmap11	293808 CY	100YR	25910.00	1413.24	1423.88	1421.04	1425.02	0.002073	8.57	3094.87	391.67	0.53
Workmap11	293703		Bridge									
Workmap11	293598 CX	100YR	25910.00	1412.15	1418.29	1418.29	1420.71	0.008631	12.49	2105.07	442.29	0.99
Workmap11	293071 CW	100YR	25910.00	1406.00	1413.54	1413.54	1415.92	0.008779	12.40	2122.15	453.45	0.99
Workmap11	292356 BB	100YR	25910.00	1400.99	1407.04	1407.04	1409.36	0.009011	12.20	2136.52	469.63	1.00
Workmap11	292030 CV	100YR	25910.00	1398.00	1404.01	1404.01	1406.21	0.009069	11.91	2193.42	501.49	1.00
Workmap11	291595 CU	100YR	25910.00	1394.26	1399.98	1399.91	1401.96	0.008815	11.31	2295.27	552.17	0.97
Workmap11	291158 BA	100YR	25910.00	1390.36	1396.04	1396.04	1397.94	0.009484	11.07	2344.78	614.77	1.00
Workmap11	290724	100YR	25910.00	1386.00	1391.72	1391.63	1393.39	0.008247	10.58	2552.90	694.79	0.93
Workmap11	290504	100YR	25910.00	1384.00	1389.76	1389.76	1391.46	0.008787	10.78	2558.32	865.78	0.96
Workmap11	290198	100YR	25910.00	1382.00	1386.90	1386.86	1388.44	0.008602	10.62	2778.32	869.61	0.95
Workmap11	289893	100YR	25910.00	1379.00	1383.85	1383.85	1385.50	0.008455	11.03	2704.28	863.10	0.95
Workmap11	289667 AZ	100YR	25910.00	1377.00	1381.82	1381.82	1383.46	0.009889	11.09	2620.39	968.22	1.01
Workmap11	289225	100YR	25910.00	1373.00	1379.12	1378.48	1380.33	0.006365	9.26	3074.59	856.96	0.82
Workmap11	289044 CS	100YR	25910.00	1370.61	1379.05	1376.04	1379.52	0.001198	5.49	4724.22	1234.83	0.39
Workmap11	288929	100YR	25910.00	1370.00	1378.32	1376.17	1379.21	0.002473	7.58	3417.16	546.34	0.53
Workmap11	288928		Bridge									
Workmap11	288766	100YR	25910.00	1369.00	1375.05	1374.58	1376.73	0.006886	10.38	2496.00	539.30	0.85
Workmap11	288696 CR	100YR	25910.00	1368.17	1374.02	1374.02	1376.08	0.008969	11.61	2310.10	963.04	0.99
Workmap11	288160 CQ	100YR	25910.00	1364.15	1368.54	1368.54	1370.18	0.010116	10.41	2538.11	774.49	1.01
Workmap11	287582 AY	100YR	25910.00	1358.43	1365.00	1363.58	1365.91	0.003186	7.65	3398.05	686.11	0.60
Workmap11	287039 CO	100YR	25910.00	1353.74	1363.24	1360.57	1364.18	0.003030	7.99	3451.73	1143.86	0.53
Workmap11	286876		Bridge									
Workmap11	286718 CN	100YR	25910.00	1351.36	1356.88	1356.83	1358.66	0.009707	10.75	2425.65	735.32	1.00
Workmap11	286407 CM	100YR	25910.00	1349.00	1354.10	1354.10	1355.86	0.010099	10.67	2470.15	760.84	1.01
Workmap11	285935 AX	100YR	25910.00	1344.16	1349.22	1348.92	1350.45	0.007457	8.92	2954.09	958.64	0.86
Workmap11	285307 CL	100YR	25910.00	1338.73	1343.32	1343.32	1344.81	0.010925	9.92	2728.16	958.66	1.02
Workmap11	284515 AW	100YR	25910.00	1331.23	1336.42	1335.93	1337.46	0.006384	8.31	3257.07	1064.40	0.80
Workmap11	283613 AV	100YR	25910.00	1323.79	1328.59	1328.59	1330.48	0.009219	11.06	2364.48	620.59	0.99
Workmap11	282827	100YR	25910.00	1316.49	1322.27	1321.36	1323.41	0.004560	8.57	3032.13	713.31	0.71
Workmap11	282470 CK	100YR	25910.00	1313.57	1319.31	1319.13	1321.21	0.008090	11.06	2346.86	579.61	0.94
Workmap11	282032 AU	100YR	26210.00	1309.57	1316.45	1315.66	1317.97	0.006395	10.08	2722.50	542.77	0.77
Workmap11	281614	100YR	26210.00	1306.01	1313.33	1312.82	1314.98	0.007978	10.31	2551.77	553.91	0.84
Workmap11	281025 CI	100YR	26210.00	1301.41	1309.10	1308.36	1310.60	0.006815	9.84	2667.59	543.94	0.78
Workmap11	280495 AT	100YR	26210.00	1297.45	1304.25	1304.25	1306.30	0.009765	11.72	2392.01	589.48	0.93
Workmap11	279819 CH	100YR	26210.00	1291.98	1297.76	1297.59	1299.31	0.009713	10.70	2767.73	746.33	0.91
Workmap11	279255 CG	100YR	26210.00	1287.24	1295.54	1293.50	1296.39	0.002843	8.10	3915.90	652.65	0.54
Workmap11	279107 AS	100YR	26210.00	1285.71	1293.35	1293.35	1295.59	0.007911	12.25	2737.93	903.44	0.87
Workmap11	278930	100YR	26210.00	1283.95	1291.99	1291.99	1294.17	0.007799	12.30	2957.16	853.08	0.87
Workmap11	277980 CE	100YR	26210.00	1277.56	1285.15	1284.60	1286.87	0.006631	11.96	3797.56	1648.69	0.81
Workmap11	277377 AR	100YR	26210.00	1272.99	1281.67	1280.56	1283.43	0.005043	11.42	3316.29	2705.92	0.73


PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
Santa Clara R Workmap11
Legend
WS 100YR
Ground
Elevation (ft)
Main Channel Distance (ft)
1250
1300
1350
1400
1450
1500
0
5000
10000
15000
20000
25000
277980
278930
279255
279819
280495
281025
281614
282032
282470
282827
283613
284515
285307
285935
286407
286718
286876
287582
288160
288696
288928
289225
289667
290198
290504
290724
291158
291595
292030
292356
293071
293598
293808
294327
294750
295386
296017
296673
297265
297469
297761
298582


PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 298582
.1
.036
.032
.036
.1
Legend
WS 100YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1450
1460
1470
1480
1490
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1510
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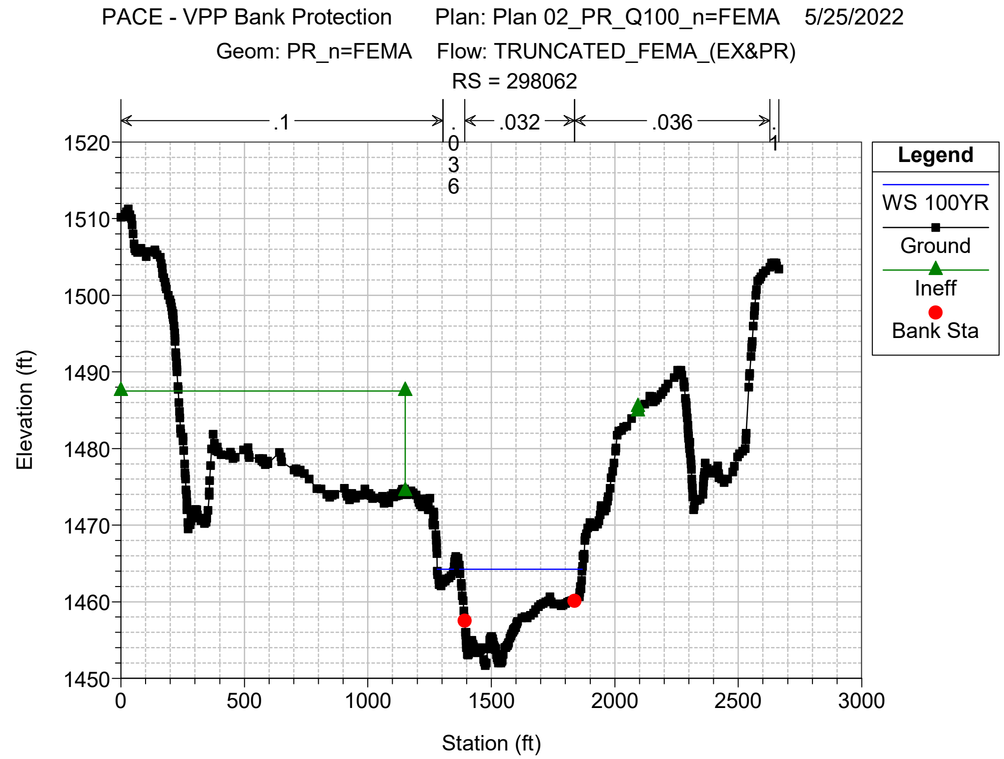
1500
2000
2500
3000

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RS = 298062
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.036
.032
.036
.1
Legend
WS 100YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
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1460
1470
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1490
1500
1510
1520
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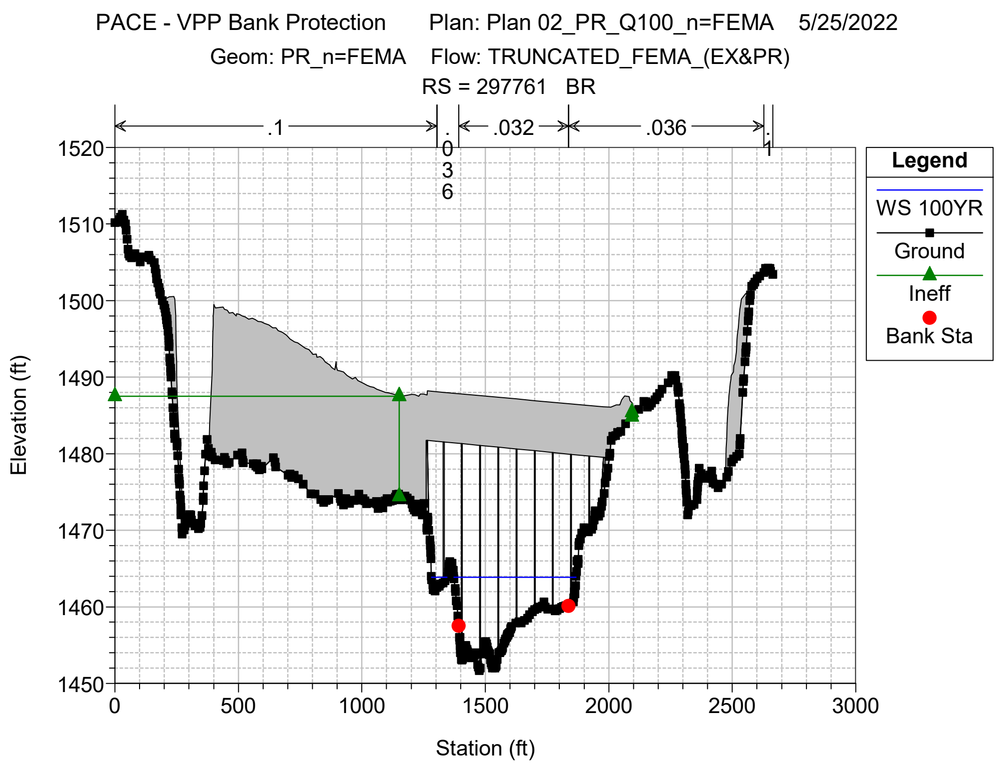
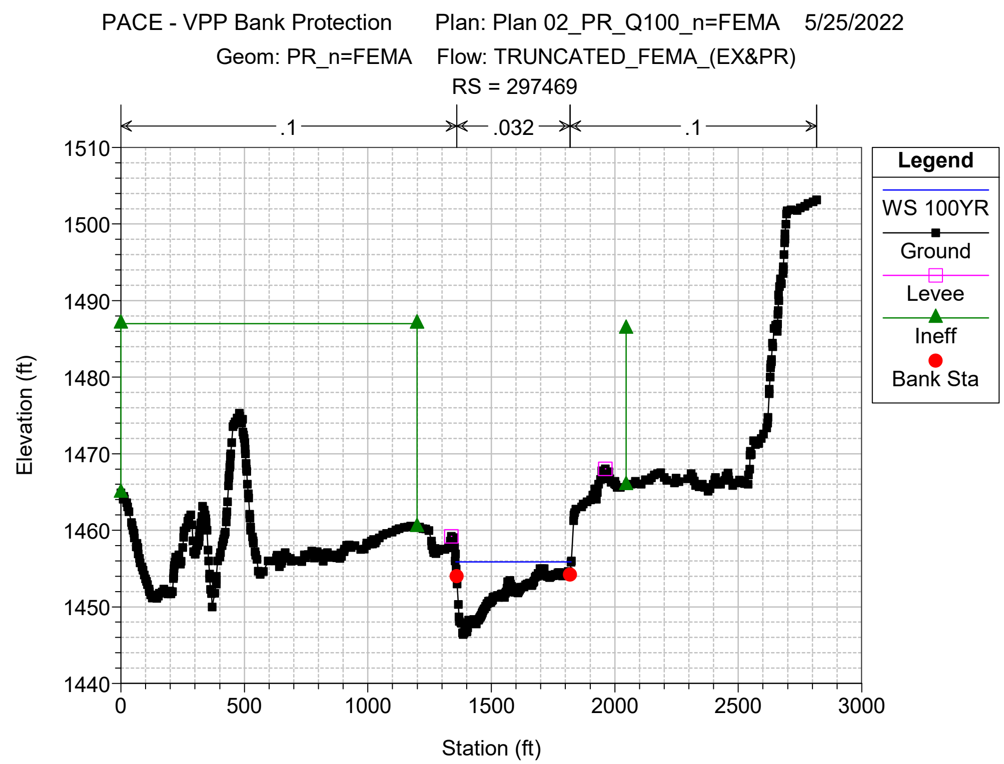
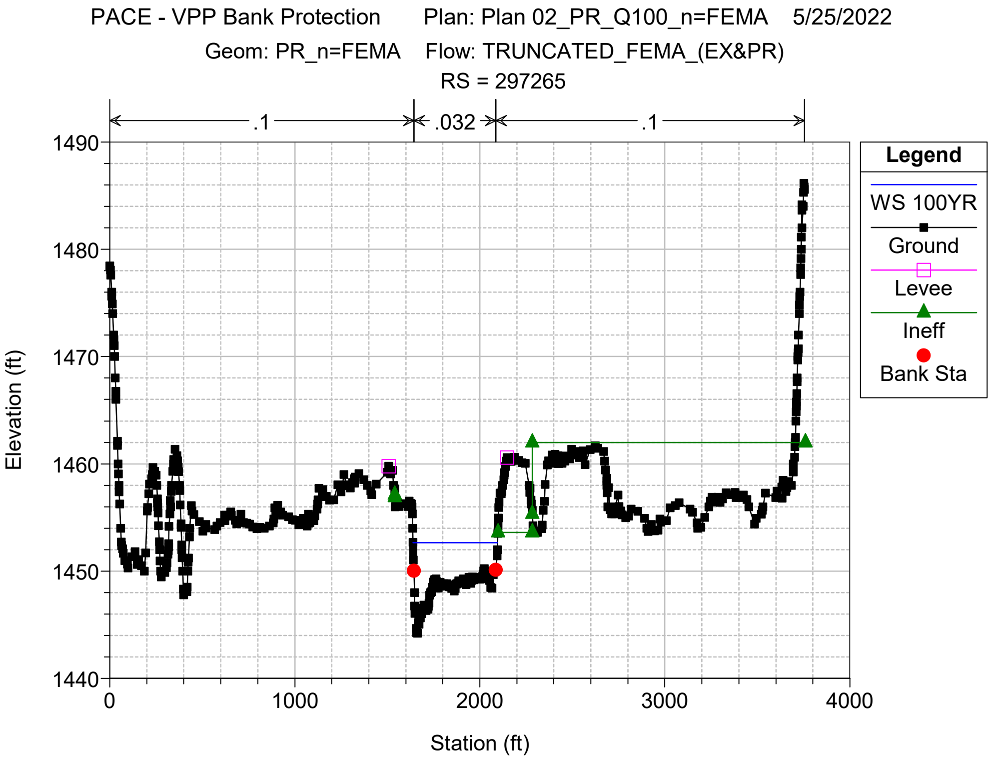
1000
1500
2000
2500
3000

PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 297761 BR
.1
.036
.032
.036
.1
Legend
WS 100YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1450
1460
1470
1480
1490
1500
1510
1520
0
500
1000
1500
2000
2500
3000

PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 297469
.1
.032
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1440
1450
1460
1470
1480
1490
1500
1510
0
500
1000
1500
2000
2500
3000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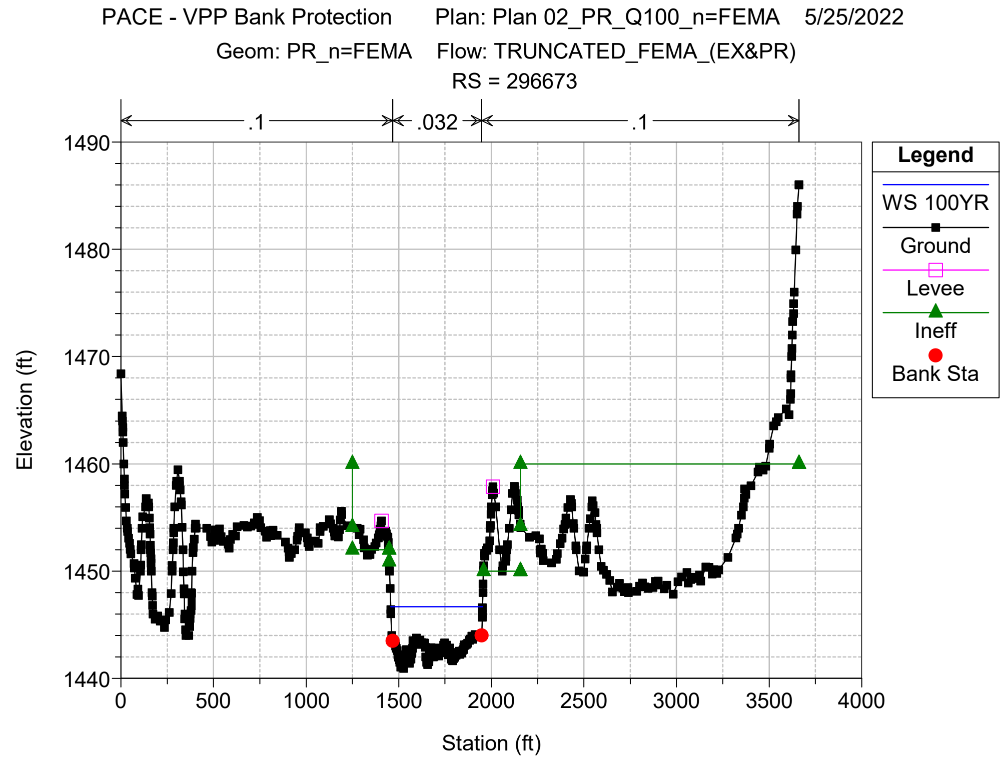
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 297265
.1
.032
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
1490
1480
1470
1460
1450
1440
0
1000
2000
3000
4000
Station (ft)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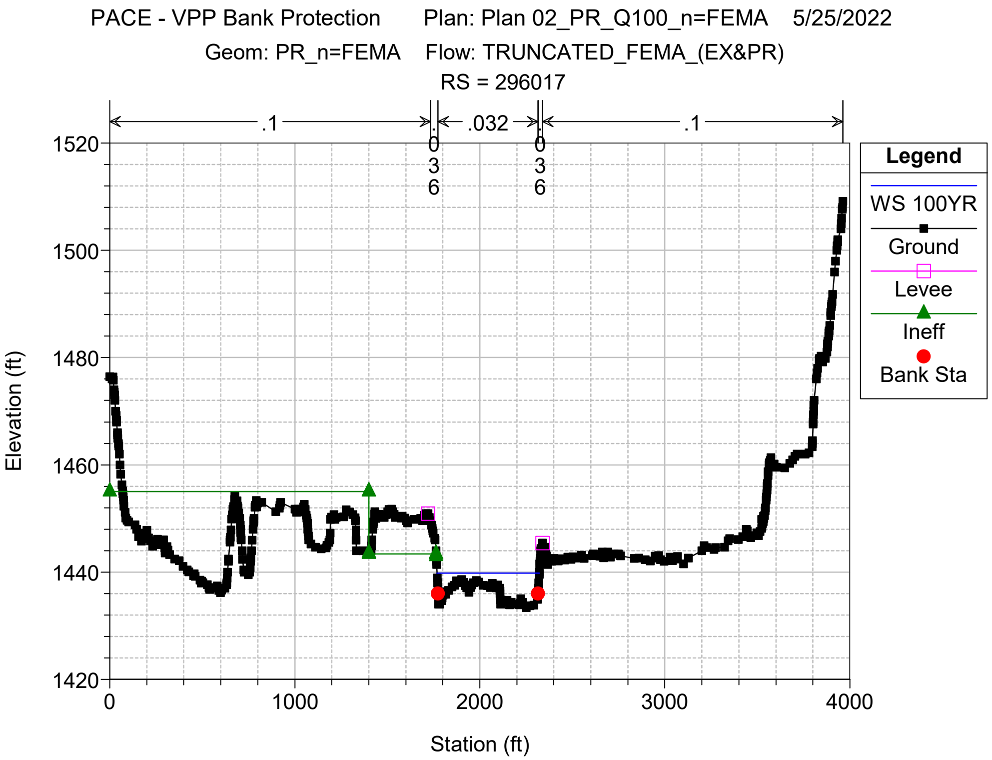
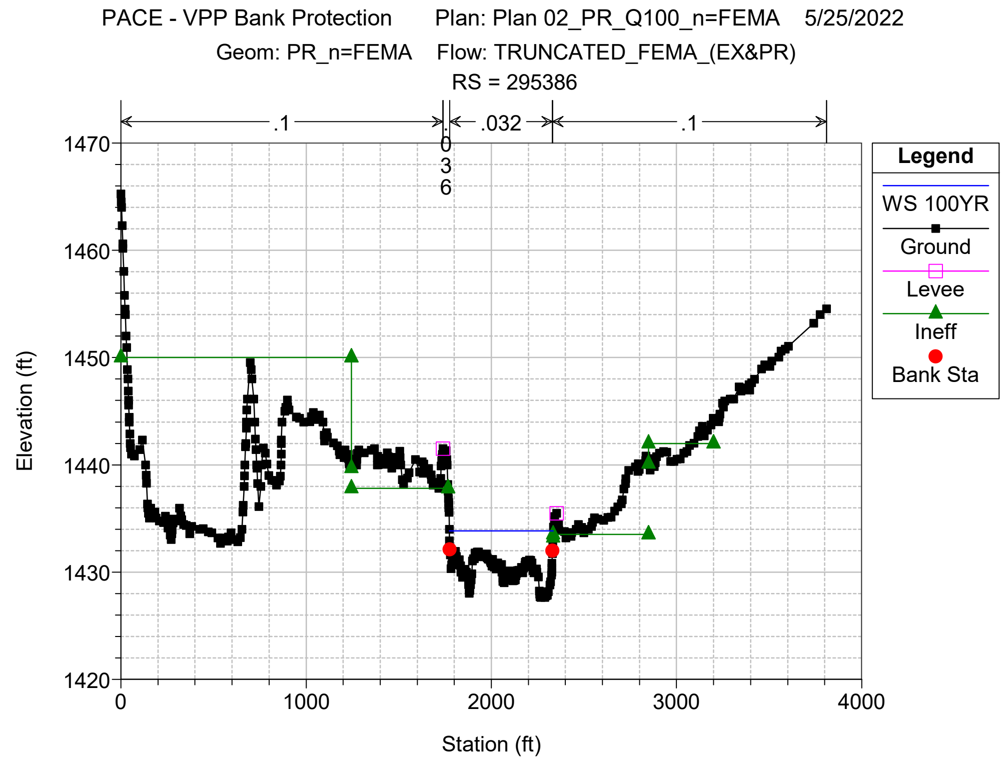
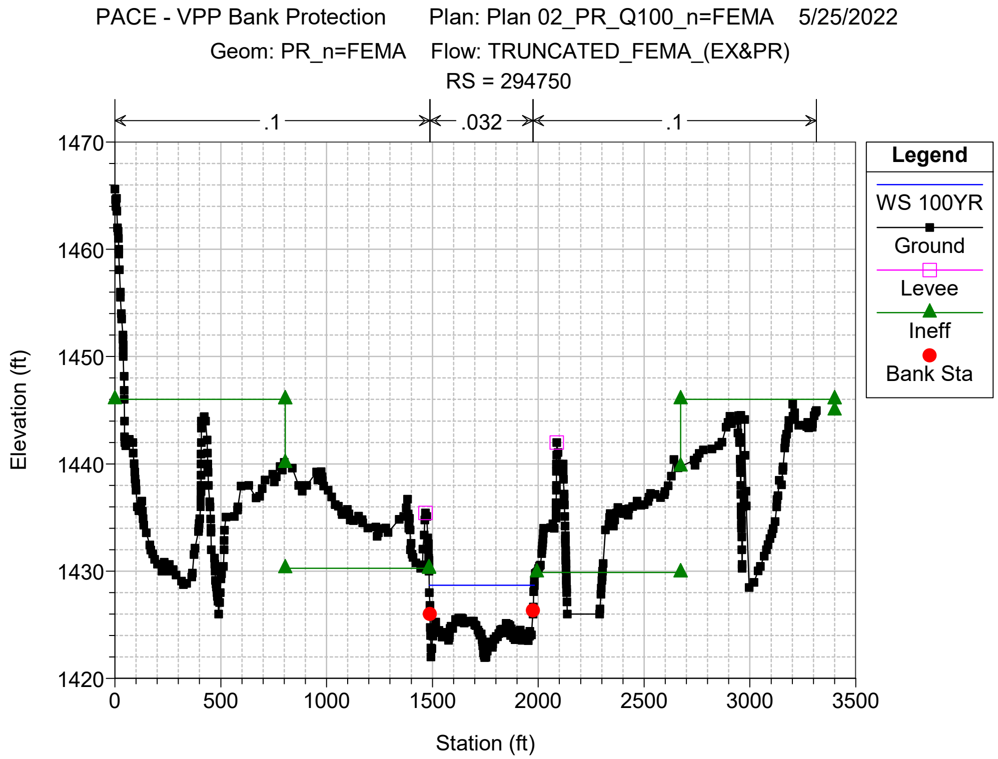
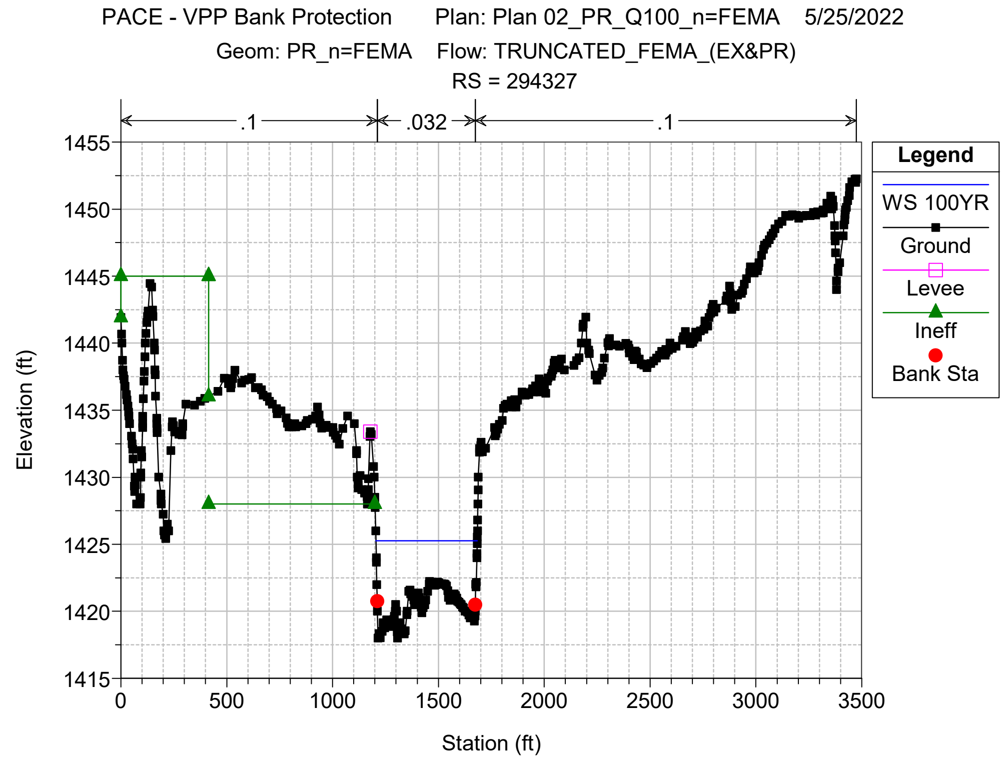
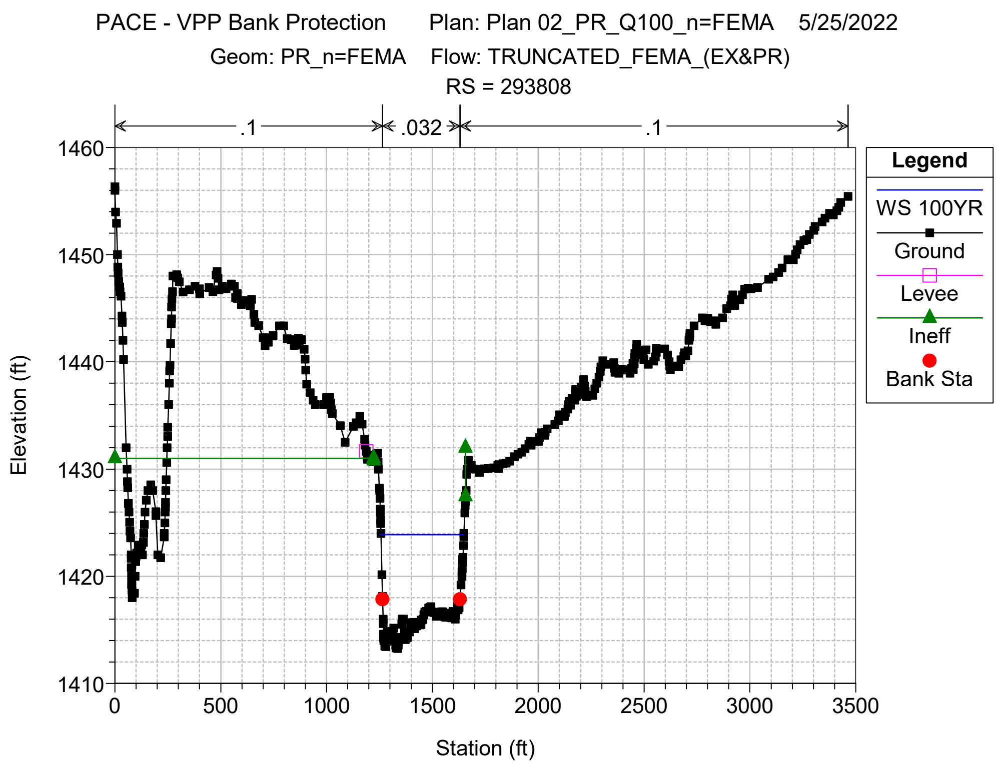
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 296673
.1
.032
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
1490
1480
1470
1460
1450
1440
0
500
1000
1500
2000
2500
3000
3500
4000
Station (ft)

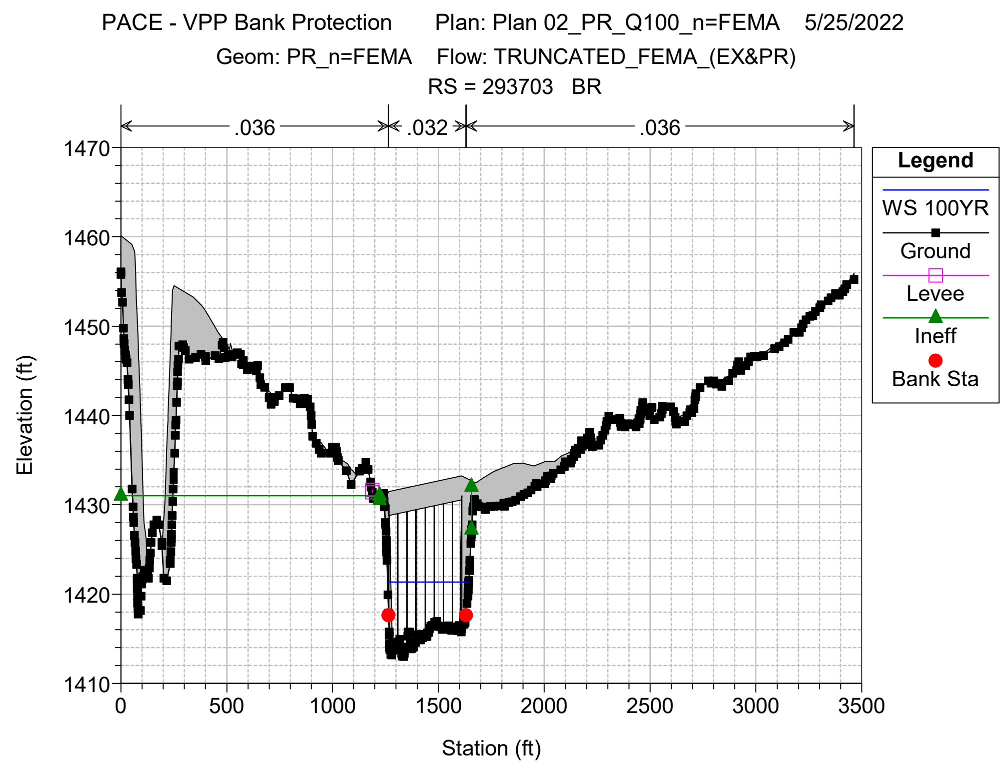

PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 296017
.1
.032
.1
0
3
6
0
3
6
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
1520
1500
1480
1460
1440
1420
0
1000
2000
3000
4000
Station (ft)

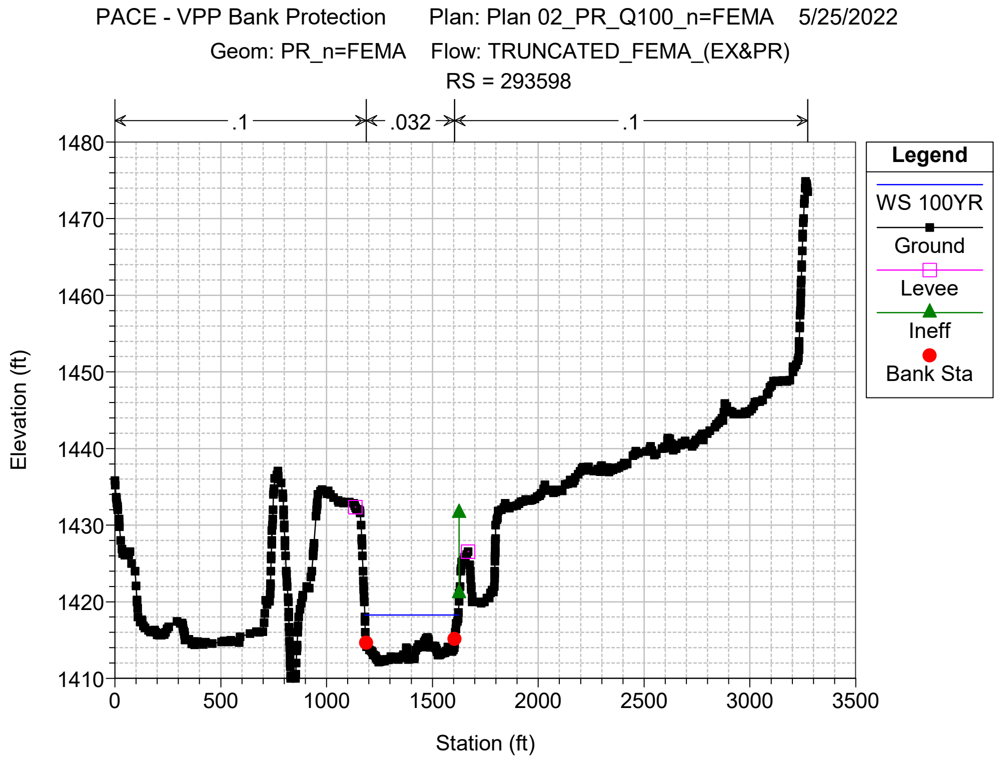

PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 295386
.1
.032
.1
0
3
6
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
1470
1460
1450
1440
1430
1420
0
1000
2000
3000
4000
Station (ft)

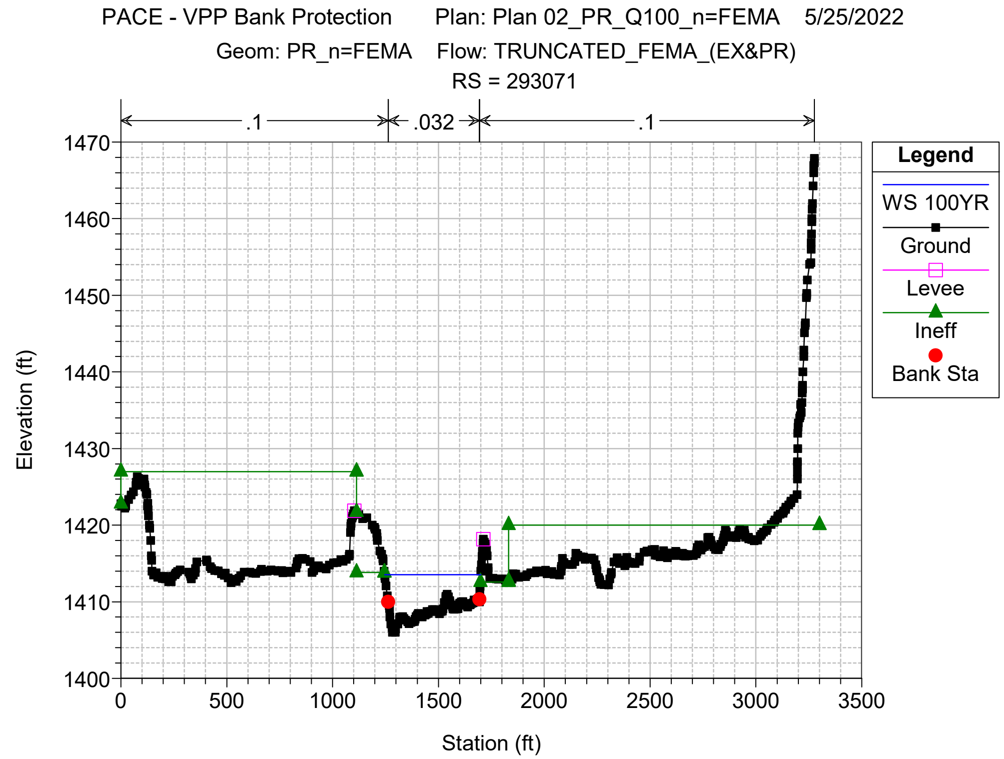

PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 294750
.1
.032
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1420
1430
1440
1450
1460
1470
0
500
1000
1500
2000
2500
3000
3500


PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 294327
.1
.032
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1415
1420
1425
1430
1435
1440
1445
1450
1455
0
500
1000
1500
2000
2500
3000
3500


PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 293808
.1
.032
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1410
1420
1430
1440
1450
1460
0
500
1000
1500
2000
2500
3000
3500


PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 293703 BR
.036
.032
.036
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1410
1420
1430
1440
1450
1460
1470
0
500
1000
1500
2000
2500
3000
3500


PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 293598
.1
.032
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)


PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 293071
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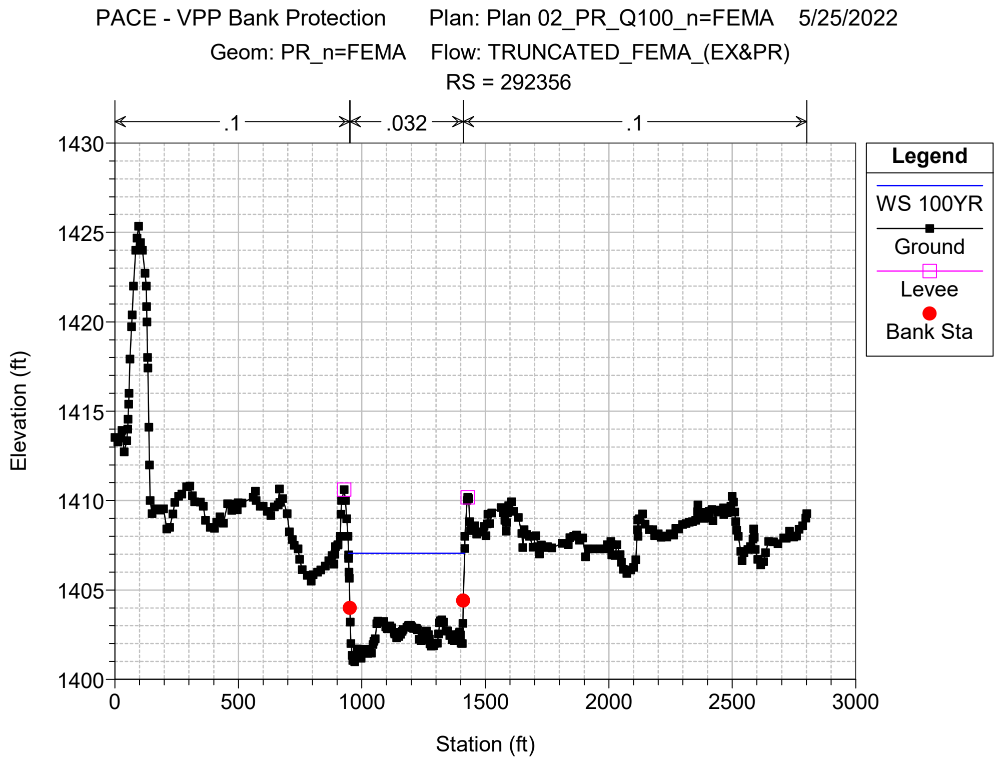
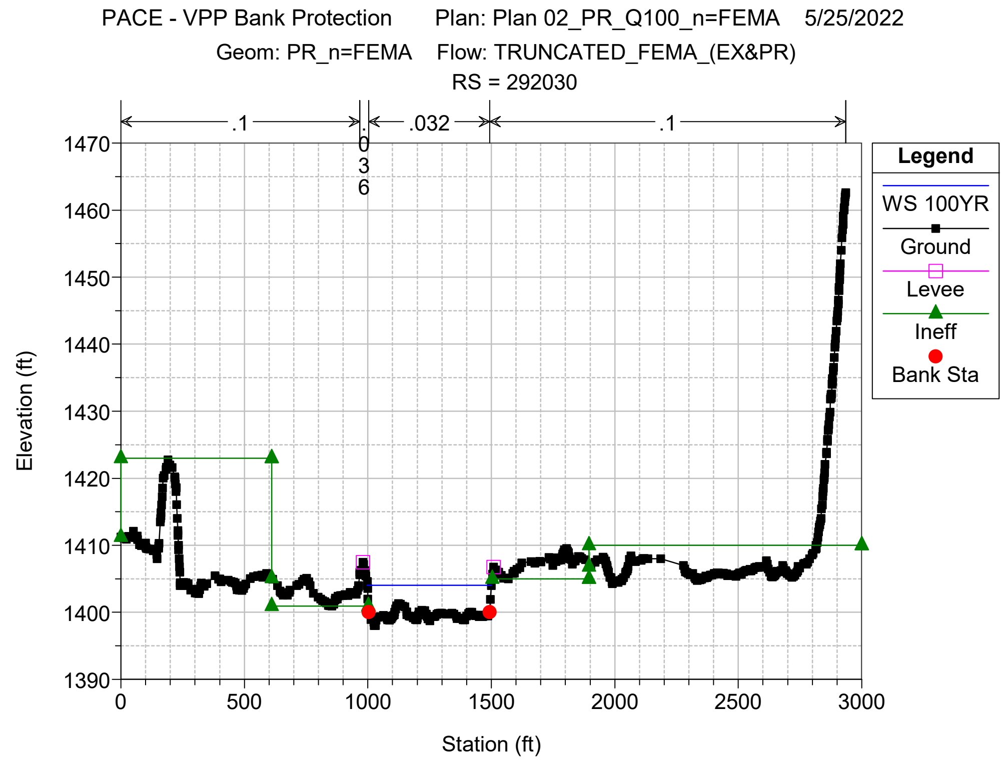
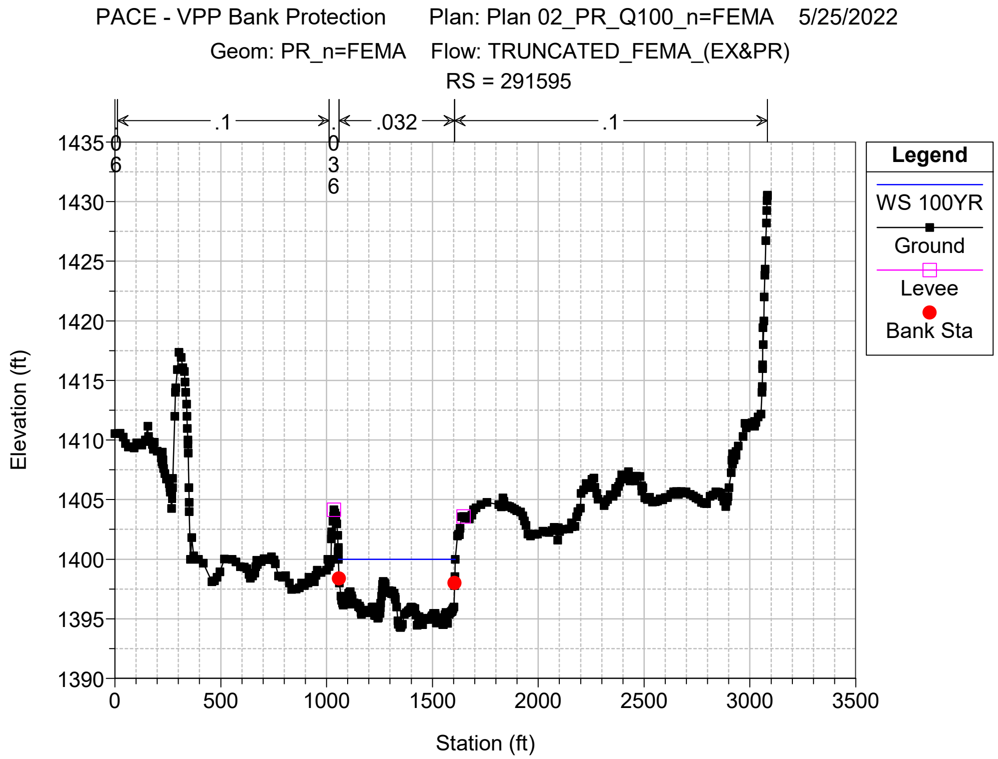
.032
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)


PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 292356
.1
.032
.1
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 292030
.1
0
3
6
.032
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)


PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
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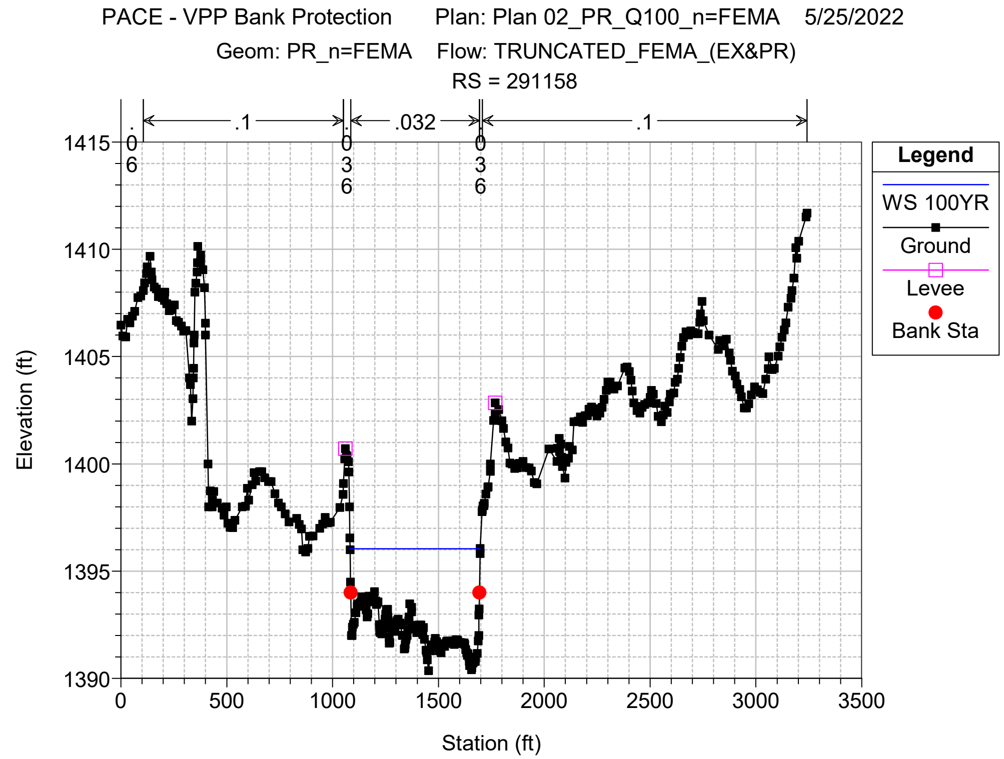
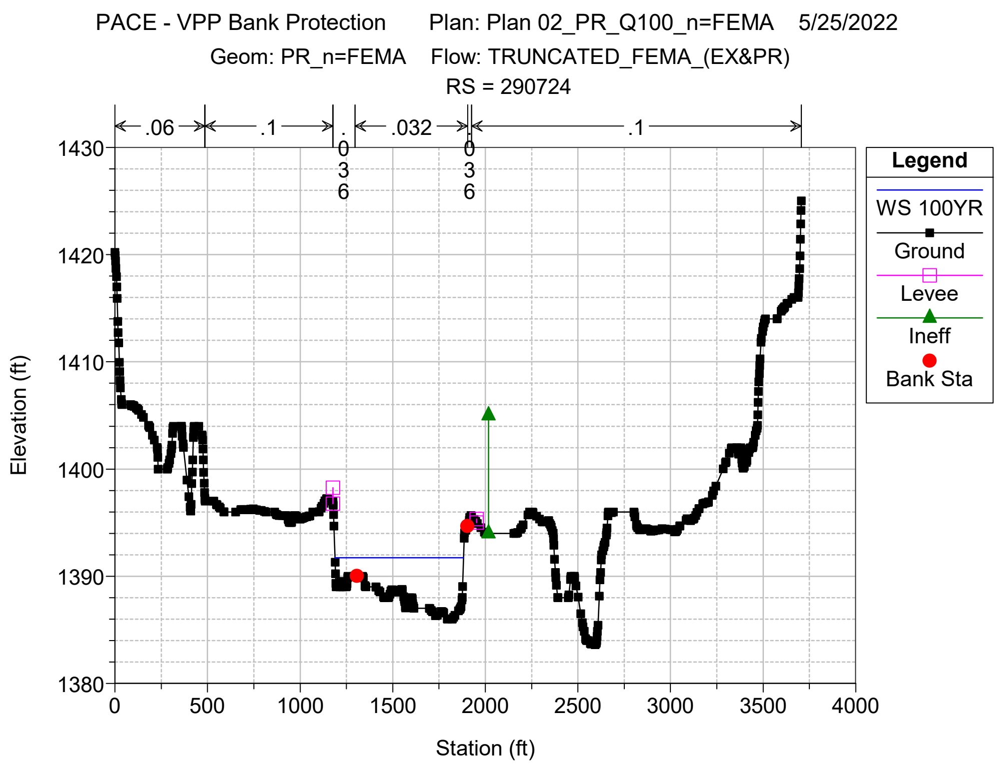
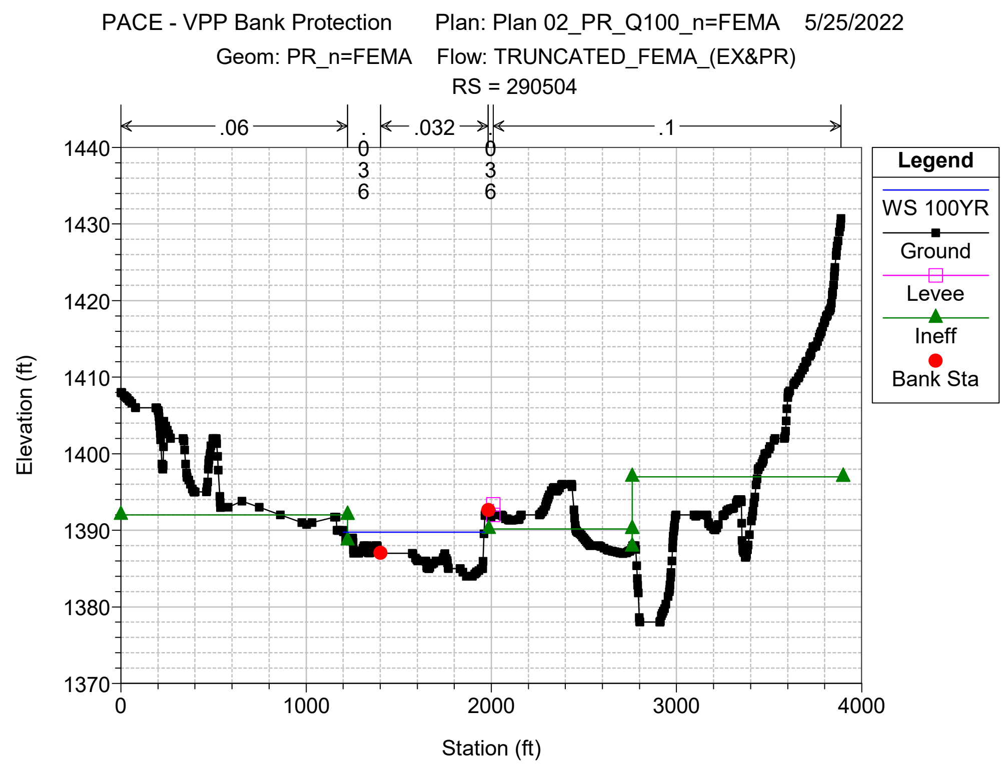
.1
.032
.1
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 291158
.1
.032
.1
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 290724
.06
.1
.032
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)


PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 290504
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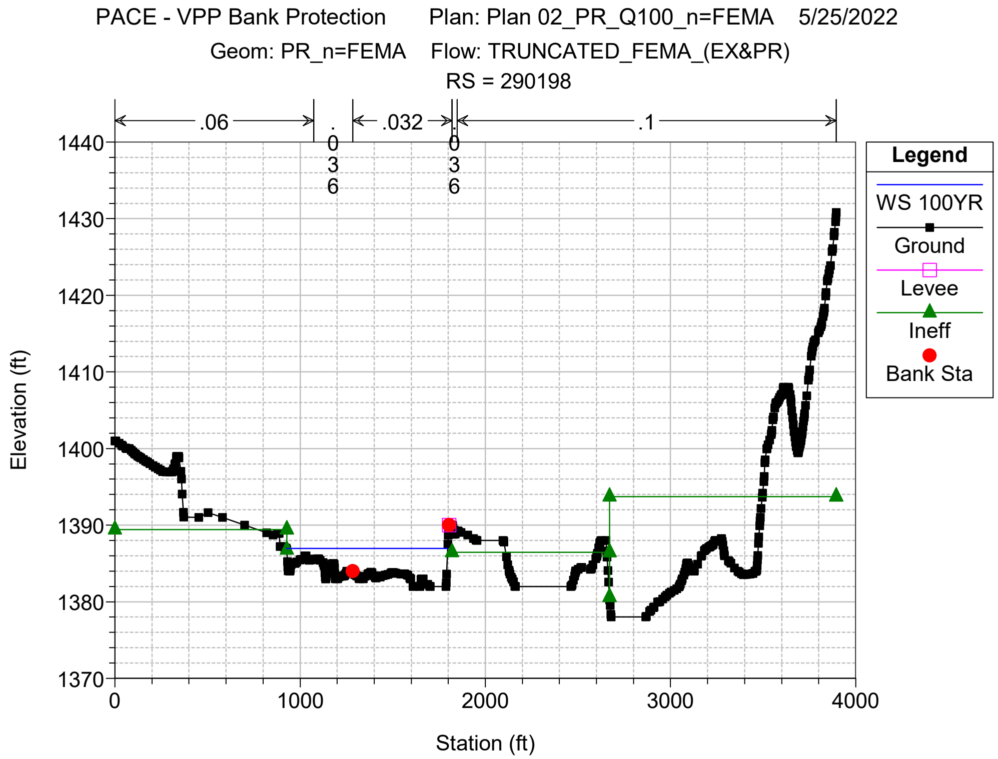
.032
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)


PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 290198
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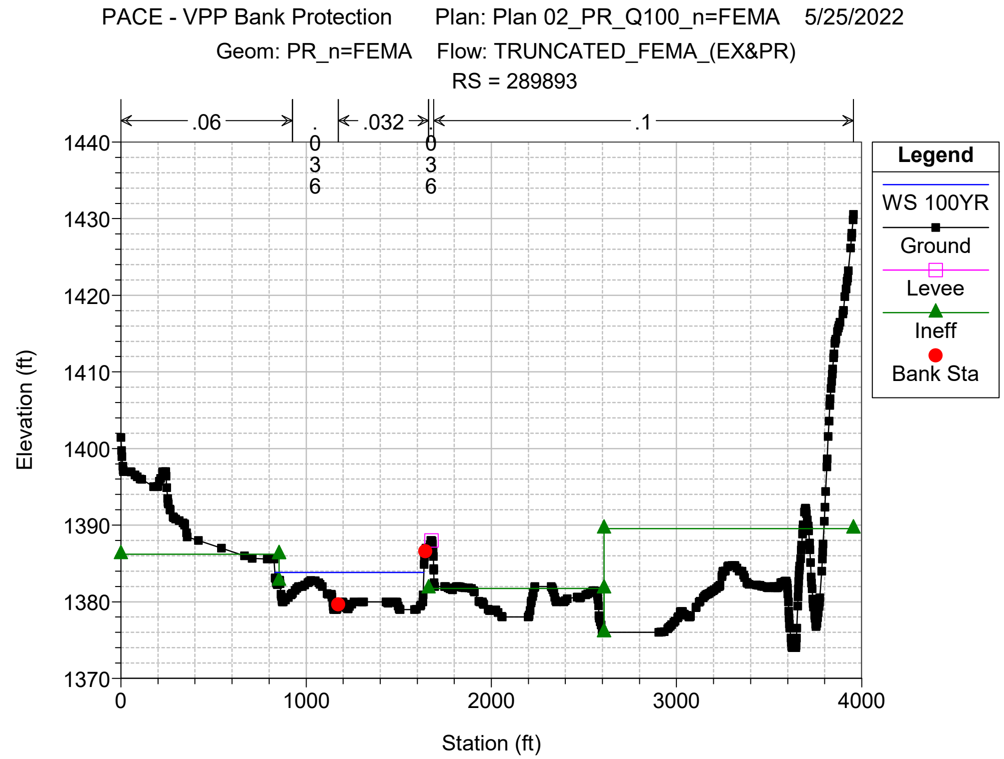
.036
.036
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)


PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 289893
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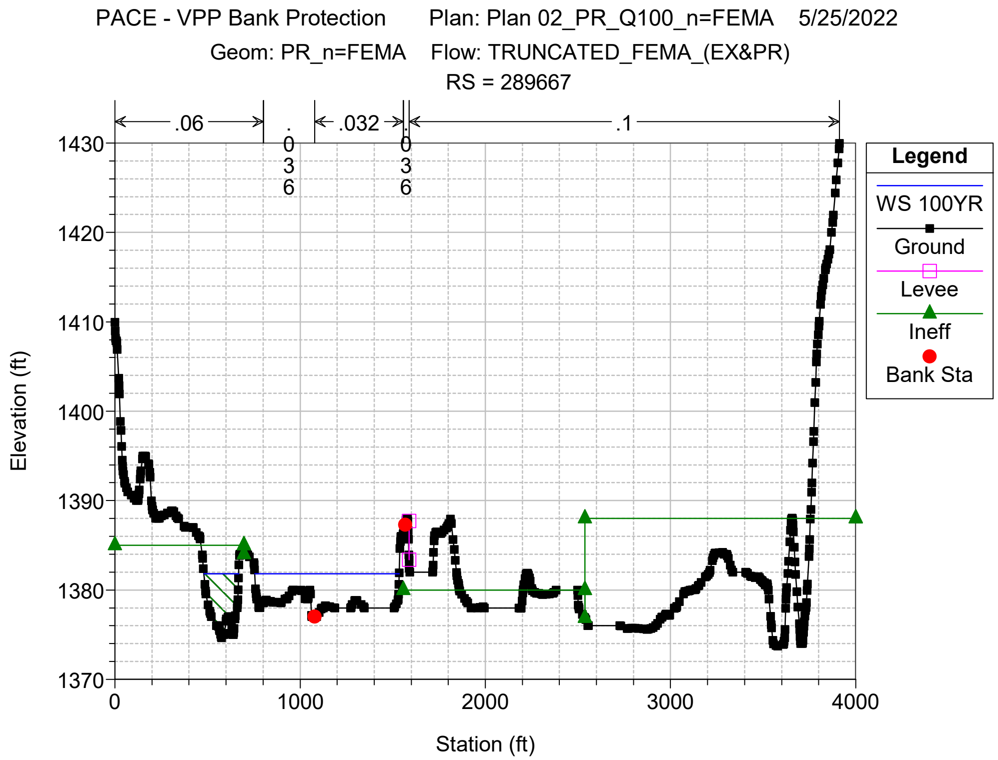
.032
.1
.036
.036
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)


PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 289667
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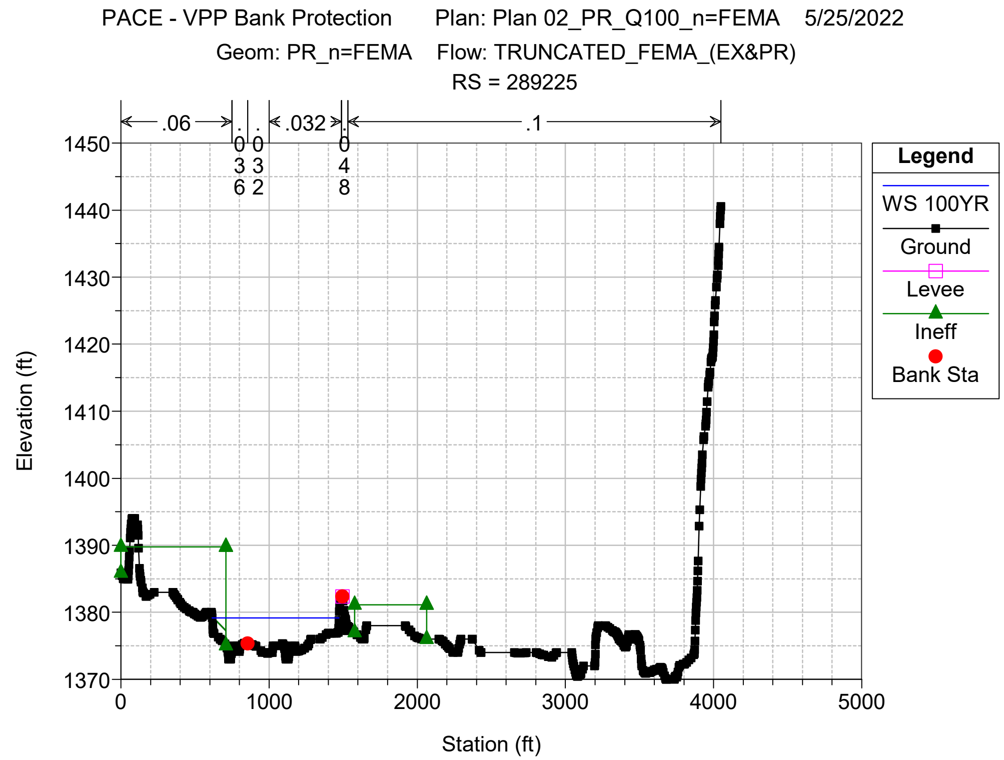
.032
.1
.036
.036
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)


PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 289225
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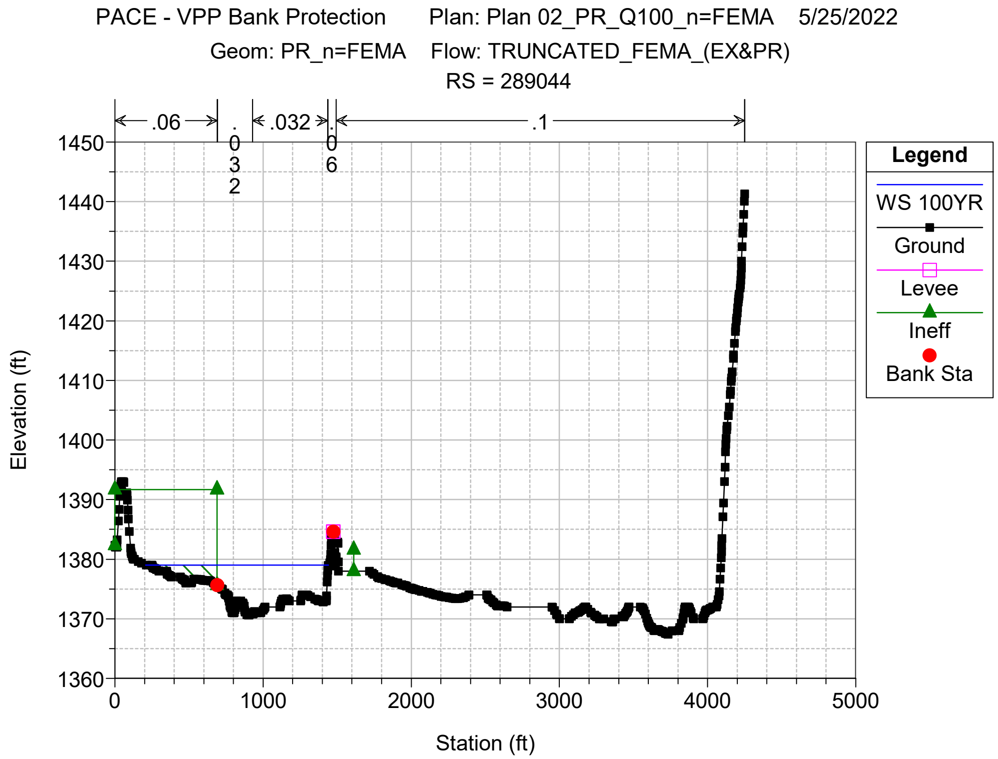
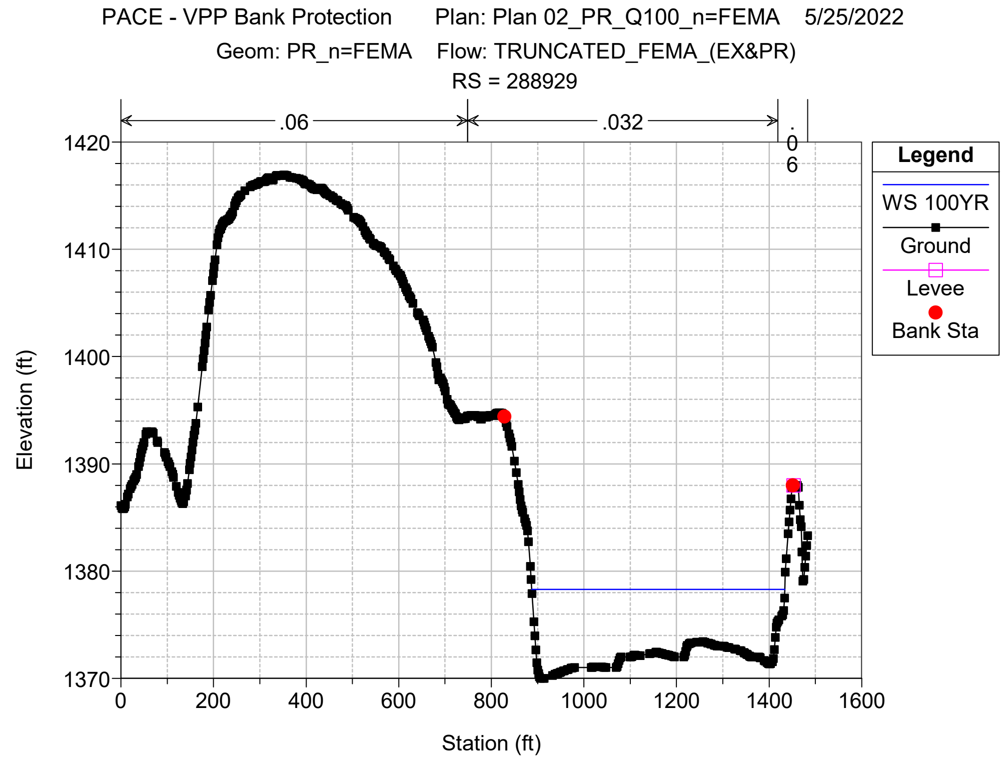
.032
.1
.036
.032
.048
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)


PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 289044
.06
.032
.032
.06
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1450
1440
1430
1420
1410
1400
1390
1380
1370
1360
0
1000
2000
3000
4000
5000


PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 288929
.06
.032
.06
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
1420
1410
1400
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1380
1370
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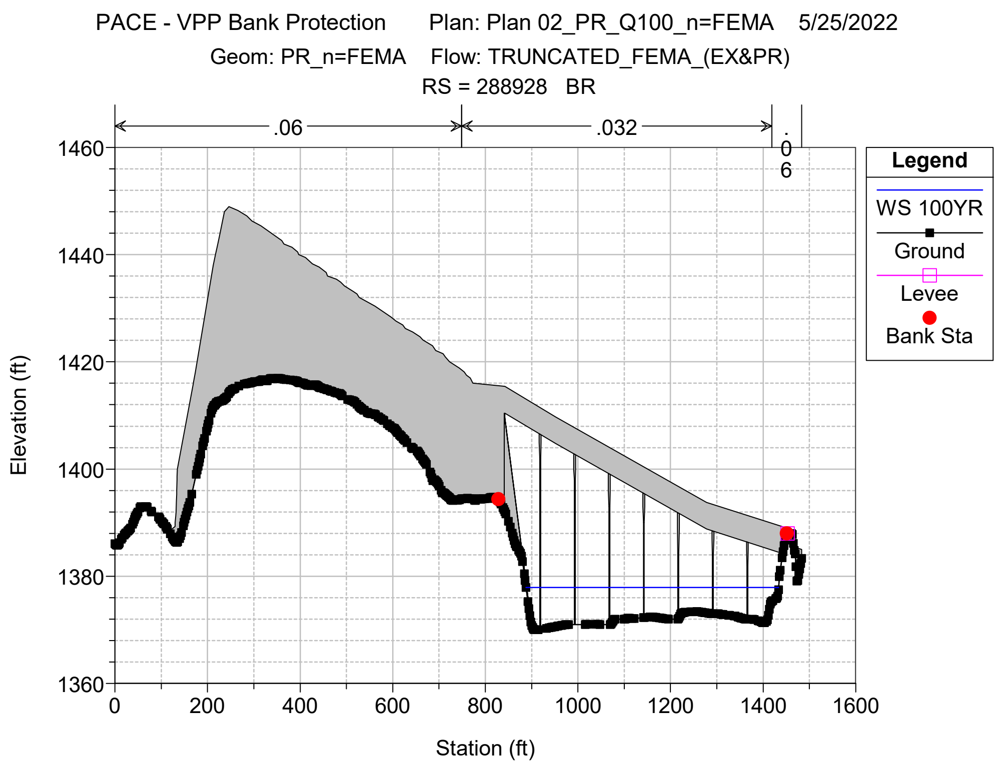
200
400
600
800
1000
1200
1400
1600


PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 288928 BR
.06
.032
.06
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
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1440
1420
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1360
0
200
400
600
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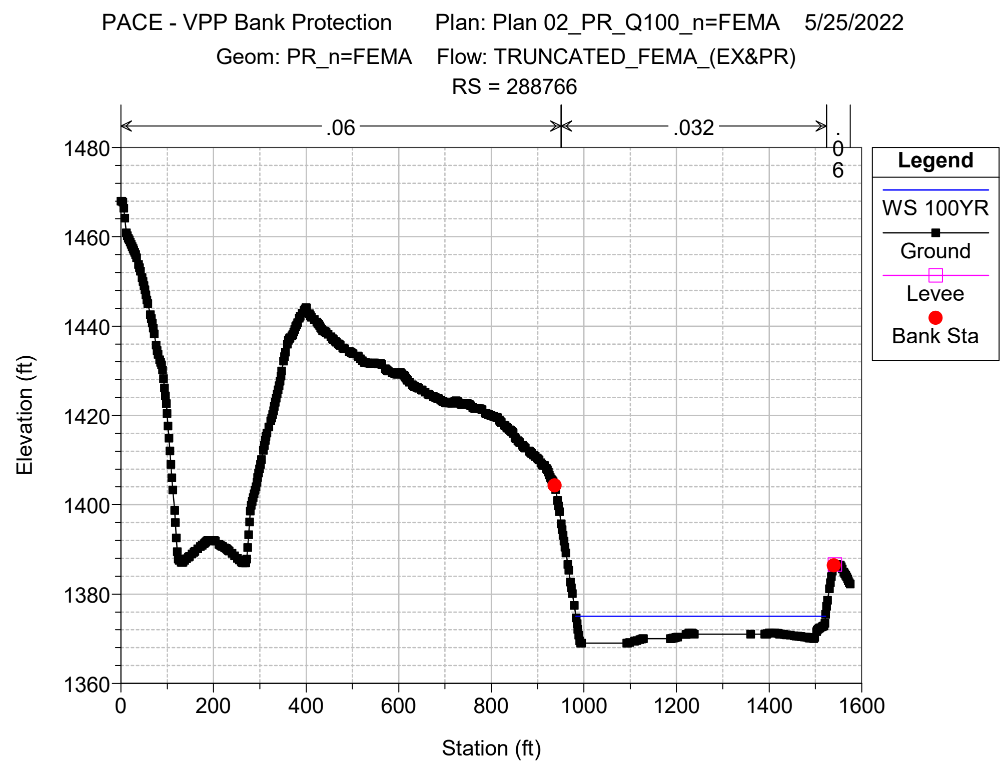
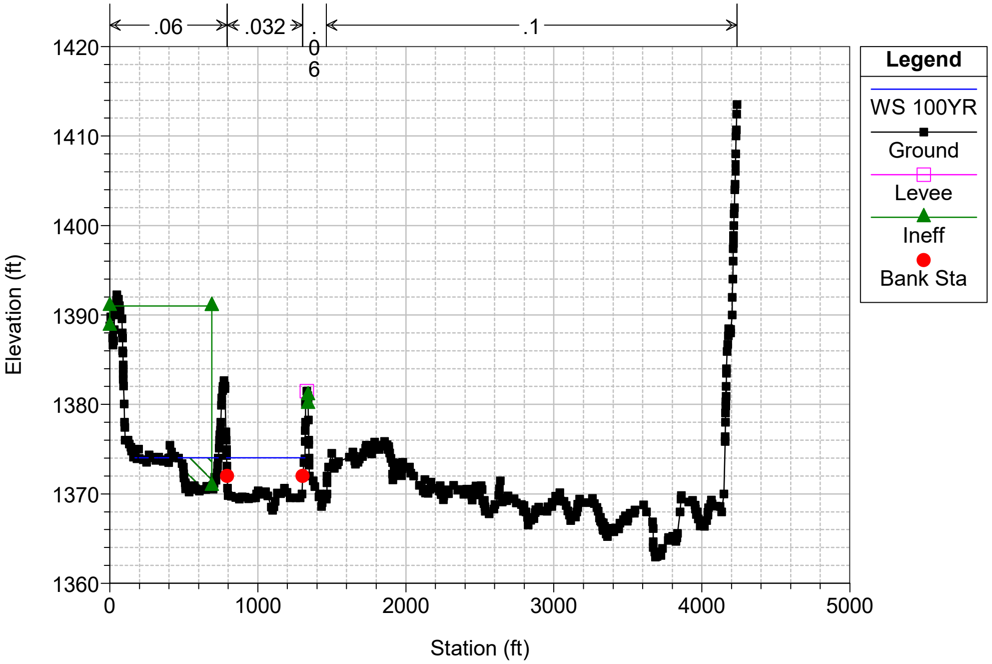
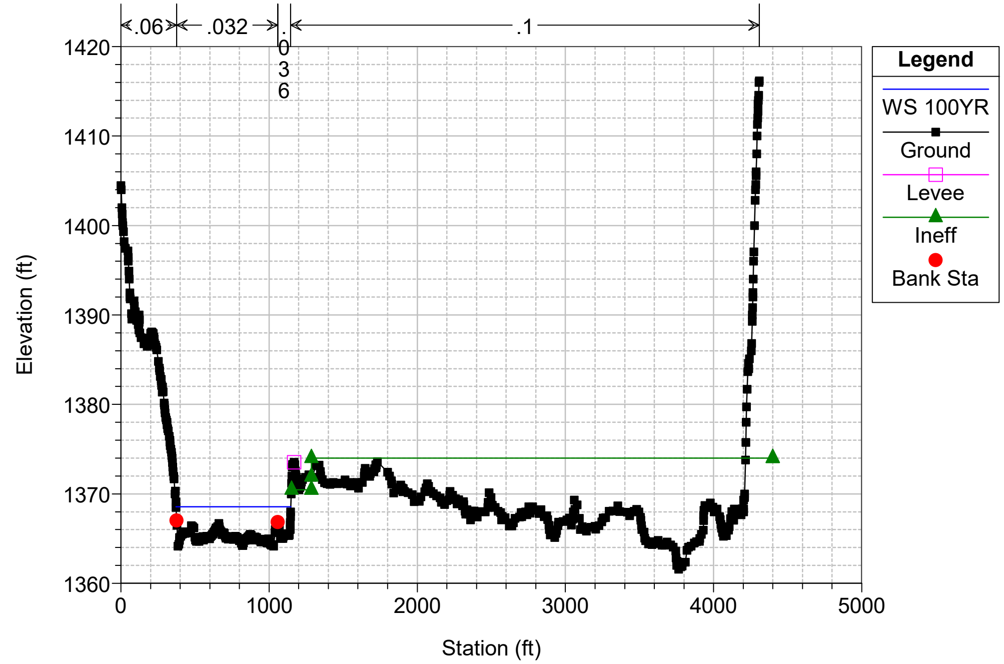
1000
1200
1400
1600


PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 288766
.06
.032
.06
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
1480
1460
1440
1420
1400
1380
1360
0
200
400
600
800
1000
1200
1400
1600

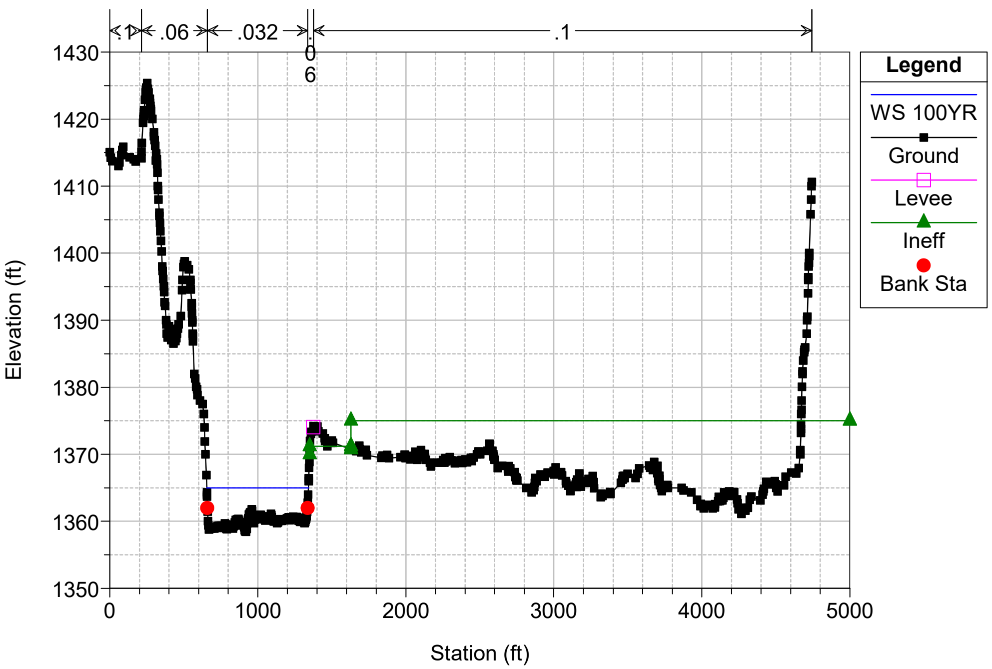
PACE - VPP Bank Protection   Plan: Plan 02_PR_Q100_n=FEMA   5/25/2022
Geom: PR_n=FEMA   Flow: TRUNCATED_FEMA_(EX&PR)
RS = 288696



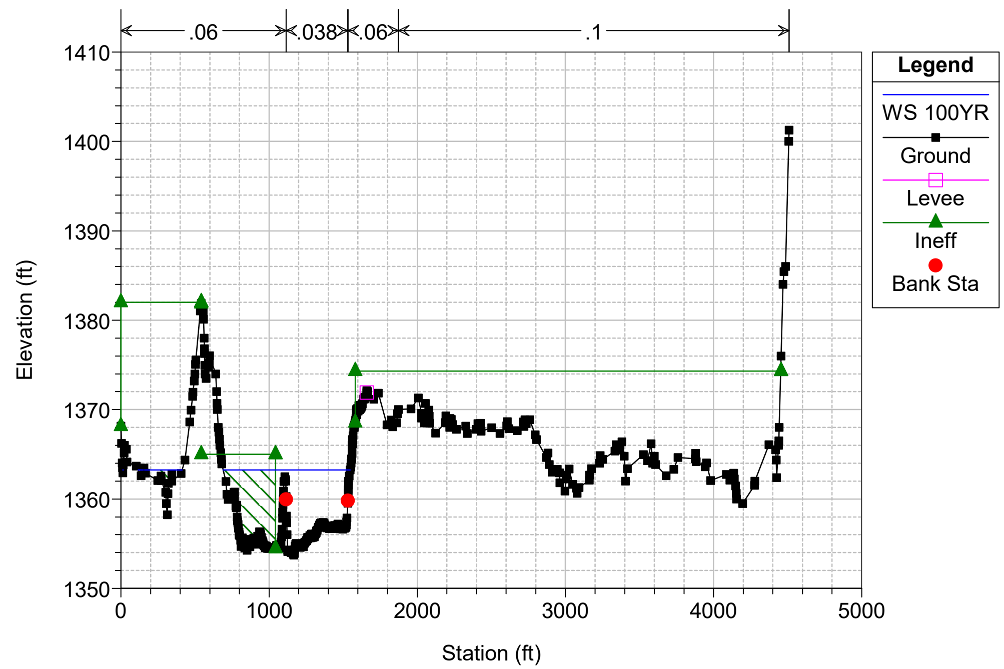
PACE - VPP Bank Protection   Plan: Plan 02_PR_Q100_n=FEMA   5/25/2022
Geom: PR_n=FEMA   Flow: TRUNCATED_FEMA_(EX&PR)
RS = 288160



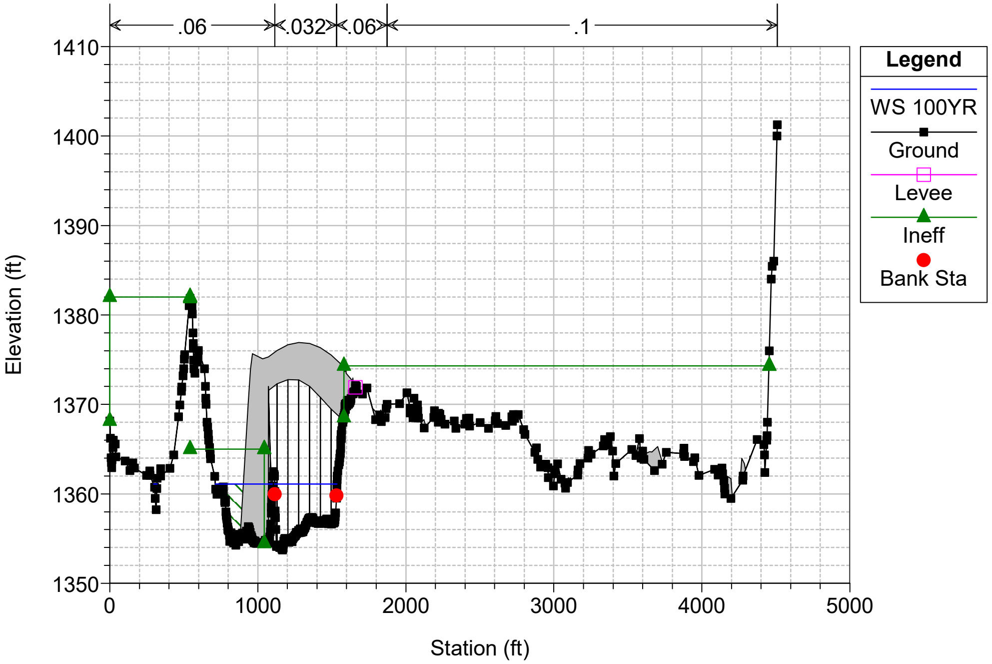
PACE - VPP Bank Protection   Plan: Plan 02_PR_Q100_n=FEMA   5/25/2022
Geom: PR_n=FEMA   Flow: TRUNCATED_FEMA_(EX&PR)
RS = 287582



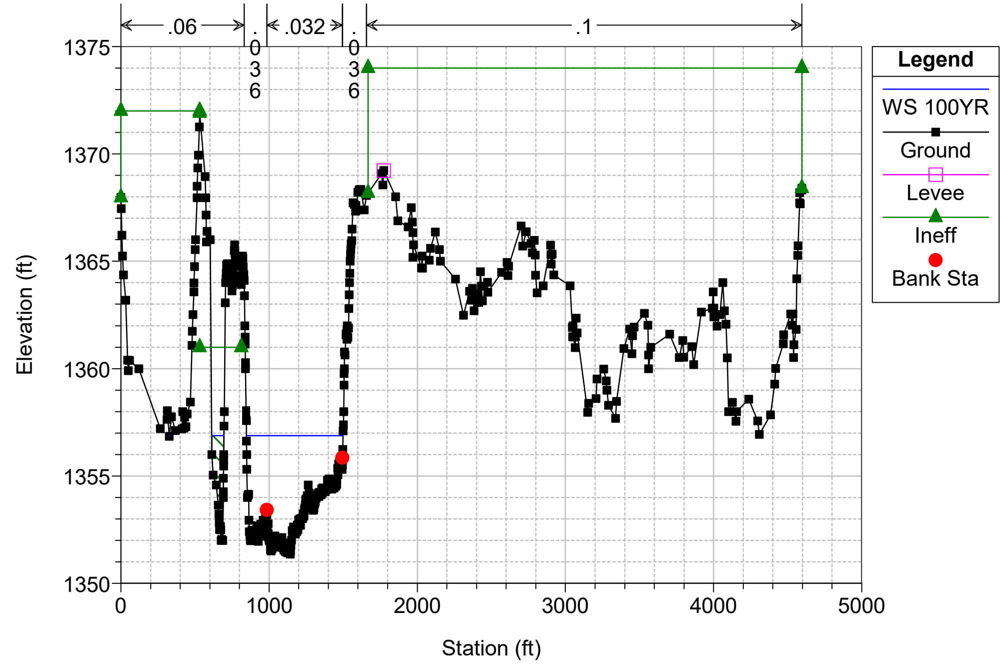
PACE - VPP Bank Protection   Plan: Plan 02_PR_Q100_n=FEMA   5/25/2022
Geom: PR_n=FEMA   Flow: TRUNCATED_FEMA_(EX&PR)
RS = 287039



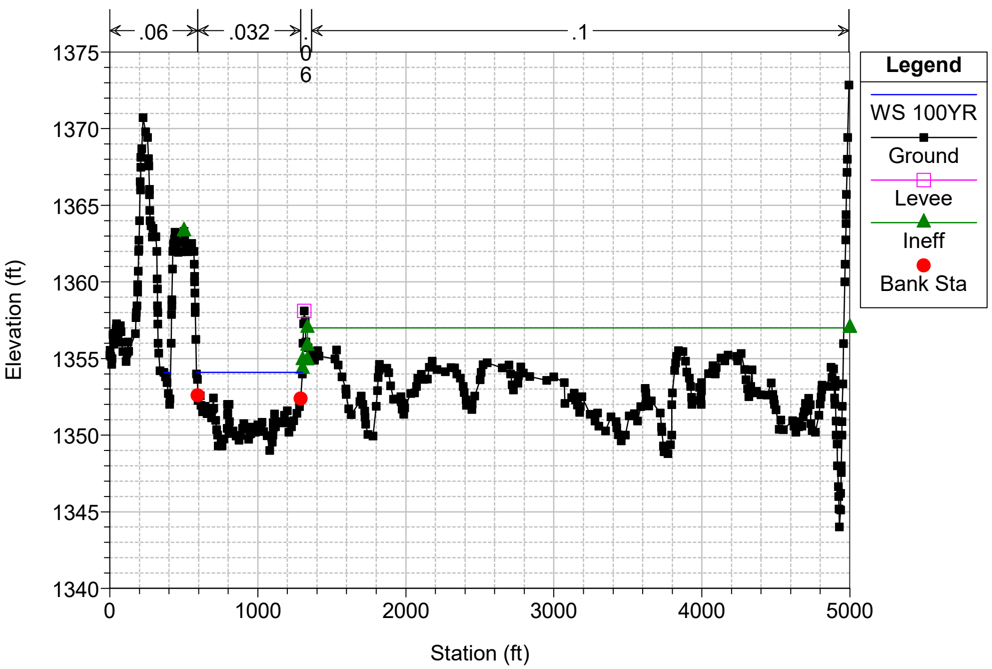
PACE - VPP Bank Protection   Plan: Plan 02_PR_Q100_n=FEMA   5/25/2022
Geom: PR_n=FEMA   Flow: TRUNCATED_FEMA_(EX&PR)
RS = 286876   BR



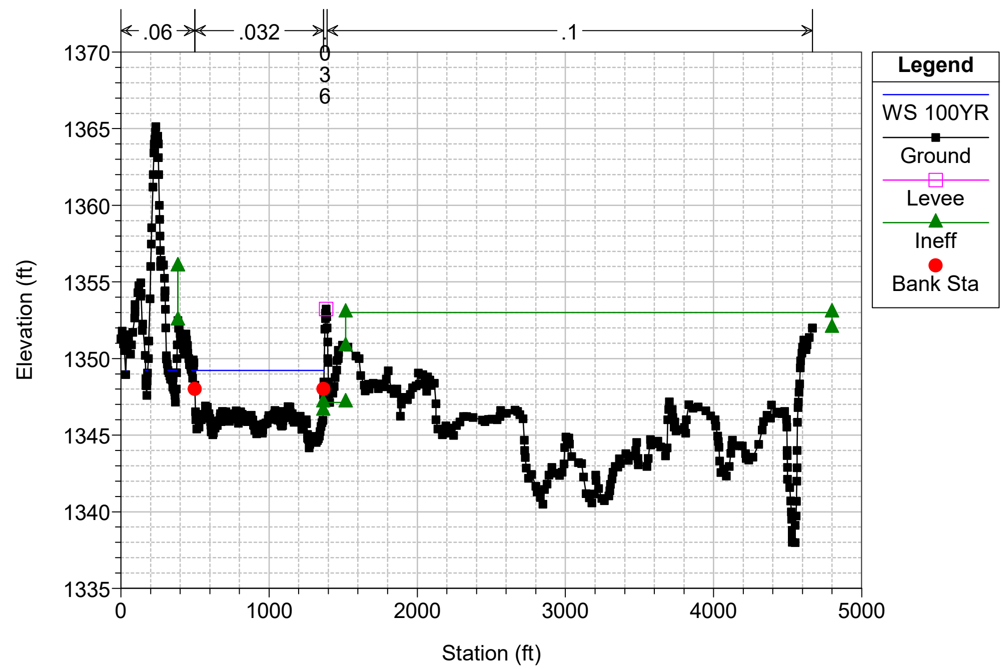
PACE - VPP Bank Protection   Plan: Plan 02_PR_Q100_n=FEMA   5/25/2022
Geom: PR_n=FEMA   Flow: TRUNCATED_FEMA_(EX&PR)
RS = 286718

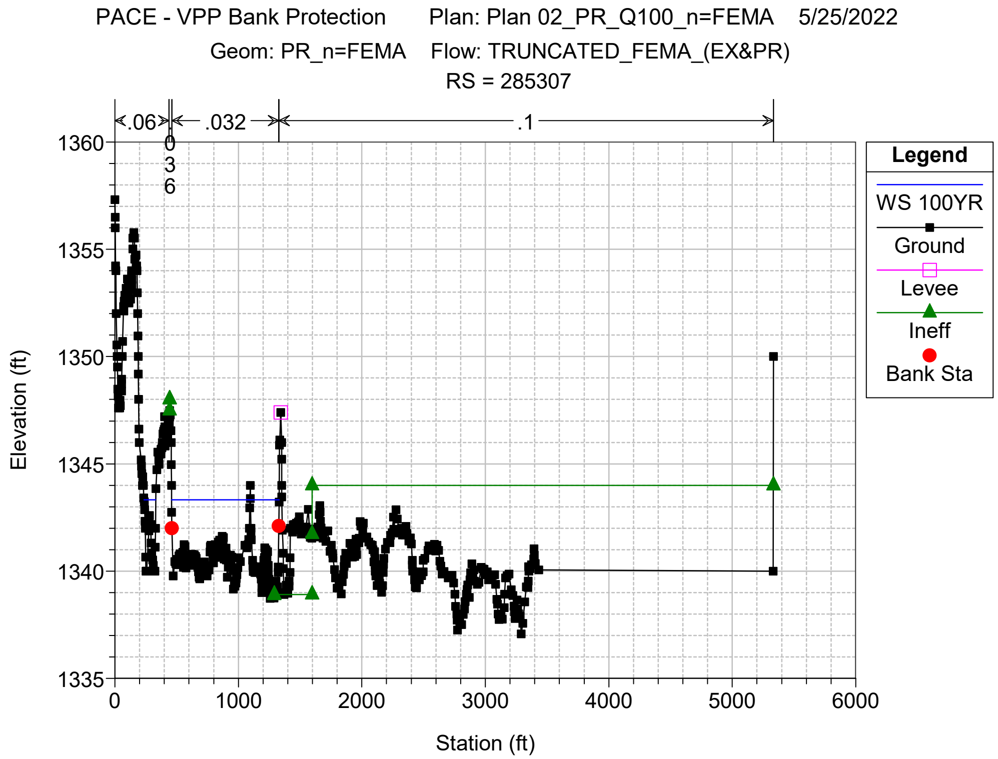


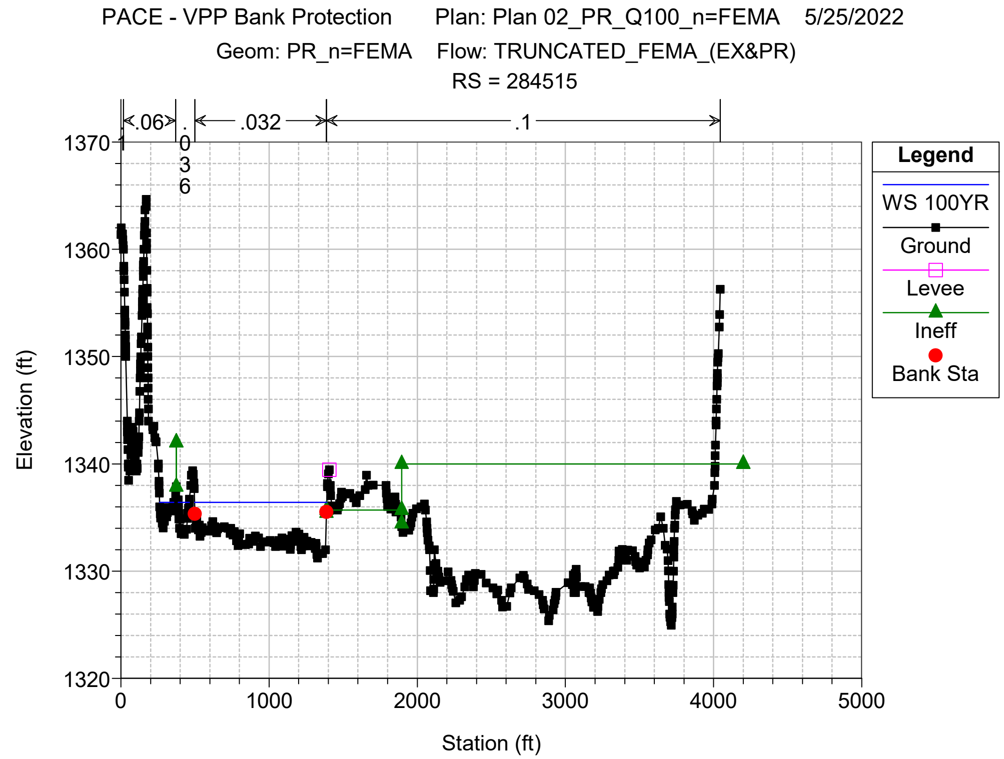
PACE - VPP Bank Protection   Plan: Plan 02_PR_Q100_n=FEMA   5/25/2022
Geom: PR_n=FEMA   Flow: TRUNCATED_FEMA_(EX&PR)
RS = 286407

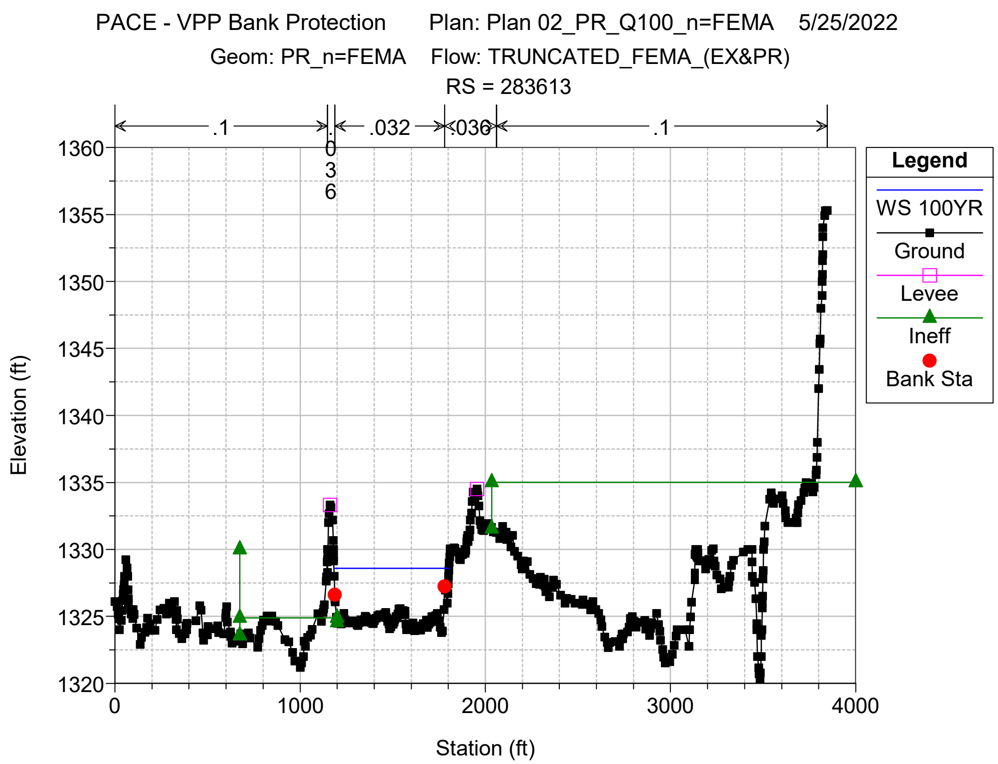


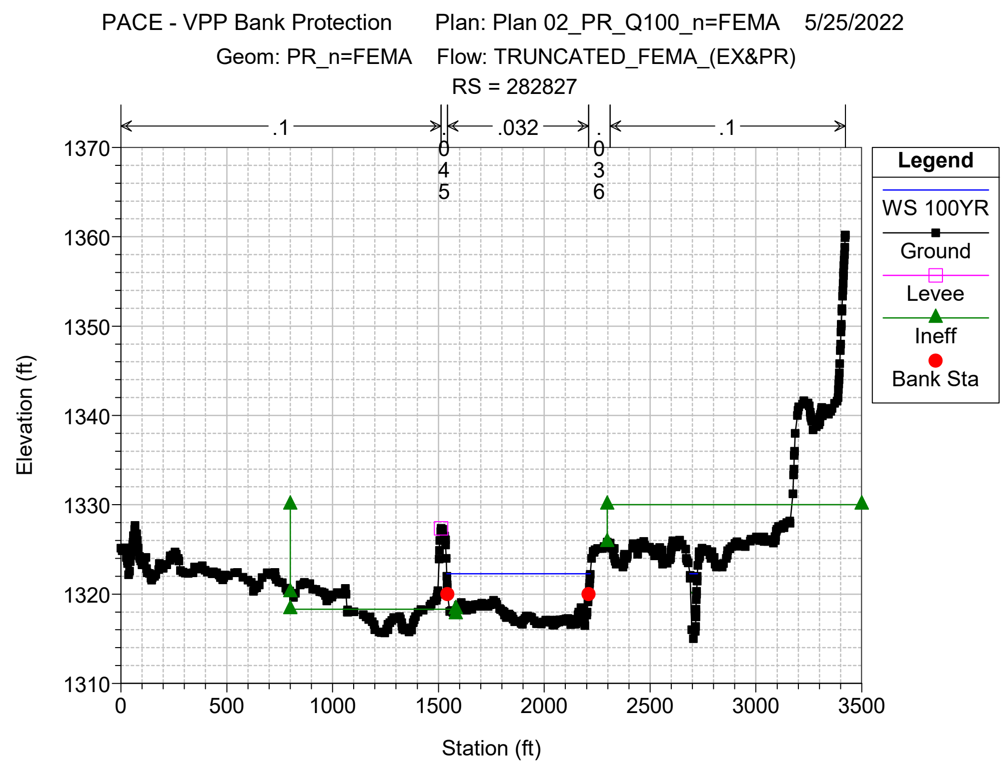
PACE - VPP Bank Protection   Plan: Plan 02_PR_Q100_n=FEMA   5/25/2022
Geom: PR_n=FEMA   Flow: TRUNCATED_FEMA_(EX&PR)
RS = 285935

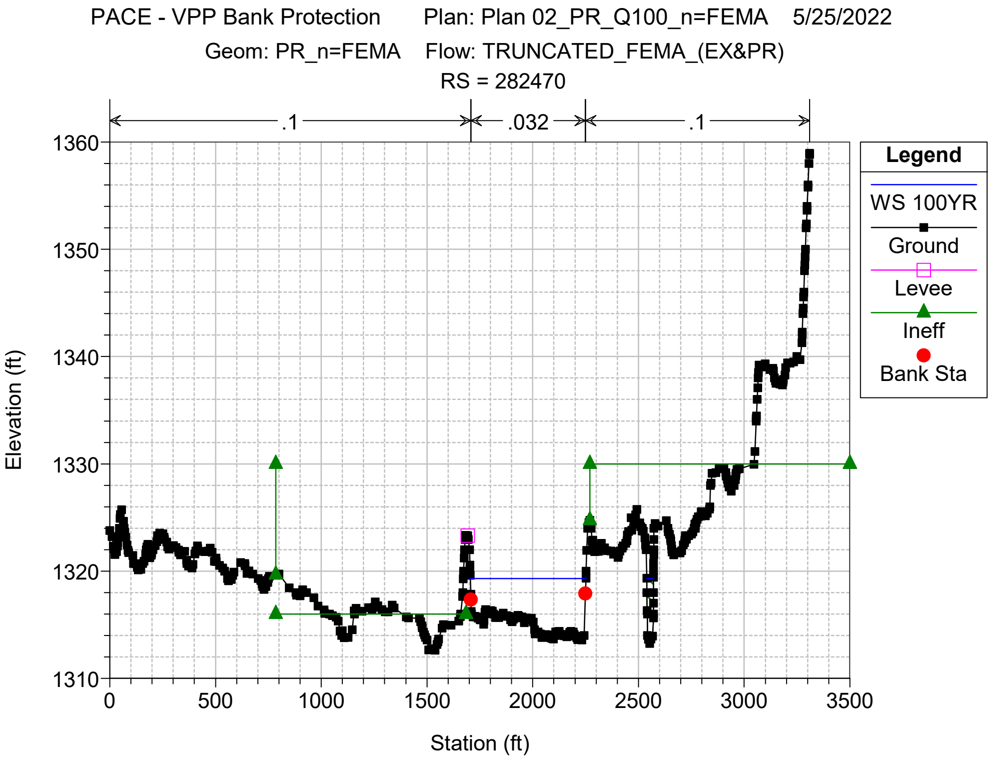


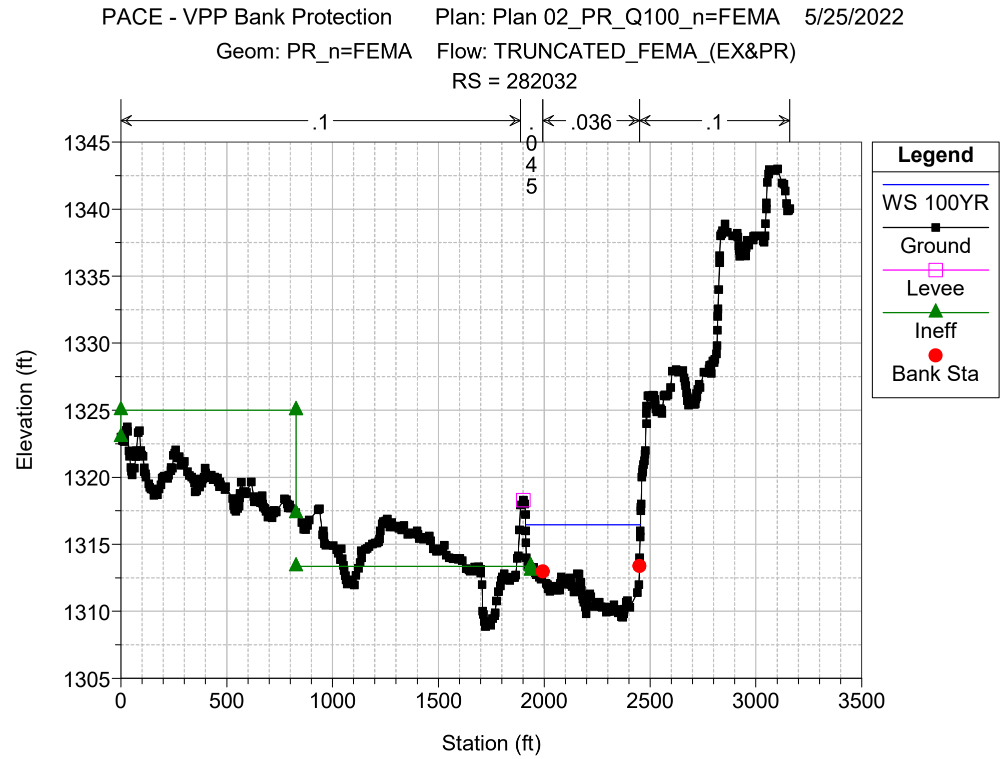

PACE - VPP Bank Protection
Plan: Plan 02_PR_Q100_n=FEMA
5/25/2022
Geom: PR_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 285307
.06
.032
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

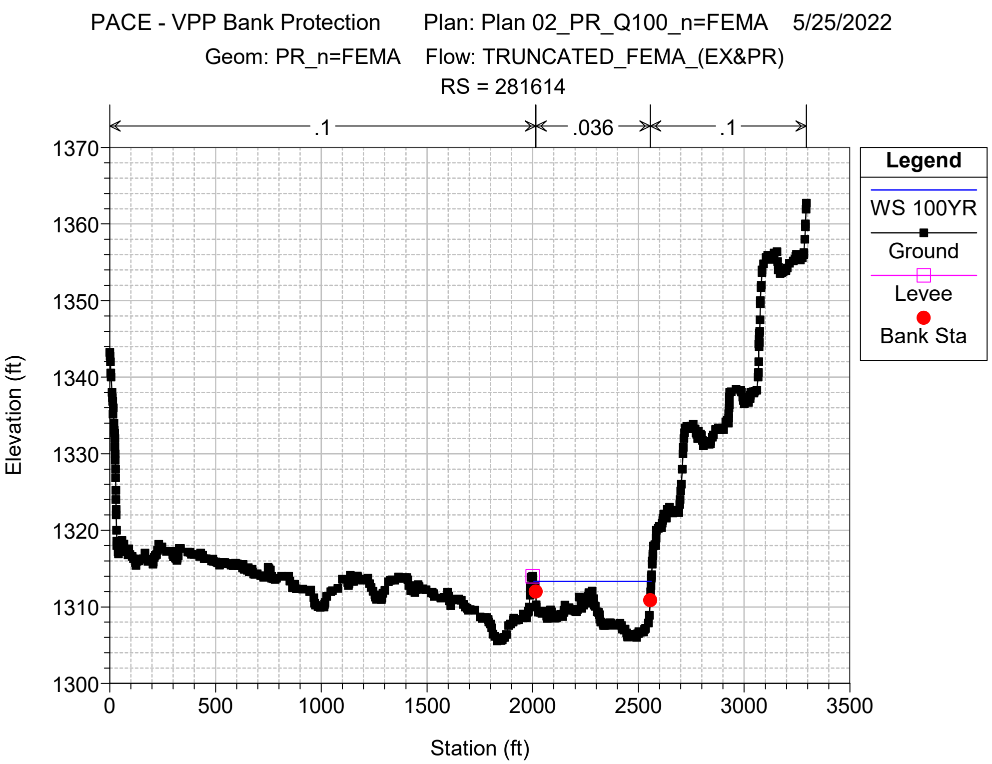

PACE - VPP Bank Protection
Plan: Plan 02_PR_Q100_n=FEMA
5/25/2022
Geom: PR_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 284515
.06
.032
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

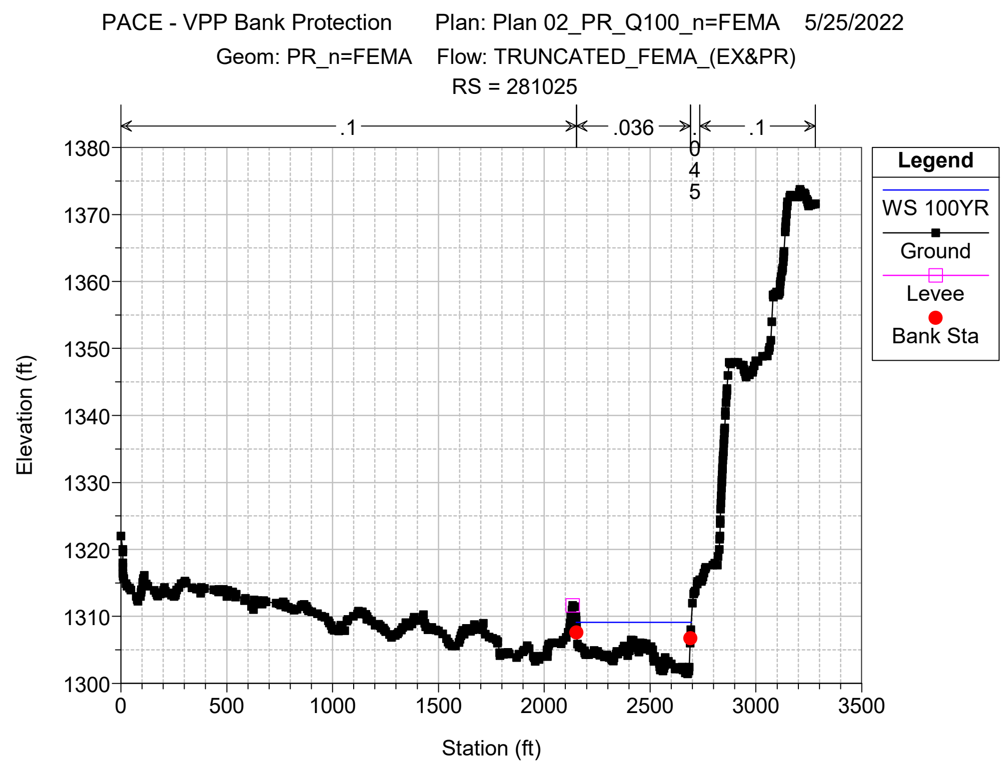

PACE - VPP Bank Protection
Plan: Plan 02_PR_Q100_n=FEMA
5/25/2022
Geom: PR_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 283613
.1
.032
.036
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

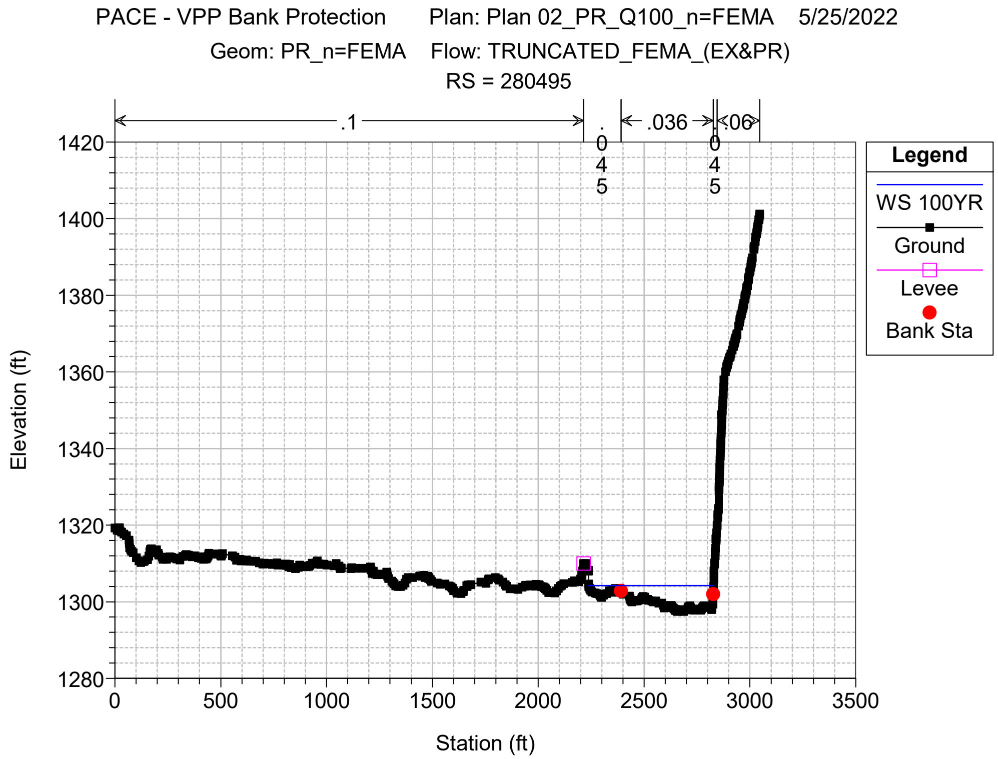

PACE - VPP Bank Protection
Plan: Plan 02_PR_Q100_n=FEMA
5/25/2022
Geom: PR_n=FEMA
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 282827
.1
.032
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

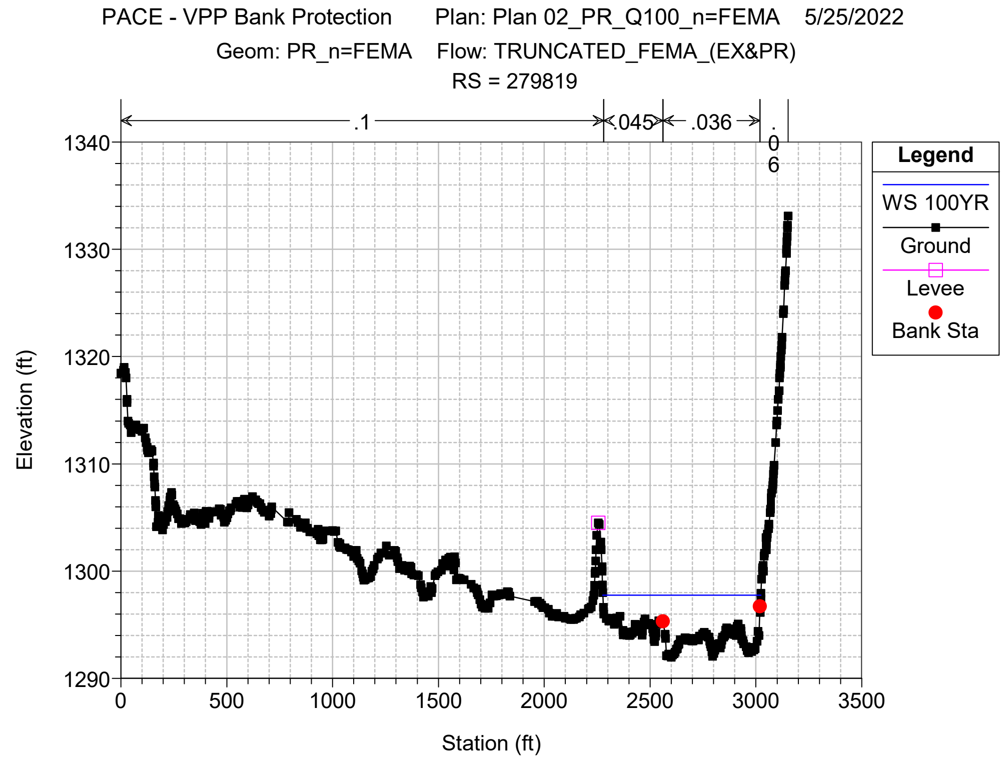

PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 282470
.1
.032
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

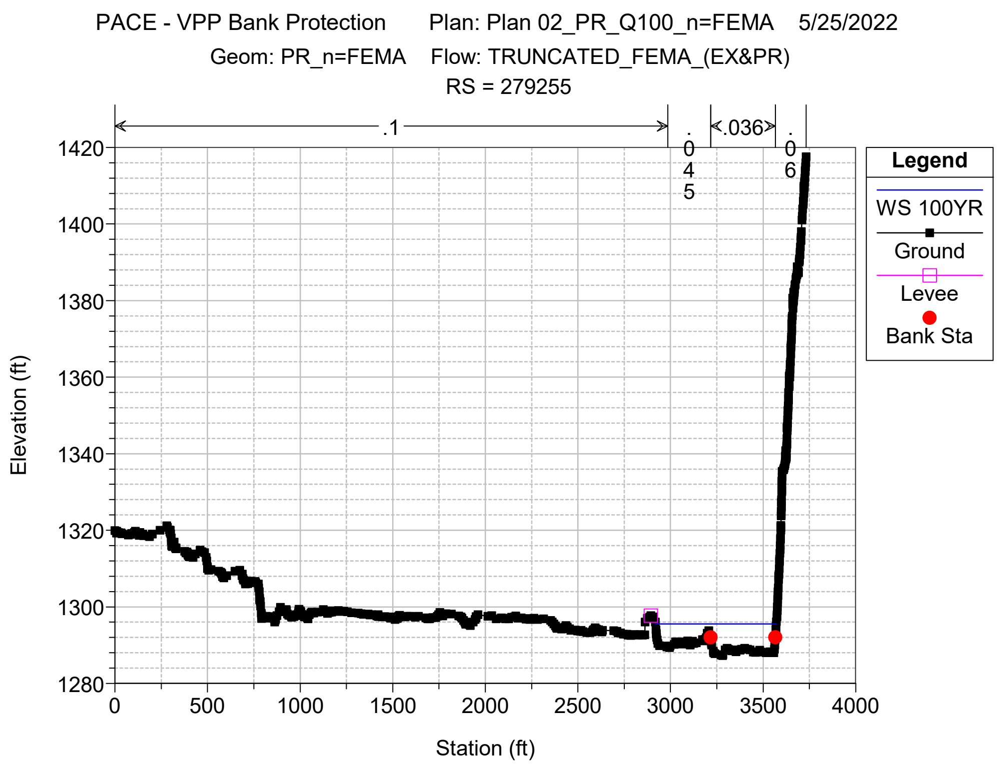

PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 282032
.1
.045
.036
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

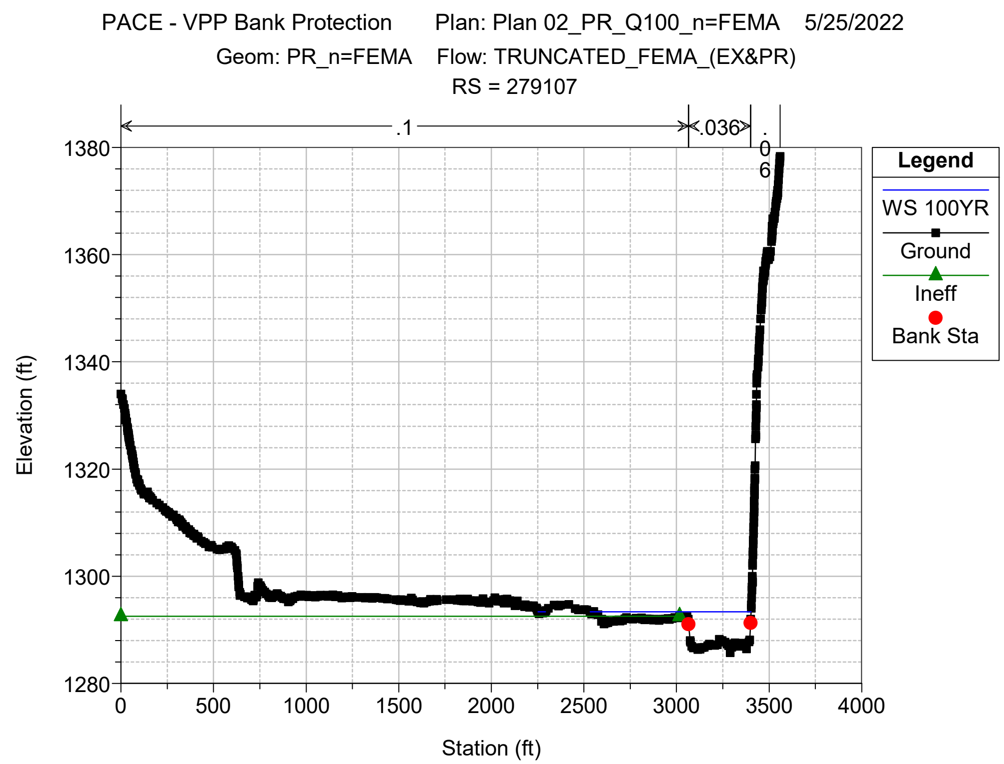

PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 281614
.1
.036
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Bank Sta

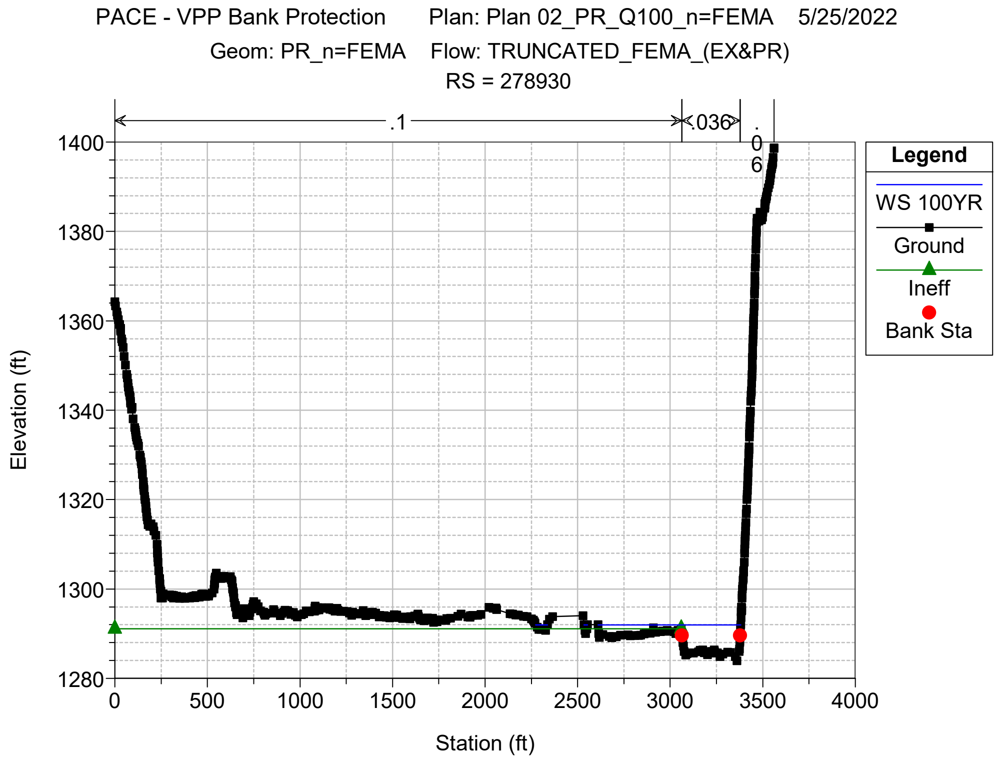

PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 281025
.1
.036
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Bank Sta


PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 280495
.1
.045
.036
.045
.06
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

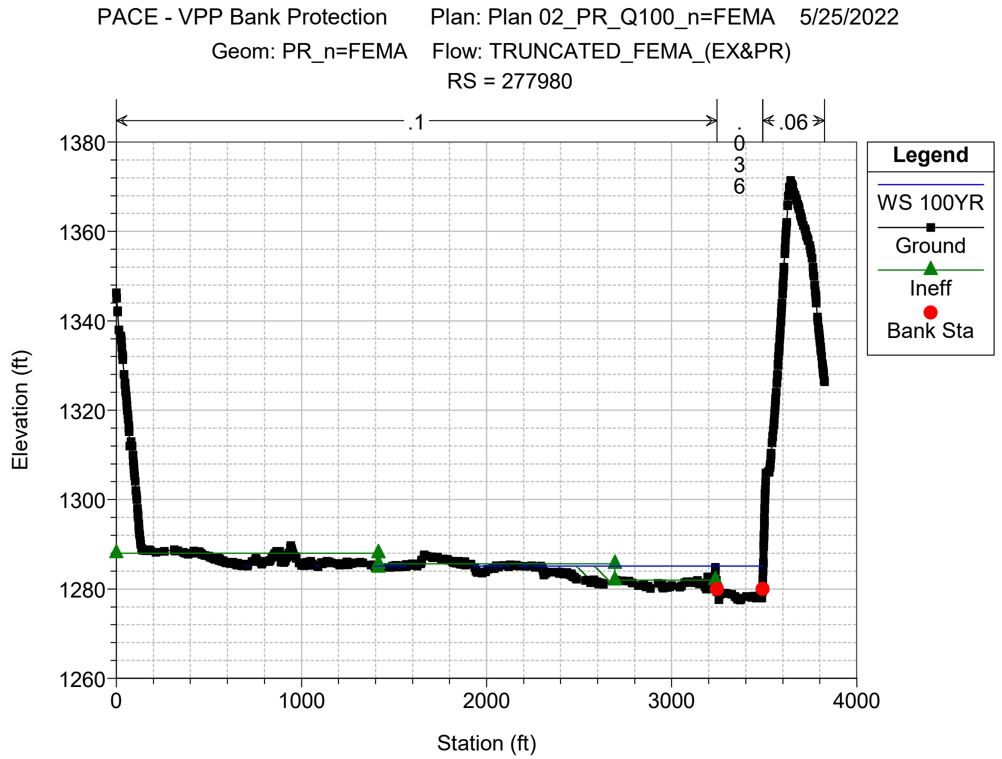

PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 279819
.1
.045
.036
.06
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 279255
.1
.045
.036
.06
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

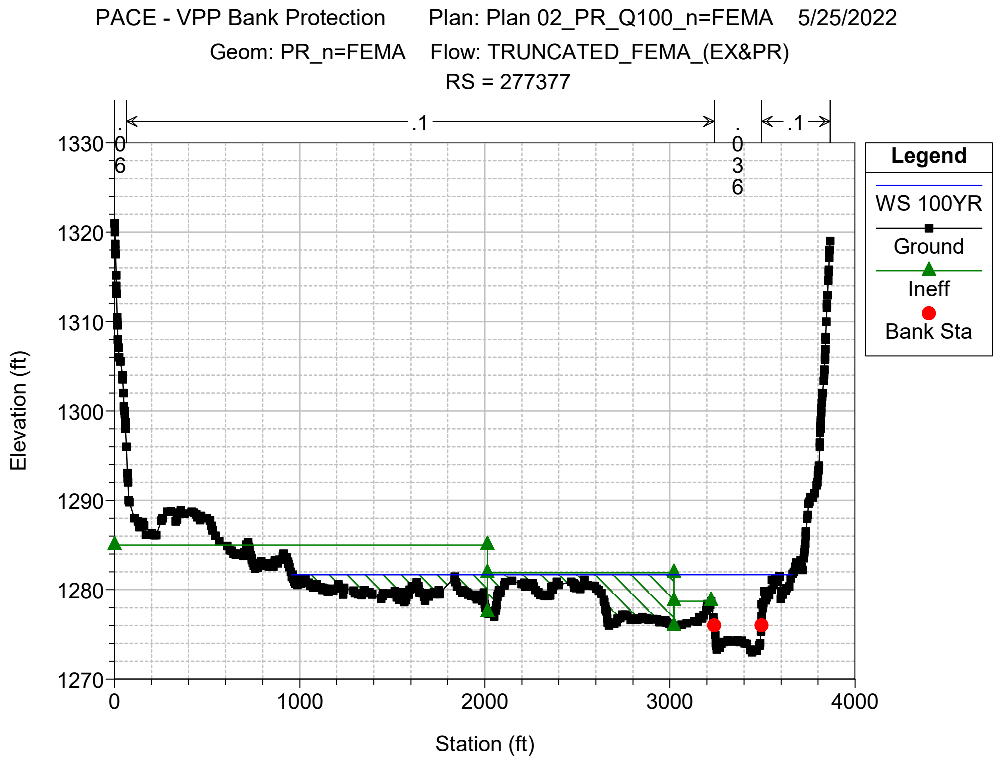

PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 279107
.1
.036
.06
Legend
WS 100YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)



PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 278930
.1
.036
.06
Legend
WS 100YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1400
1380
1360
1340
1320
1300
1280
0
500
1000
1500
2000
2500
3000
3500
4000



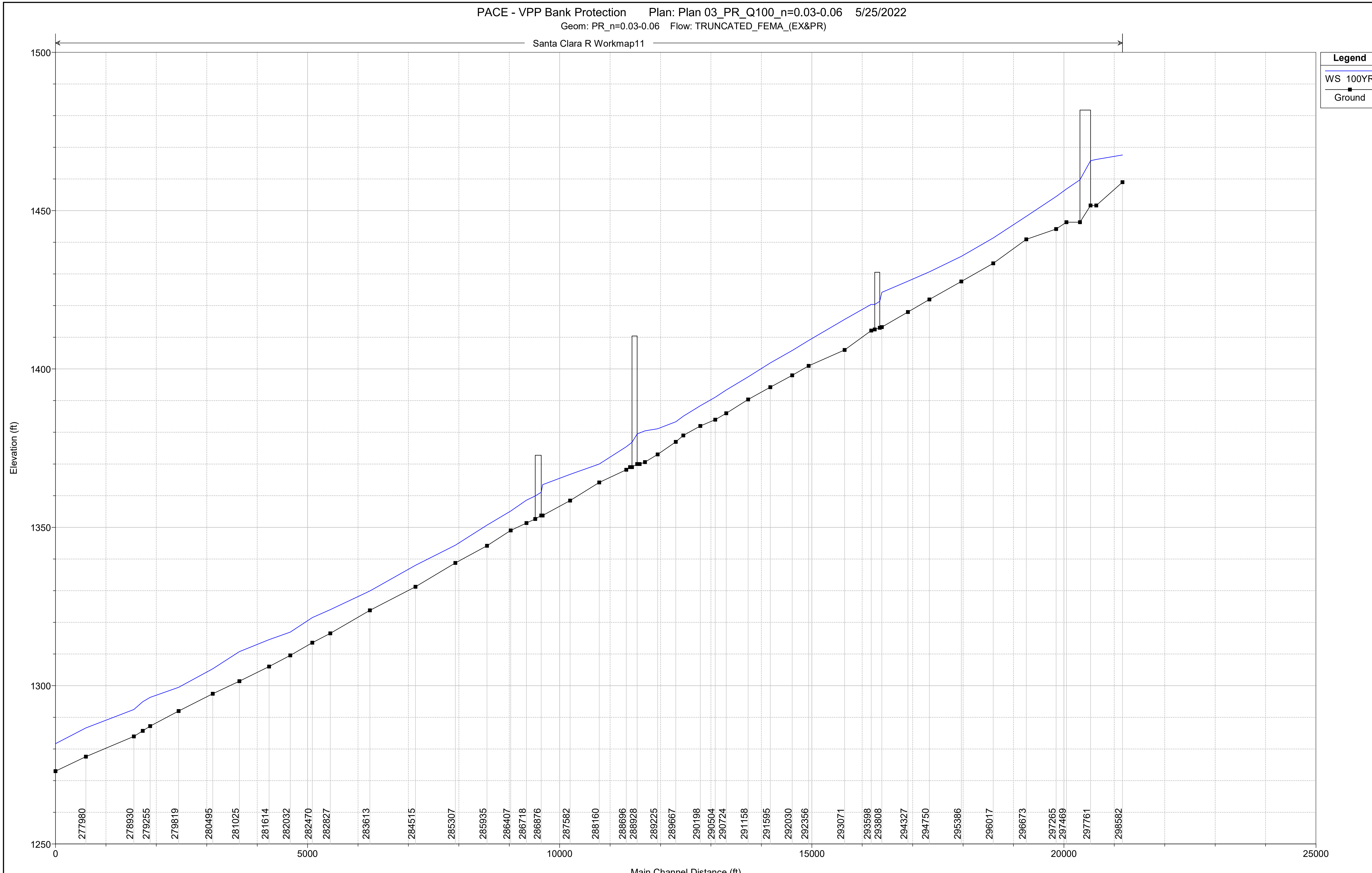
PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 277980
.1
.036
.06
Legend
WS 100YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1380
1360
1340
1320
1300
1280
1260
0
1000
2000
3000
4000



PACE - VPP Bank Protection Plan: Plan 02_PR_Q100_n=FEMA 5/25/2022
Geom: PR_n=FEMA Flow: TRUNCATED_FEMA_(EX&PR)
RS = 277377
.06
.1
.036
.1
Legend
WS 100YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1330
1320
1310
1300
1290
1280
1270
0
1000
2000
3000
4000

HEC-RAS Plan: Plan 02 River: Santa Clara R Reach: Workmap11 Profile: 100YR

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Workmap11	298582 BE	100YR	21690.00	1459.01	1465.15		1466.41	0.005694	9.08	2422.86	596.34	0.78
Workmap11	298062 DD	100YR	21690.00	1451.65	1464.26	1460.97	1464.87	0.001285	6.33	3583.86	562.69	0.41
Workmap11	297761		Bridge									
Workmap11	297469 DC	100YR	21690.00	1446.37	1455.89	1455.89	1457.95	0.009437	11.51	1890.74	466.71	1.00
Workmap11	297265 DB	100YR	21690.00	1444.21	1452.65	1452.65	1454.74	0.009216	11.60	1888.74	456.81	1.00
Workmap11	296673	100YR	21690.00	1440.93	1446.68	1446.68	1448.66	0.009431	11.30	1942.53	495.96	1.00
Workmap11	296017 BD	100YR	21690.00	1433.35	1439.82	1439.76	1441.58	0.009104	10.65	2047.07	552.60	0.97
Workmap11	295386 DA	100YR	21690.00	1427.63	1433.84	1433.84	1435.64	0.009692	10.76	2020.43	561.28	1.00
Workmap11	294750	100YR	21690.00	1421.94	1428.69	1428.26	1430.28	0.006657	10.13	2152.18	495.27	0.85
Workmap11	294327 BC	100YR	25910.00	1418.00	1425.27	1424.98	1427.28	0.007290	11.38	2305.70	478.78	0.91
Workmap11	293808 CY	100YR	25910.00	1413.24	1423.88	1421.04	1425.02	0.002073	8.57	3094.87	391.67	0.53
Workmap11	293703		Bridge									
Workmap11	293598 CX	100YR	25910.00	1412.15	1418.29	1418.29	1420.71	0.008631	12.49	2105.07	442.29	0.99
Workmap11	293071 CW	100YR	25910.00	1406.00	1413.54	1413.54	1415.92	0.008779	12.40	2122.15	453.45	0.99
Workmap11	292356 BB	100YR	25910.00	1400.99	1407.04	1407.04	1409.36	0.009011	12.20	2136.52	469.63	1.00
Workmap11	292030 CV	100YR	25910.00	1398.00	1404.01	1404.01	1406.21	0.009069	11.91	2193.42	501.49	1.00
Workmap11	291595 CU	100YR	25910.00	1394.26	1399.98	1399.91	1401.96	0.008815	11.31	2295.27	552.17	0.97
Workmap11	291158 BA	100YR	25910.00	1390.36	1396.04	1396.04	1397.94	0.009484	11.07	2344.78	614.77	1.00
Workmap11	290724	100YR	25910.00	1386.00	1391.72	1391.63	1393.39	0.008247	10.58	2552.90	694.79	0.93
Workmap11	290504	100YR	25910.00	1384.00	1389.76	1389.76	1391.46	0.008787	10.78	2558.32	759.43	0.96
Workmap11	290198	100YR	25910.00	1382.00	1386.94	1386.86	1388.44	0.008303	10.50	2810.77	870.06	0.93
Workmap11	289893	100YR	25910.00	1379.00	1383.82	1383.82	1385.50	0.008723	11.14	2677.38	804.61	0.97
Workmap11	289667 AZ	100YR	25910.00	1377.00	1381.82	1381.82	1383.46	0.009889	11.09	2620.39	968.22	1.01
Workmap11	289225	100YR	25910.00	1373.00	1379.16	1378.40	1380.26	0.005504	8.67	3107.20	857.18	0.77
Workmap11	289044 CS	100YR	25910.00	1370.61	1379.03	1376.04	1379.50	0.001207	5.50	4713.49	1233.07	0.39
Workmap11	288929	100YR	25910.00	1370.00	1378.30	1376.17	1379.20	0.002500	7.61	3405.62	546.29	0.54
Workmap11	288928		Bridge									
Workmap11	288766	100YR	25910.00	1369.00	1375.01	1374.58	1376.72	0.006716	10.47	2474.21	539.20	0.86
Workmap11	288696 CR	100YR	25910.00	1368.17	1374.02	1374.02	1376.08	0.008969	11.61	2310.10	963.04	0.99
Workmap11	288160 CQ	100YR	25910.00	1364.15	1368.54	1368.54	1370.18	0.010116	10.41	2538.11	774.49	1.01
Workmap11	287582 AY	100YR	25910.00	1358.43	1365.00	1363.58	1365.91	0.003186	7.65	3398.05	686.11	0.60
Workmap11	287039 CO	100YR	25910.00	1353.74	1363.24	1360.57	1364.18	0.003030	7.99	3451.73	1143.86	0.53
Workmap11	286876		Bridge									
Workmap11	286718 CN	100YR	25910.00	1351.36	1356.88	1356.83	1358.66	0.009707	10.75	2425.65	735.32	1.00
Workmap11	286407 CM	100YR	25910.00	1349.00	1354.10	1354.10	1355.86	0.010099	10.67	2470.15	760.84	1.01
Workmap11	285935 AX	100YR	25910.00	1344.16	1349.22	1348.92	1350.45	0.007457	8.92	2954.09	958.64	0.86
Workmap11	285307 CL	100YR	25910.00	1338.73	1343.32	1343.32	1344.81	0.010925	9.92	2728.16	958.66	1.02
Workmap11	284515 AW	100YR	25910.00	1331.23	1336.42	1335.93	1337.46	0.006384	8.31	3257.07	1064.40	0.80
Workmap11	283613 AV	100YR	25910.00	1323.79	1328.59	1328.59	1330.48	0.009219	11.06	2364.48	620.59	0.99
Workmap11	282827	100YR	25910.00	1316.49	1322.27	1321.36	1323.41	0.004560	8.57	3032.13	713.31	0.71
Workmap11	282470 CK	100YR	25910.00	1313.57	1319.31	1319.13	1321.21	0.008090	11.06	2346.86	579.61	0.94
Workmap11	282032 AU	100YR	26210.00	1309.57	1316.45	1315.66	1317.97	0.006395	10.08	2722.50	542.77	0.77
Workmap11	281614	100YR	26210.00	1306.01	1313.33	1312.82	1314.98	0.007978	10.31	2551.77	553.91	0.84
Workmap11	281025 CI	100YR	26210.00	1301.41	1309.10	1308.36	1310.60	0.006815	9.84	2667.59	543.94	0.78
Workmap11	280495 AT	100YR	26210.00	1297.45	1304.25	1304.25	1306.30	0.009765	11.72	2392.01	589.48	0.93
Workmap11	279819 CH	100YR	26210.00	1291.98	1297.76	1297.59	1299.31	0.009713	10.70	2767.73	746.33	0.91
Workmap11	279255 CG	100YR	26210.00	1287.24	1295.54	1293.50	1296.39	0.002843	8.10	3915.90	652.65	0.54
Workmap11	279107 AS	100YR	26210.00	1285.71	1293.35	1293.35	1295.59	0.007911	12.25	2737.93	903.44	0.87
Workmap11	278930	100YR	26210.00	1283.95	1291.99	1291.99	1294.17	0.007799	12.30	2957.16	853.08	0.87
Workmap11	277980 CE	100YR	26210.00	1277.56	1285.15	1284.60	1286.87	0.006631	11.96	3797.56	1648.69	0.81
Workmap11	277377 AR	100YR	26210.00	1272.99	1281.67	1280.56	1283.43	0.005043	11.42	3316.29	2705.92	0.73


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 5/25/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
Santa Clara R Workmap11
Legend
WS 100YR
Ground
Elevation (ft)
1500
1450
1400
1350
1300
1250
Main Channel Distance (ft)
0
5000
10000
15000
20000
25000
277980
278930
279255
279819
280495
281025
281614
282032
282470
282827
283613
284515
285307
285935
286407
286718
286876
287582
288160
288696
288928
289225
289667
290198
290504
290724
291158
291595
292030
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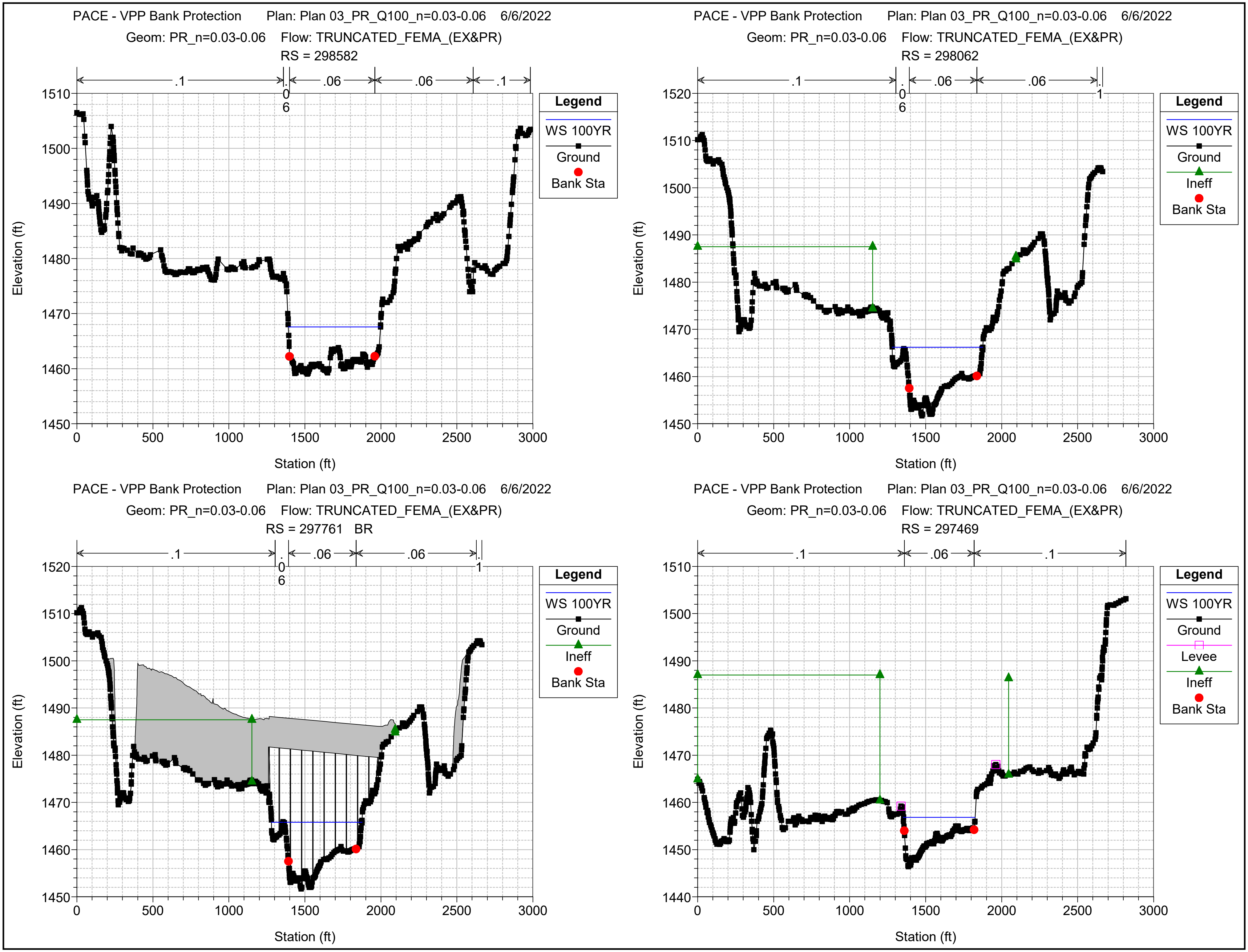
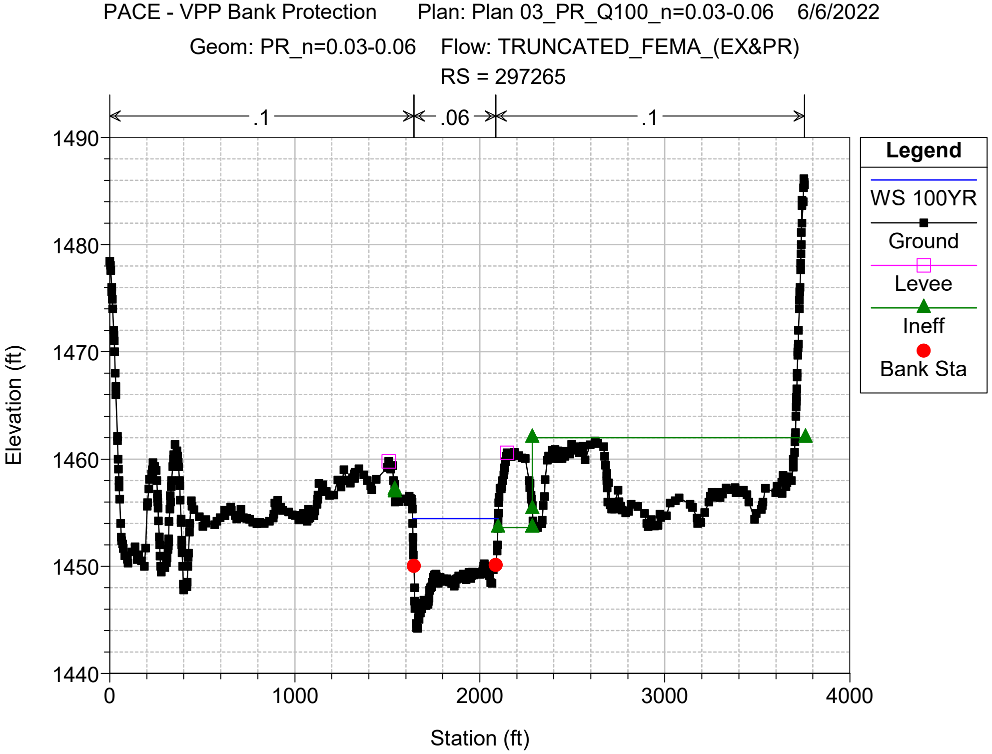
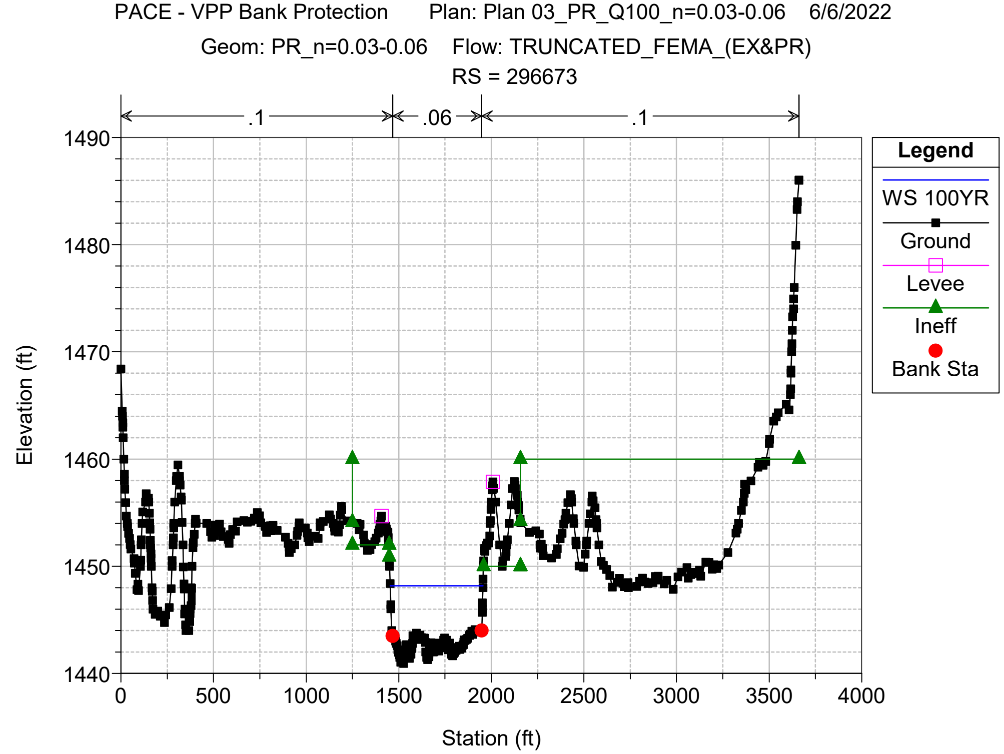
293598
293808
294327
294750
295386
296017
296673
297265
297469
297761
298582

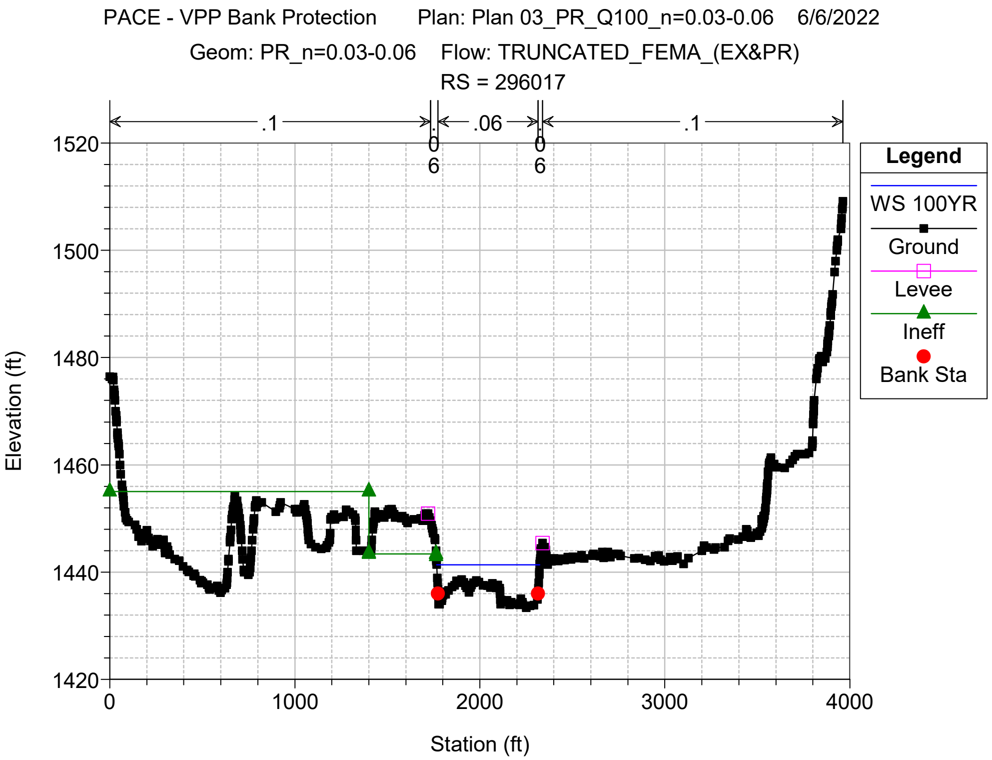

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 298582
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Bank Sta
PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 298062
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Ineff
Bank Sta
PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 297761 BR
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Ineff
Bank Sta
PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 297469
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta



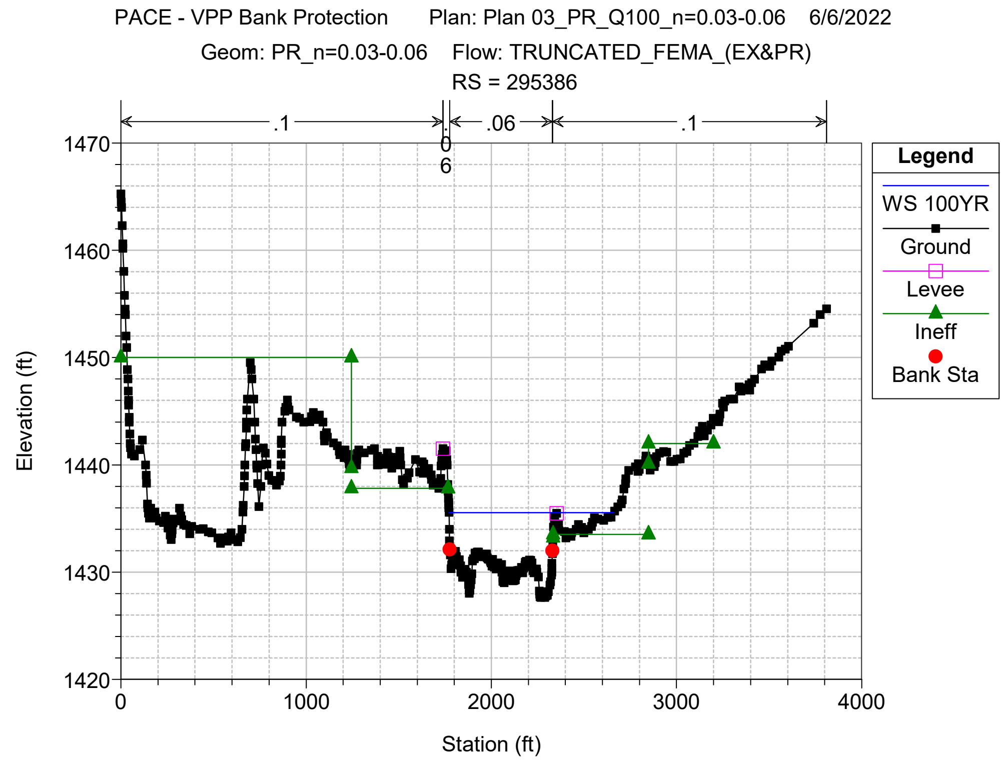
PACE - VPP Bank Protection
Plan: Plan 03_PR_Q100_n=0.03-0.06
6/6/2022
Geom: PR_n=0.03-0.06
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 297265
.1
.06
.1
Elevation (ft)
1490
1480
1470
1460
1450
1440
0
1000
2000
3000
4000
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta



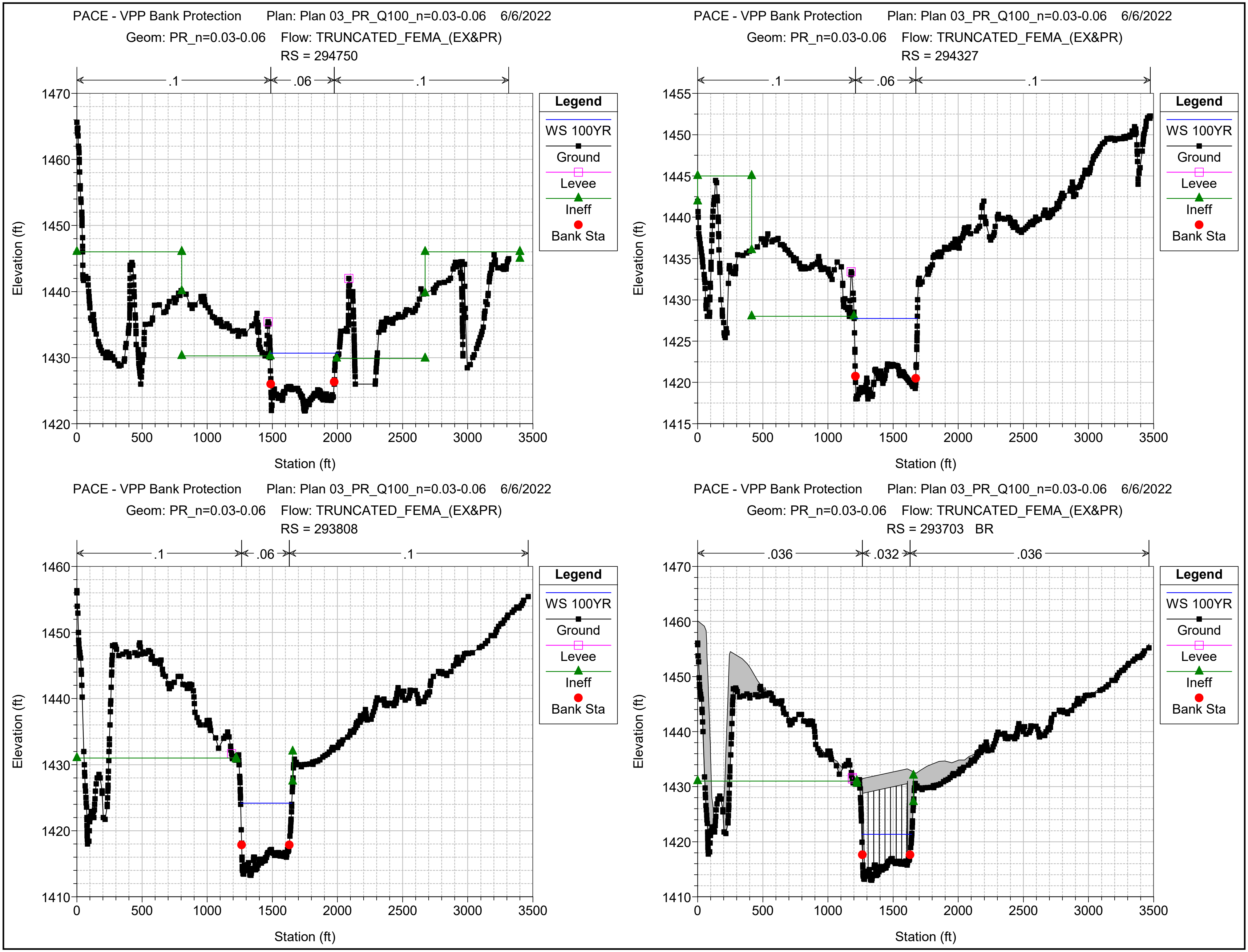
PACE - VPP Bank Protection
Plan: Plan 03_PR_Q100_n=0.03-0.06
6/6/2022
Geom: PR_n=0.03-0.06
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 296673
.1
.06
.1
Elevation (ft)
1490
1480
1470
1460
1450
1440
0
500
1000
1500
2000
2500
3000
3500
4000
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta



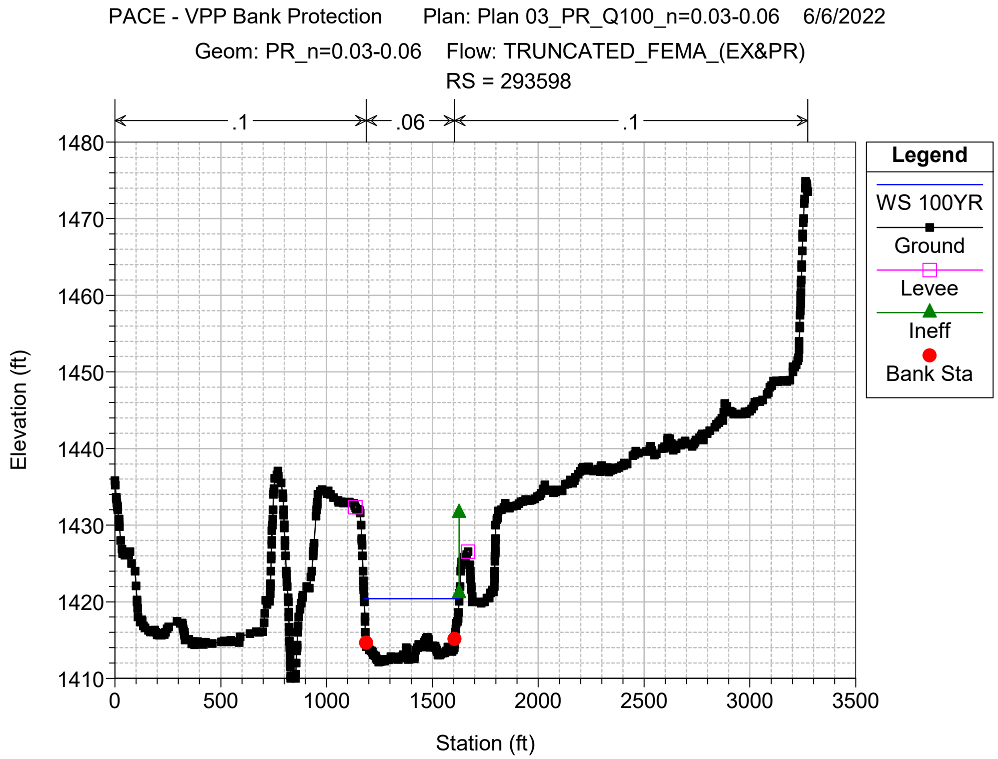
PACE - VPP Bank Protection
Plan: Plan 03_PR_Q100_n=0.03-0.06
6/6/2022
Geom: PR_n=0.03-0.06
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 296017
.1
0
6
.06
0
6
.1
Elevation (ft)
1520
1500
1480
1460
1440
1420
0
1000
2000
3000
4000
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

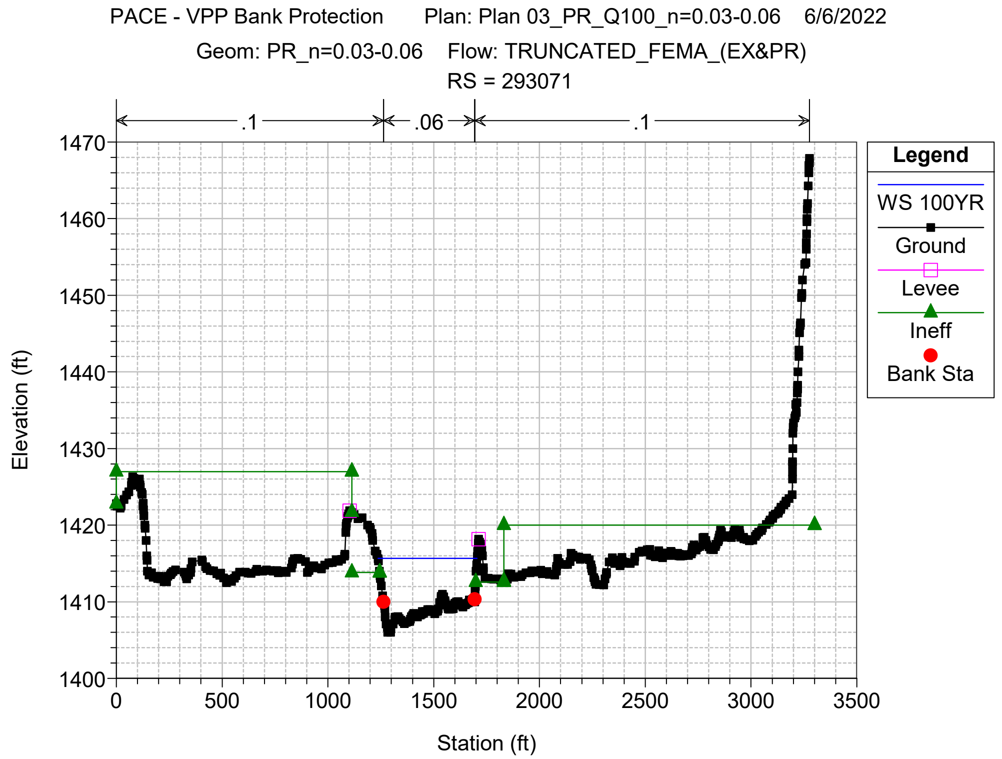


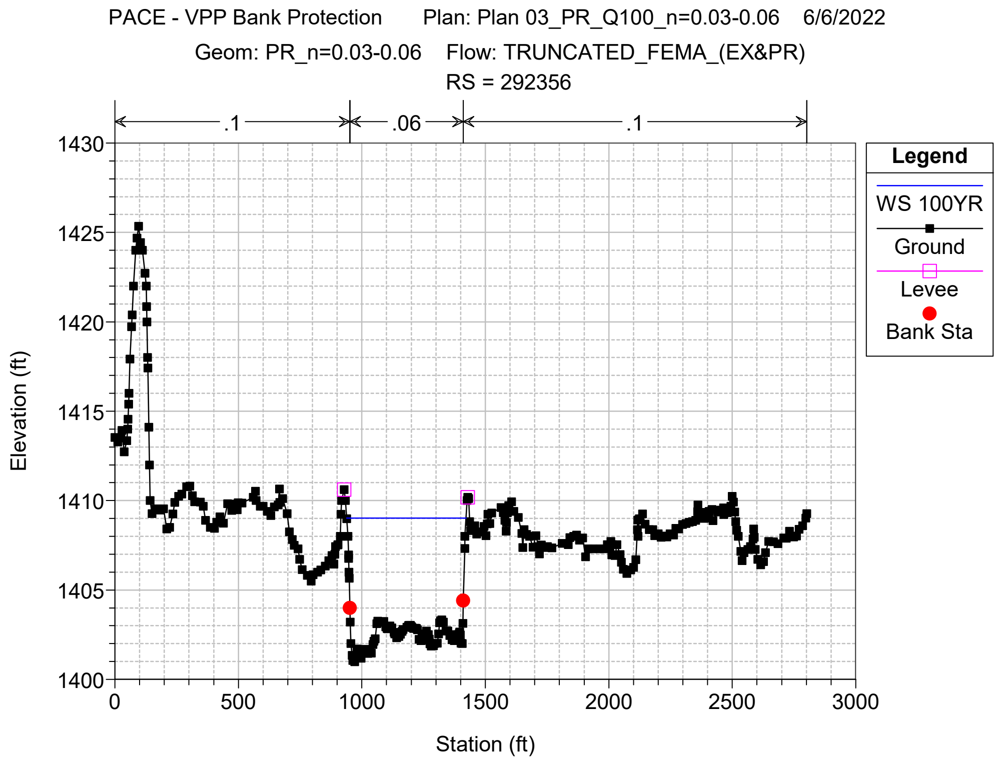
PACE - VPP Bank Protection
Plan: Plan 03_PR_Q100_n=0.03-0.06
6/6/2022
Geom: PR_n=0.03-0.06
Flow: TRUNCATED_FEMA_(EX&PR)
RS = 295386
.1
0
6
.06
.1
Elevation (ft)
1470
1460
1450
1440
1430
1420
0
1000
2000
3000
4000
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

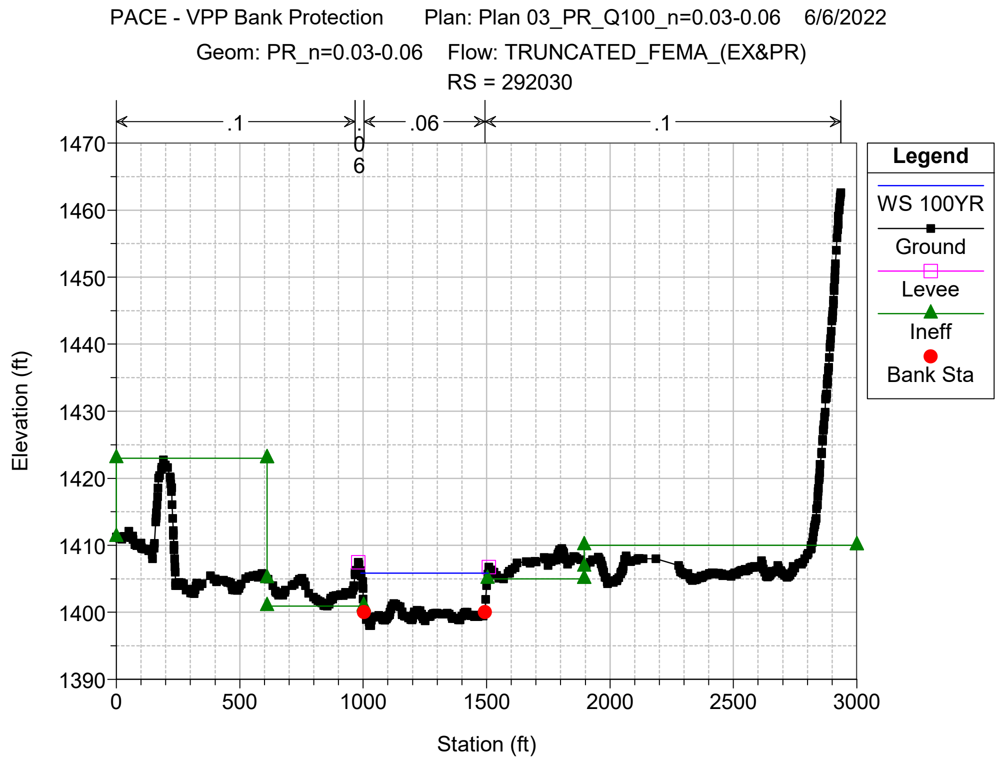


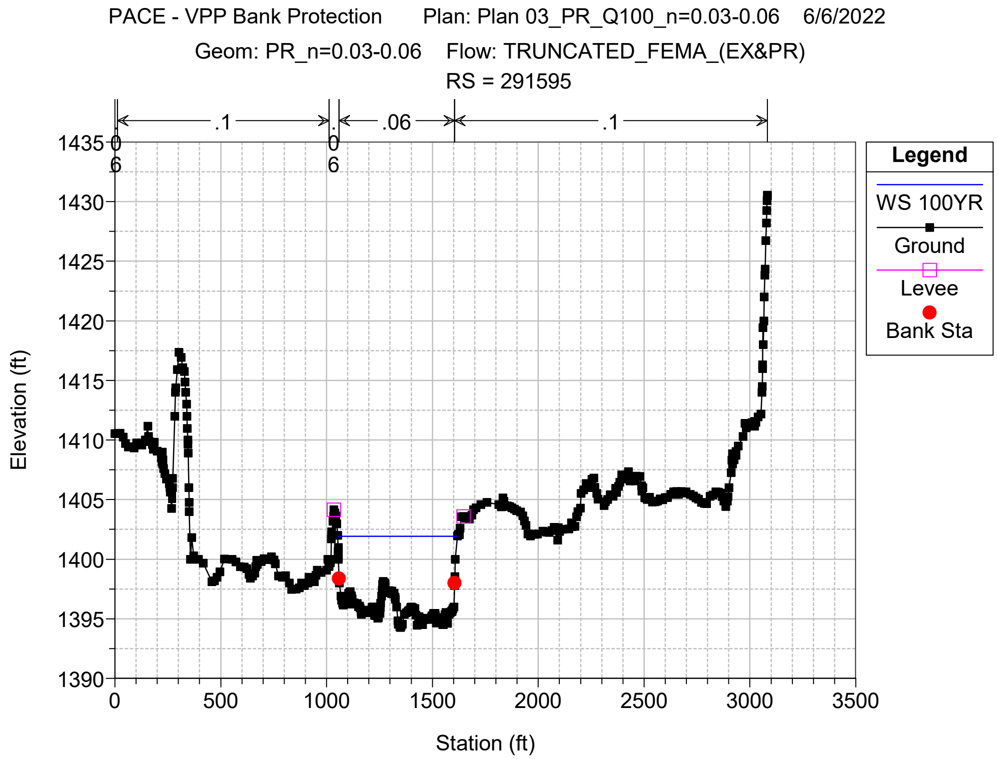
PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 294750
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 294327
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 293808
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 293703 BR
.036
.032
.036
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

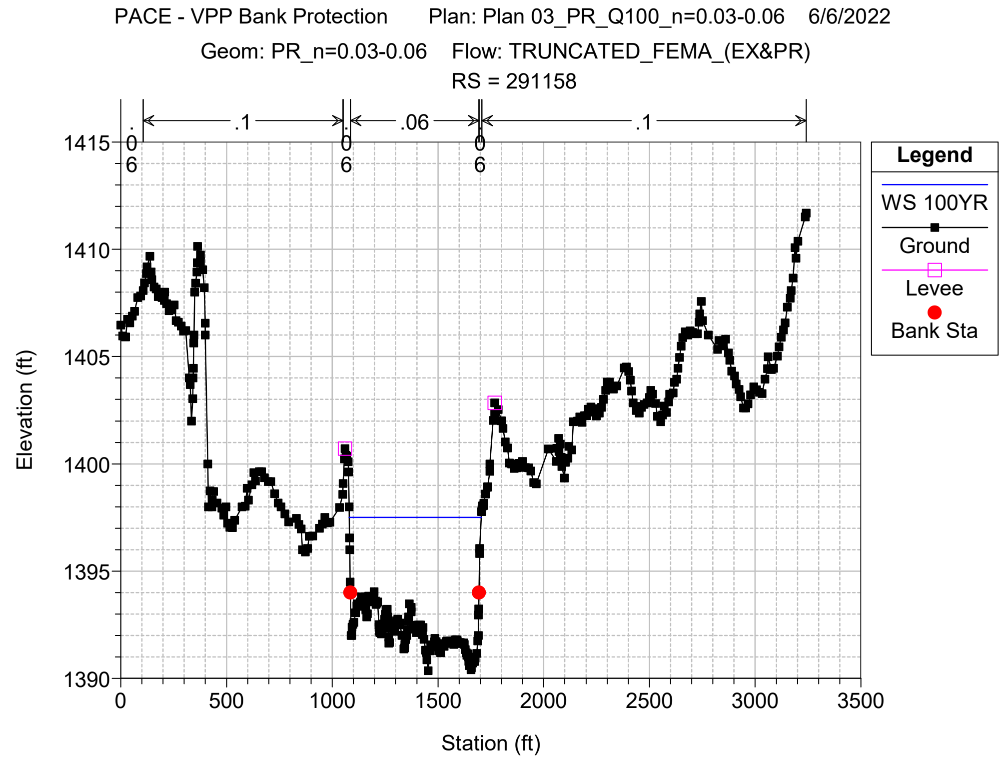

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 293598
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

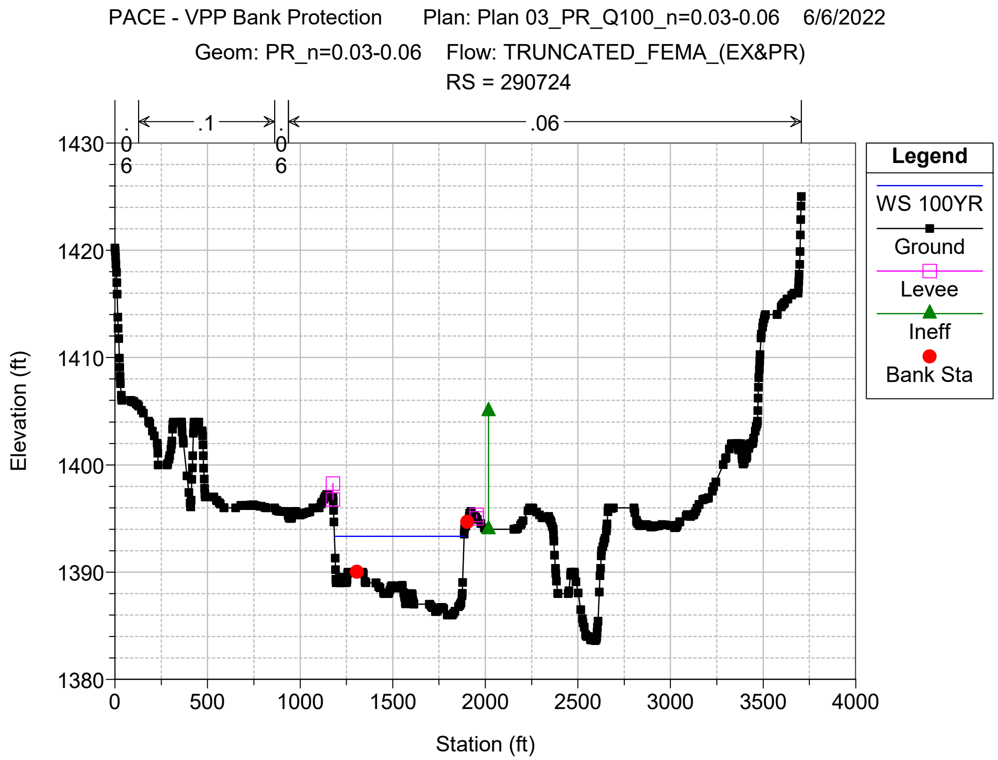

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 293071
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

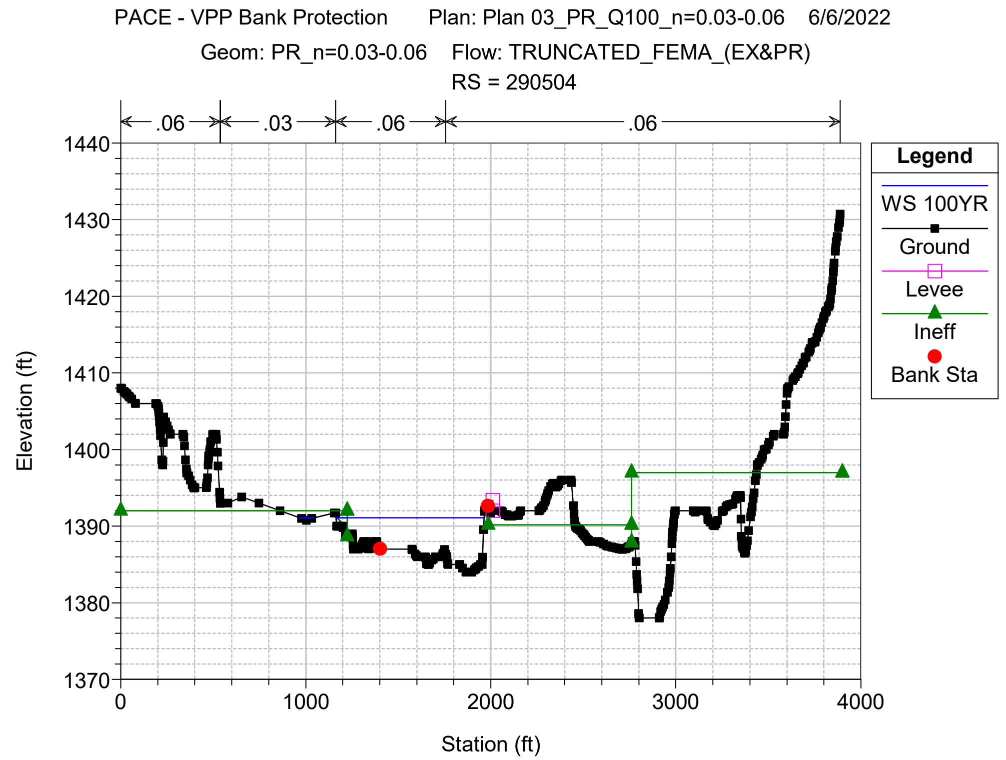

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 292356
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Bank Sta

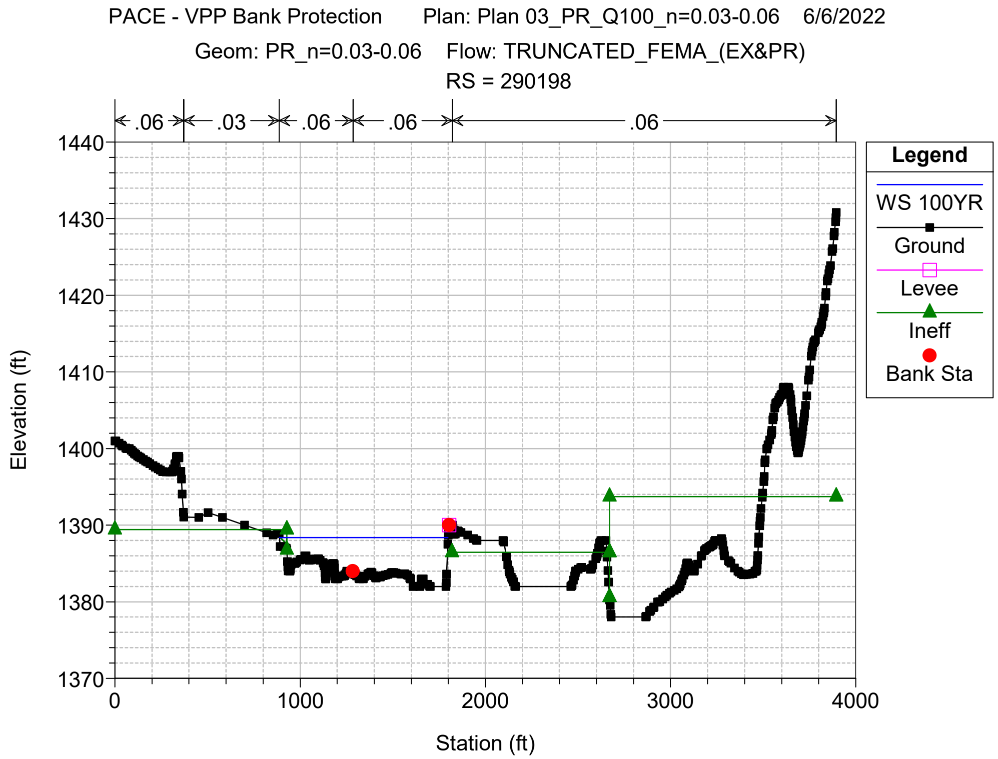

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 292030
.1
0
6
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

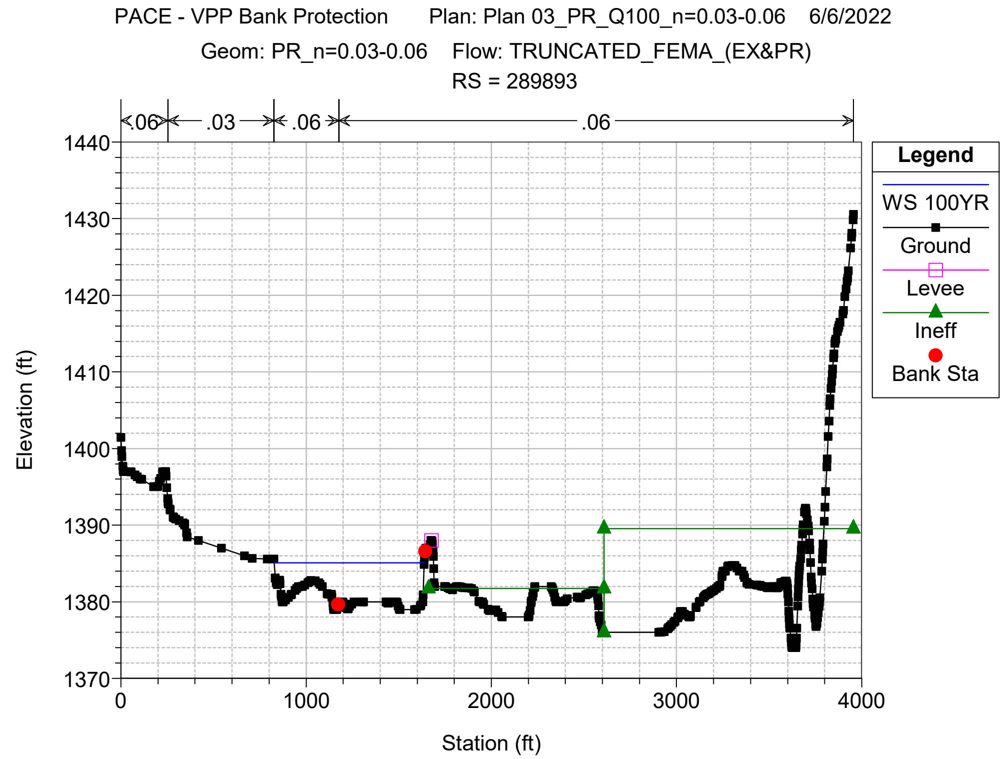

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 291595
.1
.06
.1
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

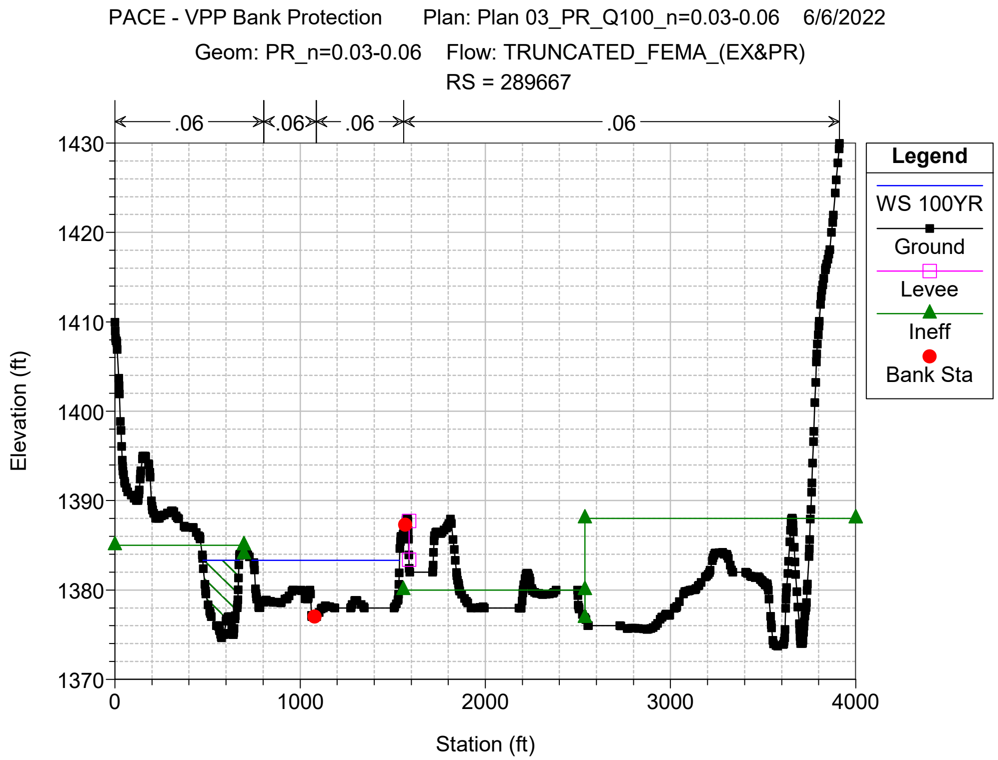

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 291158
.1
.06
.1
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

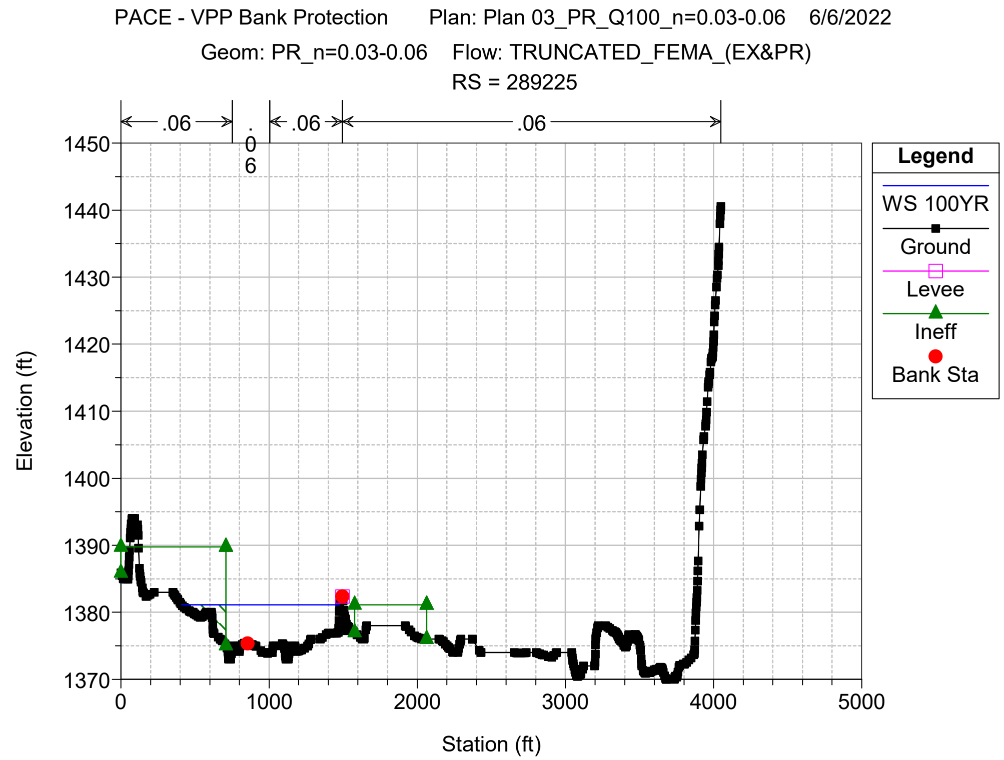

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 290724
.1
.06
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)

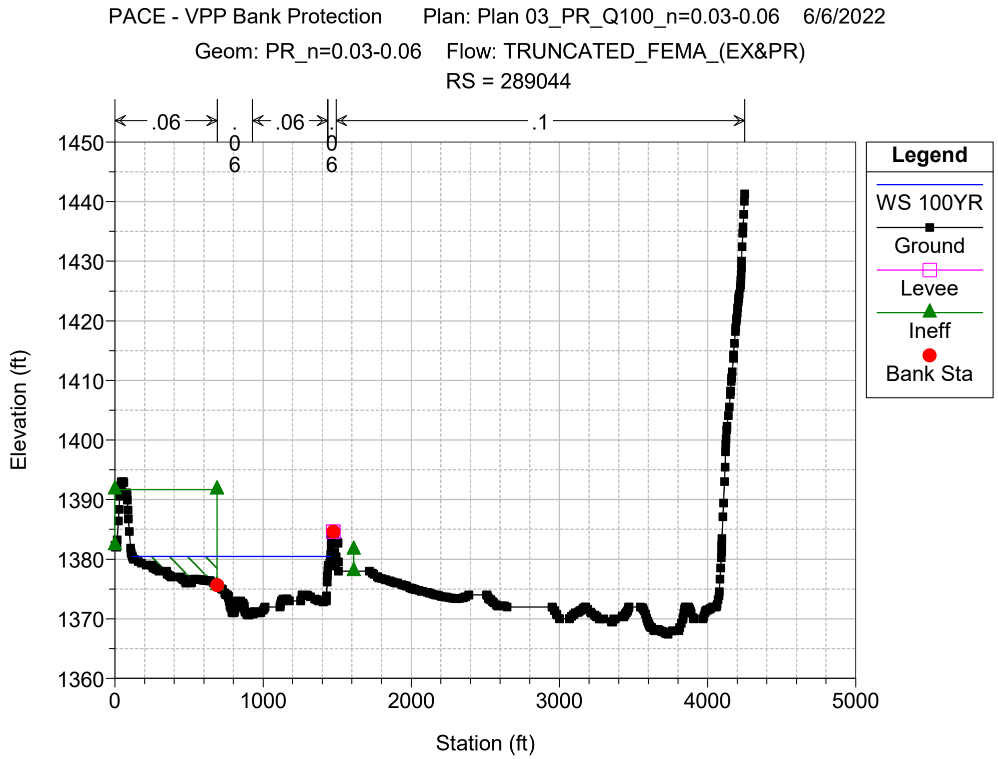

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 290504
.06
.03
.06
.06
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)

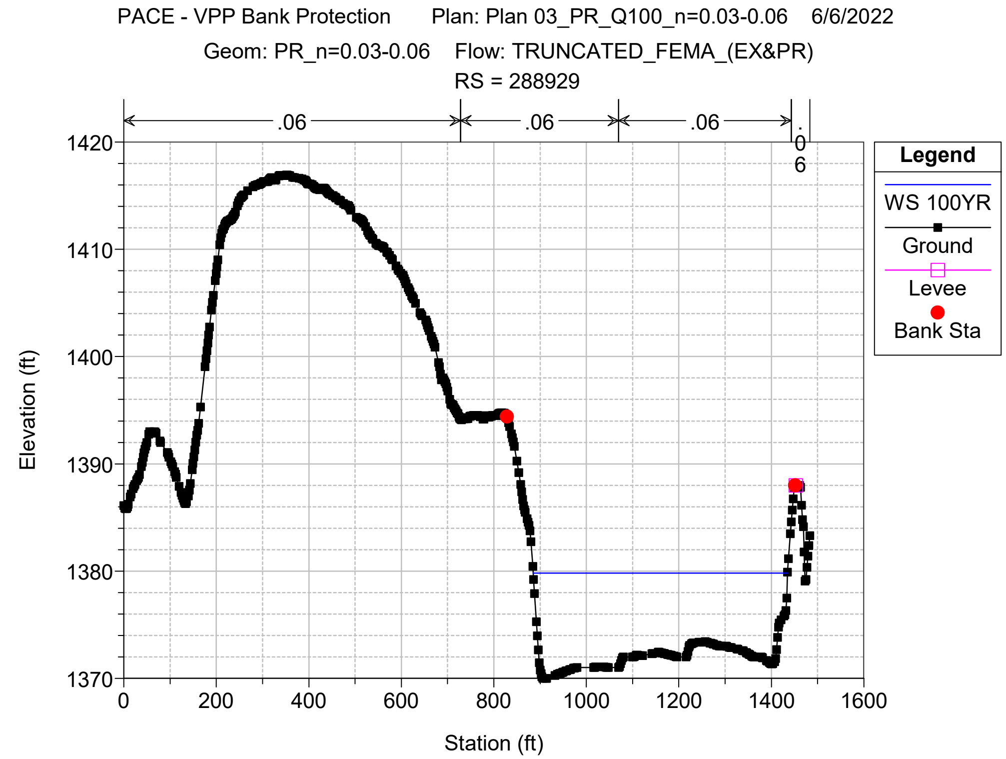

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 290198
.06 .03 .06 .06 .06
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

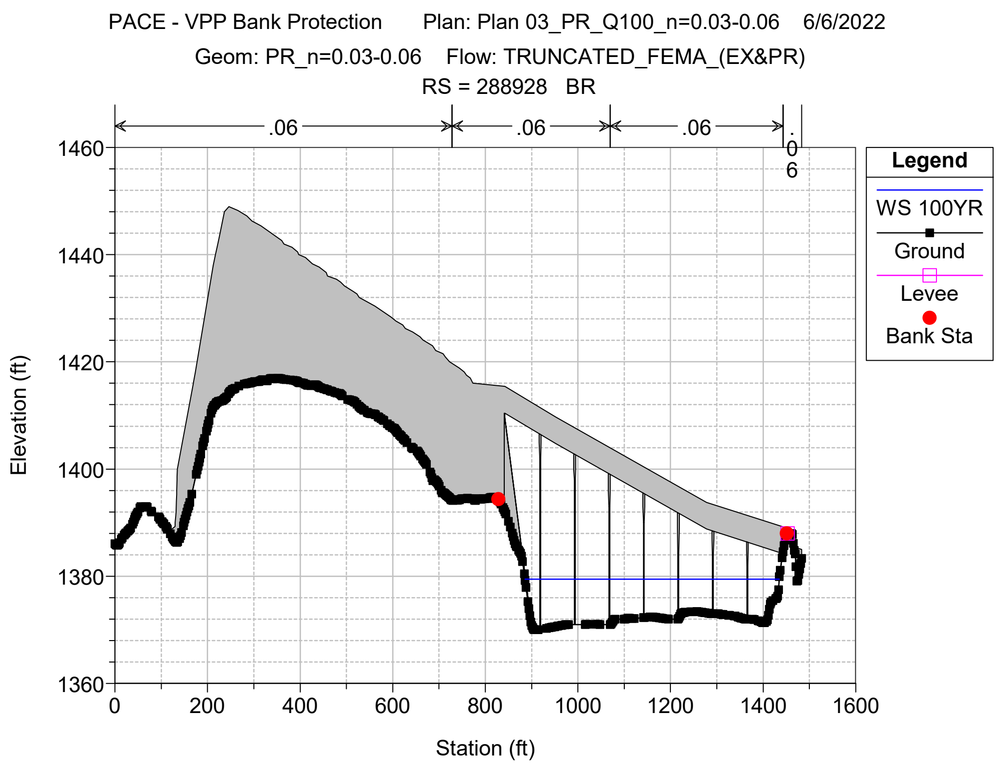

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 289893
.06 .03 .06 .06
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

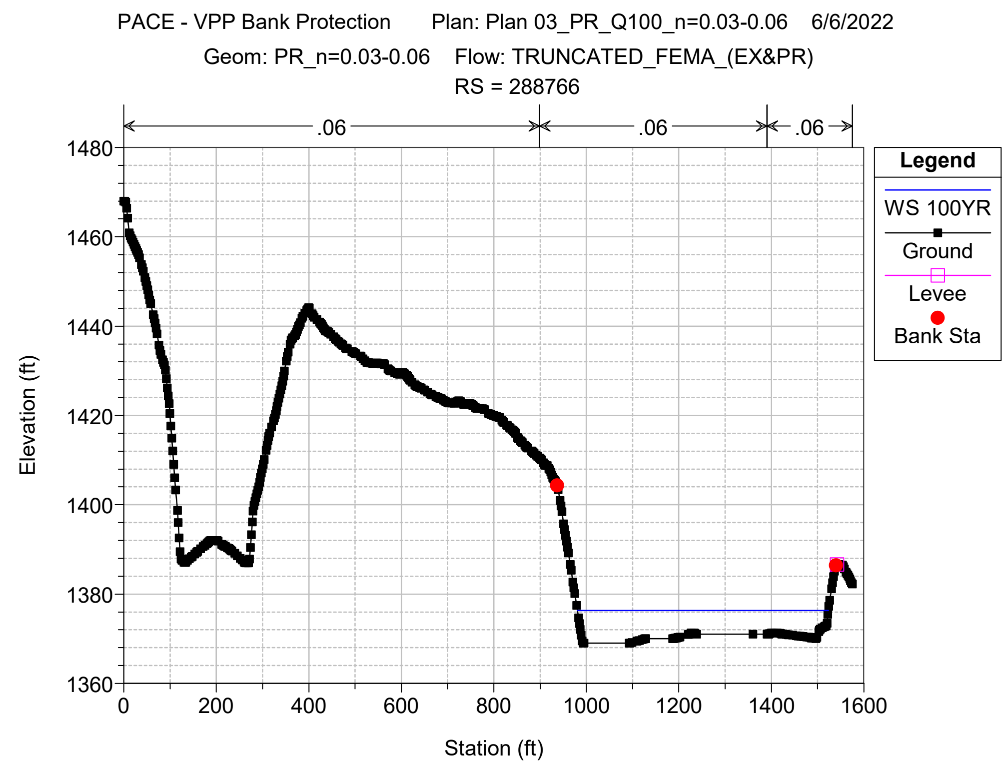

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 289667
.06 .06 .06 .06
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

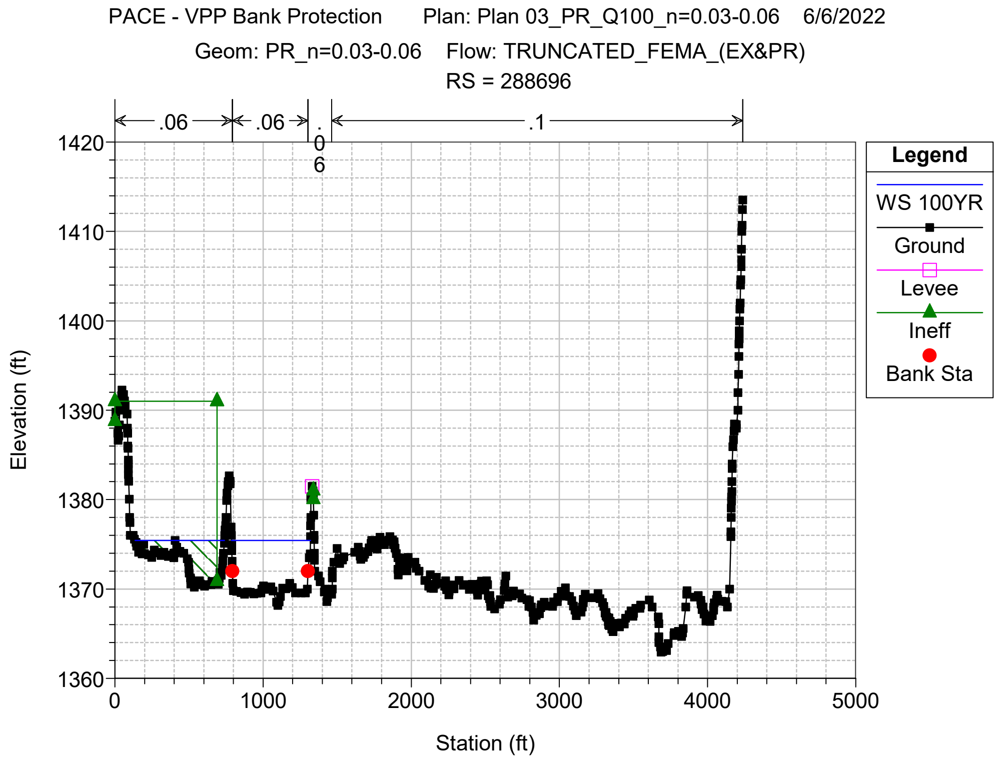

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 289225
.06 .06 .06 .06
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

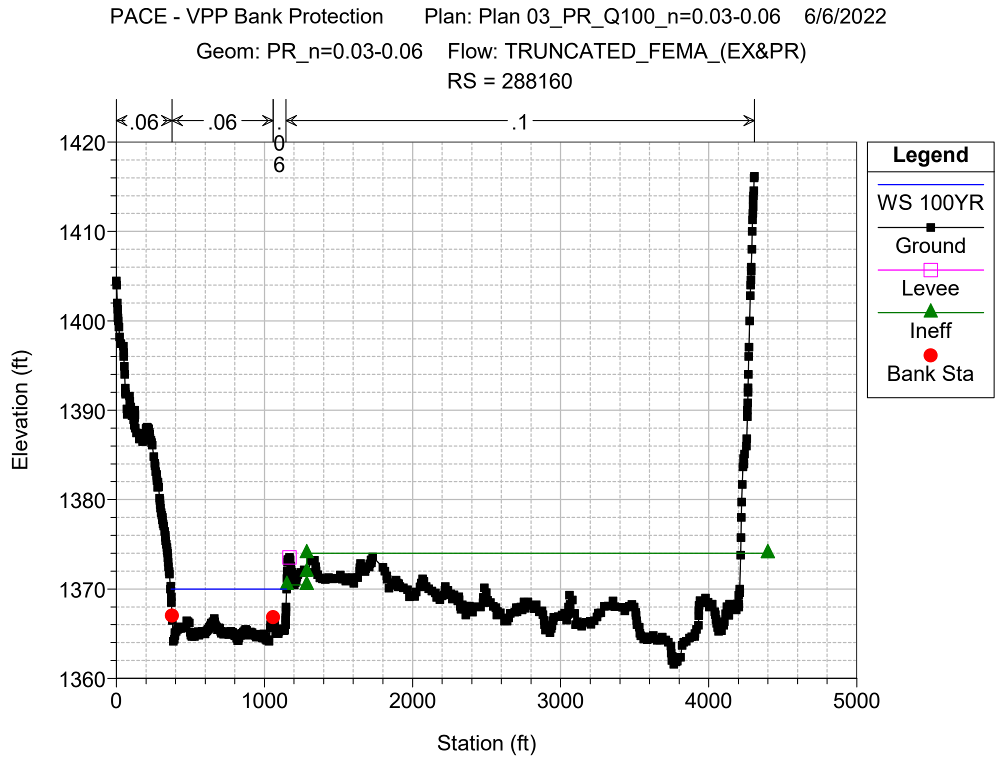

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 289044
.06
.06
.06
.06
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1450
1440
1430
1420
1410
1400
1390
1380
1370
1360
0
1000
2000
3000
4000
5000

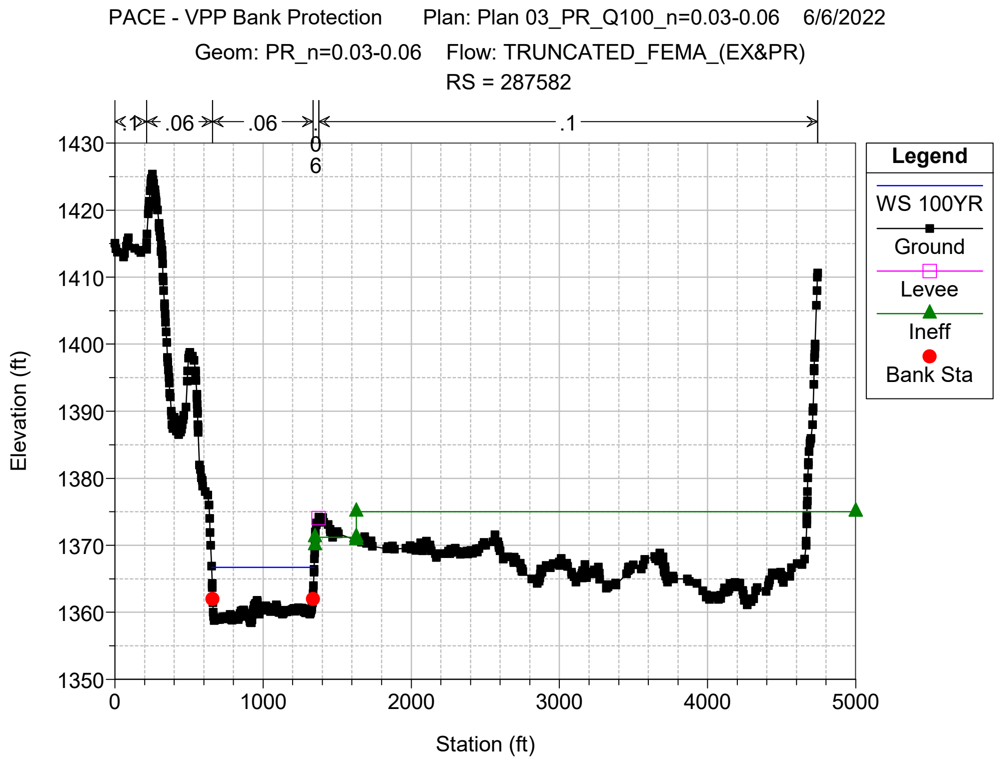

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 288929
.06
.06
.06
.06
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
1420
1410
1400
1390
1380
1370
0
200
400
600
800
1000
1200
1400
1600

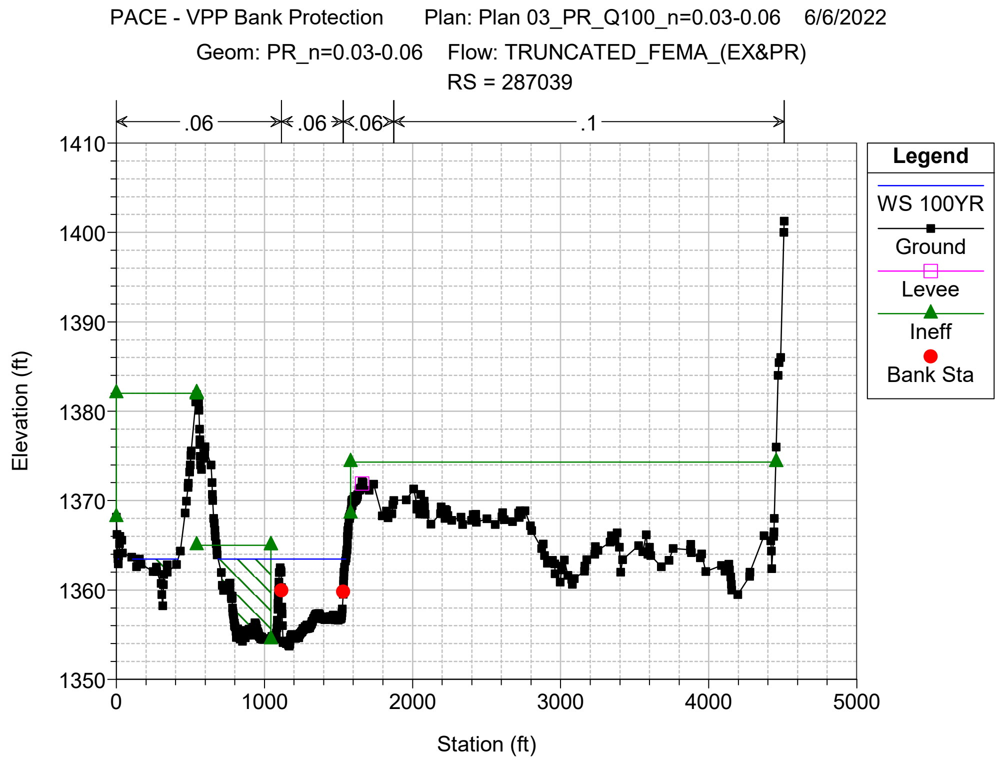

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 288928 BR
.06
.06
.06
.06
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
1460
1440
1420
1400
1380
1360
0
200
400
600
800
1000
1200
1400
1600

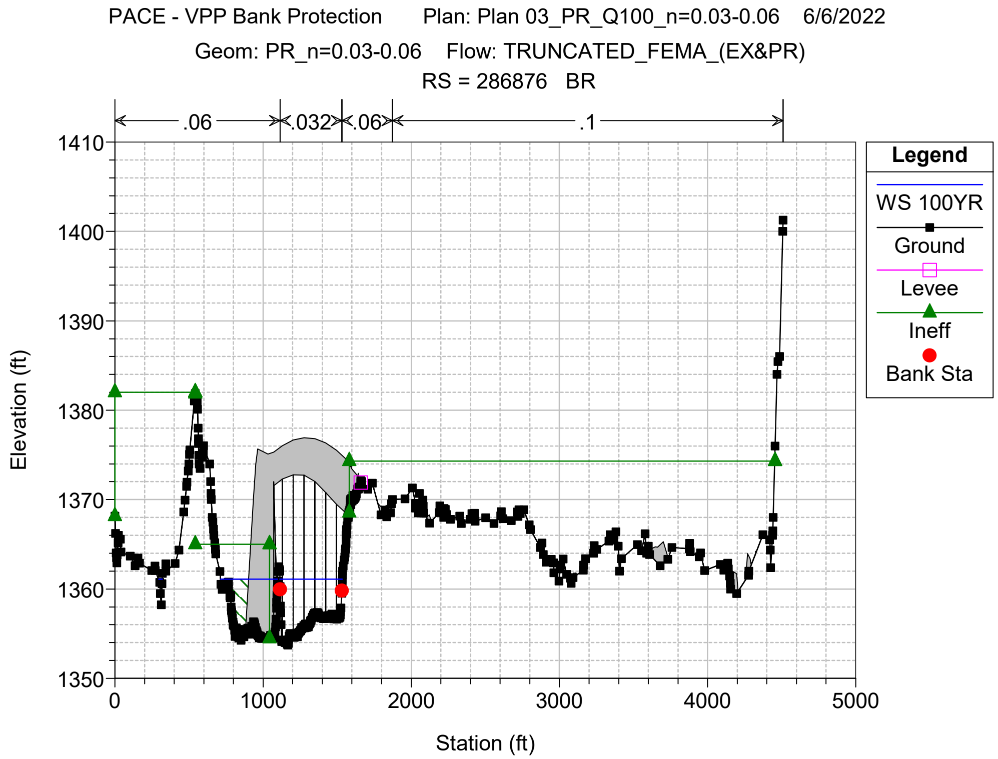

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 288766
.06
.06
.06
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
1480
1460
1440
1420
1400
1380
1360
0
200
400
600
800
1000
1200
1400
1600

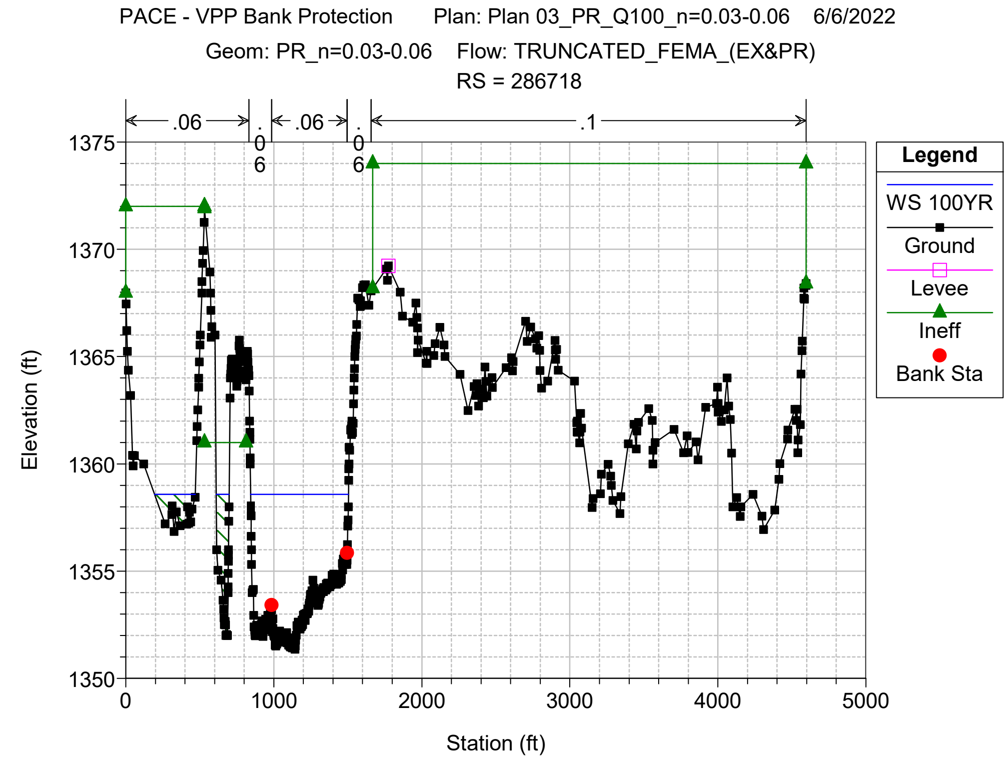

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 288696
.06
.06
.06
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)

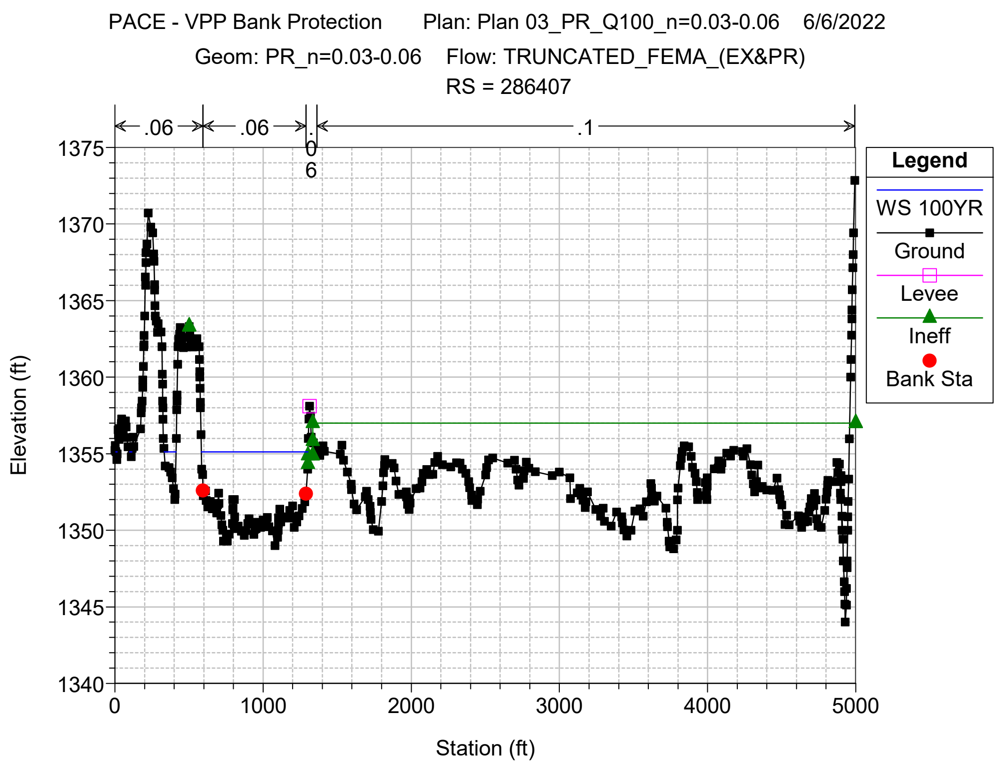

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 288160
.06
.06
.06
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)

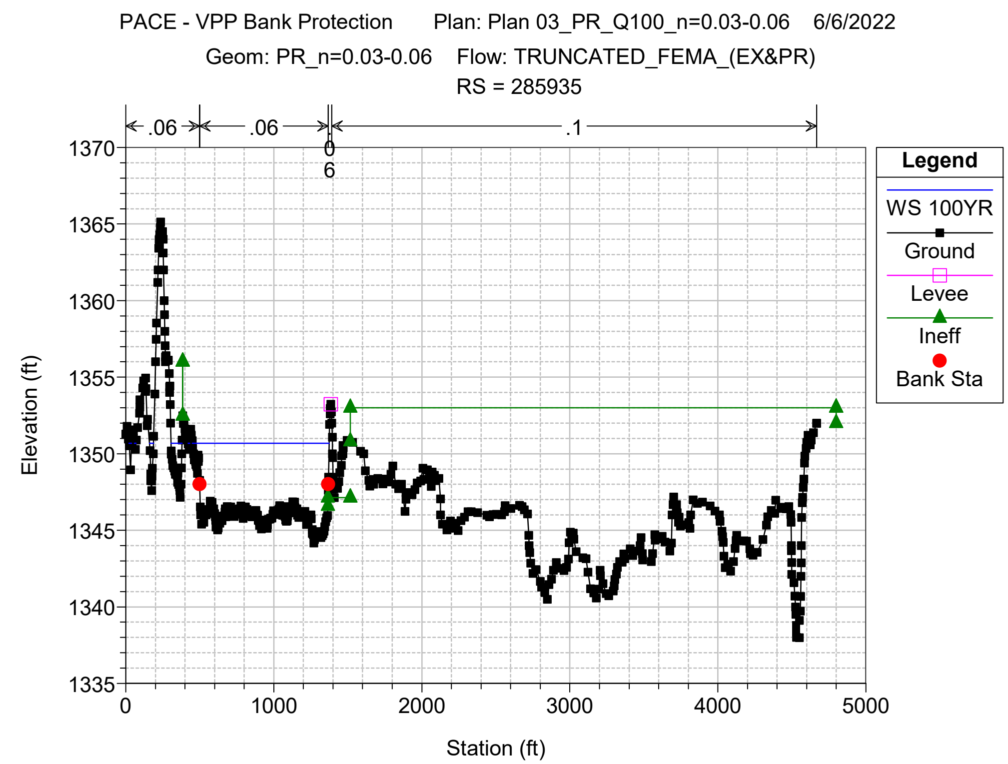

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 287582
.1
.06
.06
.06
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)

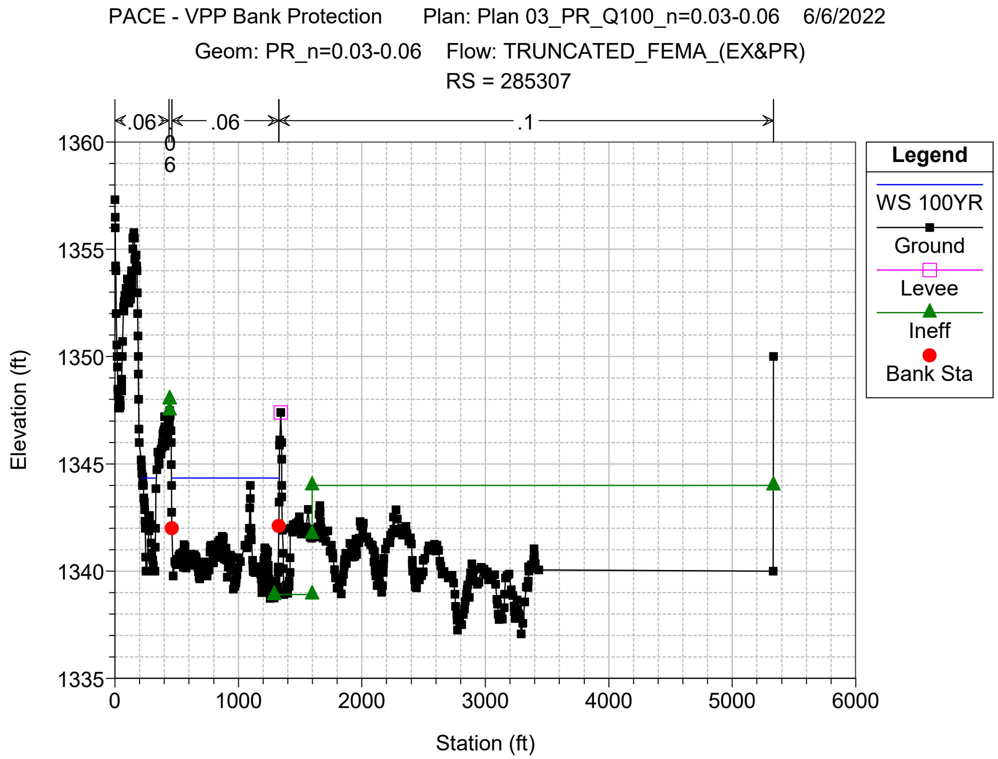

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 287039
.06
.06
.06
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)

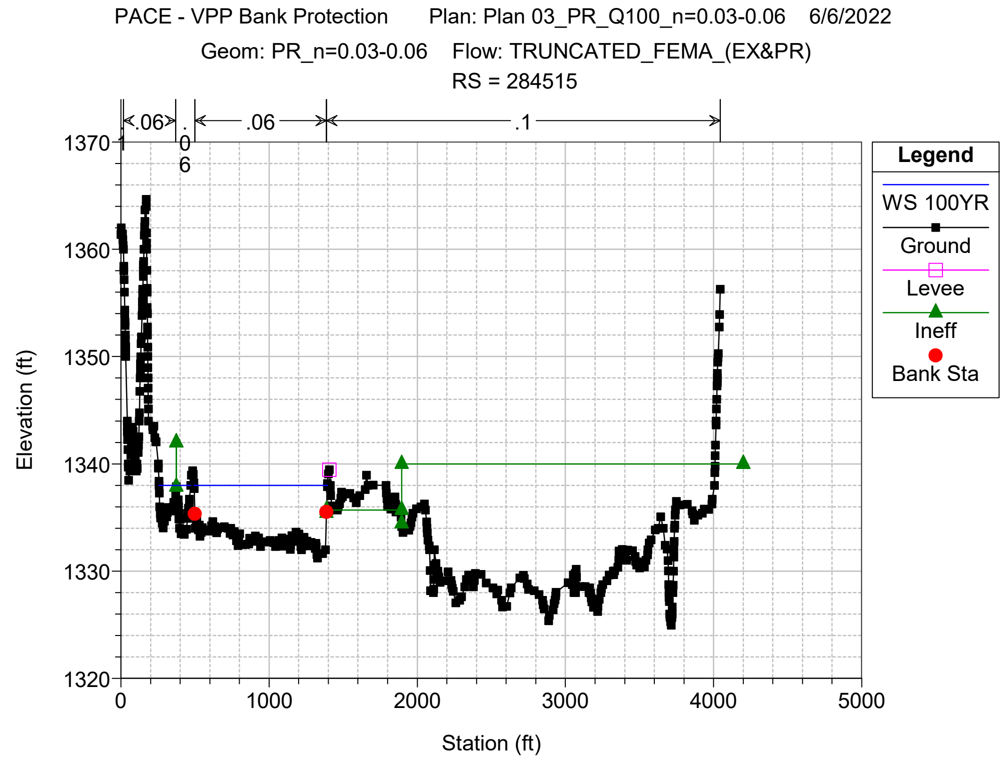

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 286876 BR
.06
.032
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

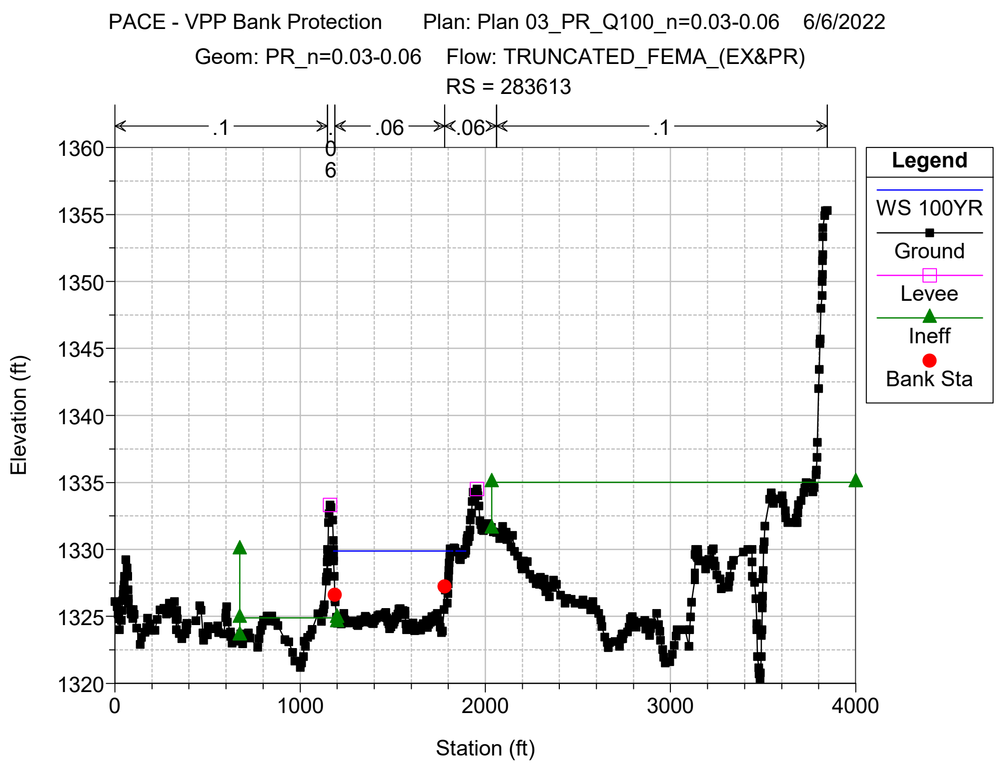

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 286718
.06
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

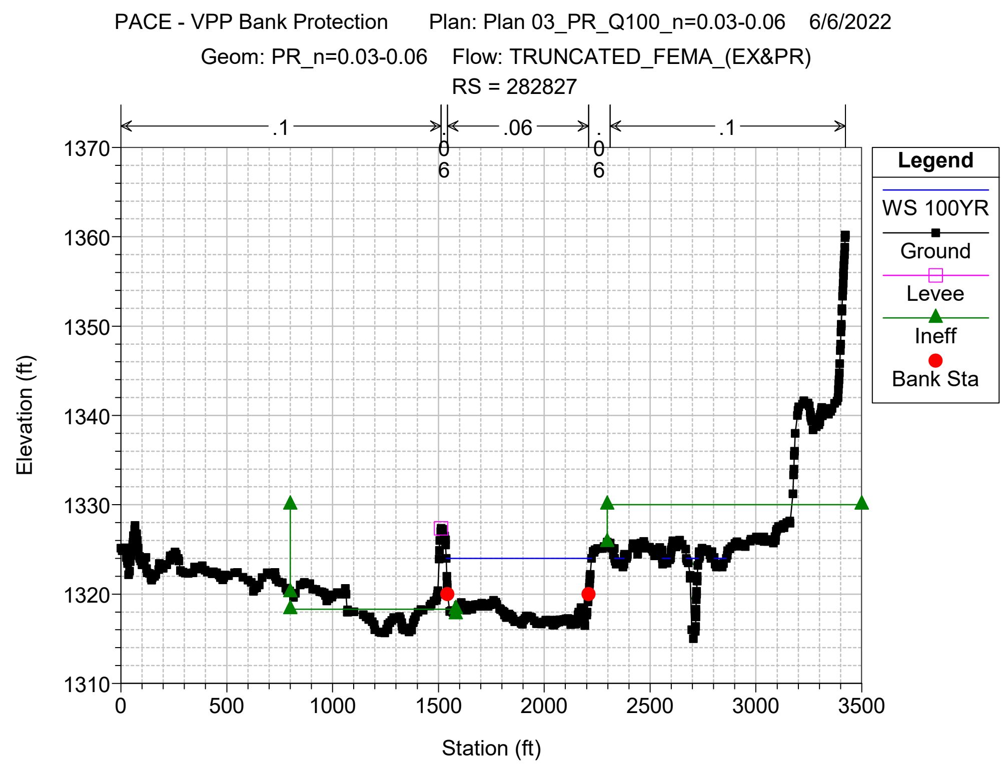

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 286407
.06
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 285935
.06
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

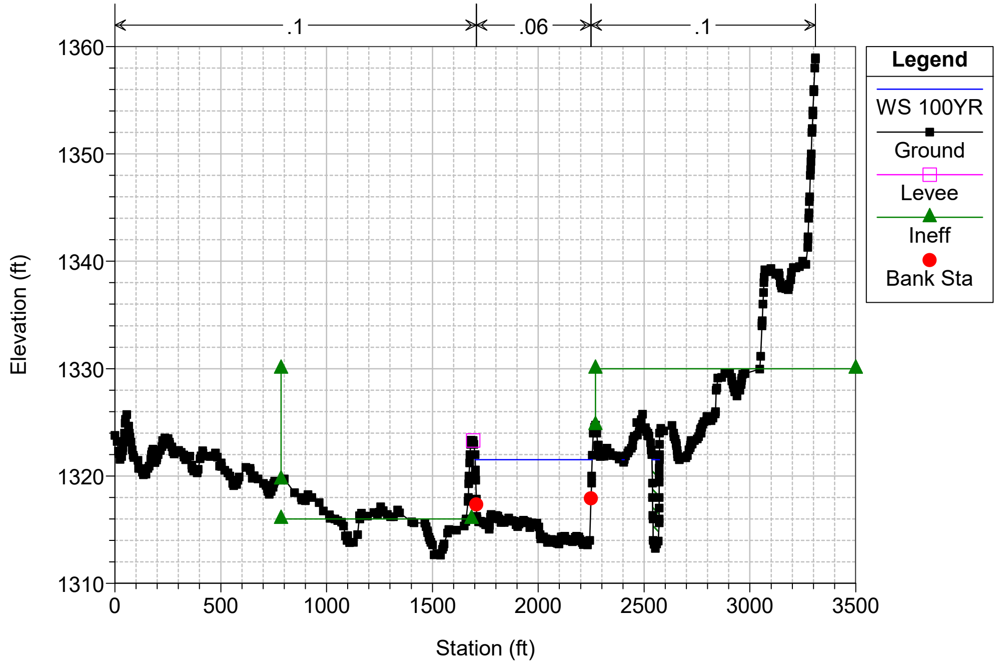

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 285307
.06
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 284515
.06
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

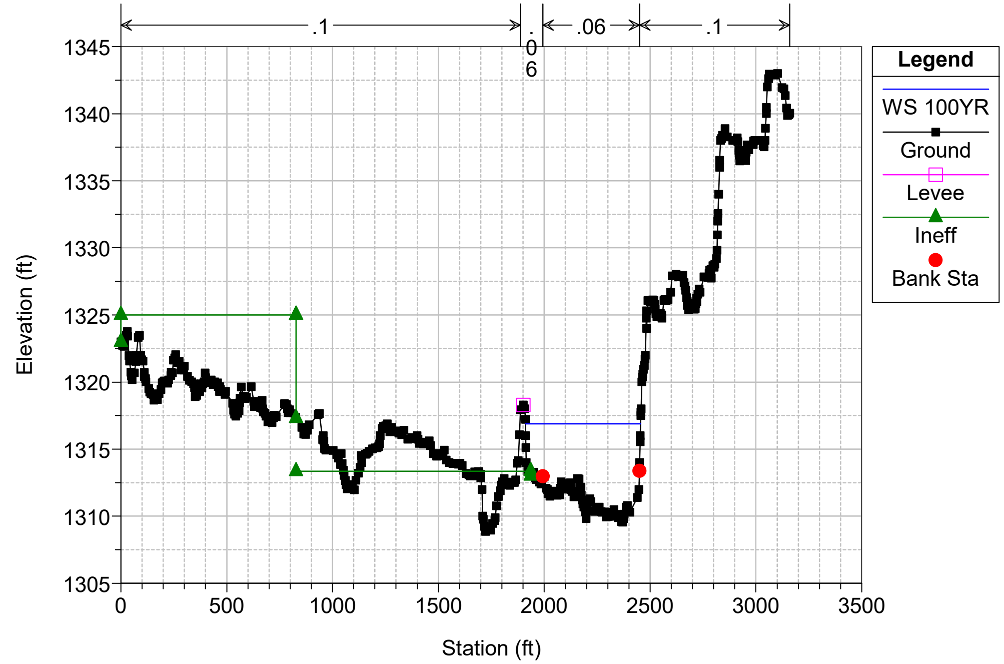

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 283613
.1
.06
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 282827
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

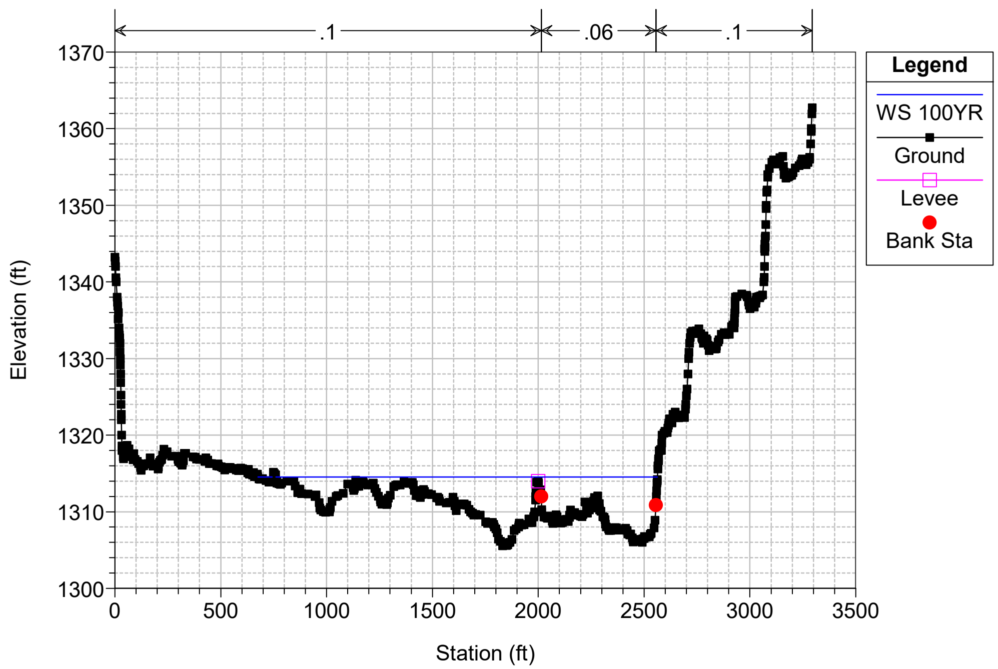
PACE - VPP Bank Protection   Plan: Plan 03_PR_Q100_n=0.03-0.06   6/6/2022
Geom: PR_n=0.03-0.06   Flow: TRUNCATED_FEMA_(EX&PR)
RS = 282470



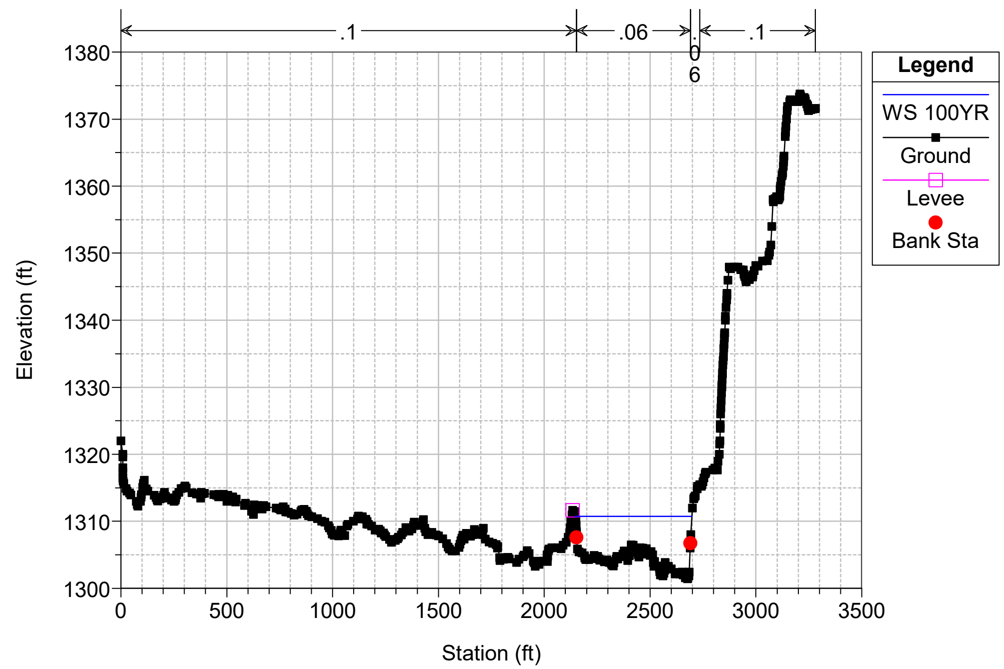
PACE - VPP Bank Protection   Plan: Plan 03_PR_Q100_n=0.03-0.06   6/6/2022
Geom: PR_n=0.03-0.06   Flow: TRUNCATED_FEMA_(EX&PR)
RS = 282032

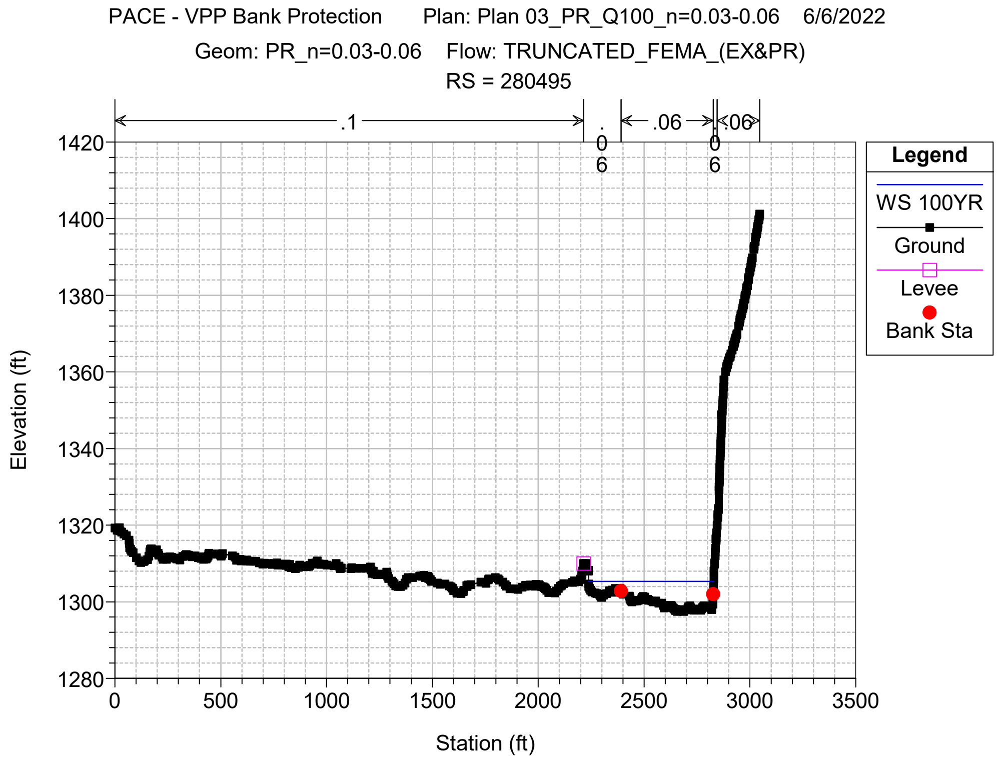


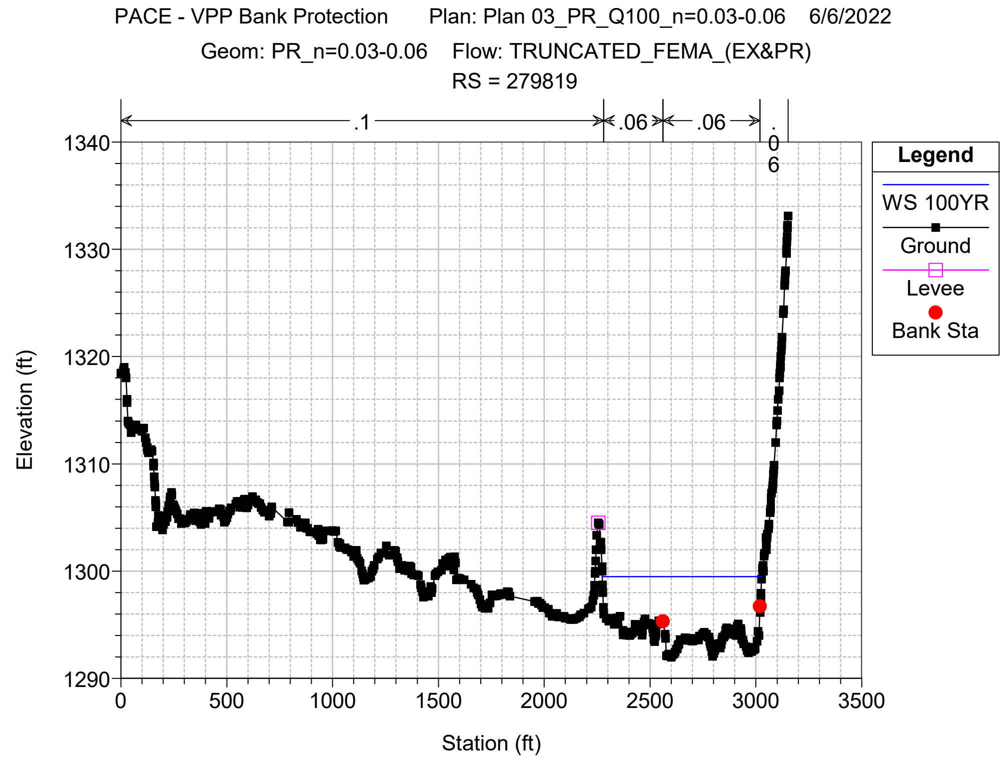
PACE - VPP Bank Protection   Plan: Plan 03_PR_Q100_n=0.03-0.06   6/6/2022
Geom: PR_n=0.03-0.06   Flow: TRUNCATED_FEMA_(EX&PR)
RS = 281614

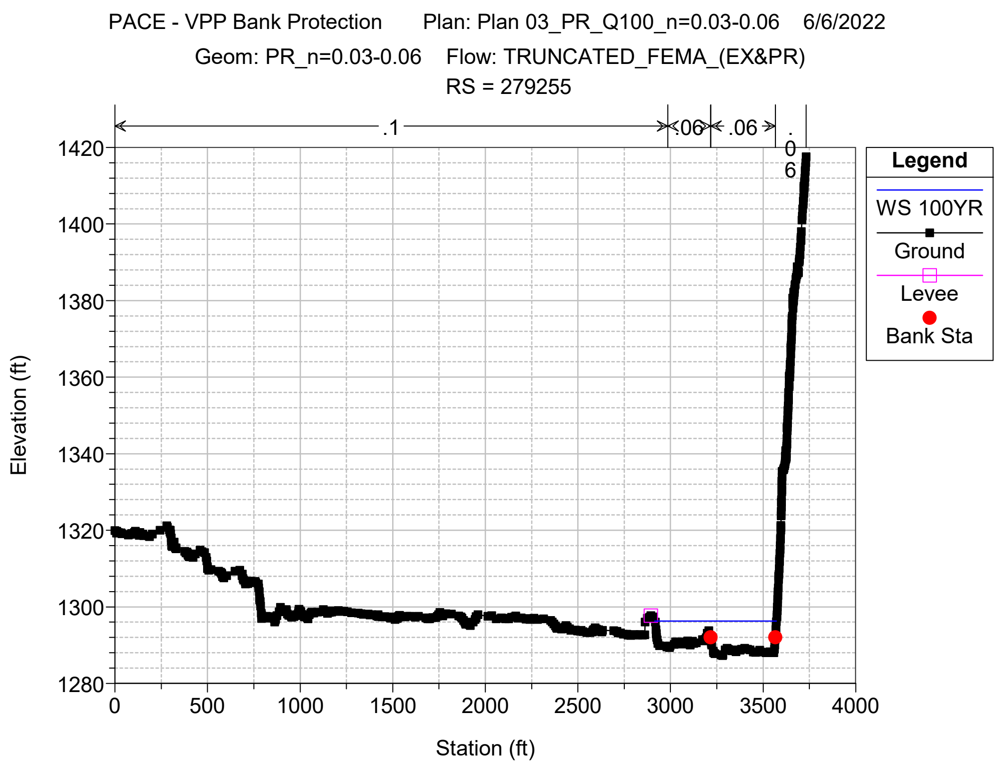


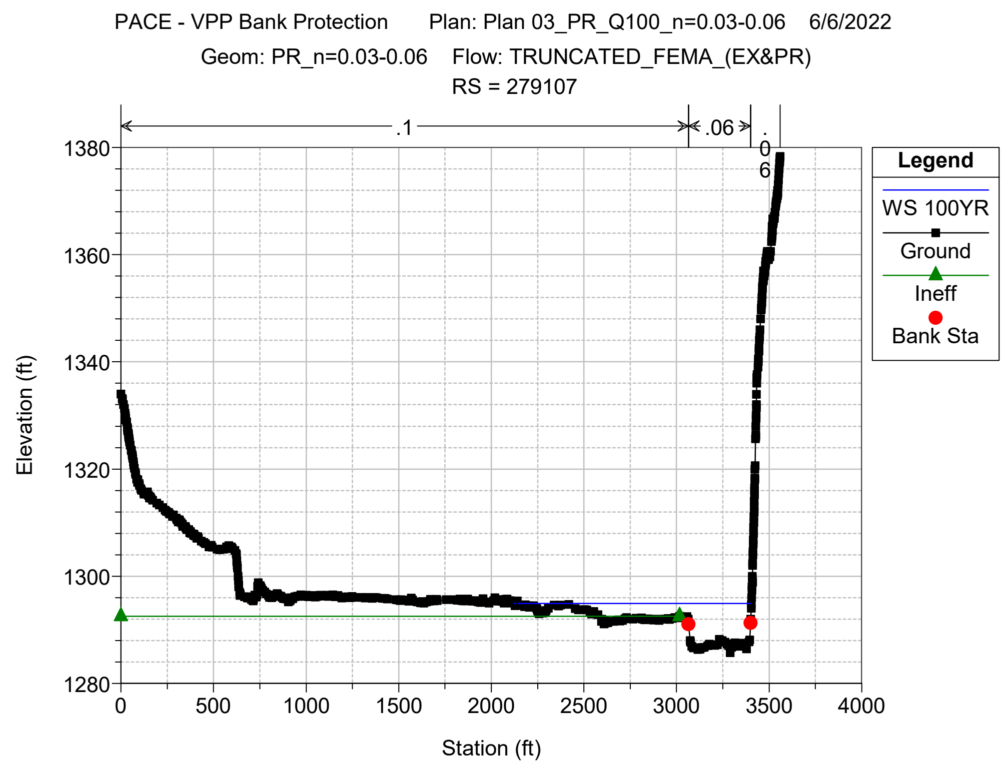
PACE - VPP Bank Protection   Plan: Plan 03_PR_Q100_n=0.03-0.06   6/6/2022
Geom: PR_n=0.03-0.06   Flow: TRUNCATED_FEMA_(EX&PR)
RS = 281025

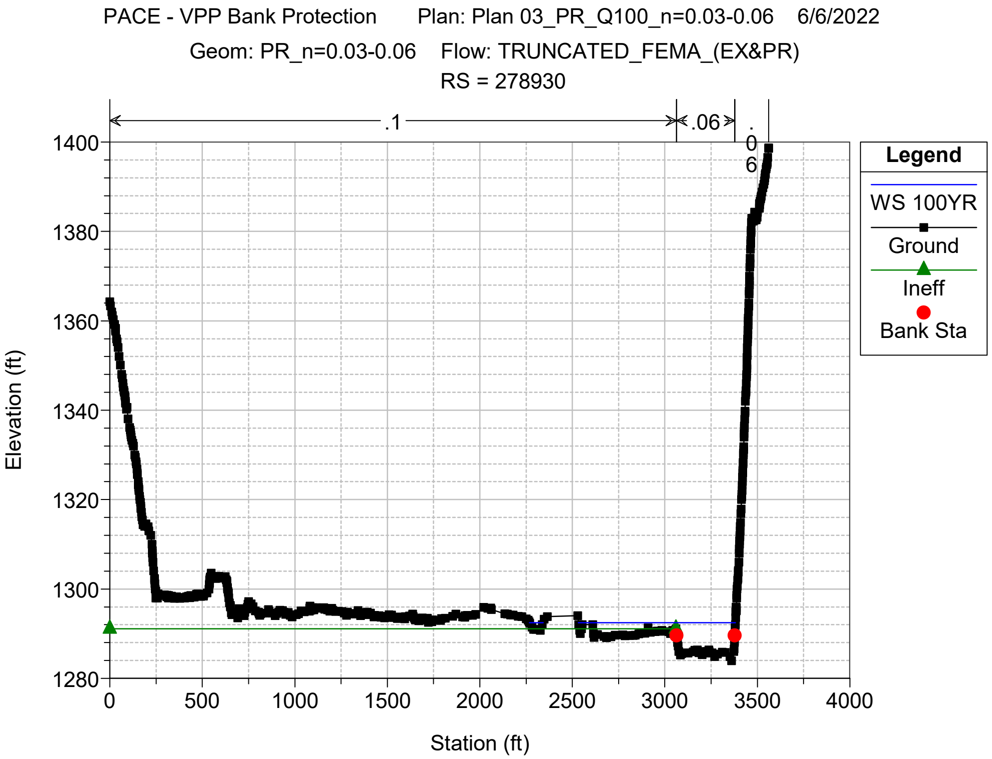


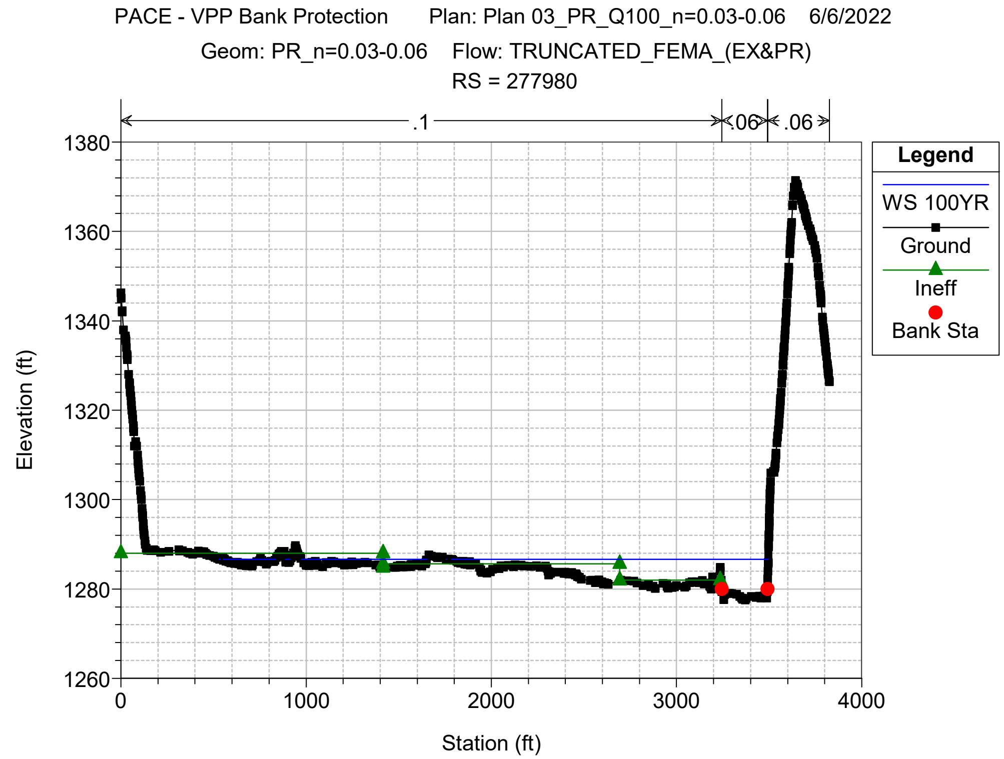

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 280495
.1
.06
.06
.06
.06
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

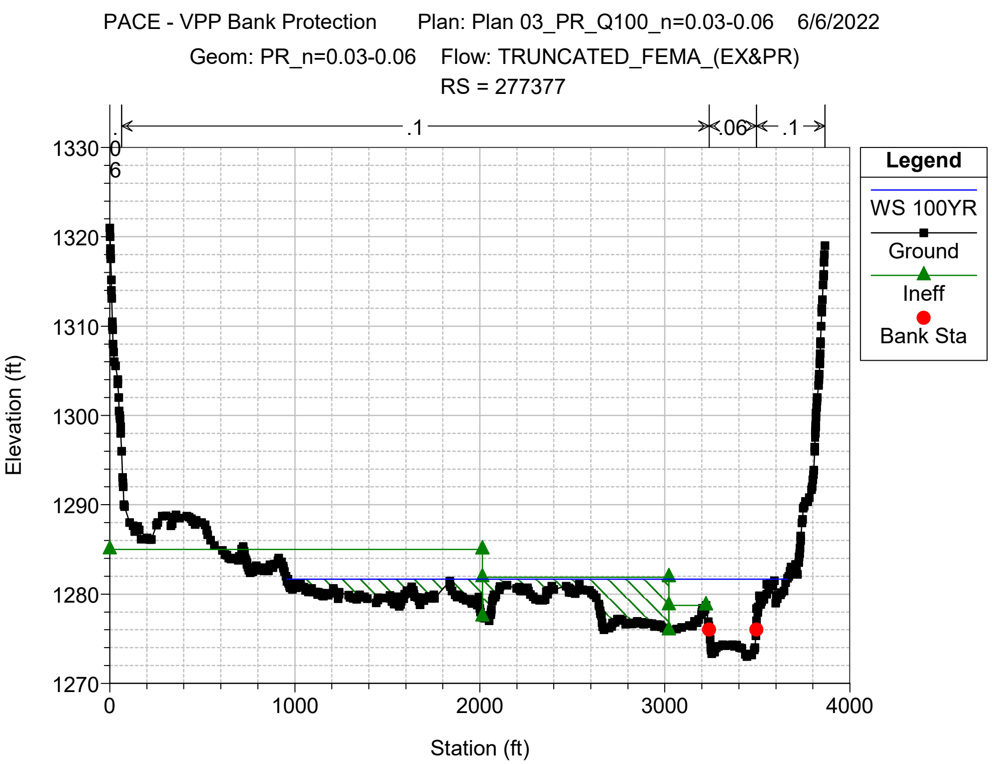

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 279819
.1
.06
.06
.06
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 279255
.1
.06
.06
.06
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 279107
.1
.06
.06
Legend
WS 100YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

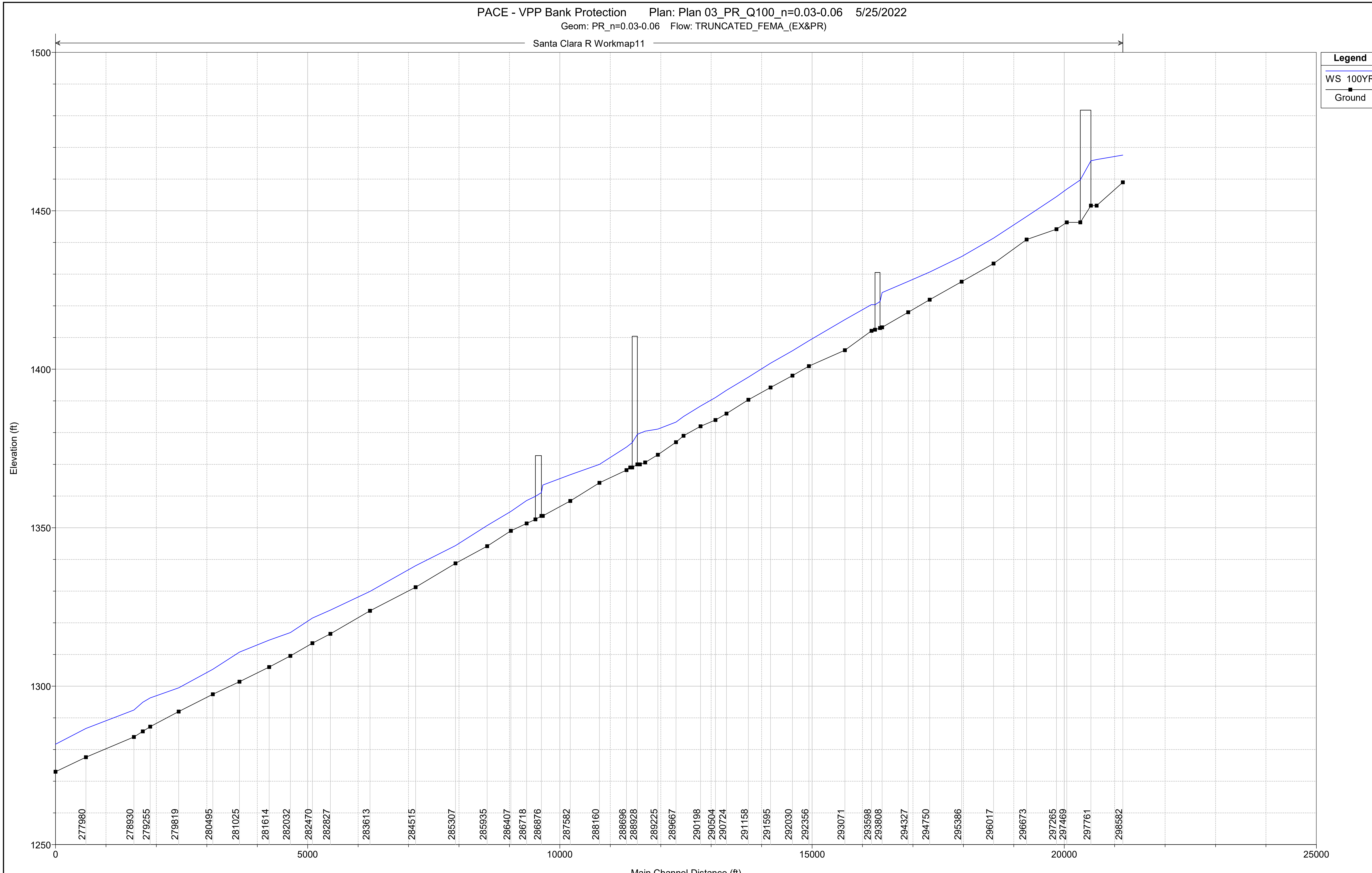

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 278930
.1
.06
.06
Elevation (ft)
Station (ft)
1400
1380
1360
1340
1320
1300
1280
0
500
1000
1500
2000
2500
3000
3500
4000
Legend
WS 100YR
Ground
Ineff
Bank Sta


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 277980
.1
.06
.06
Elevation (ft)
Station (ft)
1380
1360
1340
1320
1300
1280
1260
0
1000
2000
3000
4000
Legend
WS 100YR
Ground
Ineff
Bank Sta

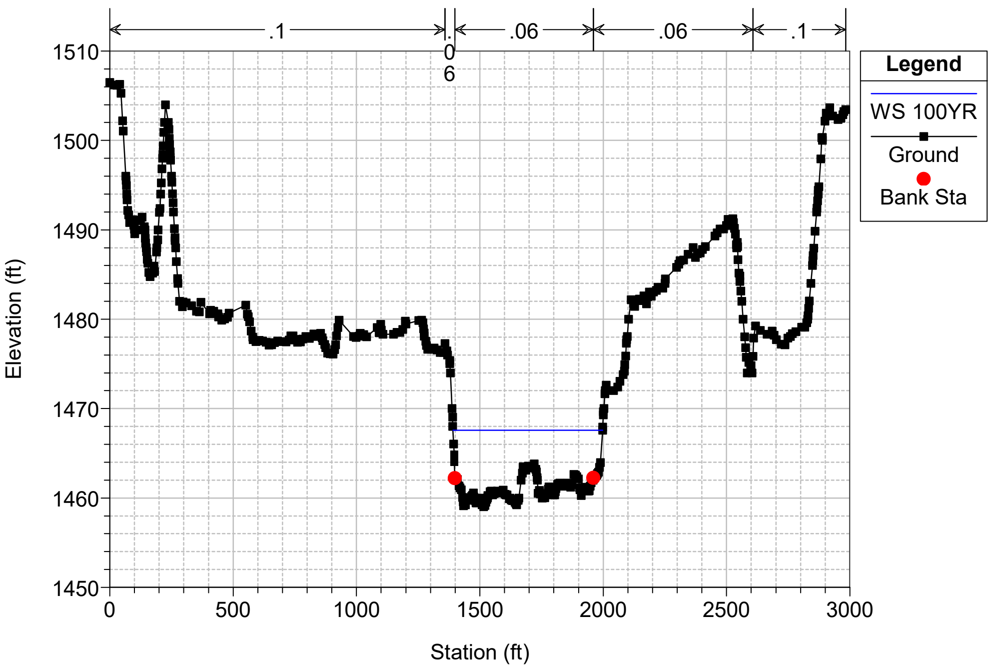

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 277377
.06
.1
.06
.1
Elevation (ft)
Station (ft)
1330
1320
1310
1300
1290
1280
1270
0
1000
2000
3000
4000
Legend
WS 100YR
Ground
Ineff
Bank Sta

HEC-RAS Plan: Plan 03 River: Santa Clara R Reach: Workmap11 Profile: 100YR

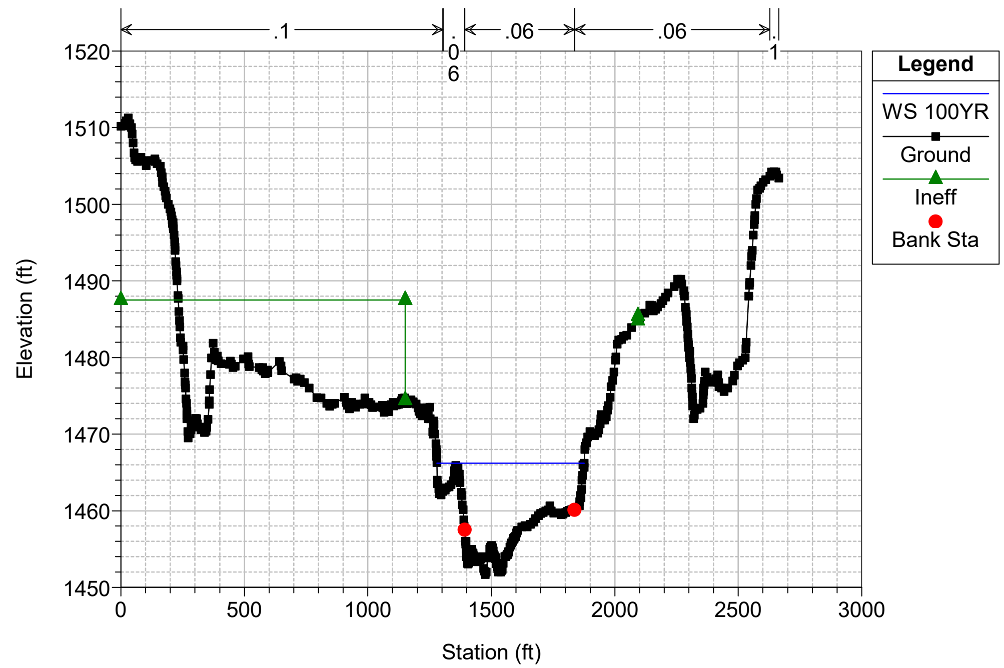
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Workmap11	298582 BE	100YR	21690.00	1459.01	1467.57		1468.06	0.004259	5.67	3876.80	606.24	0.39
Workmap11	298062 DD	100YR	21690.00	1451.65	1466.19	1460.98	1466.55	0.002000	4.90	4695.69	597.24	0.28
Workmap11	297761		Bridge									
Workmap11	297469 DC	100YR	21690.00	1446.37	1456.85	1455.89	1458.20	0.016441	9.32	2340.76	472.44	0.73
Workmap11	297265 DB	100YR	21690.00	1444.21	1454.44	1452.66	1455.46	0.009887	8.11	2710.74	463.11	0.58
Workmap11	296673	100YR	21690.00	1440.93	1448.19	1446.69	1449.22	0.011263	8.16	2693.82	501.29	0.61
Workmap11	296017 BD	100YR	21690.00	1433.35	1441.39	1439.76	1442.25	0.009913	7.49	2917.13	557.41	0.57
Workmap11	295386 DA	100YR	21690.00	1427.63	1435.55	1433.83	1436.31	0.008896	7.11	3362.71	889.04	0.54
Workmap11	294750	100YR	21690.00	1421.94	1430.67	1428.24	1431.42	0.006739	6.96	3157.41	528.26	0.49
Workmap11	294327 BC	100YR	25910.00	1418.00	1427.74	1424.96	1428.61	0.006502	7.53	3495.68	485.50	0.49
Workmap11	293808 CY	100YR	25910.00	1413.24	1424.19	1421.05	1425.23	0.006399	8.23	3214.43	392.80	0.50
Workmap11	293703		Bridge									
Workmap11	293598 CX	100YR	25910.00	1412.15	1420.41	1418.29	1421.57	0.009079	8.67	3051.75	448.99	0.58
Workmap11	293071 CW	100YR	25910.00	1406.00	1415.67	1413.54	1416.79	0.008996	8.54	3102.86	467.81	0.57
Workmap11	292356 BB	100YR	25910.00	1400.99	1409.02	1407.01	1410.14	0.009631	8.53	3073.84	483.40	0.59
Workmap11	292030 CV	100YR	25910.00	1398.00	1405.84	1404.02	1406.93	0.009975	8.39	3126.36	515.39	0.59
Workmap11	291595 CU	100YR	25910.00	1394.26	1401.91	1399.92	1402.83	0.008732	7.73	3374.13	565.61	0.55
Workmap11	291158 BA	100YR	25910.00	1390.36	1397.50	1396.04	1398.49	0.011330	8.00	3251.67	623.80	0.61
Workmap11	290724	100YR	25910.00	1386.00	1393.35	1391.61	1394.13	0.008663	7.24	3686.72	700.57	0.54
Workmap11	290504	100YR	25910.00	1384.00	1391.07	1389.76	1391.93	0.010492	7.69	3525.04	876.07	0.59
Workmap11	290198	100YR	25910.00	1382.00	1388.40	1386.84	1389.04	0.008171	6.83	4077.56	910.07	0.52
Workmap11	289893	100YR	25910.00	1379.00	1385.07	1383.77	1385.88	0.010201	7.64	3653.26	810.36	0.58
Workmap11	289667 AZ	100YR	25910.00	1377.00	1383.31	1381.76	1384.05	0.009414	7.20	3790.77	992.80	0.56
Workmap11	289225	100YR	25910.00	1373.00	1381.12	1378.40	1381.61	0.004731	5.56	4599.19	1065.79	0.40
Workmap11	289044 CS	100YR	25910.00	1370.61	1380.47	1376.06	1380.78	0.002140	4.47	5804.95	1338.83	0.29
Workmap11	288929	100YR	25910.00	1370.00	1379.81	1376.17	1380.39	0.004065	6.12	4234.11	549.92	0.39
Workmap11	288928		Bridge									
Workmap11	288766	100YR	25910.00	1369.00	1376.36	1374.58	1377.38	0.010054	8.09	3201.94	542.59	0.59
Workmap11	288696 CR	100YR	25910.00	1368.17	1375.45	1374.00	1376.53	0.011444	8.47	3135.08	1136.42	0.62
Workmap11	288160 CQ	100YR	25910.00	1364.15	1369.98	1368.53	1370.76	0.010364	7.14	3658.91	780.99	0.58
Workmap11	287582 AY	100YR	25910.00	1358.43	1366.72	1363.57	1367.22	0.004163	5.68	4582.09	691.66	0.39
Workmap11	287039 CO	100YR	25910.00	1353.74	1363.46	1360.57	1364.29	0.006248	7.41	3562.21	1170.56	0.48
Workmap11	286876		Bridge									
Workmap11	286718 CN	100YR	25910.00	1351.36	1358.57	1356.84	1359.41	0.009369	7.27	3534.69	1021.81	0.56
Workmap11	286407 CM	100YR	25910.00	1349.00	1355.12	1354.10	1356.12	0.014583	8.11	3278.06	824.02	0.68
Workmap11	285935 AX	100YR	25910.00	1344.16	1350.67	1348.92	1351.23	0.007428	6.05	4424.14	1064.41	0.49
Workmap11	285307 CL	100YR	25910.00	1338.73	1344.34	1343.31	1345.11	0.013280	7.10	3721.71	987.63	0.63
Workmap11	284515 AW	100YR	25910.00	1331.23	1337.99	1335.92	1338.42	0.005777	5.44	4963.89	1113.61	0.43
Workmap11	283613 AV	100YR	25910.00	1323.79	1329.88	1328.58	1330.93	0.012397	8.27	3182.92	685.97	0.64
Workmap11	282827	100YR	25910.00	1316.49	1324.00	1321.34	1324.59	0.005440	6.19	4207.99	883.85	0.44
Workmap11	282470 CK	100YR	25910.00	1313.57	1321.50	1319.14	1322.34	0.007223	7.33	3553.92	599.77	0.51
Workmap11	282032 AU	100YR	26210.00	1309.57	1316.88	1315.66	1318.13	0.013162	9.13	2955.91	543.99	0.67
Workmap11	281614	100YR	26210.00	1306.01	1314.52	1312.81	1314.86	0.004646	5.49	7203.99	1867.43	0.40
Workmap11	281025 CI	100YR	26210.00	1301.41	1310.72	1308.36	1311.57	0.007344	7.41	3553.72	551.23	0.51
Workmap11	280495 AT	100YR	26210.00	1297.45	1305.30	1304.26	1306.55	0.012943	9.22	3014.56	590.93	0.67
Workmap11	279819 CH	100YR	26210.00	1291.98	1299.48	1297.52	1300.14	0.007062	6.85	4054.83	753.67	0.49
Workmap11	279255 CG	100YR	26210.00	1287.24	1296.30	1293.38	1296.89	0.004710	6.69	4407.18	656.42	0.42
Workmap11	279107 AS	100YR	26210.00	1285.71	1294.94	1293.47	1295.94	0.008069	8.65	4419.88	1271.85	0.55
Workmap11	278930	100YR	26210.00	1283.95	1292.48	1291.99	1293.98	0.014364	10.54	3409.19	922.30	0.72
Workmap11	277980 CE	100YR	26210.00	1277.56	1286.67	1284.22	1287.04	0.004192	6.53	7808.98	2694.30	0.40
Workmap11	277377 AR	100YR	26210.00	1272.99	1281.67	1280.38	1283.07	0.011715	10.45	3316.29	2705.92	0.66


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 5/25/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
Santa Clara R Workmap11
Legend
WS 100YR
Ground
Elevation (ft)
Main Channel Distance (ft)
1250
1300
1350
1400
1450
1500
0
5000
10000
15000
20000
25000
277980
278930
279255
279819
280495
281025
281614
282032
282470
282827
283613
284515
285307
285935
286407
286718
286876
287582
288160
288696
288928
289225
289667
290198
290504
290724
291158
291595
292030
292356
293071
293598
293808
294327
294750
295386
296017
296673
297265
297469
297761
298582

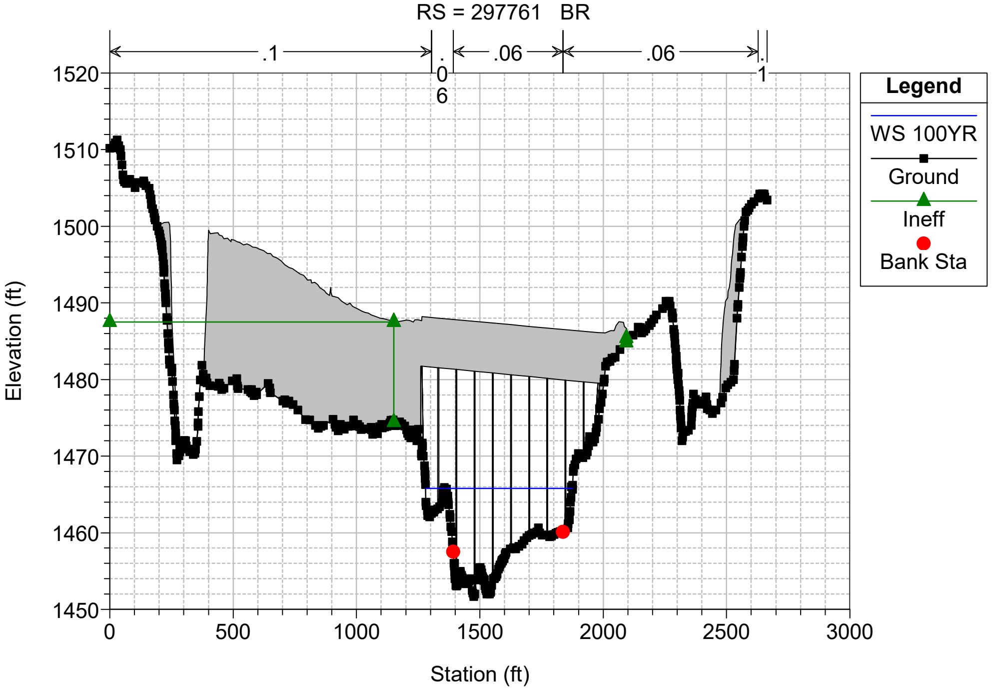
PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 298582



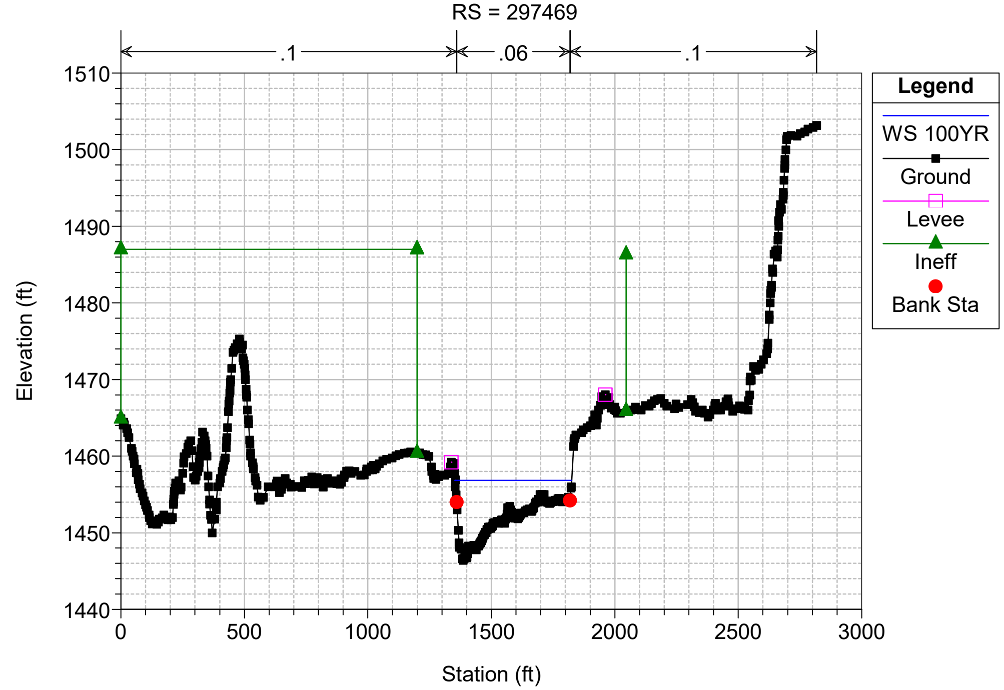
PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 298062



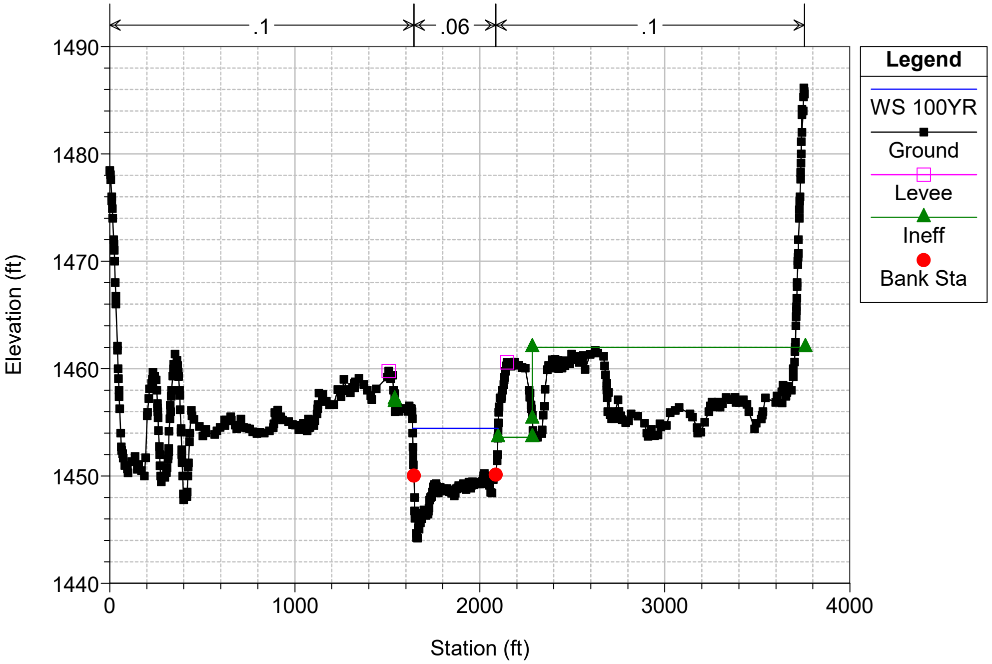
PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 297761 BR



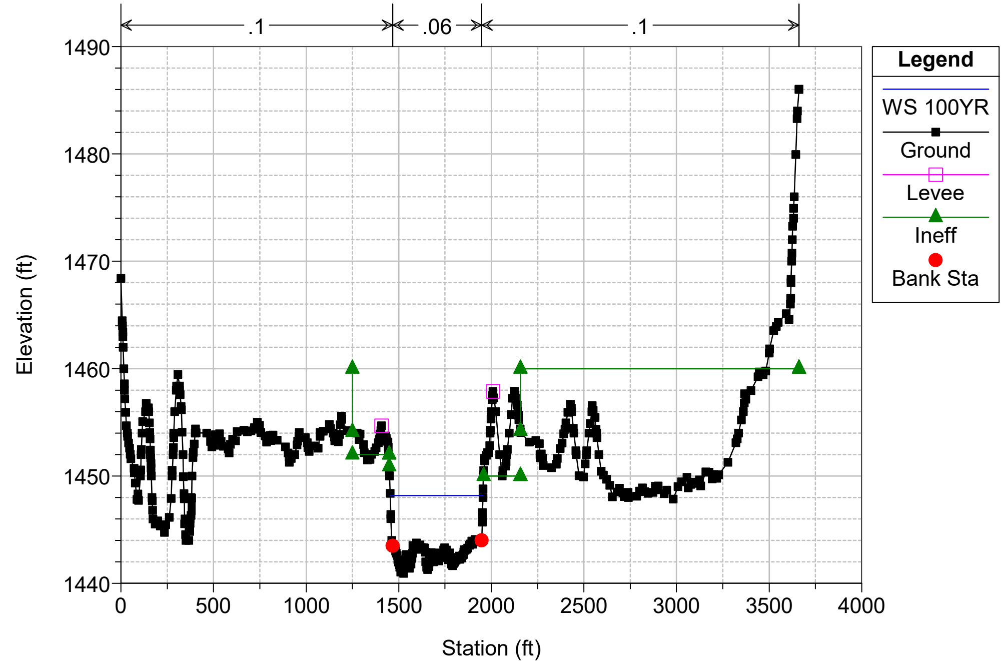
PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 297469



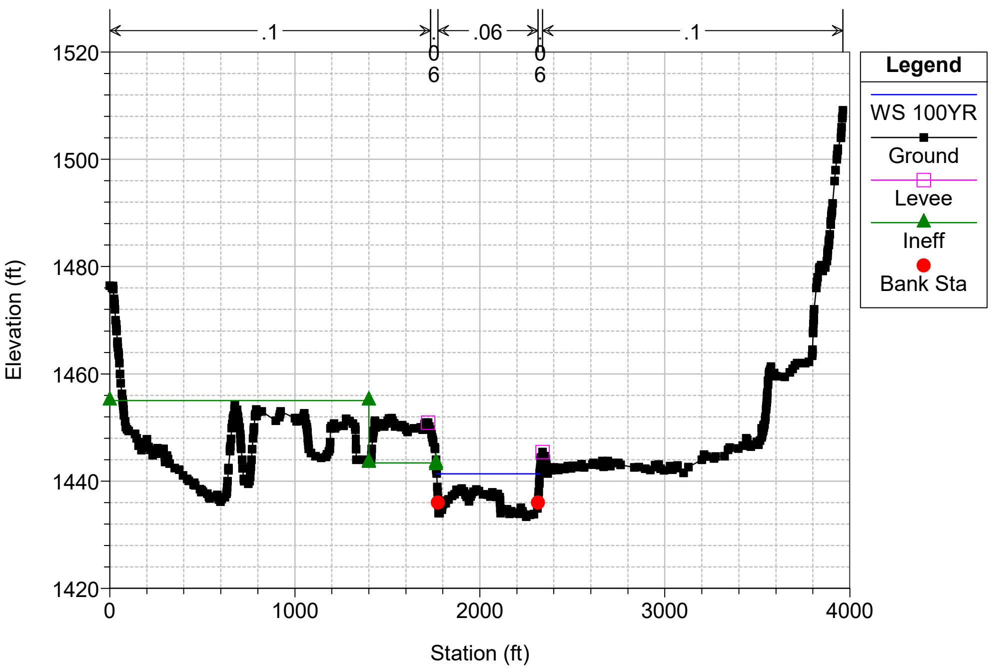
PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 297265



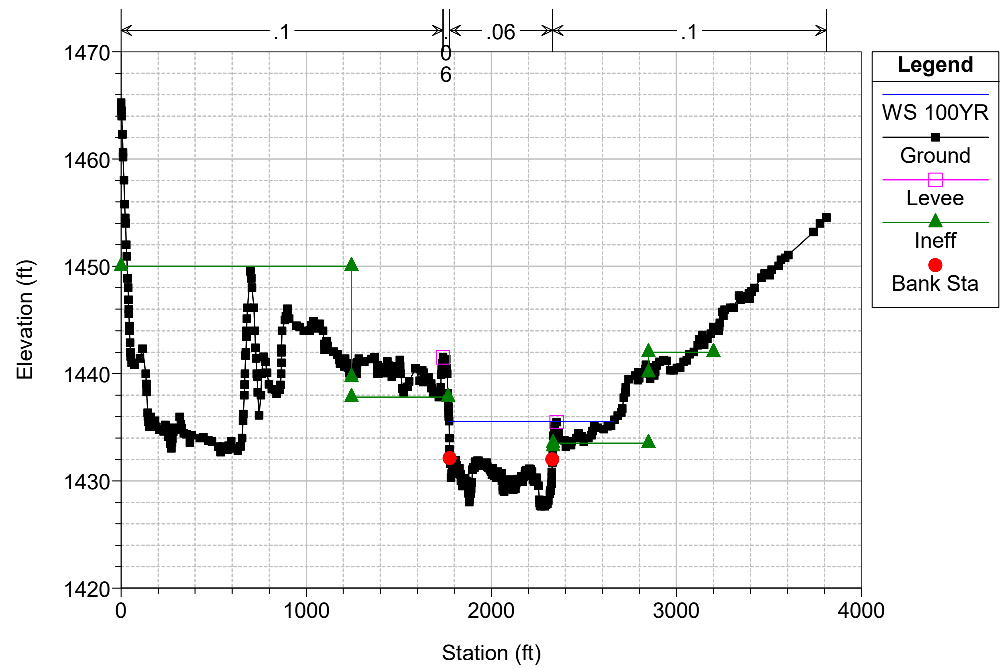
PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 296673

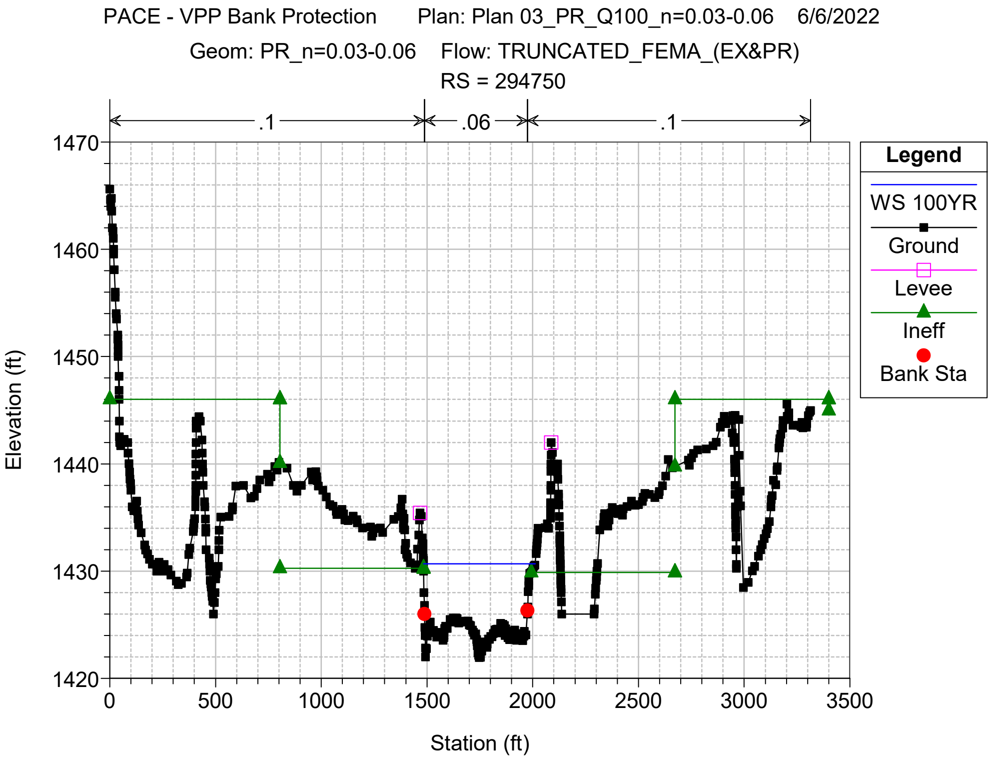


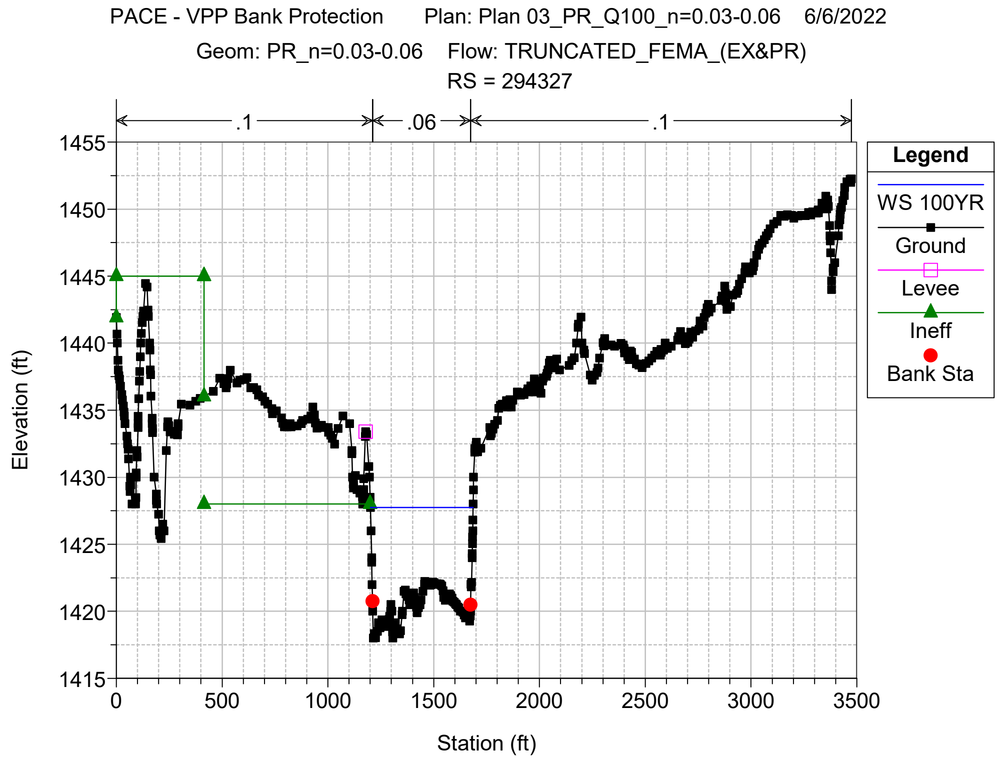
PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 296017

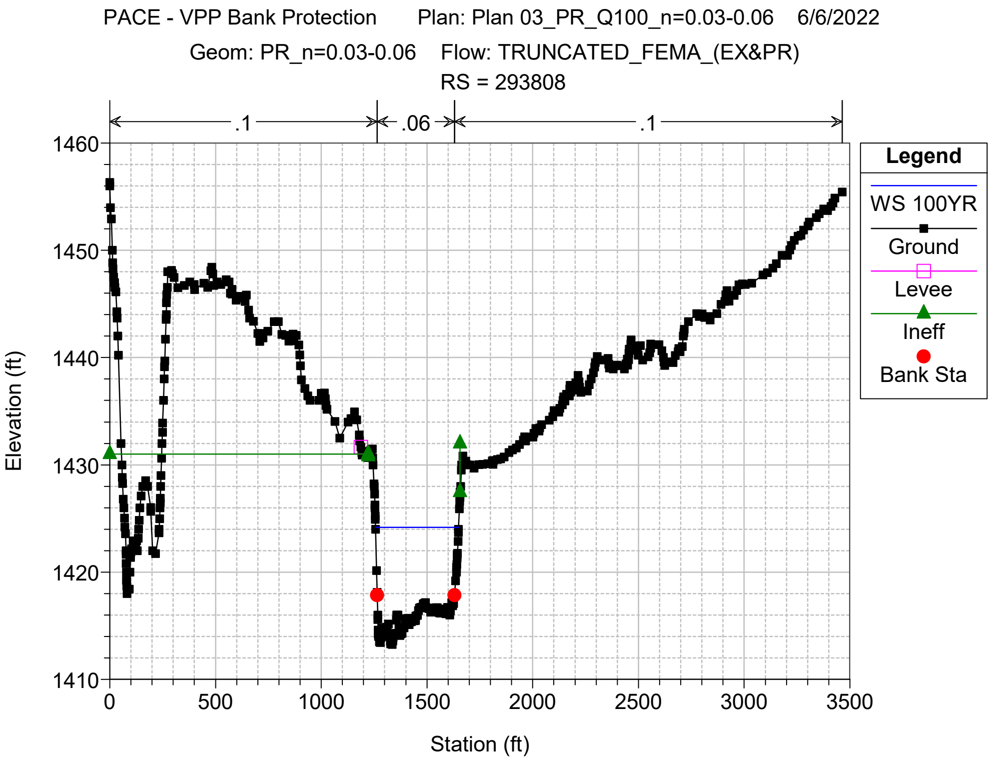


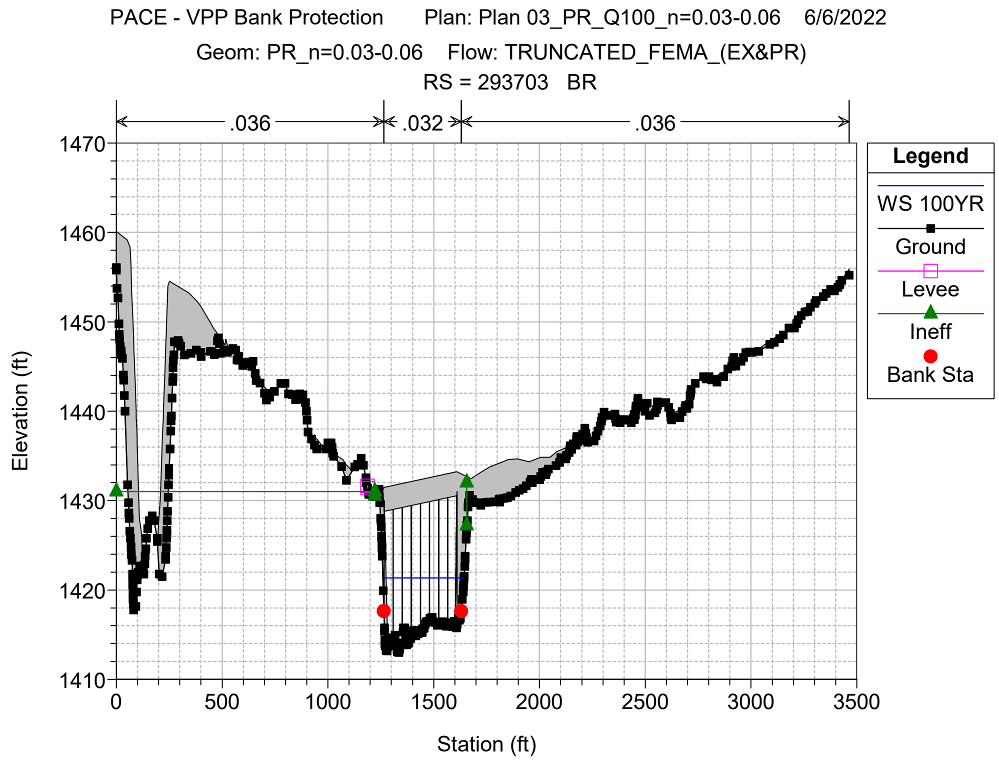
PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 295386

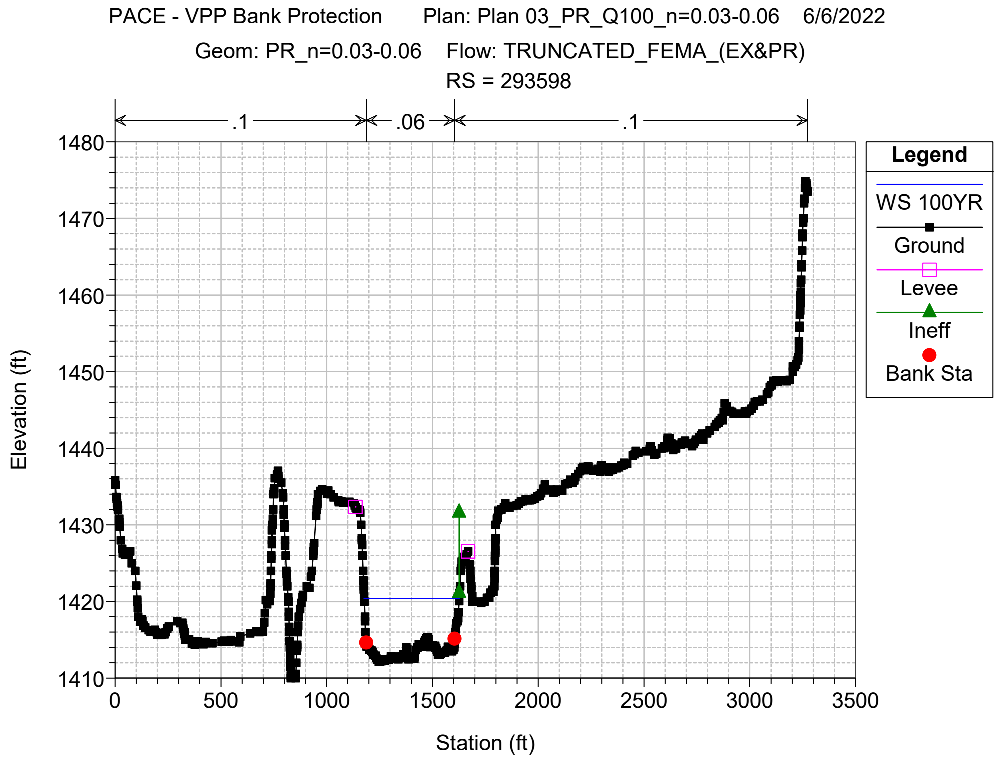


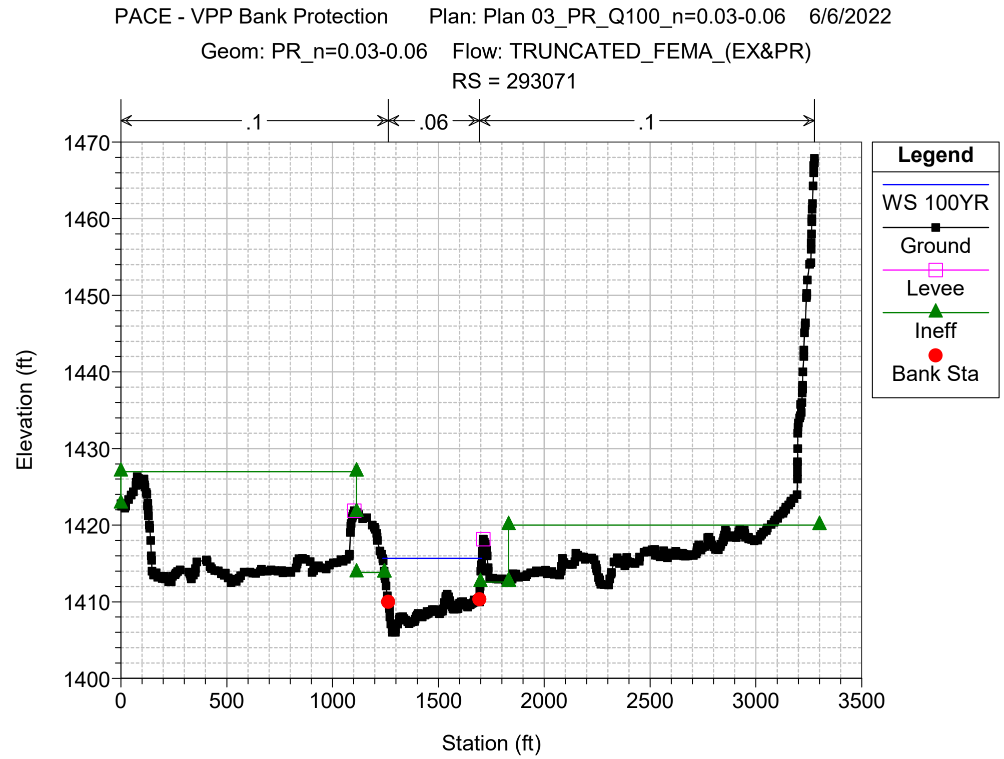

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 294750
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

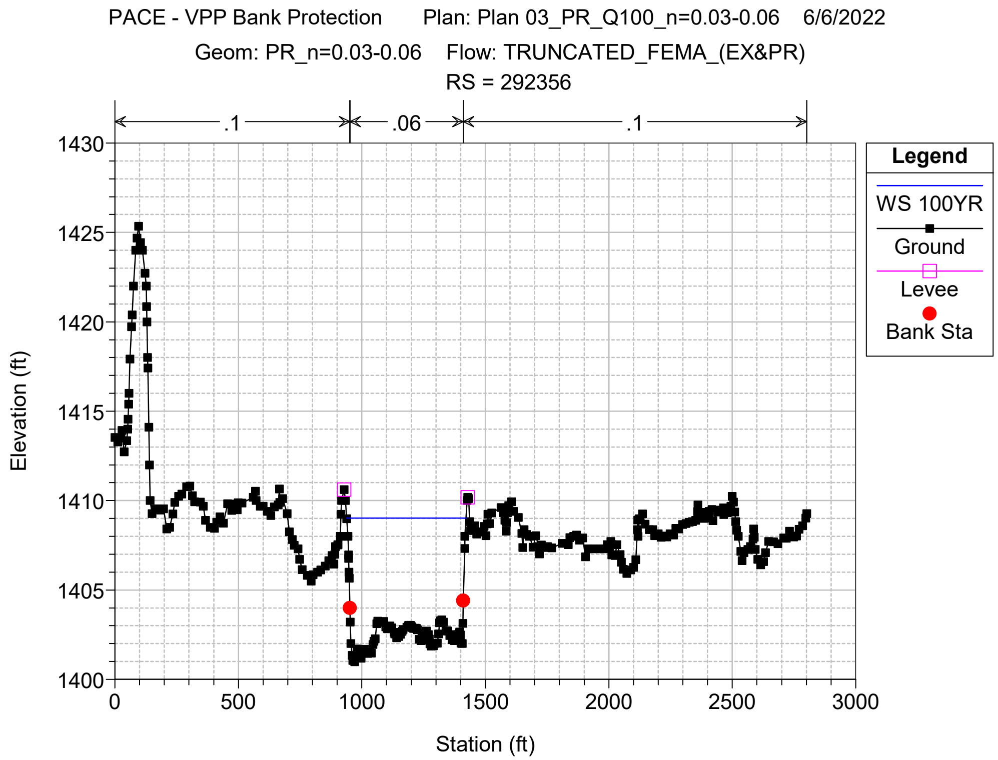

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 294327
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

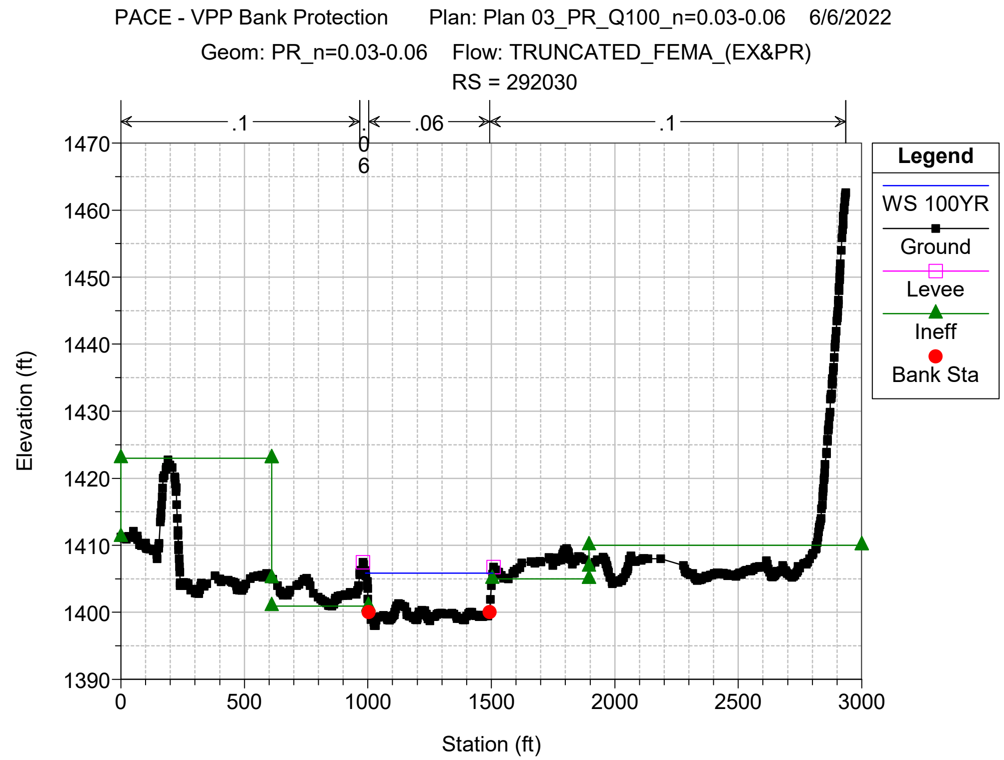

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 293808
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

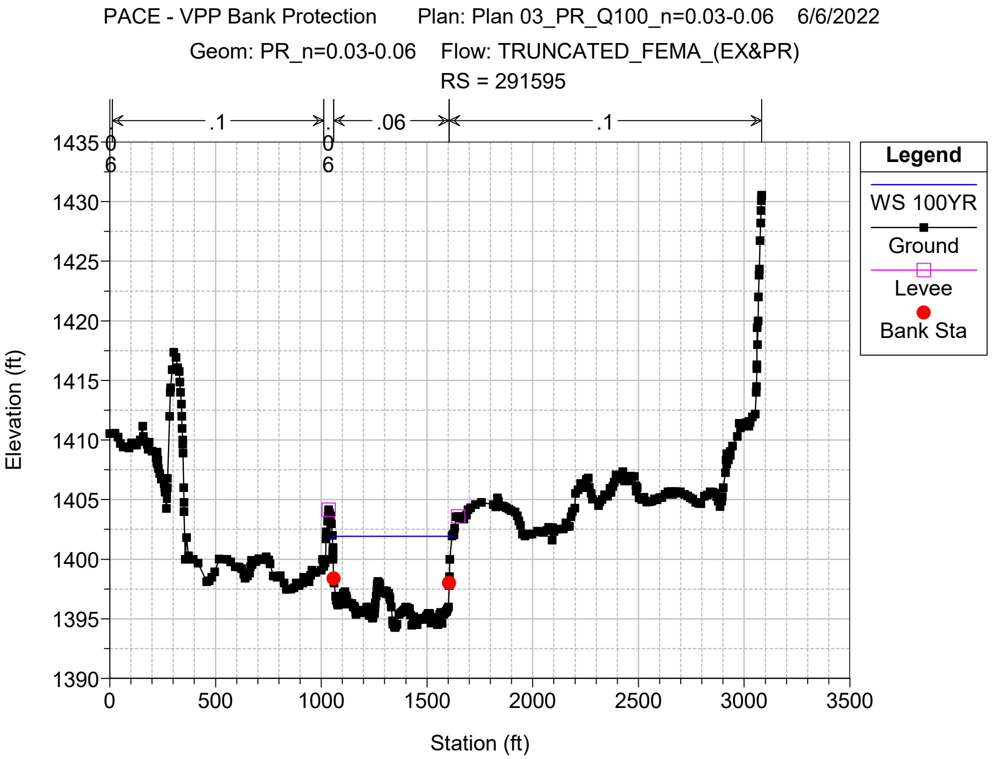

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 293703 BR
.036
.032
.036
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 293598
.1
.06
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
1410
1420
1430
1440
1450
1460
1470
1480
0
500
1000
1500
2000
2500
3000
3500
Station (ft)


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 293071
.1
.06
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
1400
1410
1420
1430
1440
1450
1460
1470
0
500
1000
1500
2000
2500
3000
3500
Station (ft)


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 292356
.1
.06
.1
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
1400
1405
1410
1415
1420
1425
1430
0
500
1000
1500
2000
2500
3000
Station (ft)


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 292030
.1
0
6
.06
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
1390
1400
1410
1420
1430
1440
1450
1460
1470
0
500
1000
1500
2000
2500
3000
Station (ft)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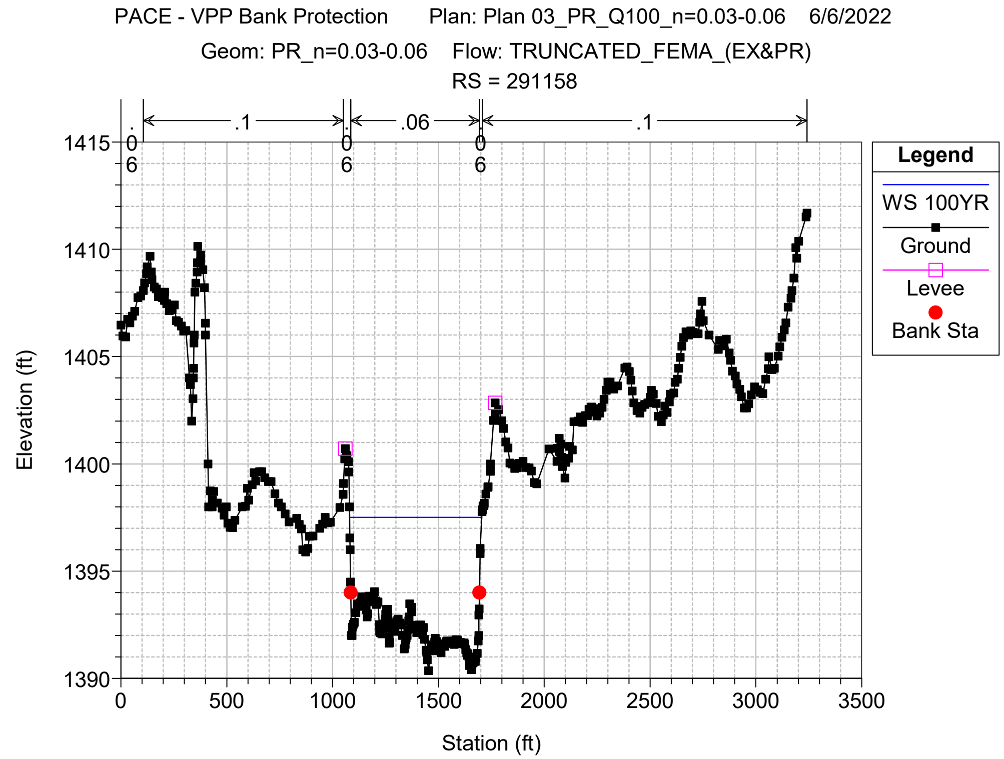
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 291595
.1
.06
.1
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)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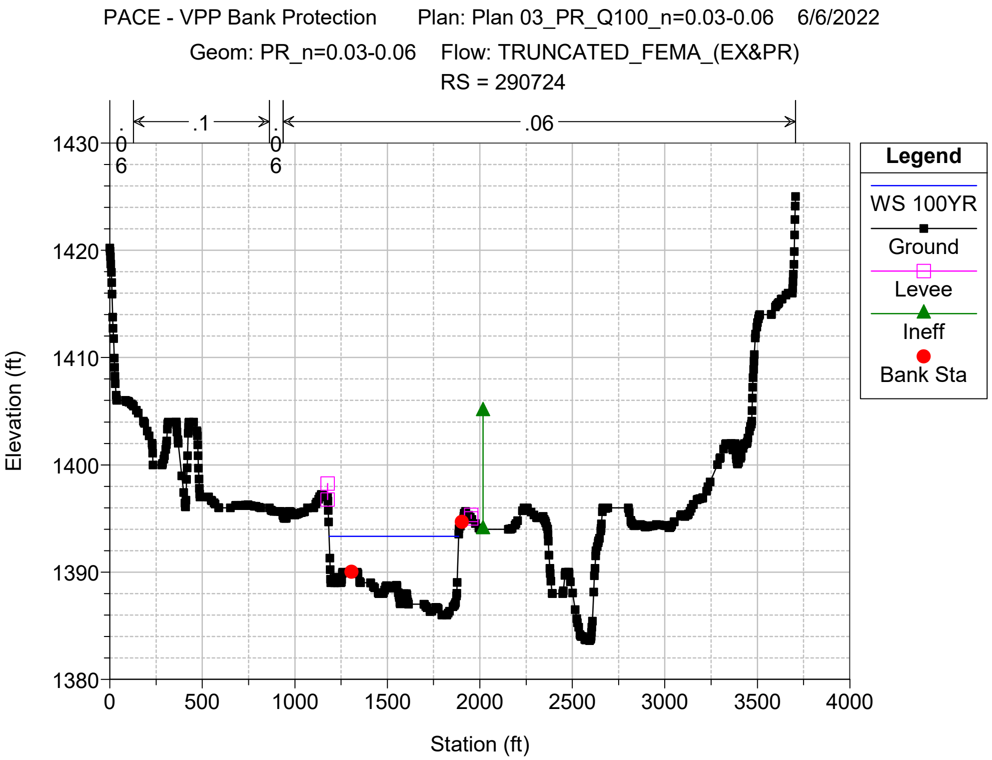
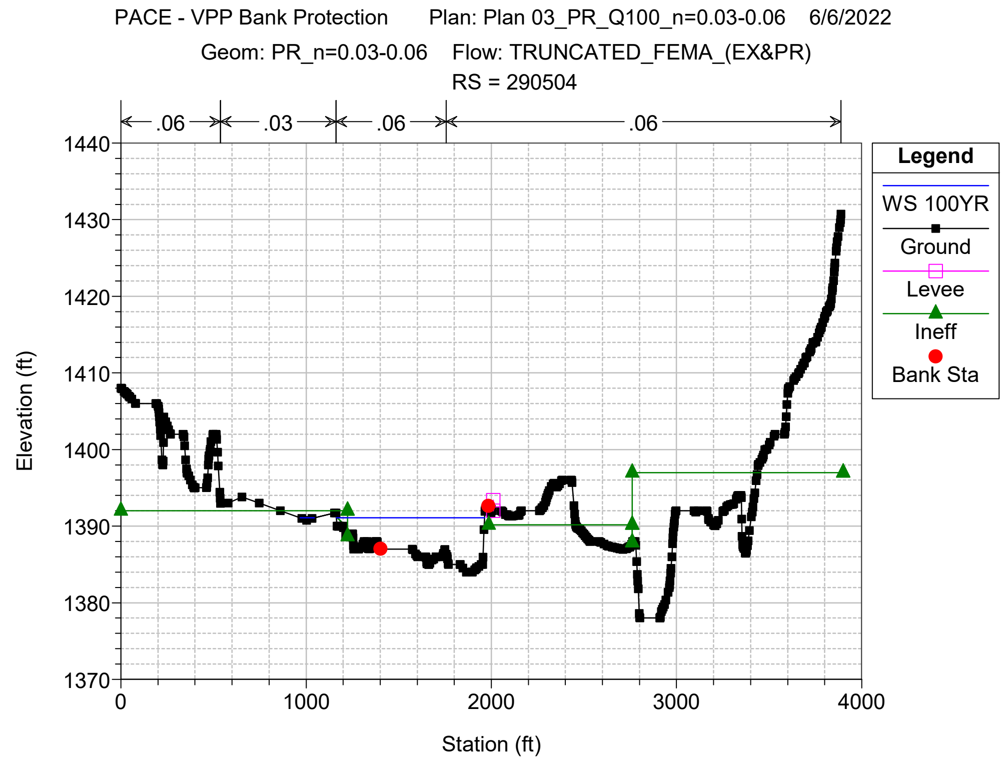
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 291158
.1
.06
.1
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 290724
.1
.06
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)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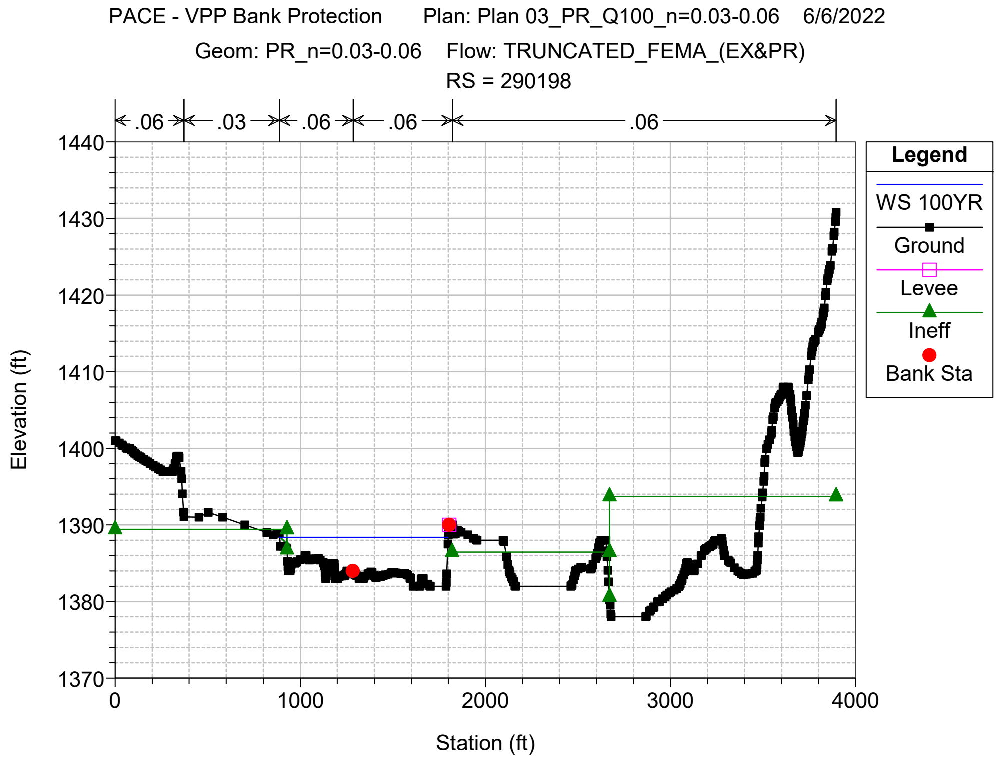
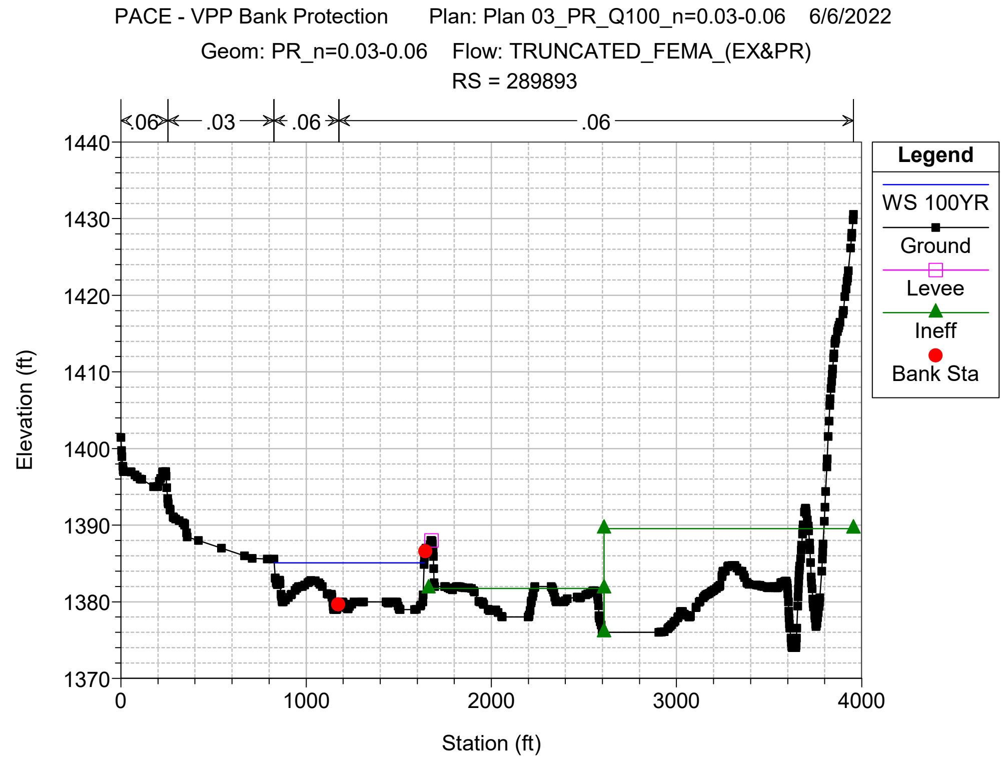
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 290504
.06
.03
.06
.06
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 290198
.06 .03 .06 .06 .06
Elevation (ft)
1370 1380 1390 1400 1410 1420 1430 1440
Station (ft)
0 1000 2000 3000 4000
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta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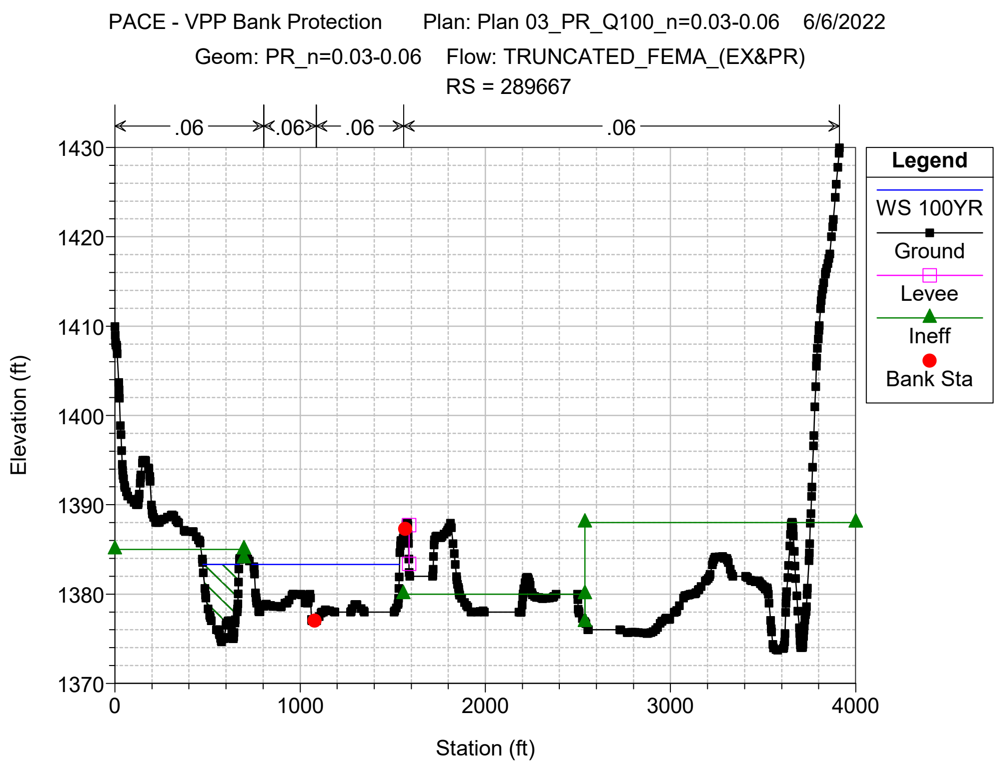
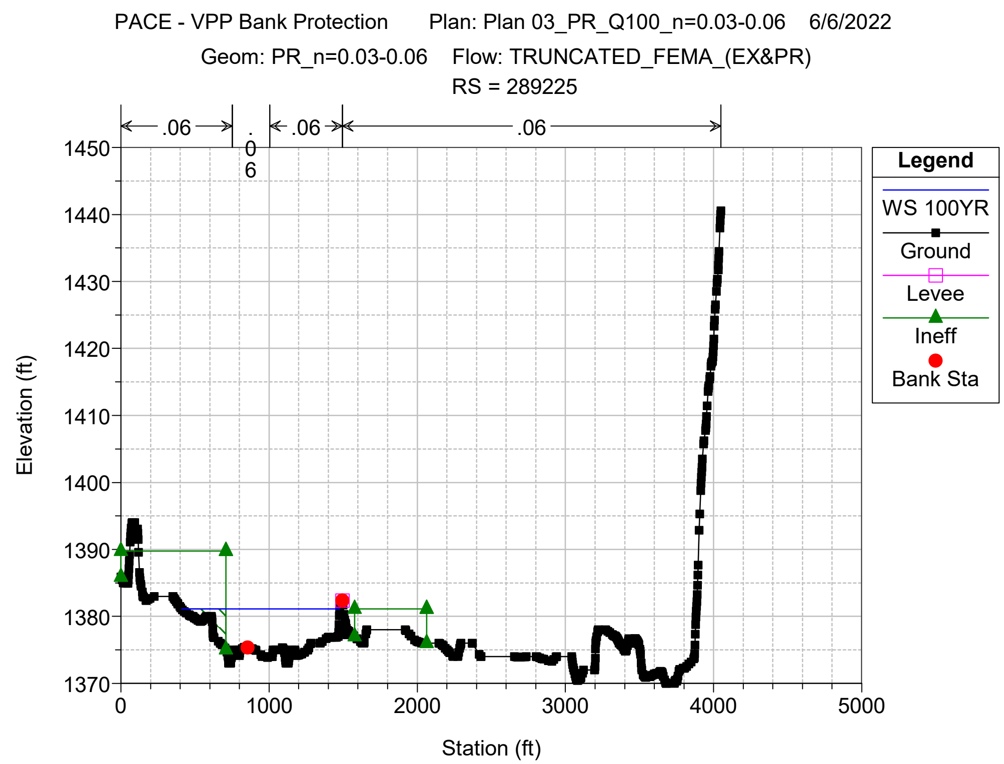
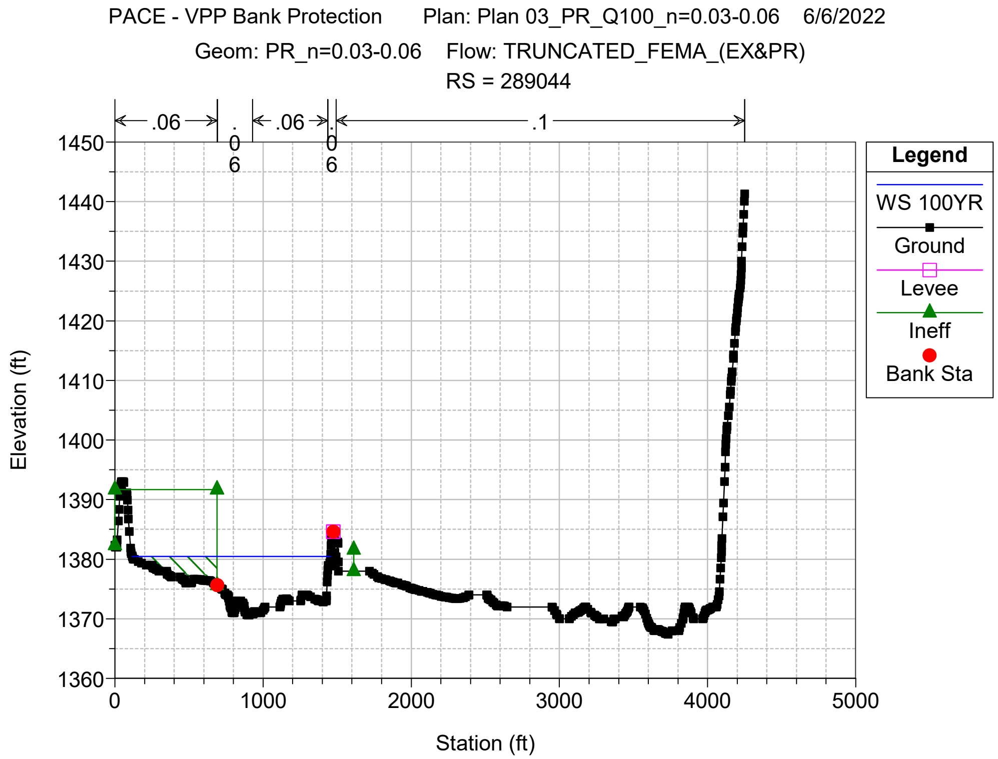
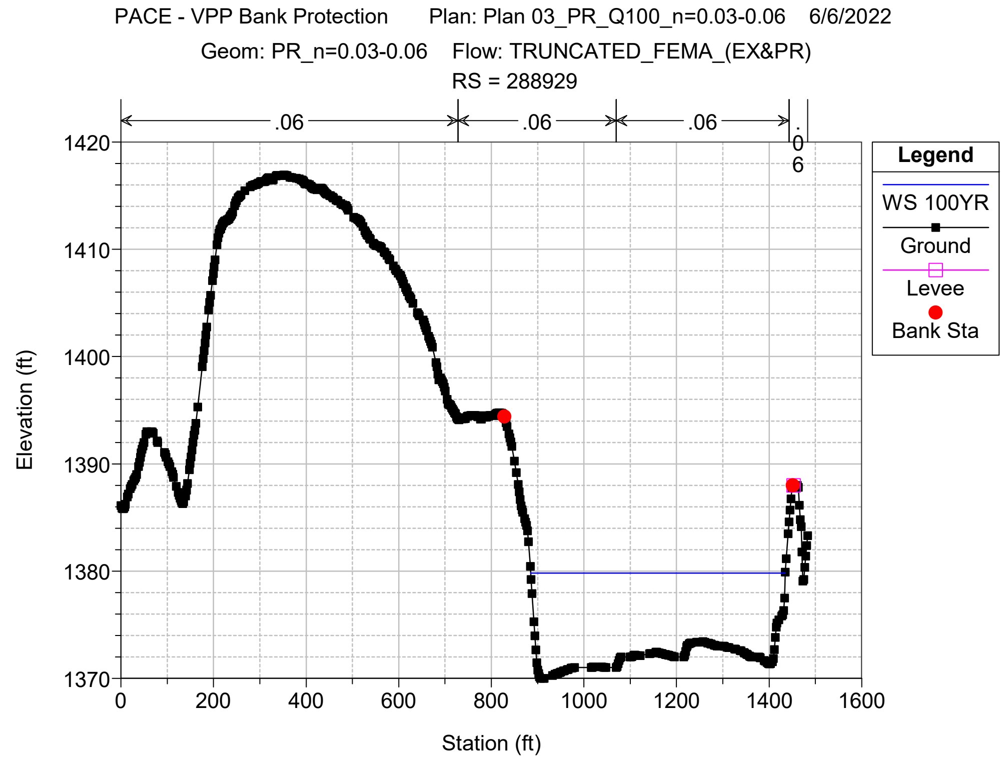
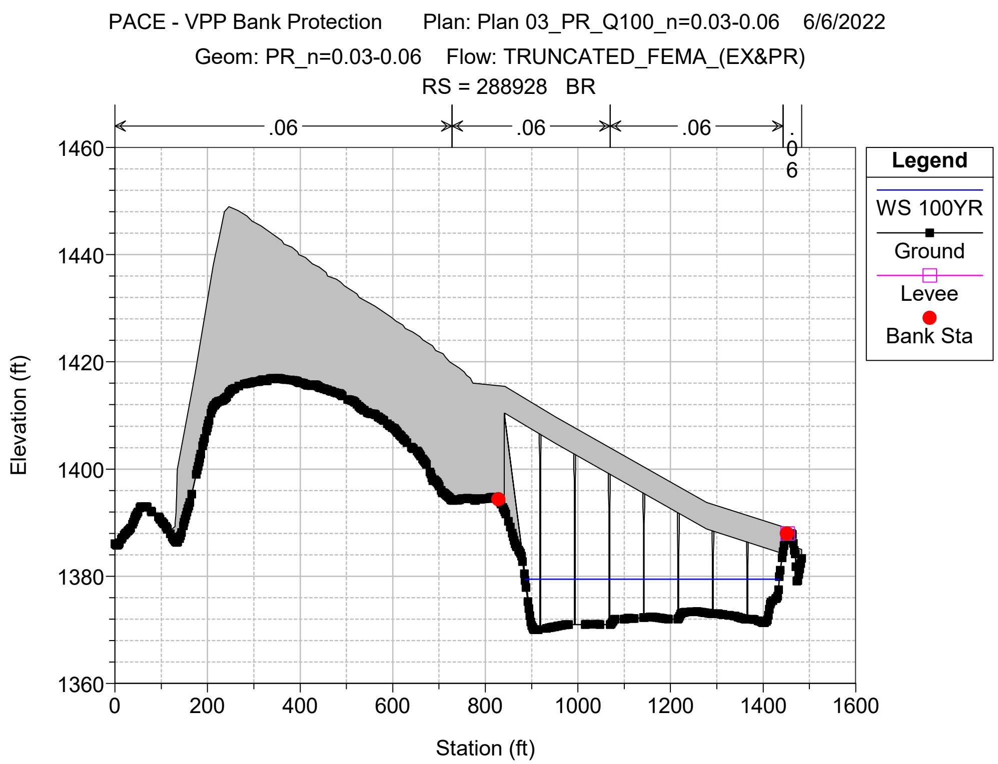
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 289893
.06 .03 .06 .06
Elevation (ft)
1370 1380 1390 1400 1410 1420 1430 1440
Station (ft)
0 1000 2000 3000 4000
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 289667
.06 .06 .06 .06
Elevation (ft)
1370 1380 1390 1400 1410 1420 1430
Station (ft)
0 1000 2000 3000 4000
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 289225
.06 .06 .06 .06
Elevation (ft)
1370 1380 1390 1400 1410 1420 1430 1440 1450
Station (ft)
0 1000 2000 3000 4000 5000
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 289044
.06
.06
.06
.06
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1360
1370
1380
1390
1400
1410
1420
1430
1440
1450
0
1000
2000
3000
4000
5000


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 288929
.06
.06
.06
.06
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
1370
1380
1390
1400
1410
1420
0
200
400
600
800
1000
1200
1400
1600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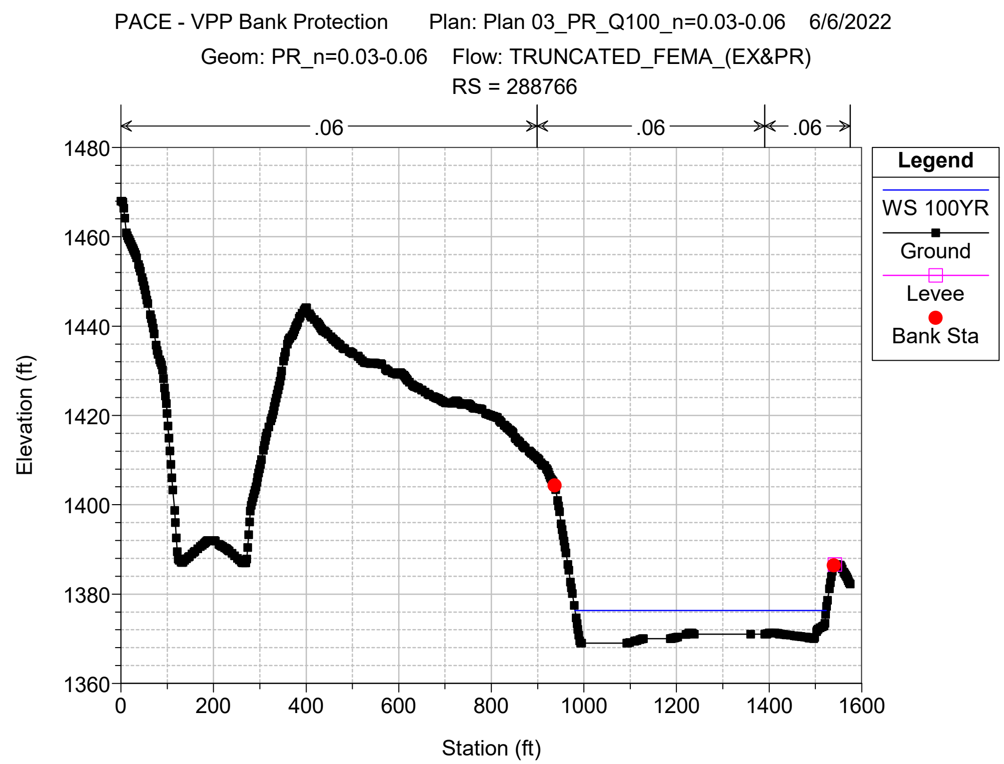
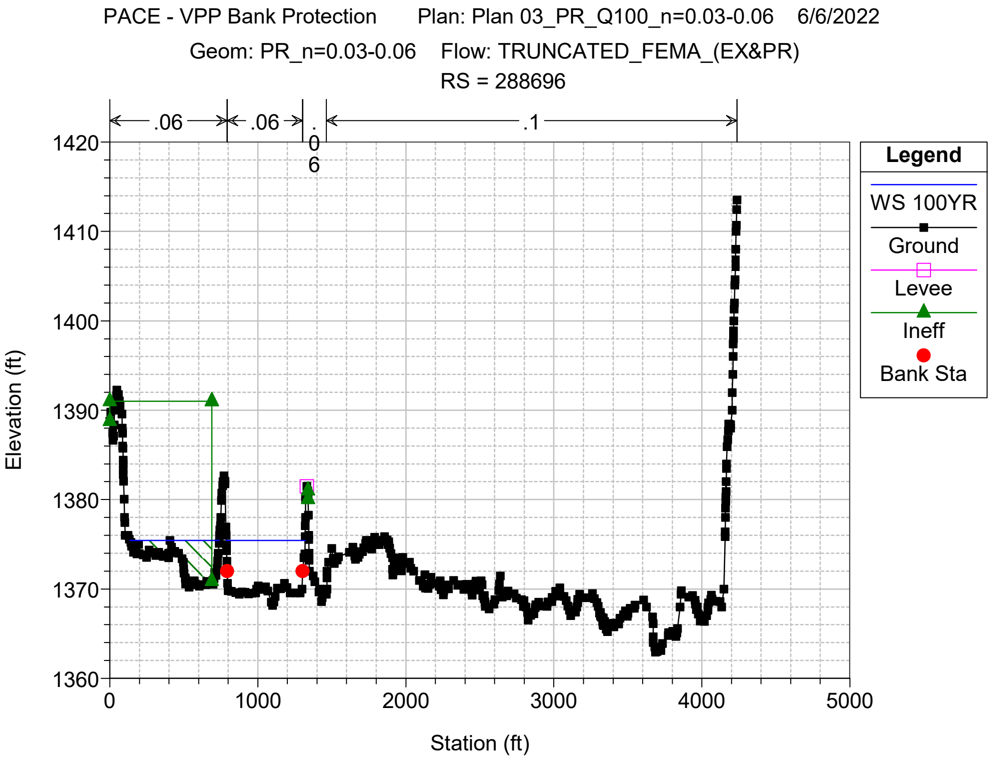
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 288928 BR
.06
.06
.06
.06
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
1360
1380
1400
1420
1440
1460
0
200
400
600
800
1000
1200
1400
1600


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 288766
.06
.06
.06
Legend
WS 100YR
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
1360
1380
1400
1420
1440
1460
1480
0
200
400
600
800
1000
1200
1400
1600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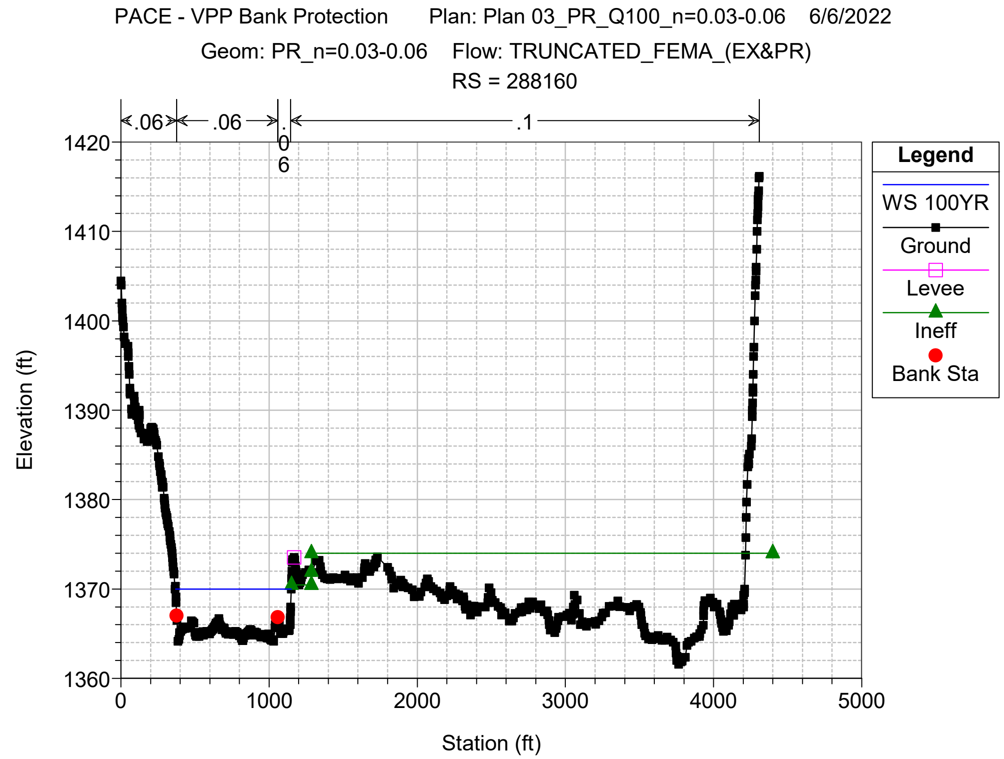
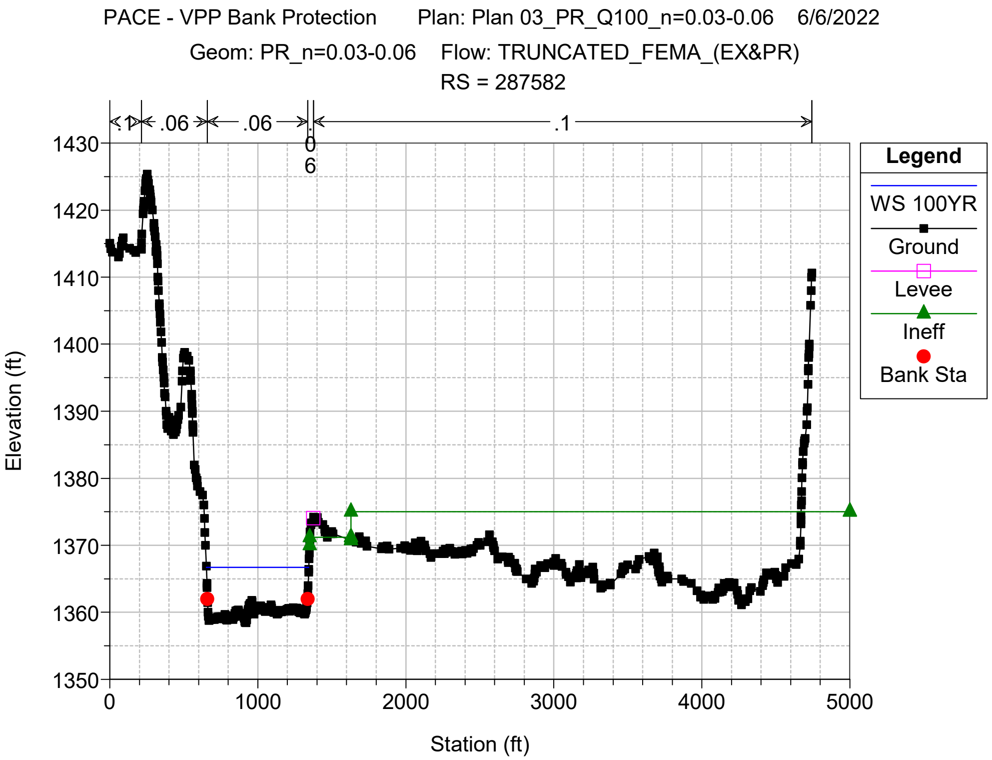
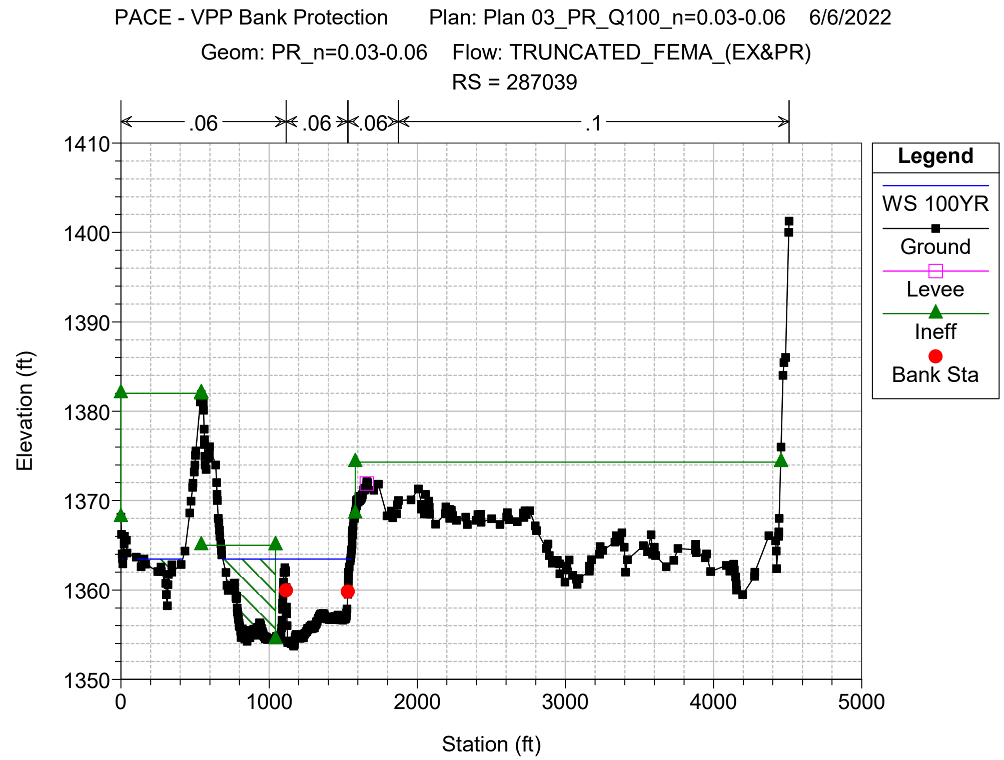
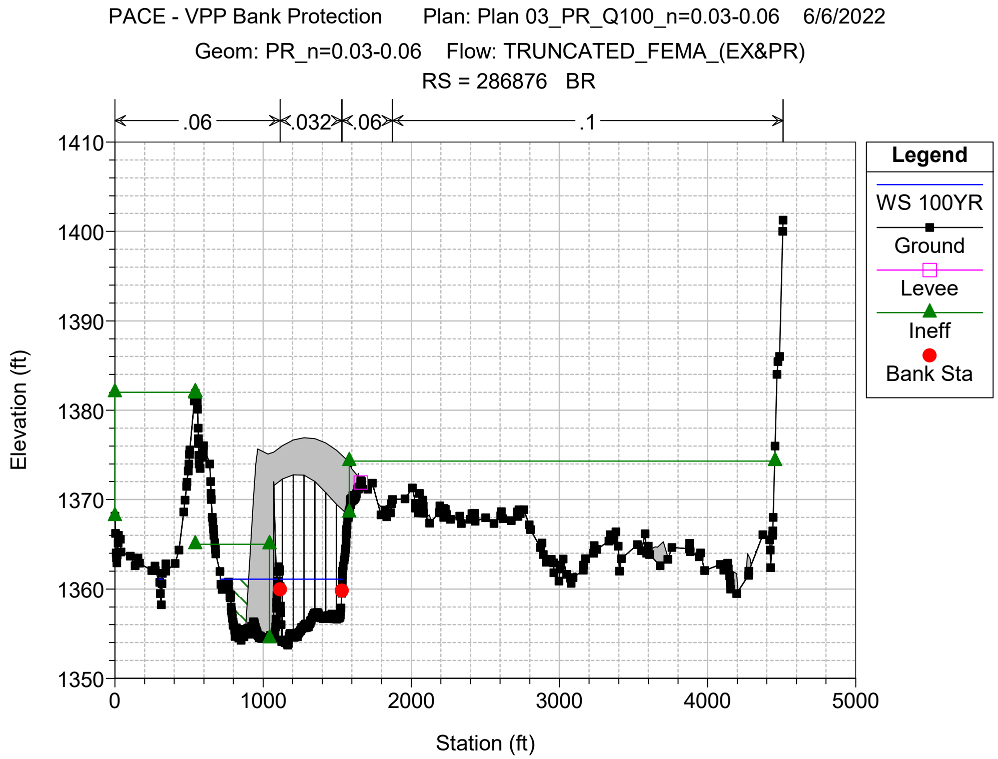
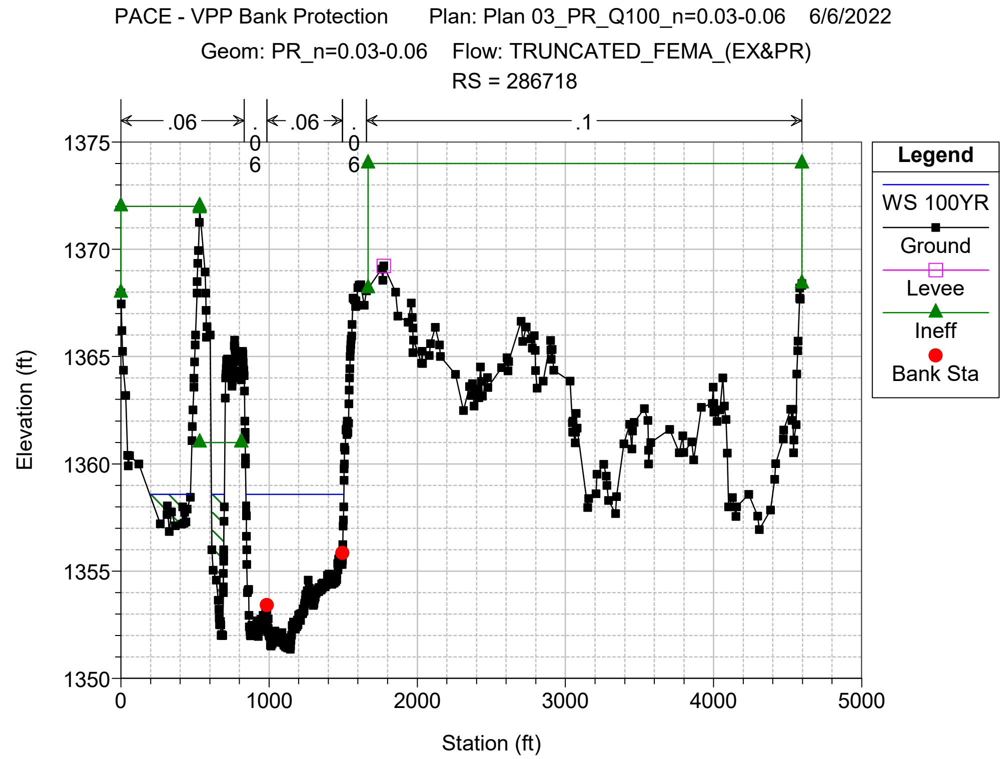
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 288696
.06
.06
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta

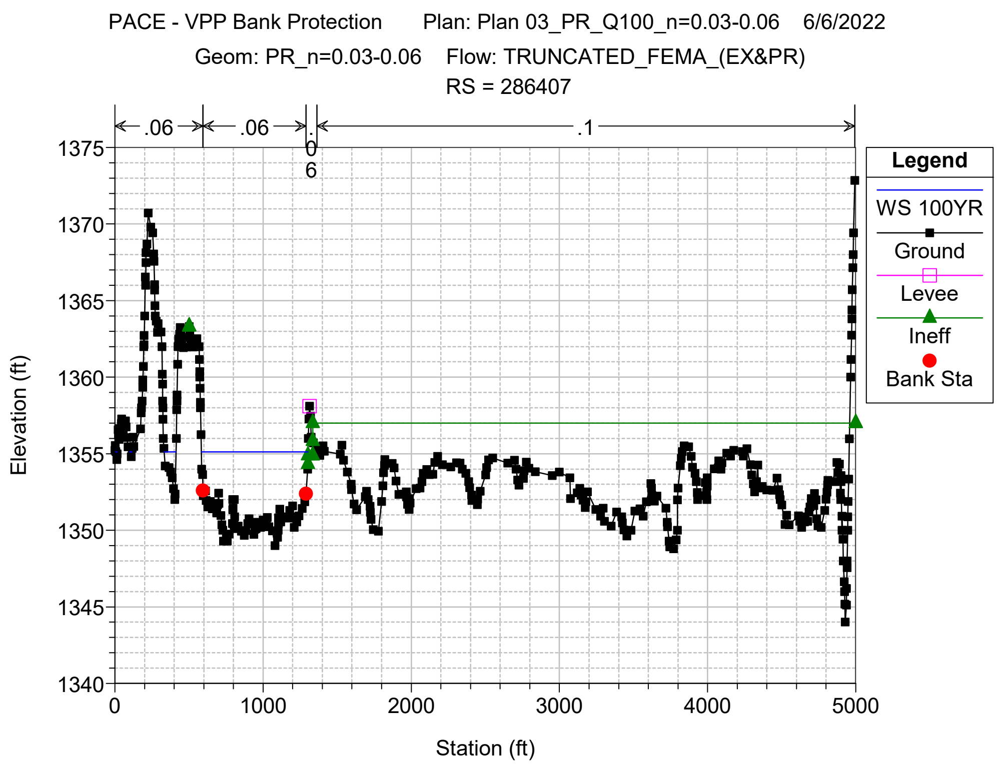

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 288160
.06
.06
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 287582
.1
.06
.06
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 287039
.06
.06
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 286876 BR
.06
.032
.06
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1350
1360
1370
1380
1390
1400
1410
0
1000
2000
3000
4000
5000


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 286718
.06
.06
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1350
1355
1360
1365
1370
1375
0
1000
2000
3000
4000
5000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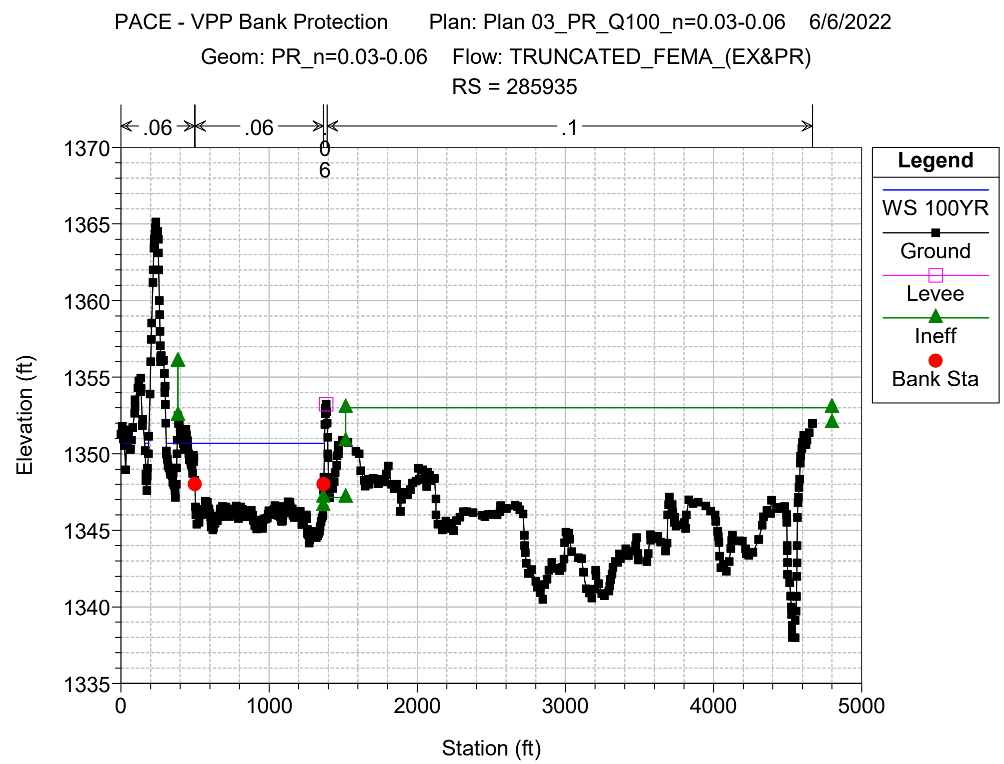
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 286407
.06
.06
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1340
1345
1350
1355
1360
1365
1370
1375
0
1000
2000
3000
4000
5000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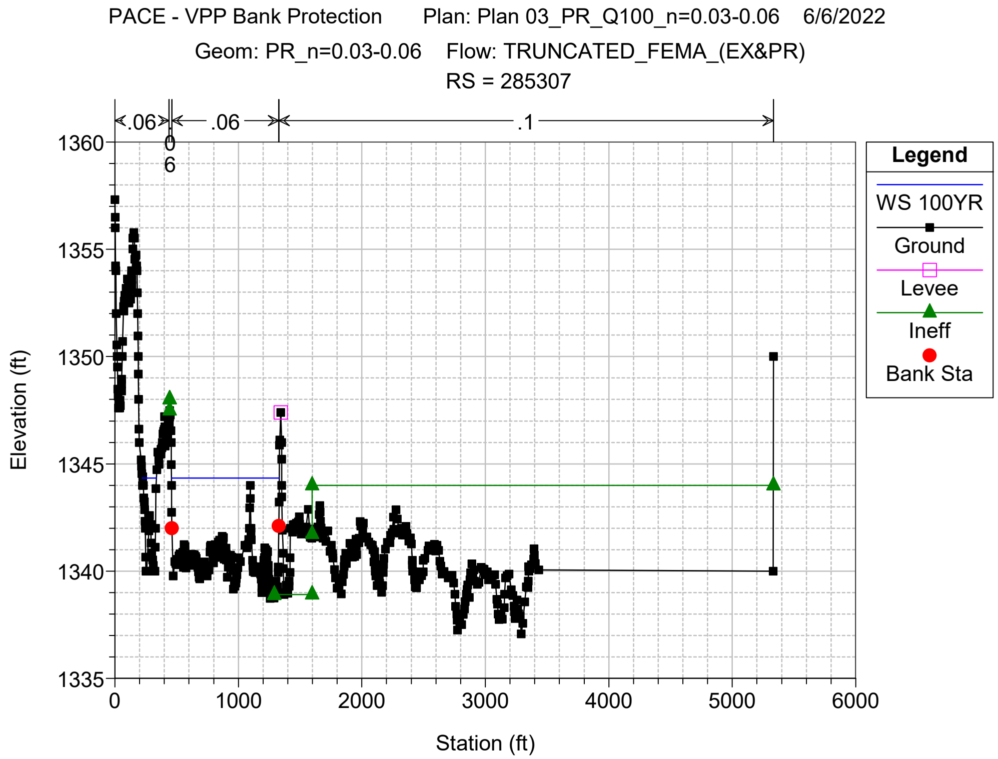
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 285935
.06
.06
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1335
1340
1345
1350
1355
1360
1365
1370
0
1000
2000
3000
4000
5000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Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 285307
.06
0
6
.06
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
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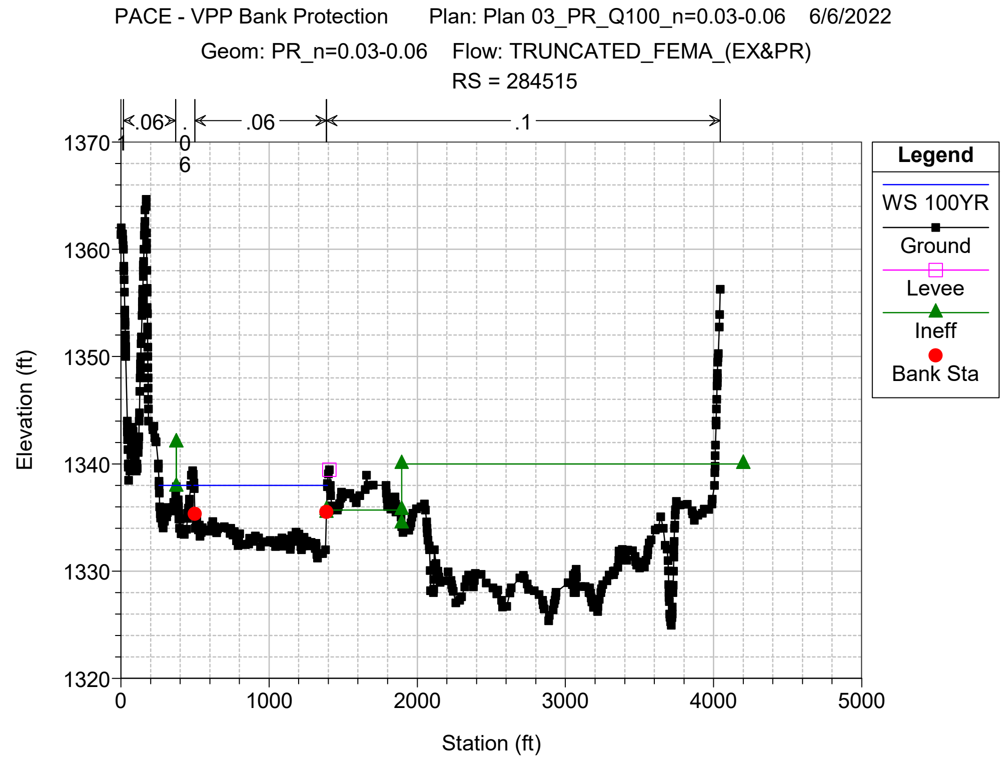
1340
1345
1350
1355
1360
0
1000
2000
3000
4000
5000
6000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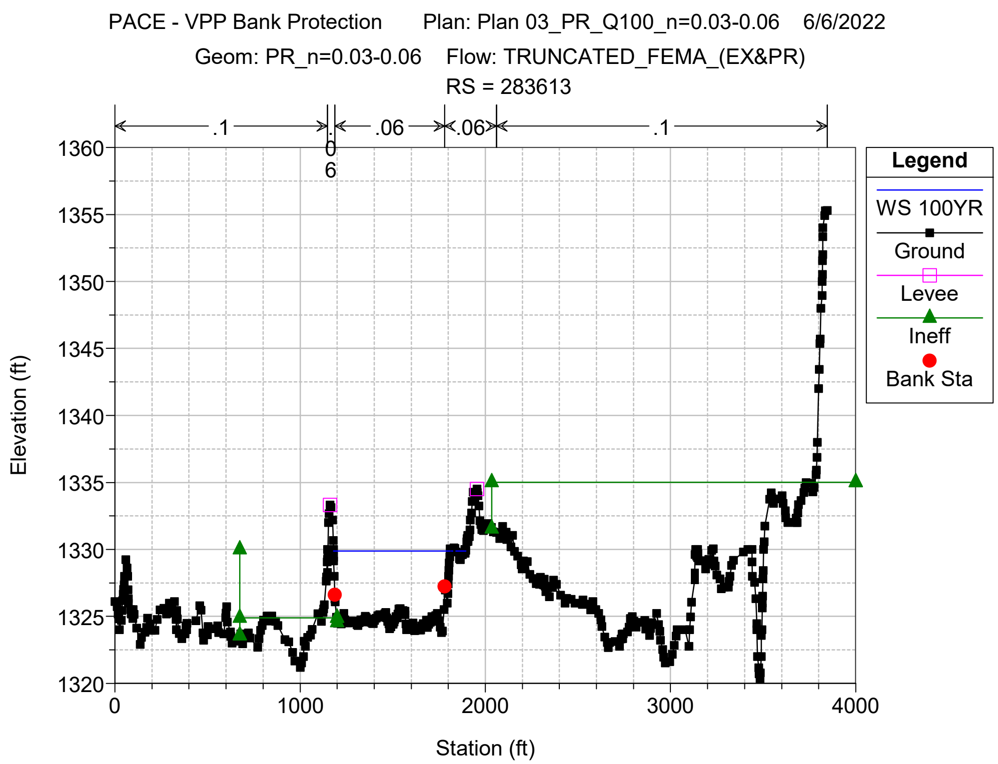
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 284515
.06
0
6
.06
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1320
1330
1340
1350
1360
1370
0
1000
2000
3000
4000
5000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Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 283613
.1
0
6
.06
.06
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
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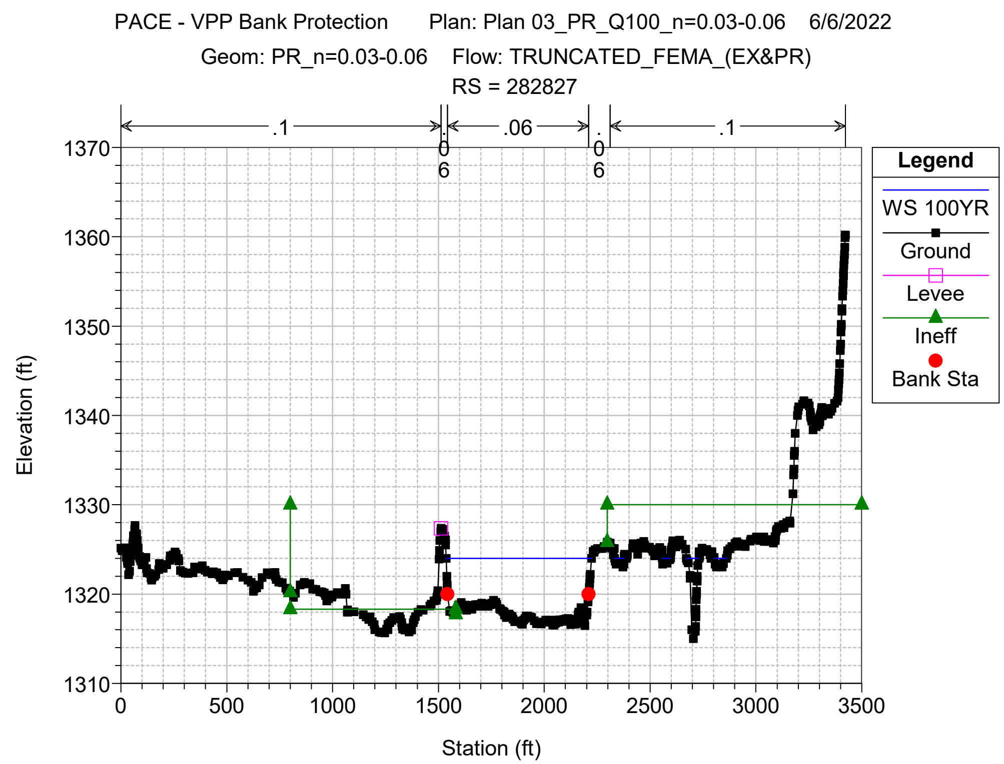
1325
1330
1335
1340
1345
1350
1355
1360
0
1000
2000
3000
4000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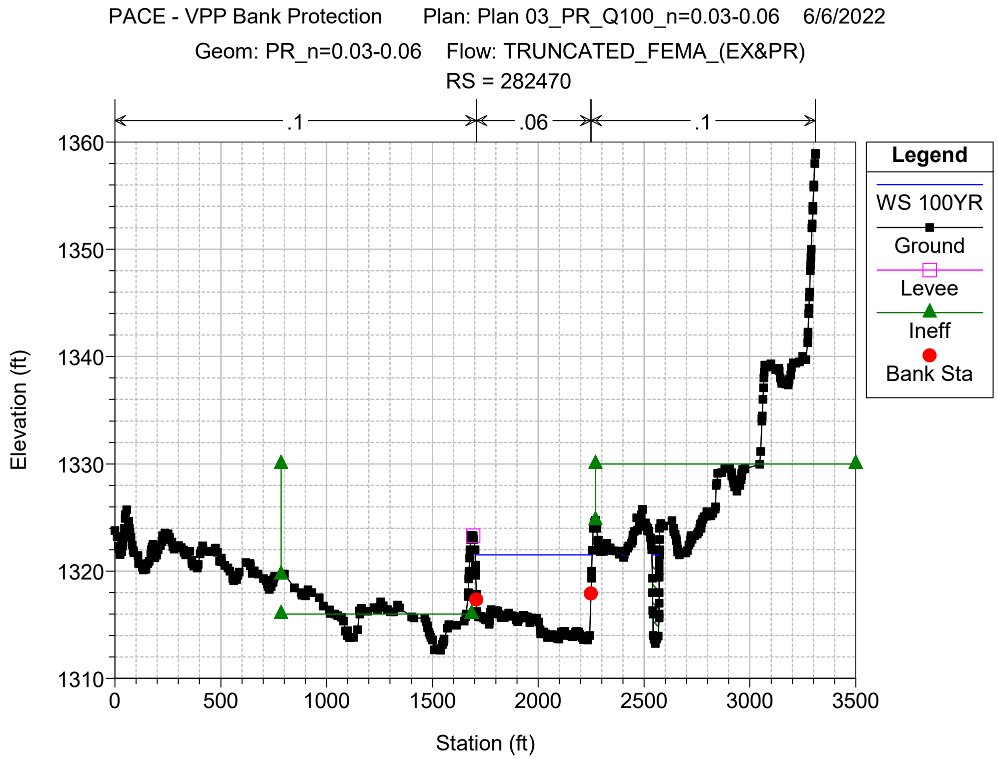
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 282827
.1
0
6
.06
0
6
.1
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1310
1320
1330
1340
1350
1360
1370
0
500
1000
1500
2000
2500
3000
3500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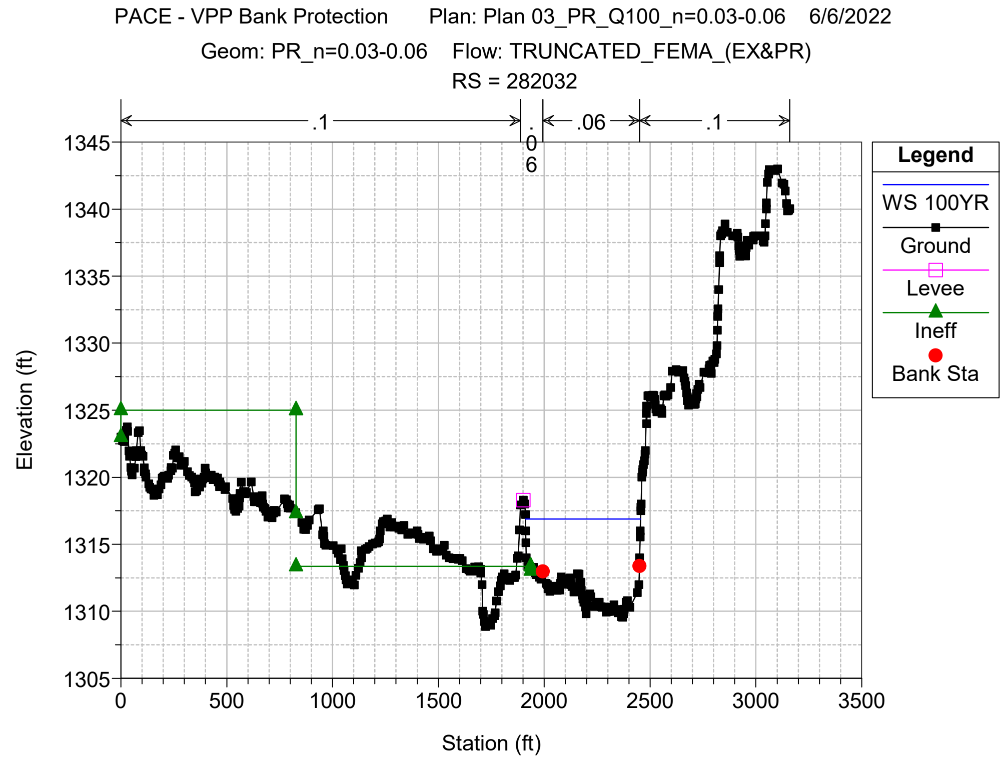
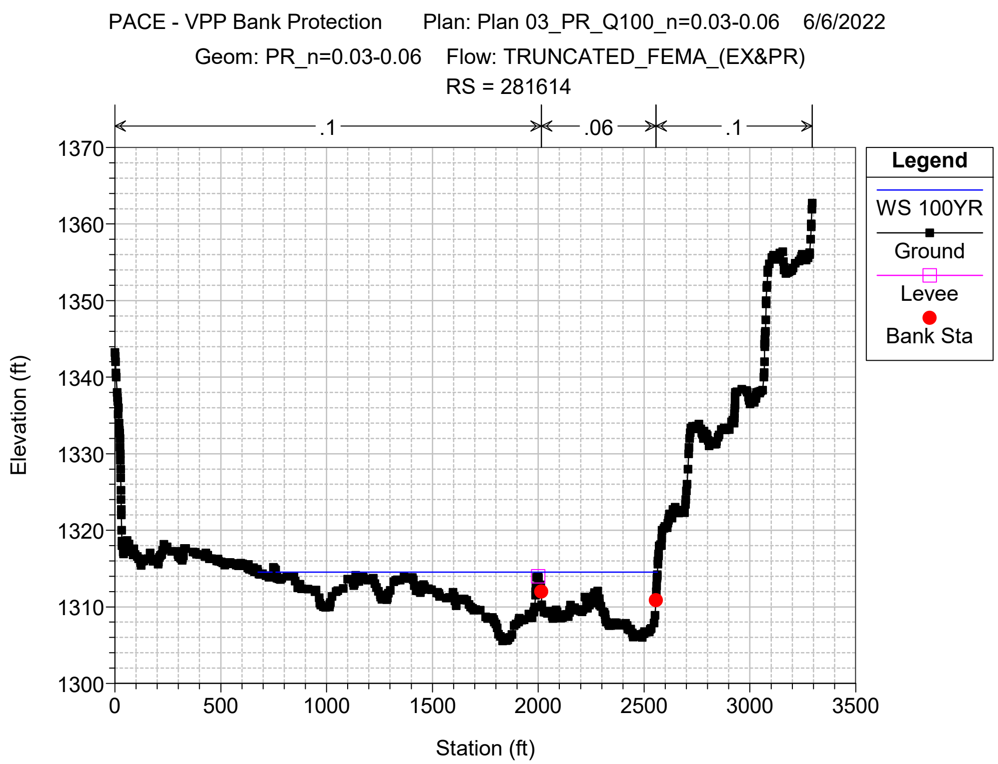
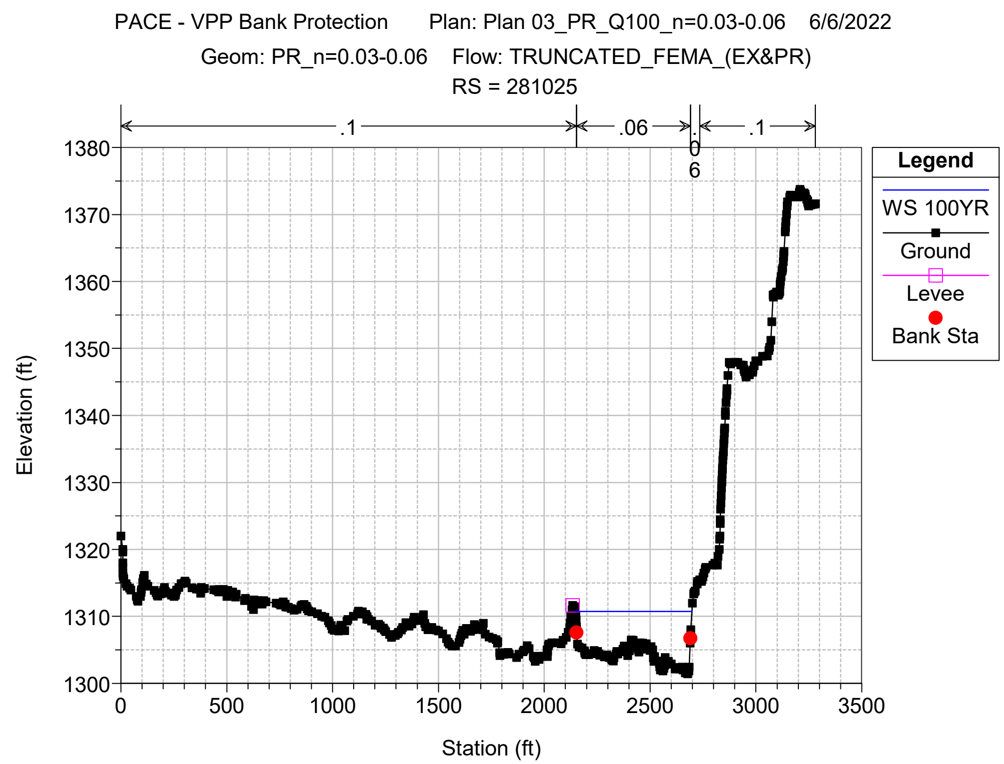
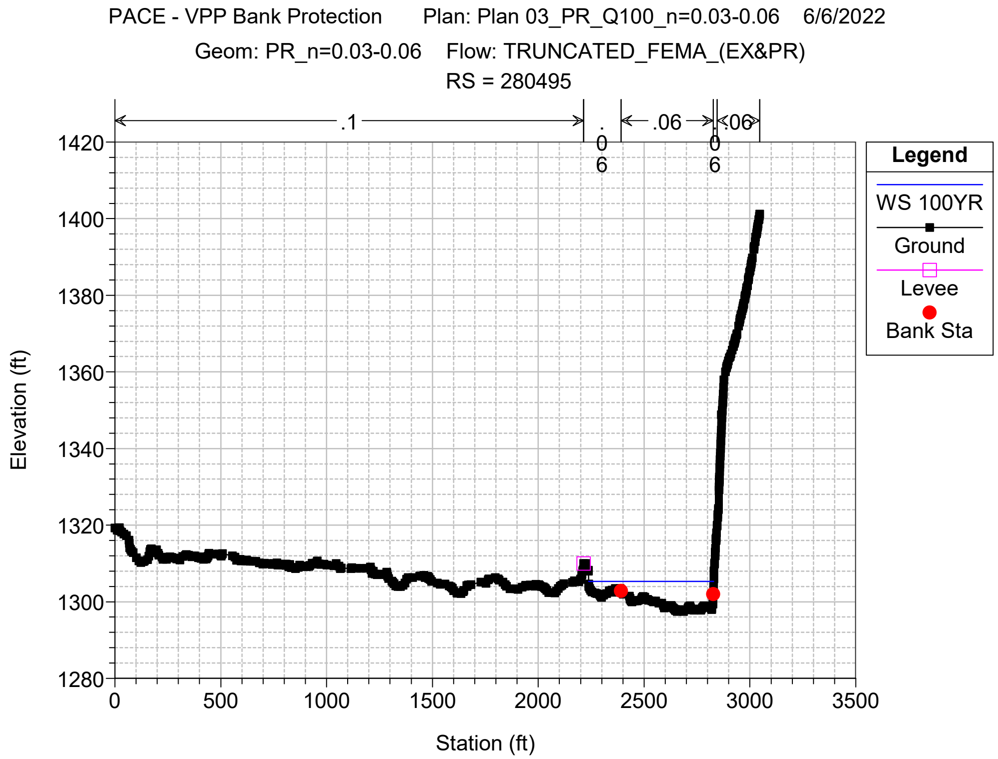
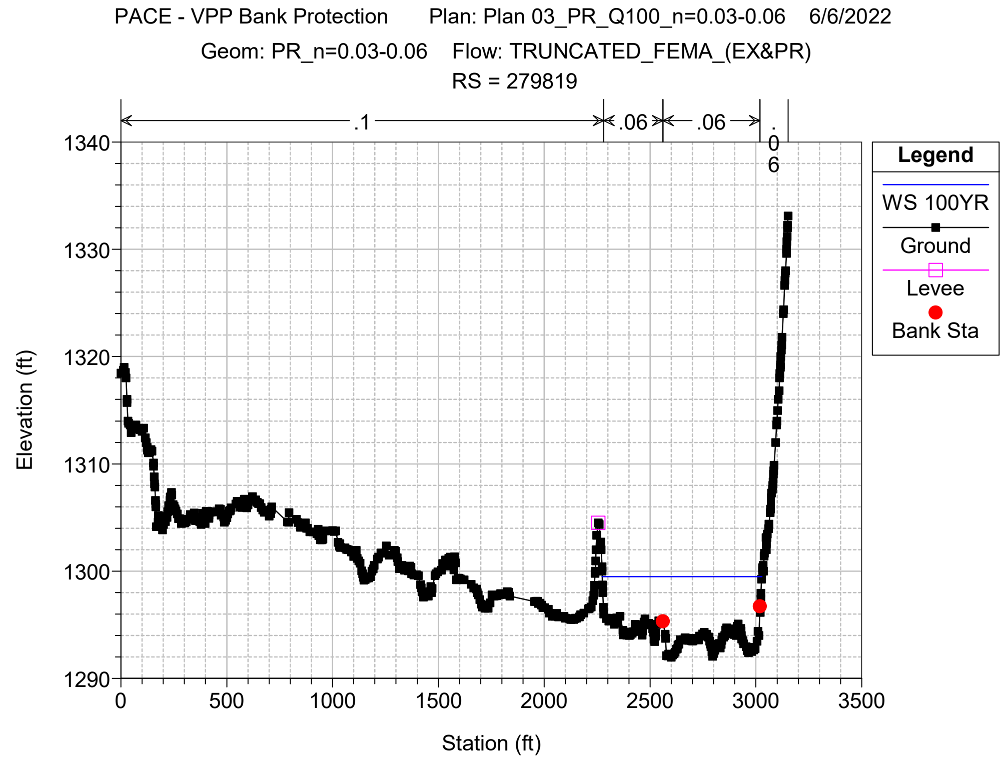
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 282470
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 282032
.1
.06
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Ineff
Bank Sta


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 281614
.1
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Bank Sta


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 281025
.1
.06
.06
.1
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Bank Sta


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 280495
.1
.06
.06
.06
.06
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Bank Sta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Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 279819
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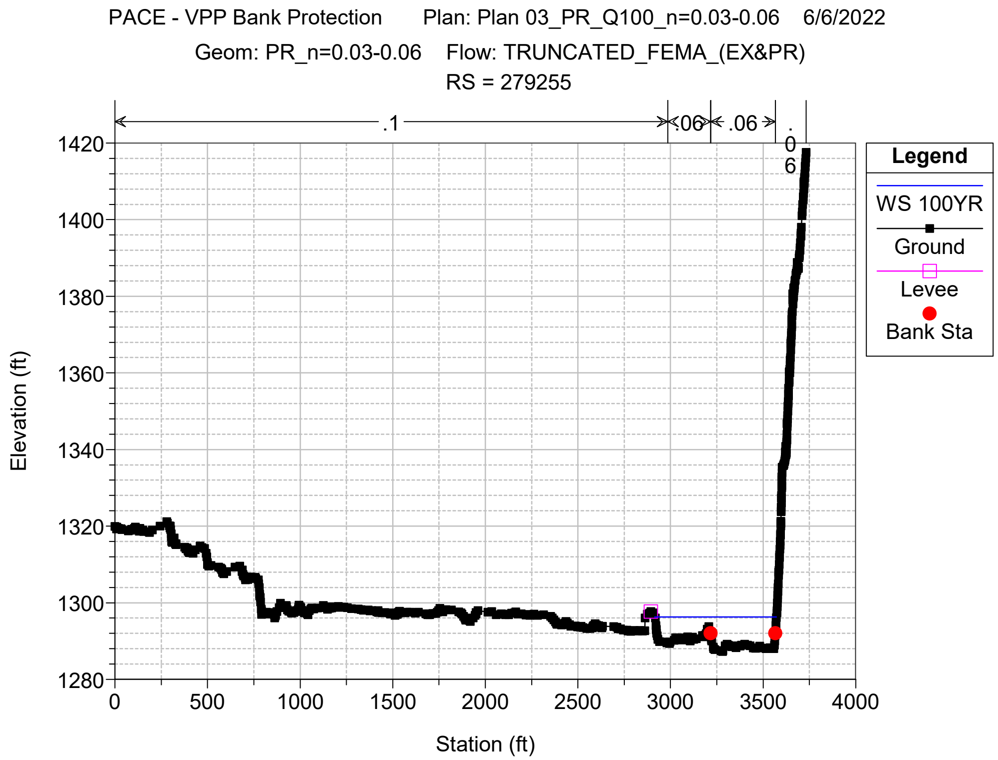
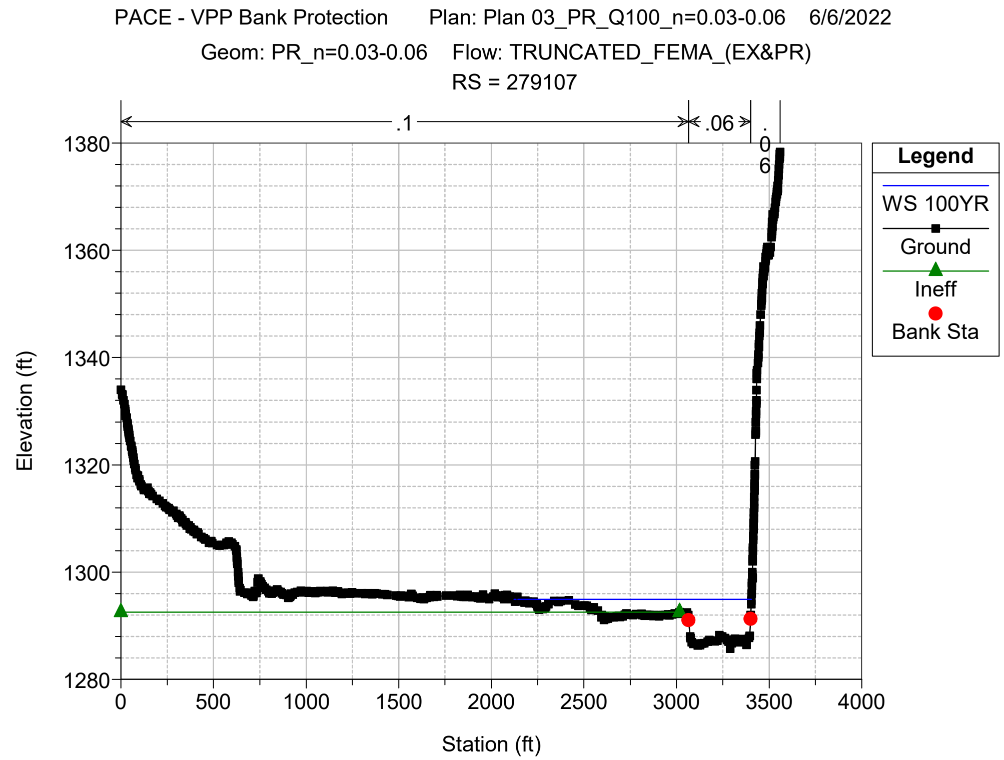
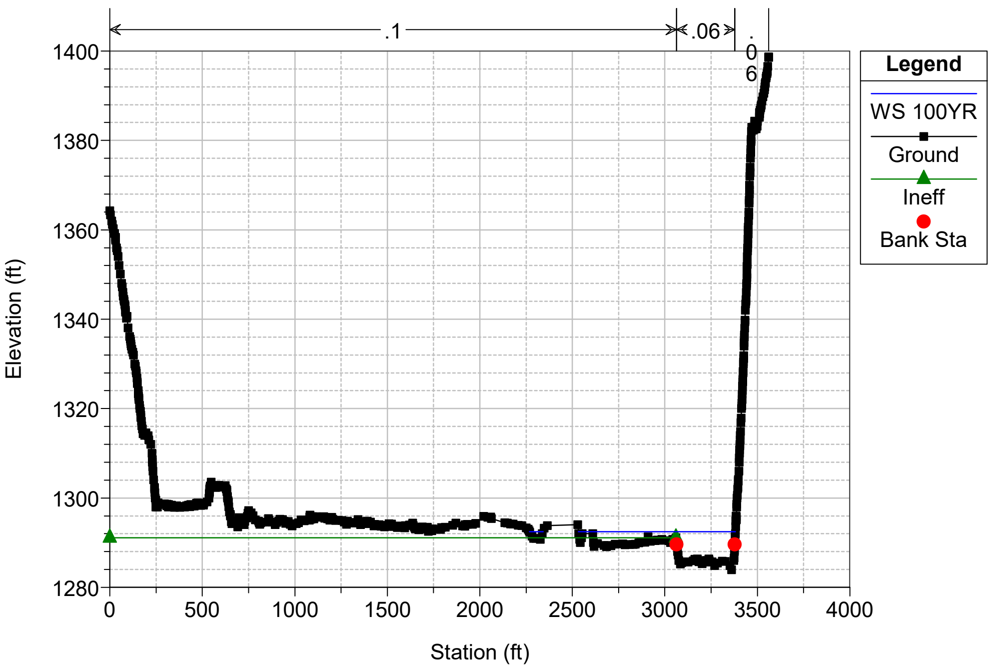
.06
.06
.06
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Bank Sta

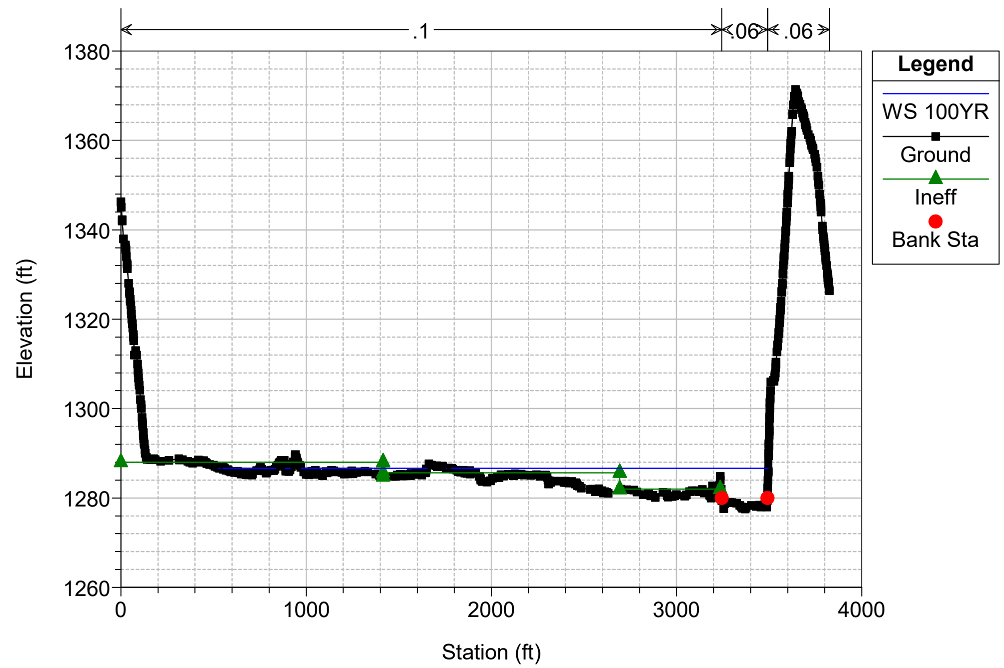

PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 279255
.1
.06
.06
.06
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Levee
Bank Sta


PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 279107
.1
.06
.06
Elevation (ft)
Station (ft)
Legend
WS 100YR
Ground
Ineff
Bank Sta

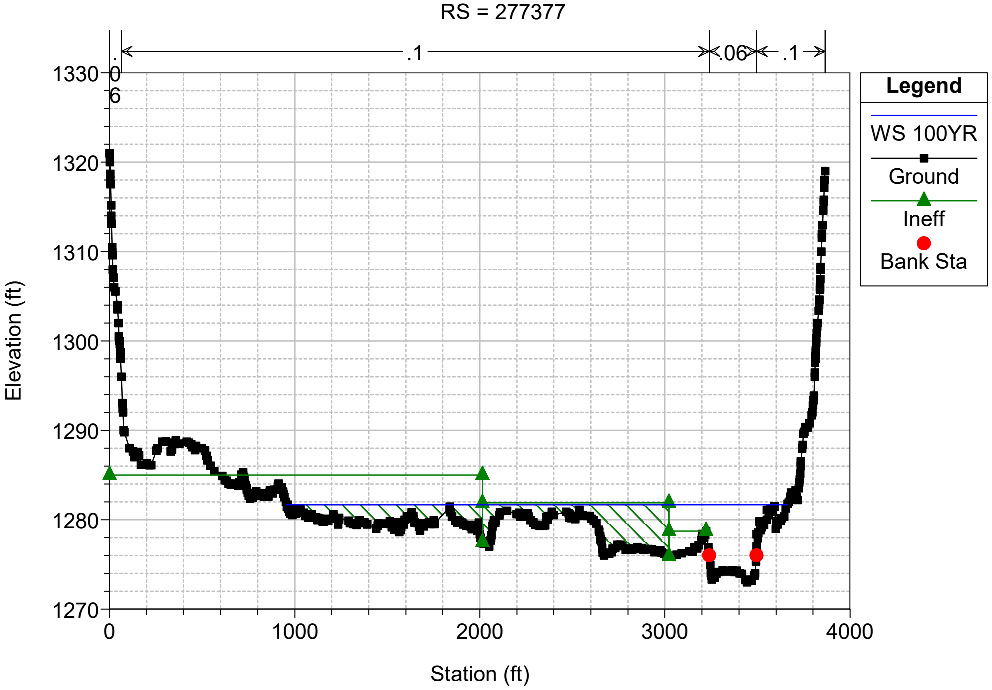
PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 278930



PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 277980



PACE - VPP Bank Protection Plan: Plan 03_PR_Q100_n=0.03-0.06 6/6/2022
Geom: PR_n=0.03-0.06 Flow: TRUNCATED_FEMA_(EX&PR)
RS = 277377



HEC-RAS Plan: Plan 04 River: Santa Clara R Reach: Workmap11 Profile: 100YR

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Workmap11	298582 BE	100YR	21690.00	1459.01	1463.72	1464.55	1466.70	0.014156	13.91	1573.29	586.53	1.47
Workmap11	298062 DD	100YR	21690.00	1451.65	1463.67	1460.98	1464.40	0.001036	6.89	3256.20	551.72	0.46
Workmap11	297761		Bridge									
Workmap11	297469 DC	100YR	21690.00	1446.37	1455.89	1455.89	1457.95	0.005761	11.51	1890.74	466.71	1.00
Workmap11	297265 DB	100YR	21690.00	1444.21	1451.35	1452.66	1455.74	0.019364	16.81	1295.68	451.72	1.74
Workmap11	296673	100YR	21690.00	1440.93	1446.47	1446.70	1448.68	0.006900	11.94	1839.02	495.21	1.08
Workmap11	296017 BD	100YR	21690.00	1433.35	1438.83	1439.76	1442.08	0.015442	14.48	1502.97	549.47	1.54
Workmap11	295386 DA	100YR	21690.00	1427.63	1433.74	1433.84	1435.64	0.006504	11.07	1963.45	560.94	1.04
Workmap11	294750	100YR	21690.00	1421.94	1427.61	1428.26	1430.41	0.010366	13.41	1620.83	491.14	1.30
Workmap11	294327 BC	100YR	25910.00	1418.00	1424.98	1424.98	1427.25	0.005464	12.11	2166.79	477.90	1.00
Workmap11	293808 CY	100YR	25910.00	1413.24	1423.80	1421.05	1424.96	0.001313	8.67	3061.61	391.33	0.54
Workmap11	293703		Bridge									
Workmap11	293598 CX	100YR	25910.00	1412.15	1416.97	1418.27	1421.50	0.014904	17.08	1527.63	429.51	1.58
Workmap11	293071 CW	100YR	25910.00	1406.00	1413.26	1413.54	1415.95	0.006556	13.18	1994.93	451.62	1.09
Workmap11	292356 BB	100YR	25910.00	1400.99	1406.12	1407.07	1409.74	0.011637	15.28	1701.78	466.16	1.40
Workmap11	292030 CV	100YR	25910.00	1398.00	1403.51	1404.01	1406.31	0.008301	13.45	1940.01	499.82	1.20
Workmap11	291595 CU	100YR	25910.00	1394.26	1399.19	1399.92	1402.20	0.010734	13.92	1863.24	549.37	1.33
Workmap11	291158 BA	100YR	25910.00	1390.36	1395.70	1396.04	1397.99	0.007876	12.14	2136.54	613.44	1.14
Workmap11	290724	100YR	25910.00	1386.00	1390.83	1391.61	1393.73	0.012097	13.88	1934.01	691.57	1.39
Workmap11	290504	100YR	25910.00	1384.00	1389.45	1389.77	1391.47	0.006722	11.75	2343.15	755.49	1.09
Workmap11	290198	100YR	25910.00	1382.00	1386.10	1386.84	1388.75	0.012003	13.79	2082.49	865.58	1.38
Workmap11	289893	100YR	25910.00	1379.00	1383.41	1383.77	1385.43	0.007188	12.10	2359.25	802.76	1.10
Workmap11	289667 AZ	100YR	25910.00	1377.00	1380.08	1380.96	1383.06	0.018010	12.73	1885.85	949.60	1.58
Workmap11	289225	100YR	25910.00	1373.00	1378.49	1378.33	1379.96	0.005161	9.53	2670.83	853.78	0.92
Workmap11	289044 CS	100YR	25910.00	1370.61	1378.42	1376.25	1379.17	0.001277	6.93	3740.64	1165.87	0.50
Workmap11	288929	100YR	25910.00	1370.00	1377.89	1376.17	1378.92	0.001801	8.14	3182.69	545.32	0.59
Workmap11	288928		Bridge									
Workmap11	288766	100YR	25910.00	1369.00	1374.58	1374.58	1376.66	0.005634	11.56	2240.97	538.14	1.00
Workmap11	288696 CR	100YR	25910.00	1368.17	1373.65	1374.00	1376.06	0.007236	12.57	2098.66	795.43	1.12
Workmap11	288160 CQ	100YR	25910.00	1364.15	1367.70	1368.54	1370.63	0.016062	13.83	1890.26	770.56	1.54
Workmap11	287582 AY	100YR	25910.00	1358.43	1364.10	1363.57	1365.45	0.003750	9.31	2785.87	683.17	0.81
Workmap11	287039 CO	100YR	25910.00	1353.74	1363.24	1360.57	1364.12	0.001201	7.64	3452.59	1144.06	0.50
Workmap11	286876		Bridge									
Workmap11	286718 CN	100YR	25910.00	1351.36	1355.78	1356.84	1359.40	0.017751	14.60	1709.00	724.22	1.62
Workmap11	286407 CM	100YR	25910.00	1349.00	1353.90	1354.10	1355.87	0.007487	11.30	2317.81	750.12	1.10
Workmap11	285935 AX	100YR	25910.00	1344.16	1348.17	1348.92	1350.82	0.016108	13.05	1991.98	894.31	1.52
Workmap11	285307 CL	100YR	25910.00	1338.73	1343.31	1343.31	1344.74	0.006394	9.69	2716.11	958.13	1.00
Workmap11	284515 AW	100YR	25910.00	1331.23	1335.39	1335.92	1337.60	0.013386	12.07	2190.08	997.78	1.39
Workmap11	283613 AV	100YR	25910.00	1323.79	1328.58	1328.58	1330.48	0.005666	11.08	2357.89	620.54	0.99
Workmap11	282827	100YR	25910.00	1316.49	1320.50	1321.34	1323.59	0.014582	14.10	1838.76	698.23	1.50
Workmap11	282470 CK	100YR	25910.00	1313.57	1319.14	1319.14	1321.20	0.005649	11.52	2253.46	578.90	1.00
Workmap11	282032 AU	100YR	26210.00	1309.57	1314.95	1315.63	1317.97	0.009436	14.15	1910.99	538.29	1.27
Workmap11	281614	100YR	26210.00	1306.01	1312.82	1312.82	1314.90	0.005637	11.56	2272.02	547.55	1.00
Workmap11	281025 CI	100YR	26210.00	1301.41	1307.75	1308.36	1310.60	0.009467	13.52	1938.86	539.69	1.26
Workmap11	280495 AT	100YR	26210.00	1297.45	1303.76	1304.26	1306.34	0.006748	13.09	2107.27	587.13	1.10
Workmap11	279819 CH	100YR	26210.00	1291.98	1296.56	1297.52	1299.82	0.014779	15.27	1874.65	741.38	1.53
Workmap11	279255 CG	100YR	26210.00	1287.24	1295.31	1293.45	1296.17	0.001437	8.10	3762.37	652.00	0.55
Workmap11	279107 AS	100YR	26210.00	1285.71	1293.26	1293.26	1295.67	0.004124	12.62	2659.08	892.79	0.90
Workmap11	278930	100YR	26210.00	1283.95	1291.94	1291.94	1294.32	0.004067	12.72	2912.22	851.31	0.90
Workmap11	277980 CE	100YR	26210.00	1277.56	1283.43	1284.81	1288.08	0.011316	18.49	2441.53	1040.72	1.45
Workmap11	277377 AR	100YR	26210.00	1272.99	1281.67	1280.65	1283.67	0.002655	11.94	3316.29	2705.92	0.76

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Appendix C – Historical Topographic Workmaps

VIA PRINCESSA LONG-TERM SCOUR ANALYSIS

1929 HISTORICAL TOPOGRAPHIC MAP

1932 USGS Map of San Fernando, CA with 1929 contours

PACE Advanced Water Engineering

0 400 800 1,600 Feet

Date: 4/30/2020

Job Number: 8894

P:\B59016-GIS\Projects\HecRas_HistoricalTopography_20200115\HecRas_HistoricalTopography_20200115.aprx - Historical Topographic Map - 1945

VIA PRINCESSA LONG-TERM SCOUR ANALYSIS

1897 HISTORICAL TOPOGRAPHIC MAP

1945 USGS Map of San Fernando, CA with 1897 contours

0 400 800 1,600 Feet

Date: 4/30/2020

Job Number: B894

P:\B590\6-GIS\Projects\HecRas_HistoricalTopography_20200115\HecRas_HistoricalTopography_20200115.aprx - Historical Topographic Map - 1995

VIA PRINCESSA LONG-TERM SCOUR ANALYSIS

1956 HISTORICAL TOPOGRAPHIC MAP

1995 USGS Map of Mint Canyon, CA with 1956 contours

PACE

0 400 800 1,600 Feet

Date: 4/30/2020

Job Number: 8894

VIA PRINCESSA LONG-TERM SCOUR ANALYSIS

1999 HISTORICAL TOPOGRAPHIC MAP

2015 USGS Map of Mint Canyon, CA with 1999 contours

0 400 800 1,600 Feet

Date: 4/30/2020

Job Number: B894

P:\B5901 6-GIS\Projects\HecRas_HistoricalTopography_20200115\HecRas_HistoricalTopography_20200115.aprx - Historical Topographic Map - 2015

P:\B59016-GIS\Projects\HecRas_HistoricalTopography_20200115\HecRas_HistoricalTopography_20200115.aprx - Historical Topographic Map - 2018

VIA PRINCESSA LONG-TERM SCOUR ANALYSIS

2018 HISTORICAL TOPOGRAPHIC MAP

2015 USGS Map of Mint Canyon, CA with 1999 contours

PACE Advanced Water Engineering

N

0 400 800 1,600 Feet

Date: 4/30/2020

Job Number: B894

LACSD SCOUR STUDY

1897 HISTORICAL TOPOGRAPHIC MAP

1945 USGS Map of San Fernando, CA with 1897 Contours

0 400 800 1,600 Feet

Date: 1/16/2020

Job Number: B590

PACE Advanced Water Engineering

P:\B590\6-GIS\Projects\HecRas_HistoricalTopography_20200115\HecRas_HistoricalTopography_20200115.aprx - Historical Topograhic Map - 1945

LACSD SCOUR STUDY

1929 HISTORICAL TOPOGRAPHIC MAP

1932 USGS Map of San Fernando, CA with 1929 Contours

PACE

0 400 800 1,600 Feet

Date: 1/16/2020

Job Number: B590

LACSD SCOUR STUDY

1956 HISTORICAL TOPOGRAPHIC MAP

1995 USGS Map of Mint Canyon, CA with 1956 Contours

PACE

0 400 800 1,600 Feet

Date: 1/16/2020

Job Number: B590

LACSD SCOUR STUDY

1999 HISTORICAL TOPOGRAPHIC MAP

2015 USGS Map of Mint Canyon, CA with 1999 Contours

PACE

0 400 800 1,600 Feet

Date: 1/16/2020

Job Number: B590

LACSD SCOUR STUDY

2018 HISTORICAL TOPOGRAPHIC MAP

2018 USGS Map of Mint Canyon, CA with 2018 Contours

0 400 800 1,600 Feet

Date: 1/16/2020

Job Number: B590

Appendix D – Toe-Down Calculation Spreadsheets

CALCULATIONS FOR TOTAL TOE-DOWN BY INDIVIDUAL ADJUSTMENT COMPONENT BASED ON LACDPW SEDIMENTATION MANUAL AND LACFCD HYDRAULIC DESIGN MANUAL

SECTION	Z_{MAX}	Z_{TOT}	V (FPS) Plan05	FLOW DEPTH (FT) Plan05	Z_{DEG}+	Z_{GS}+	PIER TYPE	B	ABUT TYPE	A	BANK PROT	Z_{LS}+ BANK	Z_{LS}+ BRIDGE	BEND COEFF	HYD DEPTH	E SLOPE	TOP WIDTH	RADIUS	Z_{BS}+	Z_I+	H/2	Z_{DM}
290504	11.5	11.5	11.8	5.5	3.0	2.7	0	0.0	1	0.0	0	2.0	0.0	0	3.1	0.007	755.5	0	0.0	2.0	1.9	10.0
290198	12.5	12.5	13.8	4.1	3.0	3.4	0	0.0	1	0.0	0	2.0	0.0	0	2.4	0.012	865.6	0	0.0	2.0	2.0	10.0
289893	11.8	11.8	12.1	4.4	3.0	2.8	0	0.0	1	0.0	0	2.0	0.0	0	3.0	0.007	802.8	0	0.0	2.0	2.0	10.0
MAXIMUM=		12.5			3.0	3.4							0.0						0.0		2.0	10.0
MINIMUM=		11.5			3.0	2.7							0.0						0.0		1.9	10.0

DEFINITIONS

V(FPS) = VELOCITY IN FEET PER SECOND
Z_{MAX} = GREATER OF **Z_{TOT}** AND **Z_{DM}**
Z_{TOT} = TOTAL POTENTIAL VERTICAL ADJUSTMENT IN FEET
Z_{DEG} = LONG TERM DEGRADATION IN FEET
Z_{GS} = GENERAL SCOUR IN FEET
Z_{LS} = LOCAL SCOUR IN FEET [**Z_{LS} BANK + Z_{LS} BRIDGE**]
Z_{LS} BRIDGE = BRIDGE LOCAL SCOUR IN FEET [PIER (APP C-4) + ABUTMENT (APP C-6)]
Z_{LS} BANK = LEVEE/BANK LOCAL SCOUR = **2.0'** IF BANK PROTECTION PRESENT
BANK PROT = BANK PROTECTION ON CHANNEL BANK
0 = YES; **1** = NO
PIER TYPE = PIER SHAPE FACTOR; IF NO PIERS = **0**
1.0 = SQUARE NOSE; **0.9** = ROUND NOSE; **0.9** = CYLINDER;
0.8 = SHARP NOSE; **0.9** = GROUP OF CYLINDERS
FLOW DEPTH = WATER DEPTH IN CHANNEL IN FEET
B = WIDTH OF PIERS IN FEET; NO PIER = **0**
ABUT TYPE = VERT WALL FACTOR; IF VERT = **2**; NON VERT = **1**
A = ABUTMENT PROTRUSION INTO FLOW PATH IN FEET
Z_{BS} = BEND SCOUR IN FEET
BEND COEFF = BEND COEFFICIENT; IF NO BEND = **0**, BEND = **1**
HYD DEPTH = HYDRAULIC DEPTH IN FEET
E SLOPE = ENERGY SLOPE, UNITLESS
TOP WIDTH = CHANNEL TOP WIDTH IN FEET
RADIUS = RADIUS OF CURVATURE TO CENTERLINE IN FEET
Z_I = LOW-FLOW INCISEMENT IN FEET, MEASURED OR 2'; VALUE **NOT LESS THAN 2'**
H = BEDFORM HEIGHT IN FEET, LIMITED TO FLOW DEPTH AFTER KENNEDY (1963)
Z_{DM} = CUT-OFF DEPTH REQUIRED BY LACFCD HYDRAULIC DESIGN MANUAL

GENERAL

THIS SPREADSHEET IS DESIGNED TO CALCULATE SCOUR PROTECTION (TOE DOWN) BASED ON LACDPW COUNTY SEDIMENTATION MANUAL (2006) PAGES 51-59 AND ASSOCIATED APPENDICES (APPENDIX C). VALUES FOR TOE-DOWN BASED ON THE CUT-OFF DEPTHS TABLE (PAGE F-31) IN THE LACFCD HYDRAULIC DESIGN MANUAL ARE PRESENTED AS PART OF THE CALCULATIONS FOR COMPARISON. THE SPREADSHEET DETERMINES THE GREATER VALUE OF TOE-DOWN BETWEEN THE TWO METHODOLOGIES (Z_{MAX}). THE CALCULATION DOES NOT CONSIDER ADJUSTMENTS TO CUT-OFF DEPTH BASED ON FIGURE F-06 (PAGE F-37). LONG TERM DEGRADATION IS USER SUPPLIED. GENERAL SCOUR VALUES ARE INTERPOLATED FROM THE GENERAL DEGRADATION GRAPH IN APPENDIX C (PAGE C-3) OF THE LACDPW SEDIMENTATION MANUAL. BEND SCOUR AND LOCAL SCOUR AT BENDS AND ABUTMENTS ARE BASED ON APPENDIX C (PAGES C-6 TO C-8) OF THE LACDPW SEDIMENTATION MANUAL. A LONGITUDINAL EXTENT BASED ON SECONDARY CURRENTS IS NOT INCLUDED. BEDFORM HEIGHT IS BASED ON APPENDIX C-9 OF THE SEDIMENTATION MANUAL. THE OCTOBER, 2005 REVISION INCLUDES ADDITIONAL TOEDOWN AT BRIDGES/ABUTMENTS WITH SOFT BOTTOMS. THE OCTOBER, 2006 REVISION INCLUDES BLOCKAGES AT BRIDGE PIERS. THE MAY REVISION INCLUDES THE Z_{MAX} CALCULATION AND UPDATES FOR THE 2006 SEDIMENTATION MANUAL.

LACDPW = LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS
LACFCD = LOS ANGELES COUNTY FLOOD CONTROL DISTRICT

COLOR CODES

OUTPUT
DATA FROM HEC-RAS
USER SUPPLIED DATA
INTERMEDIATE CALCULATIONS (INDIVIDUAL SHEETS ONLY)

DESIGNED BY DAVID A JAFFE, PHD, PE
PACIFIC ADVANCED CIVIL ENGINEERING, INC
OCTOBER, 2004
OCTOBER, 2005, REVISED
OCTOBER, 2006, REVISED
MAY, 2008, REVISED
FEBRUARY, 2009, REVISED
FEBRUARY, 2014, REVISED

Appendix E – Digital HEC-RAS Modeling Files (on CD)

Appendix F

PACE
Advanced Water Engineering

Appendix F – Geotechnical Report

GEOTECHNICAL ENGINEERING & ENGINEERING GEOLOGY

March 30, 2022

Pacific Advanced Civil Engineering
17520 Newhope Street, Suite 200
Fountain Valley, California 92708

Job No. 2018-003-054

Attention: Mr. Duong Do, P.E.

Subject: Report of Geotechnical Investigation and Infiltration Study
Proposed Site X Regional Infiltration BMP
Northwest of Existing Via Princessa Metrolink Station
Santa Clarita, California

Reference: See Attached List of References

Gentlemen:

This Report of Geotechnical Investigation and Infiltration Study presents the results of our site investigation and in-situ infiltration testing that was performed to help support the design of the proposed Regional Infiltration BMP on the Site X site (the site). This report also includes general geotechnical recommendations for minor improvements during site development. The work was performed in consideration of the Los Angeles County Department of Public Works (LACDPW), Administrative Manual GS 200.2, "Guidelines for Geotechnical Investigation and Reporting, Low Impact Development (LID) Storm Water Infiltration," dated June 30, 2017 (LACDPW, 2017).

Included with and completing this report are References, a Geotechnical Plot Plan (Figure 1), a Historically Highest Ground Water Contour Map (Figure 2), a Water Well Location Map (Figure 3), Explorations (Appendix A), Laboratory Test Data (Appendix B), Infiltration Test Data and Calculations (Appendix C), Water Well Records (Appendix D), and Geosyntec Technical Memorandum (Appendix E).

SITE HISTORY

R.T. Frankian & Associates (RTF&A) initially performed a subsurface investigation to provide preliminary geotechnical characteristics of the site and preliminary estimates of permeability for the underlying soil based on soil types (RTF&A, 2019). The initial investigation was performed in October and November 2018 and included advancing a total of 12 Cone Penetrometer Test (CPT) soundings to depths varying from about 12 to 44 feet below the existing ground surface. Following our initial investigation, we received a plan entitled "Site X CPT Location Map," dated January 2018, prepared by Pacific Advanced Civil Engineering (PACE) which provided the outline of an "infiltration gallery" and a "most likely location of BMP" for the site and the location of a proposed offsite diversion structure. The plan provided two locations for in-situ infiltration testing to be performed on the site and one offsite testing location for the proposed diversion structure. Infiltration testing was to be performed within hollow stem borings at a depth of about 20-feet below existing ground surface. . The excavation of hollow stem borings and in-situ infiltration testing was performed in January 2022.

Evaluation of site geology and hydrogeology was provided by Geosyntec Consultants within their Technical Memorandum, entitled "Desktop Analysis Site Evaluation," dated January 15, 2019 (Geosyntec, 2019).

SITE DESCRIPTION

The proposed Site X site is approximately 8-acres in size and is bounded by the Santa Clara River to the north, the Honby Creek to the east, Via Princessa Road to the south and Whites Canyon Road to the west; the Southern California Regional Rail Authority (SCRRA) Metrolink easement runs along the southern side of the site. The site is relatively level with elevations ranging from approximately 1,387 feet above mean sea level (msl) to about 1,370 feet msl trending south to north toward the river. Our understanding is that site improvements will include the construction of a subterranean storm water BMP treatment basin with an approximate area of about two-acres; the basin will consist of perforated, corrugated metal pipe, installed at a depth of about 20-feet below the existing ground surface. The proposed offsite storm drain diversion structure is to be located within the existing Metrolink Station parking lot on the south side of SCRRA easement. The location of the proposed storm water treatment basin and diversion structure is shown on the attached Geotechnical Plot Plan (Figure 1) based upon the project Preliminary BMP Layout Plan, prepared by PACE, dated February 16, 2022.

SUBSURFACE EXPLORATIONS

As mentioned above, a subsurface investigation was initially performed in October and November of 2018 (RTF&A, 2019). The primary purpose of the initial investigation was to provide preliminary geotechnical characteristics of the site and preliminary estimates of permeability of the underlying soil based on soil type to provide preliminary guidance in the design and location of proposed storm water treatment basin. The investigation included advancing a total of 12 CPT soundings (CPT-1 through CPT-12) to depths varying from about 12 to 44 feet below the existing ground surface. A CPT truck was utilized to obtain the soundings. The soundings were used to identify the engineering characteristics of the materials below the site, to aid in the determination of liquefaction potential, as well as indicate the presence of groundwater. Soil samples were obtained from the CPT soundings for laboratory testing. The locations of the CPT soundings are shown on the attached Geotechnical Map (Figure 1). The logs from previously obtained CPT soundings are presented in Appendix A of this report.

A subsequent investigation was performed in January 2022 which included the excavation of four borings to depths varying from about 20 to 50 feet below existing ground surface. A truck-mounted, hollow-stem auger drill rig with 8-inch diameter augers, was used to excavate the borings. Three of the borings (IB-1, IB-2 and B-4) were drilled on the Site X site while a fourth boring (B-3) was drilled within the existing Metrolink Station parking lot for a proposed diversion structure. Infiltration test wells were installed in two of the borings (IB-1 and IB-2) for infiltration testing. Soil samples were obtained from the borings for laboratory testing, which included relatively undisturbed driven “ring” samples, bulk samples from drill cuttings, and samples from a split-tube Standard Penetration Test (SPT) sampler. The locations of the hollow-stem borings are shown on the attached Geotechnical Map (Figure 1). The boring logs are presented in Appendix A of this report.

SOIL CONDITIONS

The result of the hollow stem borings and the CPT soundings indicate that the site is primarily underlain by naturally deposited soils. In general, the upper surficial soils at the site consist of silty sands and sandy silts that were found to be relatively moist and moderately dense, extending to about 1 to 3 feet below the present site grades. The upper surficial soils were underlain by alternating layers of clean sands and silty sands that were found to be dense. The CPT soundings indicated an occasional layer of clayey silt to silty clay within the upper 4 to 5-feet of CPT-2 and CPT-8.

The result of the offsite boring that was drilled within the Metrolink Station parking lot indicates the area of the proposed diversion structure is underlain by approximately 19-feet of existing fill soils. It is assumed that these fills were placed as part of the grading for the bus return at the existing Metrolink Station parking lot. The fill materials generally consist of silty sands and appear to be well compacted. The fill materials are underlain by naturally deposited soils.

Variations of the materials encountered are indicated in the attached hollow stem boring and CPT sounding logs are presented in Appendix A of this report. Groundwater was not encountered in the borings drilled.

LABORATORY TESTING

Laboratory tests were performed on selected samples, obtained from the CPT soundings and hollow-stem test borings, to aid in the classification of the soils and to determine the pertinent engineering properties of the soils. The laboratory tests performed included moisture content and dry density determinations, sieve analyses, R-value tests and corrosion tests. The results of the moisture content and dry density tests are indicated on the boring logs while the remaining test results are presented in Appendix B of this report.

GEOLOGIC CONDITIONS

As previously mentioned, evaluation of geology for the site was provided by Geosyntec Consultants within their Technical Memorandum, entitled "Desktop Analysis Site Evaluation," dated January 15, 2019 (Geosyntec, 2019) that is presented in Appendix E. As stated in their memorandum, the site geology is composed of recent Quaternary unconsolidated sands and gravels of primary fluvial deposition.

GROUNDWATER HYDROLOGIST

The RTF&A authorized scope of work was based on Geosyntec performing the additional work outlined in their Technical Memorandum (Geosyntec, 2019) in addition to the work to be performed by the groundwater hydrologist required as outlined in the LACDPW Administrative Manual GS 200.2 (LACDPW, 2017). This was to include additional evaluation of mounding and impacts on adjacent properties and existing improvements such as the railroad tracks, bridge, roadway abutments, and bridge foundations. However, it is our understanding that funding for this work was not yet released and Geosyntec was not yet authorized to perform this work. It is recommended that this work be performed prior to construction of the proposed infiltration system.

GROUNDWATER

Groundwater was not encountered during our subsurface investigations performed for the site. The previous CPT soundings and hollow stem borings were advanced to a maximum depth of about 50-feet below existing ground surface and did not encounter groundwater.

The California Geological Survey (CGS) provides data relative to historic high groundwater contours for use in seismic hazard evaluations. Historic high ground water contours for the site are indicated within the "Seismic Hazard Zone Report for the Mint Canyon 7.5-Minute Quadrangle" (CGS, 1998); the site is generally located between the 15-foot and 25-foot deep groundwater contours shown on the map. The historic high groundwater contours from the Seismic

Hazard Zone Report (CGS, 1998) are presented on the attached Historically Highest Ground Water Contour Map (Figure 2).

A total of three water wells are also located within 1000-feet of the site as indicated on the attached Water Well Location Map (Figure 3). Water well records from the Los Angeles County Department of Public Works (LACDPW) identify the wells as Well Nos. 7139E, 7139F and 7139G. The well records provide significant information relative to groundwater elevations, however, there have been no groundwater measurements within the last several years. The water well records are presented in Appendix D of this report. A summary of water level measurements recorded for the wells are presented in following tables.

LATEST GROUNDWATER DATA

LACO Well ID	Date Measured	Approximate GS Elevation	Approximate GW Elevation	Approximate Depth to GW
7139E	06/01/2012	1372	1287	85’
7139F	06/01/2012	1375	1290	85’
7139G	11/01/2012	1380	1299	81’

HISTORIC HIGHEST GROUNDWATER DATA

LACO Well ID	Date Measured	Approximate GS Elevation	Approximate GW Elevation	Approximate Depth to GW
7139E	04/30/1983 01/30/1984	1372	1359	13’
7139F	04/30/1983	1375	1367	8’
7139G	04/30/2005	1380	1370	10’

CONCLUSIONS

The following conclusions are based upon information obtained in the preparation of this report, review of our referenced report that included information for the subject site (RTF&A,2019), and work performed by Geosyntec (Geosyntec, 2019).

Depth to groundwater ranges from 10 up to 97 feet below ground surface (bgs) with an average depth to groundwater of about 44 feet bgs from 1983 to 2012. Based on numerous Geosyntec assumptions, maximum groundwater mounding was modeled to be approximately 32 feet beneath the center of the infiltration basin. Assuming groundwater level fluctuations are consistent with past trends, groundwater will come within 10 feet of the bottom of the infiltration basin following particularly wet winters that receive periods of prolonged and heavy precipitation. Using the 10 feet of clearance between the bottom of the basin of 17 feet (current infiltration depth is 20 feet), the recurrence interval for high groundwater that may reach this elevation is 7 to 10 years that can be mitigated by the bypass of stormwater in order to maintain the County guidance of 10 vertical feet between groundwater and the infiltration discharge point (Geosyntec, 2019).

INFILTRATION STUDY

A field infiltration study was performed at the site to determine the feasibility of infiltrating collected storm water into the site soils. Infiltration testing for the subject site was coordinated with representatives of the City of Santa Clarita and PACE in consideration of the LACDPW Administrative Manual GS 200.2 (LACDPW, 2017). It was determined that infiltration testing would consist of two tests performed using the Boring Percolation Test Procedure in 8-inch diameter drilled hollow-stem borings at a depth of about 20 feet below existing ground surface; it is our understanding that large scale percolation tests were not desired at this time due to budgetary constraints.

We were provided a plan entitled “Site X CPT Location Map,” dated January 2018, prepared by PACE which provided the outline of an “infiltration gallery” and a “most likely location of BMP” for the site. The plan provided two locations for in-situ infiltration testing to be performed for the site. It was proposed that the infiltration testing be performed within hollow stem borings at a depth of about 20-feet below existing ground surface.

SUMMARY OF TESTING

Infiltration testing was performed in January 2022 and consisted of two tests performed using the Boring Percolation Test Procedure within 8-inch diameter drilled hollow-stem borings (IB-1 and IB-2), as planned. Each of the tests were performed at a depth of approximately 20-feet below existing ground surface. A summary of the test procedures is included with Appendix C of this report.

INFILTRATION TEST RESULTS

When the Boring Percolation Test procedure is performed, the County guidelines dictate that several reduction factors be applied to the infiltration rates obtained in the field when designing LID features. The field infiltration rates for the two infiltration borings were recorded and are presented in the summary presented below. However, when County-recommended corrections for borehole diameter (RFt) are applied, it results in a reduction of the field infiltration rates. The County requires additional reduction factors for site variability, number of tests, and thoroughness of investigation (RFv) as well as for long-term siltation, plugging, and maintenance (RFs).

The County indicates that a reduction factor of 2 should be used for the boring percolation test method (RFt). Based on the subject geotechnical investigation and our infiltration testing, a value of 2 was used for RFv. A value of 2 was also used for long-term siltation, plugging, and maintenance (RFs). The RFs value of 2 is based on future infiltration systems being maintained on a bi-annual basis and some form of pre-treatment being provided. These reduction factors may be increased or decreased by the infiltration designer and are to be based upon their experience, recommendations for maintenance, and specific design details of the infiltration system.

As a result of the field testing, and when all of the various County mandated reduction factors are applied, it is recommended that the infiltration rates provided in the following table be used in the design for LID features at the site. LID features should be designed to infiltrate within the sandy, naturally deposited soils that are expected to be present at the depths and locations of where our infiltration testing was performed.

The boring field infiltration test results and correction factors are summarized in the table presented below. The infiltration testing results are also summarized in the "Boring Percolation Testing Field Logs" included in Appendix C of this report.

Infiltration Location	Approximate Infiltration Test Elevation (in feet)	Material at Infiltration Elevation	Field Infiltration Rate* (in/hr)	Boring Reduction Factor (RFt)	Boring Corrected Field Infiltration (in/hr)	RFv	RFs	Design Infiltration Rate (in/hr)
IB-1	1362	silty sand	46.80	2	23.40	2	2	5.85
IB-2	1361½	silty sand	22.24	2	11.12	2	2	2.78

* Average of last three readings
** For LID features established in naturally deposited sandy soils

CONCLUSIONS

As summarized in the above table, each of the tests meet the minimum infiltration requirement of at least 0.3 inches per hour as required within the LACDPW Administrative Manual GS 200.2 (LACDPW, 2017). The application of average infiltration rates, as indicated on the attached Preliminary BMP Layout Plan (Figure 2), was coordinated with the BMP designer based on the recommended design infiltration rates shown above.

Groundwater was not observed during our site investigation. Boring B-4 was drilled to an approximate elevation of 1,331 msl and did not encounter ground water. CPT-1 sounding was advanced to a depth of about 44-feet and also did not encounter ground water. The historically high groundwater map developed by CGS would suggest a conservative historically high ground water elevation of below 1,360 msl. The latest readings of the three adjacent LACDPW water wells indicate water levels that varied from 81- to 85-feet below ground surface at elevations varying from approximately 1287 to 1299 msl. The LACDPW Administrative Manual GS 200.2 (LACDPW, 2017) indicates that existing groundwater data may be used to verify the seasonal high groundwater elevation.

The proposed invert elevations, based on a depth of approximately 20-feet below existing ground surface, would vary from approximately 1360 to 1361 msl. The site generally meets the minimum seasonal high groundwater criteria of greater than 10-feet below the proposed invert of infiltration based upon the data contained herein. However, as discussed in the attached Geosyntec Technical Memorandum (Geosyntec, 2019), it is expected that during periods of heavy rainfall it would be necessary to bypass the infiltration system to maintain a vertical distance of 10 feet between high groundwater and the bottom of the proposed infiltration system.

SOIL CEMENT

An evaluation of the characteristics and distribution of in-place materials for the use in constructing an on-site soil cement liner was beyond the scope of the current work authorization. Based on our experience on multiple soil cement liner projects in the Santa Clarita Valley and the field investigation with laboratory testing presented in this report, portions of the existing on-site materials are considered suitable for soil cement liner construction. Once details regarding the proposed bank protection are available, we recommend that a site-specific geotechnical investigation and aggregate evaluation of subsurface soils in the vicinity of the proposed soil cement liner be performed. This work should include performing temporary slope stability calculations and obtaining representative samples of on-site materials to determine tentative mix-design cement contents; the representative samples should be mixed with various cement contents with compression testing of aged specimens. Temporary slope stability calculations to support temporary backcut gradients should also be performed as part of this work. This recommended additional work is intended to provide a more detailed assessment relative to the suitability of on-site soils for use as aggregate and to support the soil cement liner construction from a geotechnical perspective.

Plans showing the location and details of the proposed soil cement are not currently available. The following should be considered as preliminary general recommendations and should be updated and/or revised once soil cement plans and specifications are available.

GENERAL

Soil cement used in the bank protection should be mixed, placed, and compacted in accordance with generally accepted procedures by a contractor experienced in constructing soil cement bank protection. Representatives of the Geotechnical Consultant should observe and test the soil cement during on-site batching and placement. The following recommendations should be incorporated into the specifications for the soil cement bank protection.

CONSTRUCTION

The soil cement should be placed in compacted layers about 8 inches in thickness and should be compacted to at least 95 percent of its maximum dry density at no more than 2 percent over optimum moisture content for the soil cement mix as determined using ASTM Test Method D558, modified to use ASTM D1557 compaction effort, or as specified by the soil cement design engineer.

SOIL CEMENT MIX

The native on-site alluvial soils generally consist of dense mixtures of sand, silty sand, and gravelly sand. Cobbles and boulders are also expected to be present. Gradation testing performed on select alluvial soils specific to our infiltration study are presented in Appendix B. Portions of the alluvial soils at the site, after removal of oversize boulders, cobbles, and a portion of the coarse gravel, would be considered suitable for use as aggregate in the proposed soil cement project. The silts or any clayey soils should be excluded for use as aggregate. Soils used in the soil cement should not contain particles larger than 3 inches in size. Silt or clay lumps should be broken down to less than ½-inch in size. The soil aggregate should be free of organic material, or other deleterious or decomposable materials, and screening may be required prior to use as soil cement material.

The amount of portland cement required in the soil cement should be sufficient to achieve a seven-day compressive strength of at least 750 pounds per square inch (psi). The soil cement test samples should be compacted to about 95 percent of the maximum dry density for moisture-density relations for soil cement mixtures, as determined using ASTM Test Method D558, modified to use ASTM D1557 compaction effort, or as specified by the soil cement design engineer. For estimating purposes, a cement content by weight of 8 to 10 percent is suggested.

To determine the actual required cement content, the granular soils that are to be used in the soil cement bank protection should be stockpiled. Representative samples of stockpile material should be mixed with varying amounts of cement, molded into test specimens, cured for different time intervals, and then tested to determine the unconfined compressive strength. Based on the results of compression testing on the molded specimens, the actual cement content to be used during construction can be determined.

SOIL CEMENT MIXING

The soil cement material to be used in production should be mixed in an on-site plant. Once mixed, the soil cement material should be placed and compaction started within 30 minutes of mixing. During adverse conditions, such as high temperatures or wind, which promote rapid drying, the allowable time between mixing and compaction may need to be reduced. The moisture content of the soil cement mixture at the start of compaction should be within 2 percent of the optimum moisture content.

COMPACTION OF SOIL CEMENT

The soil cement for the bank protection should be placed in 8-inch-thick lifts and compacted to at least 95 percent of the maximum dry density obtainable as determined using ASTM Test Method D558, modified to use ASTM D1557 compaction effort, or as specified by the soil cement design engineer. Compaction of a soil cement layer should be completed within 30 minutes of placement of the mixture. Layers of soil cement over which subsequent layers are to be placed should be kept moist until the subsequent layers are in place or for a period of at least seven days.

Exposed and potentially exposed faces of the soil cement should be finished smooth within two hours of the end of compaction or three hours of the addition of water to the soil cement mixture, whichever is less.

CURING

The finished faces of the bank protection should be kept moist for a period of at least seven days after finishing.

OBSERVATION AND TESTING

The batching and placement of the soil cement should be performed under the observation of the Geotechnical Consultant, who should perform testing for sieve analyses, sand equivalence, compaction, unconfined compression, and moisture-density relationships on a periodic basis.

SEISMIC DESIGN PARAMETERS

As with virtually all property in southern California, the site may be subjected to strong ground shaking during earthquakes on nearby or distant faults and the improvements should be designed to resist such shaking in accordance with current codes.

The following coefficients and factors apply to seismic force design of structures at the site. The parameters were determined using the American Society of Civil Engineers (ASCE) 7 Hazard Tool Online website. The following parameters below are based on the Design Code Reference Document (DCRD) ASCE 7-16 and a Risk Category of III. We defer to the project Structural Engineer to determine the appropriate DCRD and Risk Category to be used for the subject development; we can provide additional parameters, based on an alternate DCRD or Risk Category, upon request and authorization. Since S1 is greater than 0.2, "not applicable" was reported for SM1 and SD1; it will be necessary for the Project Structural Engineer to determine Cs (Seismic Response Coefficient), with the exception for Site Class D, presented in Section 11.4.8 of ASCE 7-16.

Latitude	34.41033
Longitude	-118.47252
Site Class	D
S_S	2.273
S_1	0.821
S_{MS}	2.273
S_{M1}	n/a

S_{DS}	1.516
S_{D1}	n/a
PGA_M	1.056

LIQUEFACTION

GENERAL

Liquefaction may occur when saturated, loose to medium dense, cohesionless soils are densified by ground vibrations. The densification results in increased pore water pressures if the soils are not sufficiently permeable to dissipate these pressures during and immediately following an earthquake. When the pore water pressure is equal to or exceeds the overburden pressure, liquefaction of the affected soil layers occurs. For liquefaction to occur, three conditions are required:

- ground shaking of sufficient magnitude and duration;
- a groundwater level at or above the level of the susceptible soils during the ground shaking; and
- soils that are susceptible to liquefaction.

Ground settlement may occur during seismic shaking of an area. The settlement can be caused by liquefaction of loose granular soils, consolidation of soft, but not necessarily liquefiable, soils, and dry settlement of soils above the water table.

The Seismic Hazard Zone Map for the Mint Canyon Quadrangle, released March 25, 1999, indicates that the subject site is classified as being potentially susceptible to liquefaction. There are not currently any proposed structures (habitable or otherwise) as part of the development of this portion of this site. If habitable structures are proposed in the future, it is recommended that a liquefaction evaluation be performed.

RECOMMENDATIONS

GENERAL

The following general recommendations are provided to support construction of the storm water treatment infiltration basin and other minor site improvements. It is anticipated that the minor improvements will be limited to pavements, hardscapes, and foundations for minor structures such as retaining walls and/or the diversion structure.

All design and grading work at the subject site should be conducted in accordance with the recommendations of this report and the requirements of the Los Angeles County Building Code (CBC) as amended by the City of Santa Clarita Building Code.

INFILTRATION BASINS

It is anticipated that grading for the storm water treatment basin will consist of excavation into native soils to depths of approximately 20-feet below existing grades. The design and construction of the basin should take into consideration the following:

- all infiltration should be within the naturally deposited soils or formational deposits; infiltration into compacted fill should be avoided;

- any areas within the exposed basin subgrade that may have become disturbed during grading should be excavated back down to undisturbed soils and replaced with gravel;

- the infiltration basins should be located at least 20 feet (measured horizontally) providing a maximum 1:1 gradient (measured horizontal to vertical) from the bottom of any existing or future foundations;

- the infiltration basins should be set back at least 20 feet (measured horizontally) providing a maximum 1:1 gradient (measured horizontal to vertical) from the face of any descending natural slope;

- the infiltration basins should be set back at least 20 feet (measured horizontally) providing a maximum 1:1 gradient (measured horizontal to vertical) from the face of any existing or future descending graded slope; and

- the infiltration basin should maintain a setback of at least 20 feet from adjacent property or easement lines.

MINOR SITE IMPROVEMENTS

It is anticipated that grading will be required for construction of minor site improvements. The grading should include the removal and recompaction of the near surface soils below pavements, hardscapes, and foundations. The removals will consist of native and existing artificial fill soils, as well as any additional soils that may become disturbed during site demolition and construction.

Proposed foundations, pavements, and major slab areas should be underlain by at least 3 feet of compacted fill soil. If it is required to make cuts to establish the final grades for the improvements, the final cut grade should be over-excavated to allow for the placement of at least 3 feet of compacted fill soil below the proposed soil subgrade. It will not be required to over-excavate the existing grade in areas where it is required to place at least 3 feet of compacted fill to establish final grade for the improvements. However, any artificial fill or disturbed soils exposed at existing grade will require additional over-excavation. The removal bottoms will require processing prior to placement of compacted fill as discussed below.

It is anticipated that the foundation for the proposed diversion structure will be located approximately 10-feet below the existing Metrolink Parking Lot grades and will be founded in existing fill soils. The bottom of diversion structure foundation excavations will require processing prior to placement of reinforcing steel and/or concrete, as discussed below.

The remaining areas of the site where minor improvements are proposed, such as concrete sidewalks or walking trails, should be removed at least 12 inches below existing grade; the resulting removal bottom should be "proof-rolled" with relatively heavy grading equipment to determine if the exposed soils are satisfactory or if additional removals will be required. The proofrolling of the exposed soils should be performed under the observation of our field representative. The removal bottoms will then require processing prior to placement of compacted fill, as discussed below.

The exposed removal bottoms and diversion structure foundation bottoms should be processed prior to placement of compacted fill or reinforcing steel and/or concrete. Processing of soil should consist of scarifying the upper 6 to 12 inches of the exposed grade, adjusting the moisture content of the scarified soil to approximately two percent above optimum moisture content, and then compacting the exposed soil to at least 90 percent of the maximum dry density of the soil. The bottoms of areas to be filled should be observed and approved by a representative of the Geotechnical Engineer of Record prior to fill placement. It may be required to have a representative from the governing agency observe bottom areas prior to fill placement; the contractor selected for the project should be familiar with the requirements for regulatory inspections.

Fill should be placed in layers not exceeding 12 inches in loose thickness, adjusted to approximate optimum moisture content, and compacted to at least 90 percent of the maximum dry density of the soil as determined by the current ASTM Soil Compaction Method D1557. Organic and decomposable material should be excluded from the fill, as should solid material exceeding 8 inches in maximum dimension. Fill soils should be placed and compacted under the observation and testing of a representative of the Geotechnical Engineer of Record.

If it is required to import soil for use as compacted fill, the imported soil should be relatively non-expansive and similar to the on-site soil. A 40-pound sample of proposed import soil should be submitted to the Geotechnical Engineer of Record at least 48 hours prior to importing to the job site to determine if the soil would be acceptable for use on the project.

GENERAL GRADING REQUIREMENTS

1. All fills, unless otherwise specifically designed, shall be compacted to at least 90 percent of the maximum dry unit weight as determined by the ASTM D1557 Method of Soil Compaction.

2. No fill shall be placed until the area to receive the fill has been adequately prepared and subsequently approved by the Geotechnical Engineer of Record or his representative.

3. Fill soils should be kept free of debris and organic material.

4. Rocks or hard fragments larger than 8 inches may not be placed in the fill without approval of the Geotechnical Engineer of Record or his representative, and in a manner specified for each occurrence.

5. The fill material shall be placed in layers which, when compacted, shall not exceed 8 inches per layer. Each layer shall be spread evenly and shall be thoroughly mixed during the spreading to ensure uniformity of material and moisture.

6. When moisture content of the fill material is too low to obtain adequate compaction, water shall be added and thoroughly dispersed until the soil is approximately two percent over optimum moisture content.

7. When the moisture content of the fill material is too high to obtain adequate compaction, the fill material shall be aerated until the soil is approximately two percent over optimum moisture content.

8. Fill and cut slopes should not be constructed at gradients steeper than 2:1 (horizontal:vertical).

TEMPORARY EXCAVATIONS

Temporary excavations may be cut vertically up to heights of 4 feet. Excavations that exceed 4 feet should be sloped at a gradient not steeper than 1:1 (horizontal to vertical) to a maximum height not to exceed 14-feet. Excavations greater than 14-feet in height should be sloped at a gradient not steeper than 1.5:1 (horizontal to vertical). By temporary, we mean a period not exceeding 45-days. Excavations not complying with these requirements should be shored. It is strongly recommended that excavations formed in sands and/or dry soils be kept moist, but not saturated, at all times. Soil stockpiles or other heavy loads, including heavy equipment, should not be allowed along the top of a temporary excavation. All regulations of state or federal OSHA should be followed.

If excavations are made during the rainy season, care should be taken to protect slopes from erosion; the rainy season is normally from November through April. Measures to mitigate erosion, such as the installation of berms, plastic sheeting, or other devices, may be warranted to prevent surface water from flowing over or collecting at the tops of excavations.

FOUNDATIONS

General: The foundations for minor structures, such as diversion structures and/or retaining walls, may be supported on continuous or individual spread footings established entirely in native soils or properly compacted fill soils. Our firm should review and approve the project Foundation Plans prior to the initiation of construction.

Building setbacks for structures located adjacent to either ascending or descending slopes should be in accordance with the standards set forth in Section 1808.7 and Figure No. 1808.7.1 of the Los Angeles County Building Code and latest applicable amendments and supplements (CBC). Footings should not be constructed within one-third the height of the slope, with a maximum setback distance of 40 feet.

Footings located near the toe of a slope should not be constructed any closer to the slope than one-half the height of the slope, with a maximum setback distance of 15 feet and a minimum setback distance of H/2, where H is the wall height in feet.

All foundation excavations should be observed and approved by a representative from our firm prior to placement of reinforcing steel. Foundations should be deepened, where necessary, to prevent surcharge loads from being imposed on adjacent foundations or utilities. Observation of foundation excavations may also be required by the appropriate reviewing governmental agencies. The contractor should be familiar with the requirements of the governing reviewing agencies.

Bearing Capacity: It is assumed that proposed foundations for minor non-habitable structures will be at-grade and lightly loaded. The foundations may be designed using a bearing value of 1,500 pounds per square foot (psf). The recommended bearing value is a net value and the weight of concrete in the footings may be taken as 50 pounds per cubic foot (pcf). The weight of soil backfill may be neglected when determining the downward loads from the footings. A one-third increase in the bearing value may be used when considering wind or seismic loads.

Lateral Resistance: Lateral loads may be resisted by soil friction and by the passive resistance of the soils. A coefficient of friction of 0.4, applied to the dead loads, may be used for footings and floor slabs supported on the compacted fill soil. The passive resistance of properly compacted fill soils may be assumed to be equal to the pressure developed by a fluid with a density of 250 pcf. The frictional resistance and the passive resistance of the soils may be combined, without reduction, in determining the total lateral resistance.

Settlement: Provided that the minor structures do not exceed the previously assumed structural loads and the foundations are founded in compacted fill soils as recommended, the total settlement attributed to static and seismic conditions is estimated to be about 2.0 inches. The maximum differential settlement, when considering static and seismic conditions, is estimated to be about 1.0 inch within a horizontal distance of 30 feet.

Foundation Observations: To verify the presence of satisfactory soils at foundation design elevations, the excavations should be observed by the Geotechnical Consultant of Record. Excavations should be deepened, as necessary, to extend into satisfactory soils. Where the foundation excavations are deeper than 4 feet, the sides of the excavations should be sloped back at a gradient of 1:1 or be shored for safety.

Inspection of foundation excavations may also be required by the appropriate reviewing governmental agencies. The contractor should be familiar with the inspection requirements of the reviewing agencies.

RETAINING WALLS

General: This section of the report has been prepared to provide seismic and static retaining wall design recommendations for retaining walls that are less than 12 feet in height. The recommendations of the referenced reports remain applicable except where specifically modified in this report.

Foundations: A bearing value of 1,500 pounds per square foot (psf) may be used in the design of foundations that are founded at least 12 inches below lowest adjacent final grade. The bearing value can be increased by one-third when considering seismic and wind forces. The bearing material should consist of compacted fill soil.

Building setbacks for structures located adjacent to either ascending or descending slopes should be in accordance with the standards set forth in the CBC. Those setback requirements indicate that a footing located at the top of a slope should not be constructed within one-third the height of the slope, with a maximum setback distance of 40 feet. Footings located near the toe of a slope should not be constructed any closer to the slope than one-half the height of the slope, with a maximum setback distance of 15 feet and a minimum setback distance of 3 feet.

All foundation excavations should be observed and approved by a representative from our firm prior to placement of reinforcing steel. Foundations should be deepened, where necessary, to prevent surcharge loads from being imposed on adjacent foundations or utilities. Observation of foundation excavations may also be required by the appropriate reviewing governmental agencies. The contractor should be familiar with the requirements of the governing reviewing agencies.

Lateral Design: Lateral restraint at the bases of footings or slabs may be assumed to be the product of the dead load and a coefficient of friction of 0.4. Passive pressure on the faces of footings may also be used to resist lateral forces. A passive pressure of zero at the surface of finished grade, increasing at the rate of 350 psf per foot of depth, to a maximum value of 2,500 psf, may be used at this site. The passive pressure and friction may be combined without reduction when evaluating lateral resistance.

Lateral Earth Pressure: Cantilevered retaining walls separate and independent of buildings, where the surface of the backfill is level and the retained height of soils is less than 12 feet, may be designed assuming that drained, non-expansive soils will exert a lateral pressure equal to that developed by a fluid with a density of 30 pounds per cubic foot (pcf). The indicated pressure assumes that a lateral deflection of up to about one percent of the wall height is acceptable at the top of the wall. If it is desired to decrease the amount of potential wall deflection, a greater lateral pressure could be used in the wall design.

Where the surface of the backfill is inclined at 2:1, it may be assumed that drained soils will exert a lateral pressure equal to that developed by a fluid with a density of 45 pcf.

For the design of a rigid wall where rotation and lateral movement are not acceptable, as in the case of buildings and the proposed diversion structure, it may be assumed that drained, non-expansive soils will exert a rectangular lateral pressure with a maximum pressure equal to 22H psf, where “H” is the wall height in feet. The pressure value and distribution may vary significantly when considering wall rigidity and restraining conditions. The structural characteristics of the wall are referred to the Project Structural Engineer. If requested, we can provide additional geotechnical design parameters for specific restrained conditions.

In addition to the recommended earth pressure, walls should be designed to resist any lateral surcharges due to nearby buildings, storage, or traffic loads. A drainage system should be provided behind the walls to reduce the potential for development of hydrostatic pressure. If a drainage system is not installed, walls should be designed to resist an additional hydrostatic pressure equal to that developed by a fluid with a density of 55 pcf for the full height of the wall.

Seismic Lateral Earth Pressure: The preceding recommended values indicate earth pressures for conventional static loading conditions. Ground shaking associated with earthquakes may cause additional pressure on walls. In addition to the previously mentioned lateral earth pressures, it is recommended that all rigid (building) walls of any height, and cantilevered retaining walls greater than 6 feet in height, be designed to support an additional seismic earth pressure equal to an inverted equivalent fluid pressure of 29 pcf.

Backfill: Backfill placed behind retaining walls should be compacted to a minimum of 90 percent of the maximum dry density, as determined by the current ASTM D1557 method of compaction. When placing backfill, walls should be braced. Heavy compaction equipment should not be used any closer to the back of the wall than the height of the wall. Soils that have an Expansion Index potential in excess of 50 should not be utilized for backfill behind retaining walls. The backs of retaining walls should be waterproofed. If retaining walls are not waterproofed, adverse impacts related to moisture-related distress should be anticipated.

Density of Backfill: When designing retaining walls to resist overturning, it can be assumed that compacted, on-site soils will have a density of 125 pcf.

Wall Drainage: A drainage system should be provided behind retaining walls, or the walls should be designed to resist hydrostatic pressures. Retaining wall backfill may be drained utilizing a perforated pipe. The perforated pipe should be at least 4 inches in diameter and be placed at the base of the wall, with the perforations pointed down. The pipe should be sloped to provide positive drainage, but in no instance shall the pipe be elevated more than 2 feet above the bottom of the wall. The pipe should be surrounded by at least 6 inches of uniform-sized gravel and be permitted to outlet onto a surface that would not be subject to erosion, or the drain should be connected to a suitable outlet device. The gravel should be separated from the surrounding soils by a filter fabric, such as Mirafi 140N or equivalent, wrapped around the gravel ("burrito-wrapped"). Alternatively, the filter fabric and gravel may be omitted when using a continuous slotted pipe and sand that conforms to LACDPW "Graybook," F-1 Designated Filter Material.

Drainage panels, such as Miradrain or equivalent, or a 6- to 12-inch-wide gravel chimney drain, should be installed behind retaining walls that are greater than 3 feet in height. The top of the drainage panels or chimney drain should be capped with 18 to 24 inches of compacted, on-site soil; the thickness of the cap should be increased to provide a minimum of 3 feet of compacted fill soils under any footing within the area of the backfill, where appropriate. The intent of installing the drainage panels or chimney drain would be to reduce the potential for build-up of water directly behind the walls. Excessive build-up of water could result in wall failure.

The installed drainage system should be observed by the Geotechnical Consultant prior to backfilling the system. Observation of the drainage system may also be required by the reviewing governmental agencies prior to backfilling.

PAVEMENT DESIGN

Bulk samples of onsite soils were obtained near existing grades to perform laboratory R-value tests for pavement section design. The following preliminary pavement section recommendations are based on the test results and have been prepared assuming that the soils at the subject site have an R-value of at least 30. When the proposed fine grading operations are nearing completion, samples of the on-site soil should be obtained from near final grade, in the proposed pavement areas, to perform additional R-value tests. The final pavement section recommendations would be dependent upon the results of those R-value tests and could vary from those presented below.

Traffic Index	Asphalt Thickness (Inches)	Base Course (CAB) Thickness (Inches)	Base Course (CMB) Thickness (Inches)
4	3	6	8
6	4	8	10
8	5	11	13
10	7	14	16

Base course material should consist of crushed aggregate base (CAB), as defined by Section 200-2.2 of the Standard Specifications for Public Works Construction (Greenbook). If crushed miscellaneous base (CMB) is used, it should meet the specifications outlined in Section 200-2.4 of the Greenbook. Base course should be compacted to at least 95 percent of the maximum dry density of that material.

Base course material should be purchased from a supplier who will certify that the base course will meet or exceed the specifications as indicated in the Greenbook. Sieve analysis and sand equivalency tests would be performed, upon request, on material delivered to the site which appears suspect. Additional tests could be performed, upon request, to determine if the material is in compliance with the remaining specifications presented in the Greenbook.

The pavement section recommendations presented above are based upon assumed Traffic Index values. R. T. Frankian & Associates does not take responsibility for the numerical determination of the Traffic Index values or the areas where they apply within the site. We would be pleased to provide pavement section recommendations for alternative Traffic Index values upon request.

To potentially increase the pavement life, concrete curbs and gutters should be deepened to extend below the base course material and be seated in the compacted fill. The intent of deepening the curbs and gutters is to form a cut-off wall to reduce the amount of water flow through the base course material from adjacent landscaped areas. Subgrade soils which become saturated as a result of water flowing through base course material can reduce the life of the pavement. The curbs should be deepened to an elevation at least 6 inches below the base of the proposed base course section. The curb subgrade should be thoroughly moistened prior to casting concrete.

OBSERVATION/TESTING SERVICES

This report has been prepared assuming that R. T. Frankian & Associates will perform all geotechnical field observations and testing. If the recommendations presented in this report are utilized and observation/testing of the geotechnical work is performed by others, the party performing the observations/testing must review this report and assume responsibility for the recommendations presented herein, or provide an additional report. That party would then assume the title "Geotechnical Engineer of Record" for the project and respond to any design and construction-related issues that may arise.

A representative of the Geotechnical Engineer of Record should be present to observe grading and backfill operations as well as foundation excavations for the project. A report presenting the results of these observations and related testing should be issued upon completion of the work.

LIMITATIONS

Our professional services have been performed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers and geologists practicing in this or similar localities. No other warranty, expressed or implied, is made as to the professional advice included in this report. This report has been prepared for Chiquita Canyon Landfill and their design consultants, to be used solely for planning and design of the Landfill Entrance Facility, and associated grading. The report has not been prepared for use by other parties and may not contain sufficient information for purposes of other parties or other uses.

-oOo-

We appreciate the opportunity to be of service. Please call if you have questions or would like to discuss this report in more detail. The following are attached and complete this report.

- References
- Geotechnical Map – Figure 1
- Historically Highest Ground Water Contour Map - Figure 2
- Water Well Location Map – Figure 3
- Appendix A – Explorations
- Appendix B – Laboratory Tests
- Appendix C – Infiltration Test Data and Calculations
- Appendix D – Water Well Records
- Appendix E – Geosyntec Technical Memorandum

Respectfully submitted,

R. T. FRANKIAN & ASSOCIATES

REGISTERED PROFESSIONAL ENGINEER
ALAN W. RASPLICKA
No. GE 2558
GEOTECHNICAL
STATE OF CALIFORNIA

by: Scott David Rudd
Project Supervisor

and: Alan W. Rasplicka
Principal Geotechnical Engineer

PROFESSIONAL GEOLOGIST
12/2022
Glenn A. Lauman
No. 1955
CERTIFIED ENGINEERING GEOLOGIST
STATE OF CALIFORNIA

and: Glenn A Lauman
Principal Engineering Geologist

SDR/GAL/AWR/jh

PDF Distribution via Email:
- PACE - Attn.: Mr. Duong Do
- City of Santa Clarita – Attn.: Mr. Dan Duncan

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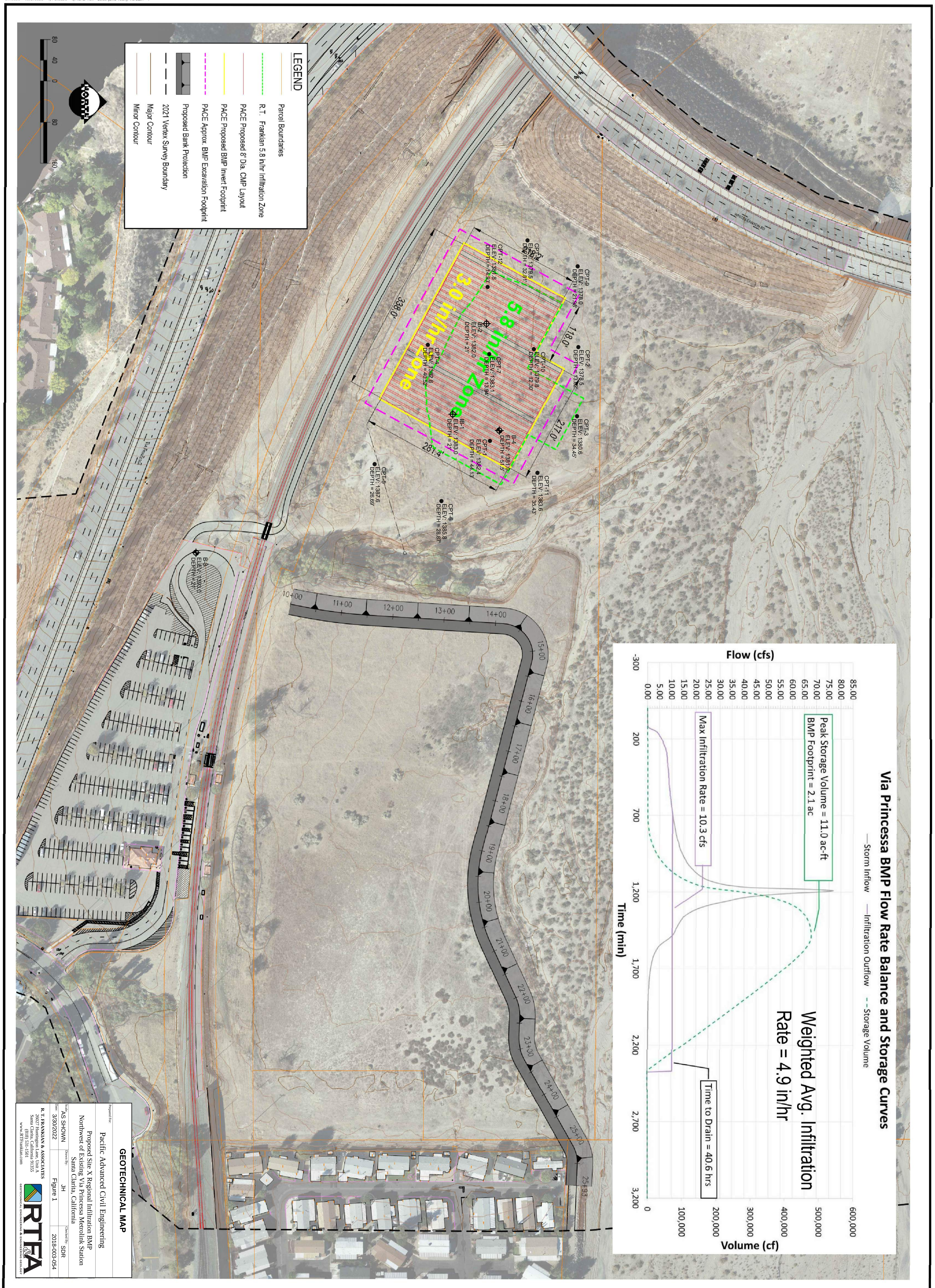
Geosyntec Consultants, 2019, "Technical Memorandum, Desktop Analysis Site Evaluation, Stormwater Infiltration BMP Facilities, Santa Clarita, California," prepared for PACE Engineers, dated January 15, 2019.

Los Angeles County Department of Public Works, Geotechnical and Materials Engineering Division, 2017, "Guidelines for Geotechnical Investigation and Reporting, Low Impact Development Stormwater Infiltration," dated June 30, 2017, GS200.1.

Xrefs: 31753_Vertex_Survey_Site_X_Rev_Linework.dwg; HECRAS_IFE_20211214.dwg; HECRAS_LEVEE_20211214.dwg; CrossSections_20211214_v2.dwg; B894 JURISDICTIONAL RESOURCES.dwg; Whites Cyn Access Rd - PDF to CAD.dwg; EXH-02_Whites Access Study-Wrkg4.dwg; ACAD-EXH-02_Whites Access Study-Wrkg4.dwg; B894 Satellite Imagery.dwg; B894 BANK LINING.dwg; ViaPrincessa_FHZ_20211214_trimmed.dwg; B894 OCAP FP.dwg; X-SITE-CITY-PRCL-PARK.dwg; B894 Frankian Infiltration Zones (2022-02-16).dwg; B894_FP_EX_PR_20220
Dimscale = 40; LTscale = 1; PSltscale = 1; ACAD Ver. = 23.0s (LMS Tech); Visretain = 1



PACE Advanced Water Engineering 17520 Newhope Street, Suite 200 | Fountain Valley, CA 92708 P: (714) 481-7300 | www.pacewater.com	SHEET 2 JOB NO. B894
JOB	VIA PRINCESSA PARK REGIONAL INFILTRATION BMP SANTA CLARITA CA
TITLE	PRELIMINARY BMP LAYOUT
PREPARED BY	PACE
PROJECT ENGINEER	DUONG DO
R.C.E. NO.	--
EXP.	xx/xx/xx
DRAWN	C.T.
SCALE	1" = 80'
DESIGNED	C.T.
CHECKED	D.D
DATE	02-16-2022

NO	BY	DATE	REVISIONS	DATE	APP.

Pacific Advanced Civil Engineering
March 30, 2022
2018-003-054

FIGURE 2
HISTORICALLY HIGHEST GROUND WATER CONTOUR MAP

Seismic Hazard Zone Report for the Mint Canyon 7.5-Minute Quadrangle

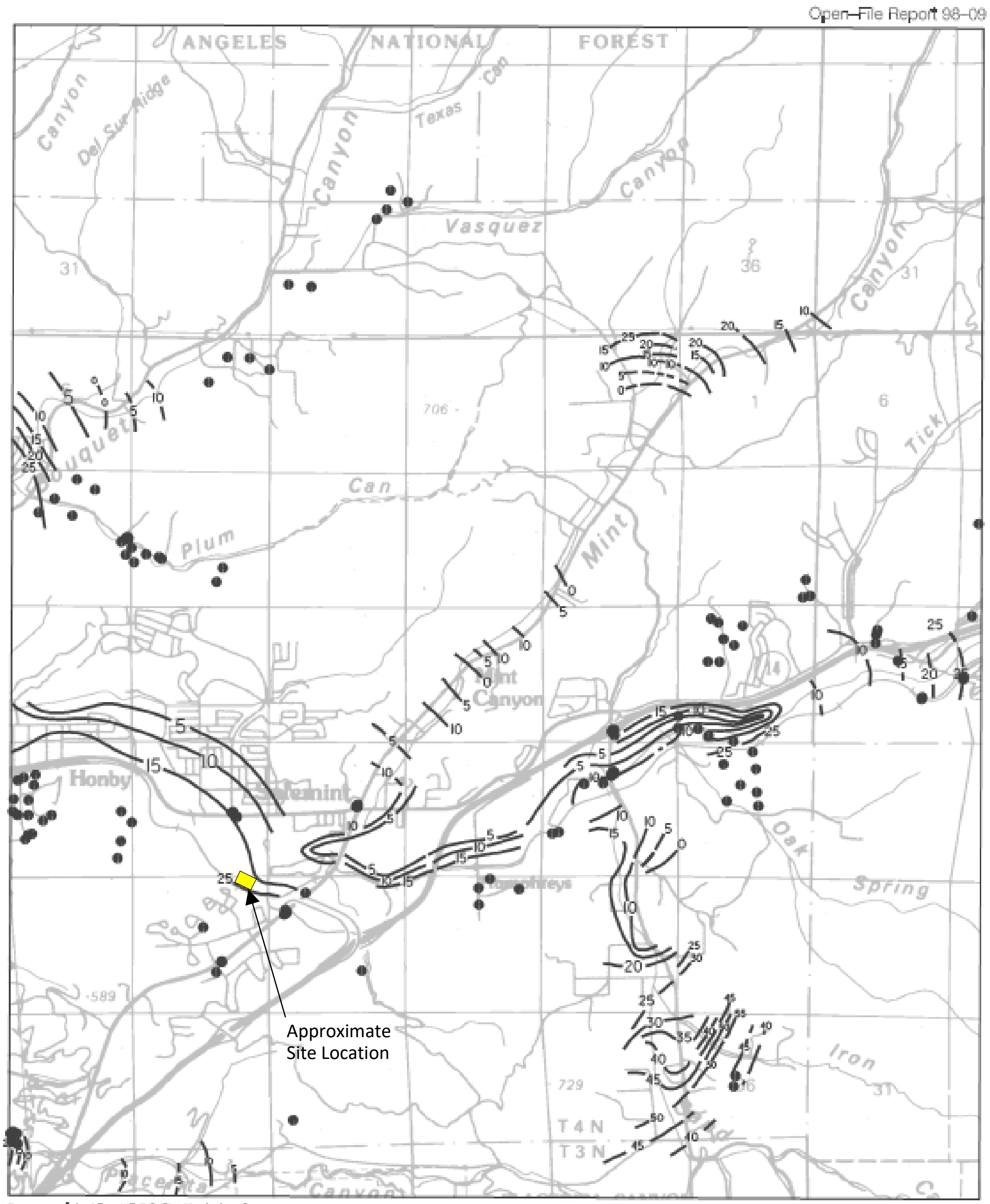


Plate 1.2 Historically Highest Ground Water Contours and Borehole Log Data Locations, Mint Canyon Quadrangle.

● Borehole Site — 30 — Depth to ground water in feet

Department of Public Works
dpw.lacounty.gov

Search By: Address/Intersection ▼ Search Buffer: None ▼ Active Wells Inactive Wells

Water Well Location Map

Prepared For: PACE		
Proposed Site X Regional Infiltration BMP Northwest of Existing Via Princessa Metrolink Station Santa Clarita, California		
Scale: As Shown	Drawn By: JH	Checked By: JAF
Date: 03/30/22	Figure 3	2018-003-054

R. T. FRANKIAN & ASSOCIATES
26027 Huntington Lane, Unit A
Santa Clarita, California 91355
(818) 531-1501
www.RTFrankian.com
RTFA GEOTECHNICAL ENGINEERING & ENGINEERING GEOLOGY

APPENDIX A

EXPLORATIONS

FIELD EXPLORATIONS

LOGGING OF EXPLORATIONS

As part of investigating the site conditions, exploratory excavations were performed at selected locations. The excavations included 4 hollow stem borings (IB-1, IB-2, B-3, and B-4) and 12 CPT soundings (CPT-1 through CPT-12). The approximate locations are presented on the Geotechnical Map. Logging was performed for each of the excavations.

The hollow stem borings were drilled with an 8-inch diameter hollow stem auger. Relatively undisturbed and bulk samples of the subsurface materials were collected from the borings for laboratory inspection and testing. A lined-barrel sampler used to take undisturbed samples has an external diameter of 3.25 inches and an internal diameter of 2.625 inches. The depths at which the undisturbed samples were obtained are indicated on the logs. The number of blows required to drive the sampler 12 inches with the hammer is also shown on the boring logs. The hollow stem auger borings ranged in depth from approximately 20 to 50 feet below the existing ground surface.

The CPT soundings were performed with a truck mounted CPT rig. Relatively undisturbed samples of the subsurface materials were collected from the soundings for laboratory inspection and testing. The samples were driven into an unlined sample tube with an internal diameter of approximately 0.75 inches. The CPT soundings varied in depth from approximately 12 to 44 feet.

BORING IB-1

JOB NUMBER: 2018-003-054
DATE DRILLED: 1/17/22
EQUIPMENT USED: 8" Hollow stem auger
ELEVATION: 1383'
LOGGED BY: SDR
DEPTH: 0-20.5'
HAMMER WEIGHT: 140 pounds; DROP: 30"
SURFACE CONDITIONS: Level Open Field with moderate brush

BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (LBS. PER CU. FT.)	N-VALUE	DEPTH (FEET)	SAMPLE LOCATION	GRAPHIC LOG	SOIL TYPE	DESCRIPTION
							SM	SILTY SAND: fine to medium with occasional coarse, medium dense, damp, light brown
12			-					clayey, dense, moist
15			-	5			SP	SAND: fine, slightly silty, dense, moist, yellowish brown
36			-					clean, damp, tan to buff
37			-	10				lens of gravel to 3/4"
90/11"			-				SM	SILTY SAND: fine to coarse, dense, moist, medium brown
70/8"			-	15			SP	SAND: fine, clean, dense, damp, tank to buff
37/5"			-	20				fine to medium with occasional coarse
								Bottom of Boring at 20.5 feet. No water. Caving below 15'.
				25				
				30				
				35				
				40				

Note: The log of subsurface conditions shown hereon is approximate and applies only at the specific location and date indicated. It is not warranted to be representative of subsurface conditions at other locations or times.

BOREHOLE LOG 2018-003-054.GPJ FRANKIAN.GDT 3/23/22

LOG OF BORING

R.T. FRANKIAN & ASSOCIATES

BORING IB-2

JOB NUMBER: 2018-003-054
DATE DRILLED: 1/17/22
EQUIPMENT USED: 8" Hollow stem auger
ELEVATION: 1382'
LOGGED BY: SDR
DEPTH: 0-21'
HAMMER WEIGHT: 140 pounds; DROP: 30"
SURFACE CONDITIONS: Level Open Field with moderate brush

BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (LBS. PER CU. FT.)	N-VALUE	DEPTH (FEET)	SAMPLE LOCATION	GRAPHIC LOG	SOIL TYPE	
							SM	SILTY SAND: fine to medium with occasional coarse, medium dense, damp, light brown
28			-				SW	SAND: fine to coarse, slightly silty, gravel to 1/2", dense, damp, medium brown
24			-	5			SM-ML	SILTY SAND: very fine to fine, dense, moist, medium brown
25			-				SM	SILTY SAND: fine, dense, damp, light yellowish brown
28			-	10				
70/8"			-					
40/3"			-	15			SW	SAND: fine to coarse, slightly silty, dense, damp, tan to buff
							SM	SILTY SAND: fine to coarse, dense, damp, tan
70/11"			-	20				
				25				Bottom of Boring at 21 feet. No water. Caving below 15'.
				30				
				35				
				40				

Note: The log of subsurface conditions shown hereon is approximate and applies only at the specific location and date indicated. It is not warranted to be representative of subsurface conditions at other locations or times.

BOREHOLE LOG 2018-003-054.GPJ FRANKIAN.GDT 3/23/22

LOG OF BORING

R.T. FRANKIAN & ASSOCIATES

BORING B-3

JOB NUMBER: 2018-003-054
DATE DRILLED: 1/17/22
EQUIPMENT USED: 8" Hollow stem auger
ELEVATION: 1393'
LOGGED BY: SDR
DEPTH: 0-21'
HAMMER WEIGHT: 140 pounds; DROP: 30"
SURFACE CONDITIONS: Existing Asphalt Parking Lot

BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (LBS. PER CU. FT.)	N-VALUE	DEPTH (FEET)	SAMPLE LOCATION	GRAPHIC LOG	SOIL TYPE	DESCRIPTION
				0				ASPHALT: 4" AC/ 4" BASE
							SM	**ARTIFICIAL FILL** SILTY SAND: fine to medium, occasional gravel to 1/2", well compacted, moist, mottled medium brown and light yellowish brown
33			-					
19			-	5				mottled medium brown and gray
23			-					
20			-	10				
30			-					
30/5"			-	15				
							SM	**NATIVE** SILTY SAND: fine to coarse, gravel to 1", dense, damp, medium yellowish brown
30			-	20				
								Bottom of Boring at 21 feet. No water. No Caving.

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40

Note: The log of subsurface conditions shown hereon is approximate and applies only at the specific location and date indicated. It is not warranted to be representative of subsurface conditions at other locations or times.

BOREHOLE LOG 2018-003-054.GPJ FRANKIAN.GDT 3/23/22

LOG OF BORING

R.T. FRANKIAN & ASSOCIATES

BORING B-4

JOB NUMBER: 2018-003-054
DATE DRILLED: 1/18/22
EQUIPMENT USED: 8" Hollow stem auger
ELEVATION: 1381'
LOGGED BY: SDR
DEPTH: 0-51.5'
HAMMER WEIGHT: 140 pounds; DROP: 30"
SURFACE CONDITIONS: Level Open Field with moderate brush

BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (LBS. PER CU. FT.)	N-VALUE	DEPTH (FEET)	SAMPLE LOCATION	GRAPHIC LOG	SOIL TYPE	DESCRIPTION
							SM	SILTY SAND: fine to coarse, medium dense, damp, light brown
21			-					
33			-	5			SP	SAND: fine to very coarse, clean, dense, damp to moist, light yellowish brown
24			-					fine to medium with occasional coarse, damp
46			-	10				lens of gravel to 3/4"
-			43					fine to coarse
62			-	15				fine to very coarse
-			39					
25/1"			-	20				
								gravel lens
-			*	25				(* 25 blows for the first 6")
-			48	30				fine to medium with occasional coarse
-			55	35				fine to very coarse, gravel to 1/2"
				40				

(CONTINUED ON THE FOLLOWING FIGURE)

Note: The log of subsurface conditions shown hereon is approximate and applies only at the specific location and date indicated. It is not warranted to be representative of subsurface conditions at other locations or times.

LOG OF BORING

R.T. FRANKIAN & ASSOCIATES

BORING B-4 (CONTINUED)

JOB NUMBER: 2018-003-054
DATE DRILLED: 1/18/22
EQUIPMENT USED: 8" Hollow stem auger
ELEVATION: 1381'
LOGGED BY: SDR
DEPTH: 0-51.5'
HAMMER WEIGHT: 140 pounds; DROP: 30"
SURFACE CONDITIONS: Level Open Field with moderate brush

BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (LBS. PER CU. FT.)	N-VALUE	DEPTH (FEET)	SAMPLE LOCATION	GRAPHIC LOG	SOIL TYPE	DESCRIPTION
-			32		X		SP	
-			53	45	X			fine to coarse
-			91/11"	50	X			fine to very coarse
								Bottom of Boring at 51.5 feet. No water. No Caving.
				55				
				60				
				65				
				70				
				75				
				80				

Note: The log of subsurface conditions shown hereon is approximate and applies only at the specific location and date indicated.
It is not warranted to be representative of subsurface conditions at other locations or times.

LOG OF BORING

R.T. FRANKIAN & ASSOCIATES

GREGG DRILLING & TESTING, LLC.
GEOTECHNICAL AND ENVIRONMENTAL INVESTIGATION SERVICES

11/2/18

R.T. Frankian & Associates
Attn: Jim Frankian

Subject: CPT Site Investigation
CSC LID Site X
Santa Clarita, California
GREGG Project Number: D1180644SH

Dear Mr. Frankian:

The following report presents the results of GREGG Drilling & Testing's Cone Penetration Test investigation for the above referenced site. The following testing services were performed:

1	Cone Penetration Tests	(CPTU)	☒
2	Pore Pressure Dissipation Tests	(PPD)	☒
3	Seismic Cone Penetration Tests	(SCPTU)	☐
4	UVOST Laser Induced Fluorescence	(UVOST)	☐
5	Groundwater Sampling	(GWS)	☐
6	Soil Sampling	(SS)	☐
7	Vapor Sampling	(VS)	☐
8	Pressuremeter Testing	(PMT)	☐
9	Vane Shear Testing	(VST)	☐
10	Dilatometer Testing	(DMT)	☐

A list of reference papers providing additional background on the specific tests conducted is provided in the bibliography following the text of the report. If you would like a copy of any of these publications or should you have any questions or comments regarding the contents of this report, please do not hesitate to contact our office at (562) 427-6899.

Sincerely,
GREGG Drilling & Testing, LLC.

Frank Stolfi
HRSC Division Manager, Gregg Drilling & Testing, LLC.

2726 Walnut Ave. • Signal Hill, California 90755 • (562) 427-6899 • FAX (562) 427-3314
www.greggdrilling.com

Cone Penetration Test Sounding Summary

-Table 1-

CPT Sounding Identification	Date	Termination Depth (feet)	Depth of Groundwater Samples (feet)	Depth of Soil Samples (feet)	Depth of Pore Pressure Dissipation Tests (feet)
CPT-1	10/30/2018	44.13	-	-	44.4
CPT-2	10/30/2018	13.62	-	-	-
CPT-3	10/30/2018	34.45	-	10, 16	-
CPT-4	10/30/2018	40.52	-	-	15.7, 16.2
CPT-5	10/30/2018	29.69	-	15, 17, 18, 20, 25	-
CPT-6	10/31/2018	28.87	-	-	-
CPT-7	10/31/2018	13.94	-	-	-
CPT-8	10/31/2018	32.81	-	15, 18, 20, 24, 26	-
CPT-9	10/31/2018	21.98	-	-	-
CPT-10	11/1/2018	12.3	-	-	-
CPT-11	11/1/2018	35.43	-	-	-
CPT-12	11/1/2018	14.93	-	-	-

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Zemo, D.A., T.A. Delfino, J.D. Gallinatti, V.A. Baker and L.R. Hilpert, "Field Comparison of Analytical Results from Discrete-Depth Groundwater Samplers" BAT EnviroProbe and QED HydroPunch, Sixth national Outdoor Action Conference, Las Vegas, Nevada Proceedings, 1992, pp 299-312.

Copies of ASTM Standards are available through www.astm.org

Cone Penetration Testing Procedure (CPT)

Gregg Drilling carries out all Cone Penetration Tests (CPT) using an integrated electronic cone system, *Figure CPT*.

The cone takes measurements of tip resistance (q_c), sleeve resistance (f_s), and penetration pore water pressure (u_2). Measurements are taken at either 2.5 or 5 cm intervals during penetration to provide a nearly continuous profile. CPT data reduction and basic interpretation is performed in real time facilitating on-site decision making. The above mentioned parameters are stored electronically for further analysis and reference. All CPT soundings are performed in accordance with revised ASTM standards (D 5778-12).

The 5mm thick porous plastic filter element is located directly behind the cone tip in the u_2 location. A new saturated filter element is used on each sounding to measure both penetration pore pressures as well as measurements during a dissipation test (*PPDT*). Prior to each test, the filter element is fully saturated with oil under vacuum pressure to improve accuracy.

When the sounding is completed, the test hole is backfilled according to client specifications. If grouting is used, the procedure generally consists of pushing a hollow tremie pipe with a "knock out" plug to the termination depth of the CPT hole. Grout is then pumped under pressure as the tremie pipe is pulled from the hole. Disruption or further contamination to the site is therefore minimized.

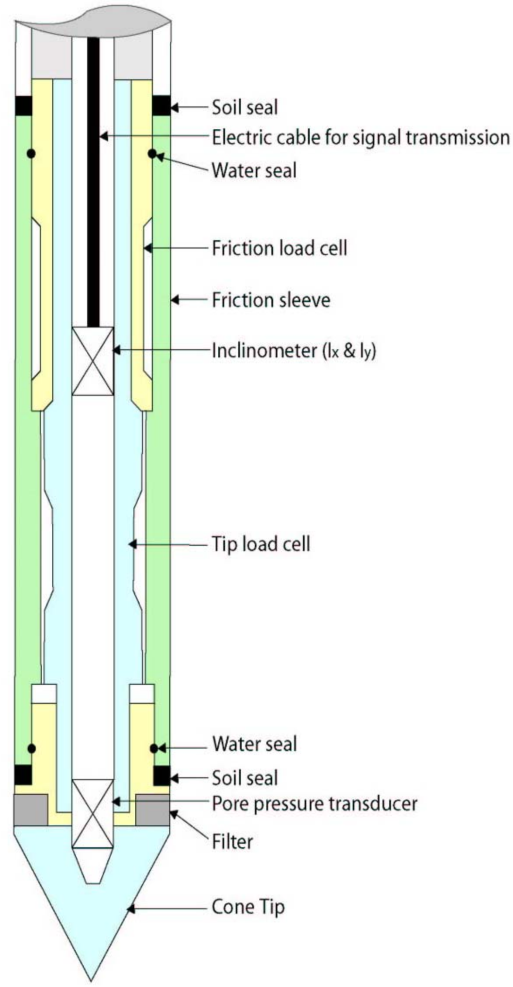


Figure CPT

Gregg 15cm^2 Standard Cone Specifications

Dimensions	
Cone base area	15 cm^2
Sleeve surface area	225 cm^2
Cone net area ratio	0.80
Specifications	
Cone load cell	
Full scale range	180 kN (20 tons)
Overload capacity	150%
Full scale tip stress	120 MPa (1,200 tsf)
Repeatability	120 kPa (1.2 tsf)
Sleeve load cell	
Full scale range	31 kN (3.5 tons)
Overload capacity	150%
Full scale sleeve stress	1,400 kPa (15 tsf)
Repeatability	1.4 kPa (0.015 tsf)
Pore pressure transducer	
Full scale range	7,000 kPa (1,000 psi)
Overload capacity	150%
Repeatability	7 kPa (1 psi)

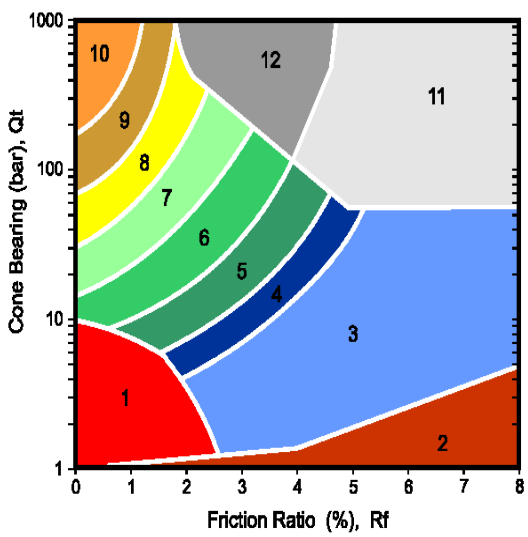
Note: The repeatability during field use will depend somewhat on ground conditions, abrasion, maintenance and zero load stability.

Cone Penetration Test Data & Interpretation

The Cone Penetration Test (CPT) data collected are presented in graphical and electronic form in the report. The plots include interpreted Soil Behavior Type (SBT) based on the charts described by Robertson (1990). Typical plots display SBT based on the non-normalized charts of Robertson et al (1986). For CPT soundings deeper than 30m, we recommend the use of the normalized charts of Robertson (1990) which can be displayed as SBTn, upon request. The report also includes spreadsheet output of computer calculations of basic interpretation in terms of SBT and SBTn and various geotechnical parameters using current published correlations based on the comprehensive review by Lunne, Robertson and Powell (1997), as well as recent updates by Professor Robertson (Guide to Cone Penetration Testing, 2015). The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed. Gregg Drilling & Testing Inc. does not warranty the correctness or the applicability of any of the geotechnical parameters interpreted by the software and does not assume any liability for use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used in the software. Some interpretation methods require input of the groundwater level to calculate vertical effective stress. An estimate of the in-situ groundwater level has been made based on field observations and/or CPT results, but should be verified by the user.

A summary of locations and depths is available in Table 1. Note that all penetration depths referenced in the data are with respect to the existing ground surface.

Note that it is not always possible to clearly identify a soil type based solely on q_t, f_s, and u_2. In these situations, experience, judgment, and an assessment of the pore pressure dissipation data should be used to infer the correct soil behavior type.



ZONE		SBT
1		Sensitive, fine grained
2		Organic materials
3		Clay
4		Silty clay to clay
5		Clayey silt to silty clay
6		Sandy silt to clayey silt
7		Silty sand to sandy silt
8		Sand to silty sand
9		Sand
10		Gravely sand to sand
11		Very stiff fine grained*
12		Sand to clayey sand*

*over consolidated or cemented

Figure SBT (After Robertson et al., 1986) – Note: Colors may vary slightly compared to plots

Cone Penetration Test (CPT) Interpretation

Gregg uses a proprietary CPT interpretation and plotting software. The software takes the CPT data and performs basic interpretation in terms of soil behavior type (SBT) and various geotechnical parameters using current published empirical correlations based on the comprehensive review by Lunne, Robertson and Powell (1997). The interpretation is presented in tabular format using MS Excel. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed. Gregg does not warranty the correctness or the applicability of any of the geotechnical parameters interpreted by the software and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used in the software.

The following provides a summary of the methods used for the interpretation. Many of the empirical correlations to estimate geotechnical parameters have constants that have a range of values depending on soil type, geologic origin and other factors. The software uses 'default' values that have been selected to provide, in general, conservatively low estimates of the various geotechnical parameters.

Input:

1. Units for display (Imperial or metric) (atm. pressure, p_a = 0.96 tsf or 0.1 MPa)
2. Depth interval to average results (ft or m). Data are collected at either 0.02 or 0.05m and can be averaged every 1, 3 or 5 intervals.
3. Elevation of ground surface (ft or m)
4. Depth to water table, z_w (ft or m) – input required
5. Net area ratio for cone, a (default to 0.80)
6. Relative Density constant, C_{Dr} (default to 350)
7. Young's modulus number for sands, α (default to 5)
8. Small strain shear modulus number
   a. for sands, S_G (default to 180 for SBT_n 5, 6, 7)
   b. for clays, C_G (default to 50 for SBT_n 1, 2, 3 & 4)
9. Undrained shear strength cone factor for clays, N_{kt} (default to 15)
10. Over Consolidation ratio number, k_{ocr} (default to 0.3)
11. Unit weight of water, (default to γ_w = 62.4 lb/ft^3 or 9.81 kN/m^3)

Column

1. Depth, z, (m) – CPT data is collected in meters
2. Depth (ft)
3. Cone resistance, q_c (tsf or MPa)
4. Sleeve resistance, f_s (tsf or MPa)
5. Penetration pore pressure, u (psi or MPa), measured behind the cone (i.e. u_2)
6. Other – any additional data
7. Total cone resistance, q_t (tsf or MPa) $\qquad q_t = q_c + u\,(1-a)$

8	Friction Ratio, R_f (%)	$R_f = (f_s/q_t) \times 100\%$
9	Soil Behavior Type (non-normalized), SBT	see note
10	Unit weight, γ (pcf or kN/m^3)	based on SBT, see note
11	Total overburden stress, σ_v (tsf)	$\sigma_{vo} = \sigma\ z$
12	In-situ pore pressure, u_o (tsf)	$u_o = \gamma_w (z - z_w)$
13	Effective overburden stress, σ'_{vo} (tsf)	$\sigma'_{vo} = \sigma_{vo} - u_o$
14	Normalized cone resistance, Q_{t1}	$Q_{t1} = (q_t - \sigma_{vo}) / \sigma'_{vo}$
15	Normalized friction ratio, F_r (%)	$F_r = f_s / (q_t - \sigma_{vo}) \times 100\%$
16	Normalized Pore Pressure ratio, B_q	$B_q = u - u_o / (q_t - \sigma_{vo})$
17	Soil Behavior Type (normalized), SBT_n	see note
18	SBT_n Index, I_c	see note
19	Normalized Cone resistance, Q_{tn} (n varies with I_c)	see note
20	Estimated permeability, k_{SBT} (cm/sec or ft/sec)	see note
21	Equivalent SPT N_{60}, blows/ft	see note
22	Equivalent SPT $(N_1)_{60}$ blows/ft	see note
23	Estimated Relative Density, D_r, (%)	see note
24	Estimated Friction Angle, ϕ', (degrees)	see note
25	Estimated Young's modulus, E_s (tsf)	see note
26	Estimated small strain Shear modulus, Go (tsf)	see note
27	Estimated Undrained shear strength, s_u (tsf)	see note
28	Estimated Undrained strength ratio	s_u/σ_v'
29	Estimated Over Consolidation ratio, OCR	see note

Notes:

1 Soil Behavior Type (non-normalized), SBT (Lunne et al., 1997 and table below)

2 Unit weight, γ either constant at 119 pcf or based on Non-normalized SBT (Lunne et al., 1997 and table below)

3 Soil Behavior Type (Normalized), SBT_n Lunne et al. (1997)

4 SBT_n Index, I_c $I_c = ((3.47 - \log Q_{t1})^2 + (\log F_r + 1.22)^2)^{0.5}$

5 Normalized Cone resistance, Q_{tn} (n varies with Ic)

$Q_{tn} = ((q_t - \sigma_{vo})/pa)\ (pa/(\sigma'_{vo})^n$ and recalculate I_c, then iterate:

When $I_c < 1.64$, $n = 0.5$ (clean sand)
When $I_c > 3.30$, $n = 1.0$ (clays)
When $1.64 < I_c < 3.30$, $n = (I_c - 1.64)0.3 + 0.5$
Iterate until the change in n, $\Delta n < 0.01$

6 Estimated permeability, k_{SBT} based on Normalized SBT_n (Lunne et al., 1997 and table below)

7 Equivalent SPT N_{60}, blows/ft Lunne et al. (1997)

$$\frac{(q_t/p_a)}{N_{60}} = 8.5\left(1 - \frac{I_c}{4.6}\right)$$

8 Equivalent SPT $(N_1)_{60}$ blows/ft $(N_1)_{60} = N_{60} C_N$,
where $C_N = (pa/\sigma'_{vo})^{0.5}$

9 Relative Density, D_r, (%) $D_r^2 = Q_{tn} / C_{Dr}$
Only SBT_n 5, 6, 7 & 8 *Show 'N/A' in zones 1, 2, 3, 4 & 9*

10 Friction Angle, φ', (degrees) $\tan\phi' = \frac{1}{2.68}\left[\log\left(\frac{q_c}{\sigma'_{vo}}\right) + 0.29\right]$

Only SBT_n 5, 6, 7 & 8 *Show'N/A' in zones 1, 2, 3, 4 & 9*

11 Young's modulus, E_s $E_s = \alpha\, q_t$
Only SBT_n 5, 6, 7 & 8 *Show 'N/A' in zones 1, 2, 3, 4 & 9*

12 Small strain shear modulus, Go

a. $G_o = S_G (q_t\ \sigma'_{vo}\ pa)^{1/3}$ *For SBT_n 5, 6, 7*

b. $G_o = C_G\, q_t$ *For SBT_n 1, 2, 3& 4*

Show 'N/A' in zones 8 & 9

13 Undrained shear strength, s_u $s_u = (q_t - \sigma_{vo}) / N_{kt}$
Only SBT_n 1, 2, 3, 4 & 9 *Show 'N/A' in zones 5, 6, 7 & 8*

14 Over Consolidation ratio, OCR $OCR = k_{ocr} Q_{t1}$
Only SBT_n 1, 2, 3, 4 & 9 *Show 'N/A' in zones 5, 6, 7 & 8*

The following updated and simplified SBT descriptions have been used in the software:

SBT Zones		**SBT_n Zones**	
1	sensitive fine grained	1	sensitive fine grained
2	organic soil	2	organic soil
3	clay	3	clay
4	clay & silty clay	4	clay & silty clay
5	clay & silty clay		
6	sandy silt & clayey silt		

7	silty sand & sandy silt	5	silty sand & sandy silt
8	sand & silty sand	6	sand & silty sand
9	sand		
10	sand	7	sand
11	very dense/stiff soil*	8	very dense/stiff soil*
12	very dense/stiff soil*	9	very dense/stiff soil*

*heavily overconsolidated and/or cemented

Track when soils fall with zones of same description and print that description (i.e. if soils fall only within SBT zones 4 & 5, print ‘clays & silty clays’)

Estimated Permeability (see Lunne et al., 1997)

SBT_n	Permeability (ft/sec)	(m/sec)
1	$3x\ 10^{-8}$	$1x\ 10^{-8}$
2	$3x\ 10^{-7}$	$1x\ 10^{-7}$
3	$1x\ 10^{-9}$	$3x\ 10^{-10}$
4	$3x\ 10^{-8}$	$1x\ 10^{-8}$
5	$3x\ 10^{-6}$	$1x\ 10^{-6}$
6	$3x\ 10^{-4}$	$1x\ 10^{-4}$
7	$3x\ 10^{-2}$	$1x\ 10^{-2}$
8	$3x\ 10^{-6}$	$1x\ 10^{-6}$
9	$1x\ 10^{-8}$	$3x\ 10^{-9}$

Estimated Unit Weight (see Lunne et al., 1997)

SBT	Approximate Unit Weight (lb/ft^3)	(kN/m^3)
1	111.4	17.5
2	79.6	12.5
3	111.4	17.5
4	114.6	18.0
5	114.6	18.0
6	114.6	18.0
7	117.8	18.5
8	120.9	19.0
9	124.1	19.5
10	127.3	20.0
11	130.5	20.5
12	120.9	19.0

Pore Pressure Dissipation Tests (PPDT)

Pore Pressure Dissipation Tests (PPDT's) conducted at various intervals can be used to measure equilibrium water pressure (at the time of the CPT). If conditions are hydrostatic, the equilibrium water pressure can be used to determine the approximate depth of the ground water table. A PPDT is conducted when penetration is halted at specific intervals determined by the field representative. The variation of the penetration pore pressure (*u*) with time is measured behind the tip of the cone and recorded.

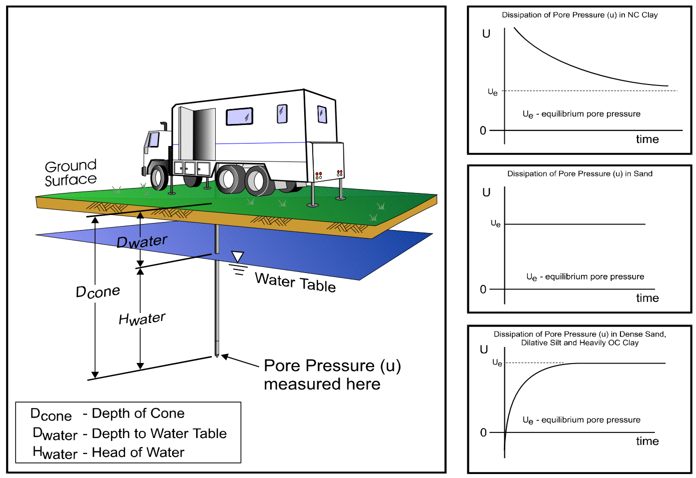
Pore pressure dissipation data can be interpreted to provide estimates of:

- Equilibrium piezometric pressure
- Phreatic Surface
- In situ horizontal coefficient of consolidation (c_h)
- In situ horizontal coefficient of permeability (k_h)

In order to correctly interpret the equilibrium piezometric pressure and/or the phreatic surface, the pore pressure must be monitored until it reaches equilibrium, *Figure PPDT*. This time is commonly referred to as t_{100}, the point at which 100% of the excess pore pressure has dissipated.

A complete reference on pore pressure dissipation tests is presented by Robertson et al. 1992 and Lunne et al. 1997.

A summary of the pore pressure dissipation tests are summarized in Table 1.



Water Table Calculation

$$D_{water} = D_{cone} - H_{water}$$

where $H_{water} = U_e$ (depth units)

Useful Conversion Factors: 1psi = 0.704m = 2.31 feet (water)
1tsf = 0.958 bar = 13.9 psi
1m = 3.28 feet

Figure PPDT

Seismic Cone Penetration Testing (SCPT)

Seismic Cone Penetration Testing (SCPT) can be conducted at various intervals during the Cone Penetration Test. Shear wave velocity (Vs) can then be calculated over a specified interval with depth. A small interval for seismic testing, such as 1-1.5m (3-5ft) allows for a detailed look at the shear wave profile with depth. Conversely, a larger interval such as 3-6m (10-20ft) allows for a more average shear wave velocity to be calculated. Gregg's cones have a horizontally active geophone located 0.2m (0.66ft) behind the tip.

To conduct the seismic shear wave test, the penetration of the cone is stopped and the rods are decoupled from the rig. An automatic hammer is triggered to send a shear wave into the soil. The distance from the source to the cone is calculated knowing the total depth of the cone and the horizontal offset distance between the source and the cone. To calculate an interval velocity, a minimum of two tests must be performed at two different depths. The arrival times between the two wave traces are compared to obtain the difference in time (Δt). The difference in depth is calculated (Δd) and velocity can be determined using the simple equation: $v = \Delta d/\Delta t$

Multiple wave traces can be recorded at the same depth to improve quality of the data.

A complete reference on seismic cone penetration tests is presented by Robertson et al. 1986 and Lunne et al. 1997.

A summary the shear wave velocities, arrival times and wave traces are provided with the report.

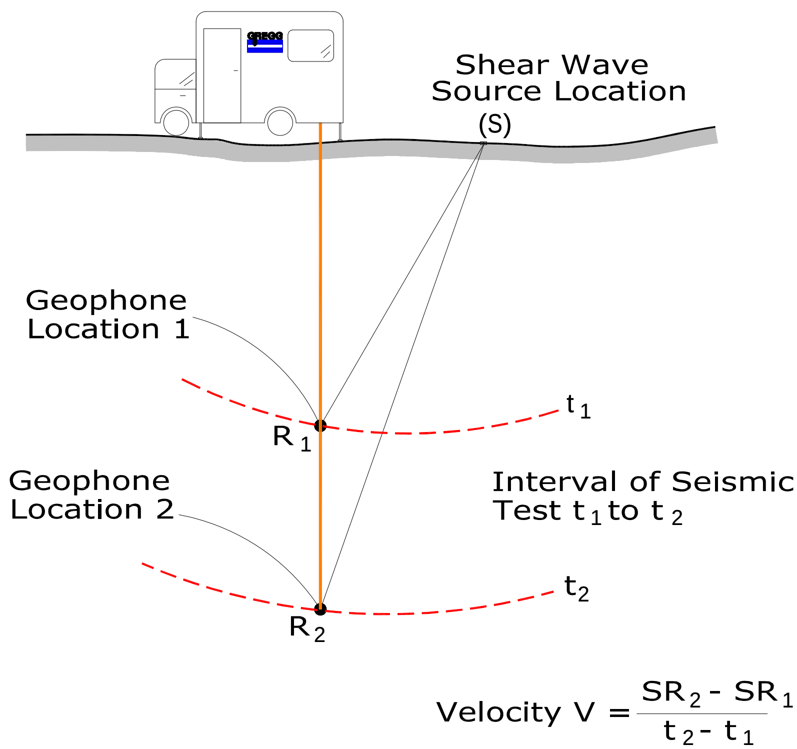


Figure SCPT

Groundwater Sampling

Gregg Drilling & Testing, Inc. conducts groundwater sampling using a sampler as shown in *Figure GWS*. The groundwater sampler has a retrievable stainless steel or disposable PVC screen with steel drop off tip. This allows for samples to be taken at multiple depth intervals within the same sounding location. In areas of slower water recharge, provisions may be made to set temporary PVC well screens during sampling to allow the pushing equipment to advance to the next sample location while the groundwater is allowed to infiltrate.

The groundwater sampler operates by advancing 44.5mm (1¾ inch) hollow push rods with the filter tip in a closed configuration to the base of the desired sampling interval. Once at the desired sample depth, the push rods are retracted; exposing the encased filter screen and allowing groundwater to infiltrate hydrostatically from the formation into the inlet screen. A small diameter bailer (approximately ½ or ¾ inch) is lowered through the push rods into the screen section for sample collection. The number of downhole trips with the bailer and time necessary to complete the sample collection at each depth interval is a function of sampling protocols, volume requirements, and the yield characteristics and storage capacity of the formation. Upon completion of sample collection, the push rods and sampler, with the exception of the PVC screen and steel drop off tip are retrieved to the ground surface, decontaminated and prepared for the next sampling event.

For a detailed reference on direct push groundwater sampling, refer to Zemo et. al., 1992.

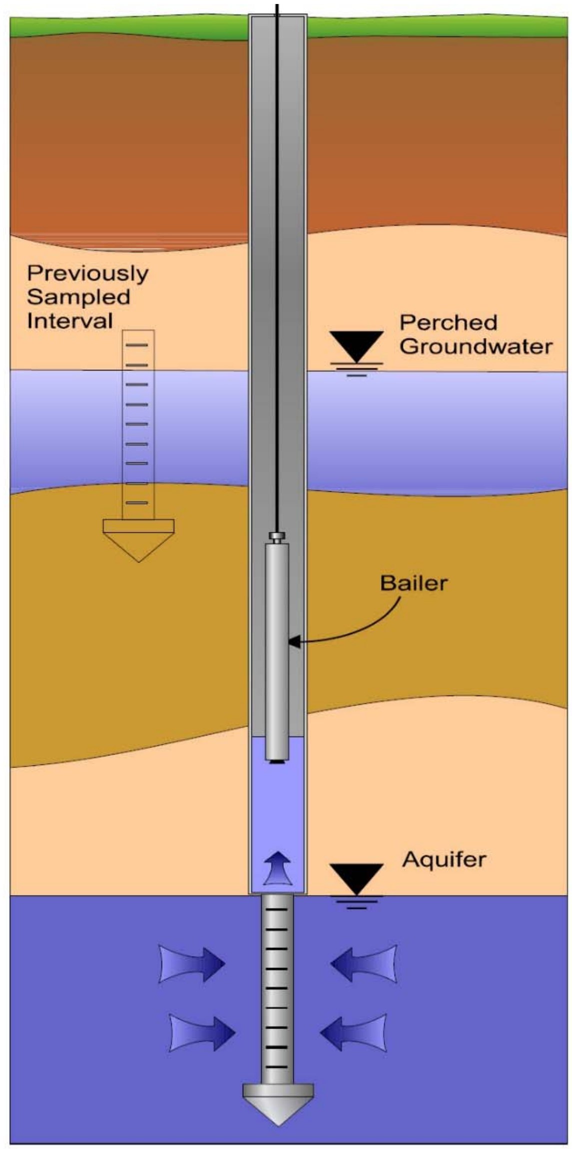


Figure GWS

Soil Sampling

Gregg Drilling & Testing, Inc. uses a piston-type push-in sampler to obtain small soil samples without generating any soil cuttings, *Figure SS*. Two different types of samplers (12 and 18 inch) are used depending on the soil type and density. The soil sampler is initially pushed in a "closed" position to the desired sampling interval using the CPT pushing equipment. Keeping the sampler closed minimizes the potential of cross contamination. The inner tip of the sampler is then retracted leaving a hollow soil sampler with inner 1¼" diameter sample tubes. The hollow sampler is then pushed in a locked "open" position to collect a soil sample. The filled sampler and push rods are then retrieved to the ground surface. Because the soil enters the sampler at a constant rate, the opportunity for 100% recovery is increased. For environmental analysis, the soil sample tube ends are sealed with Teflon and plastic caps. Often, a longer "split tube" can be used for geotechnical sampling.

For a detailed reference on direct push soil sampling, refer to Robertson et al, 1998.

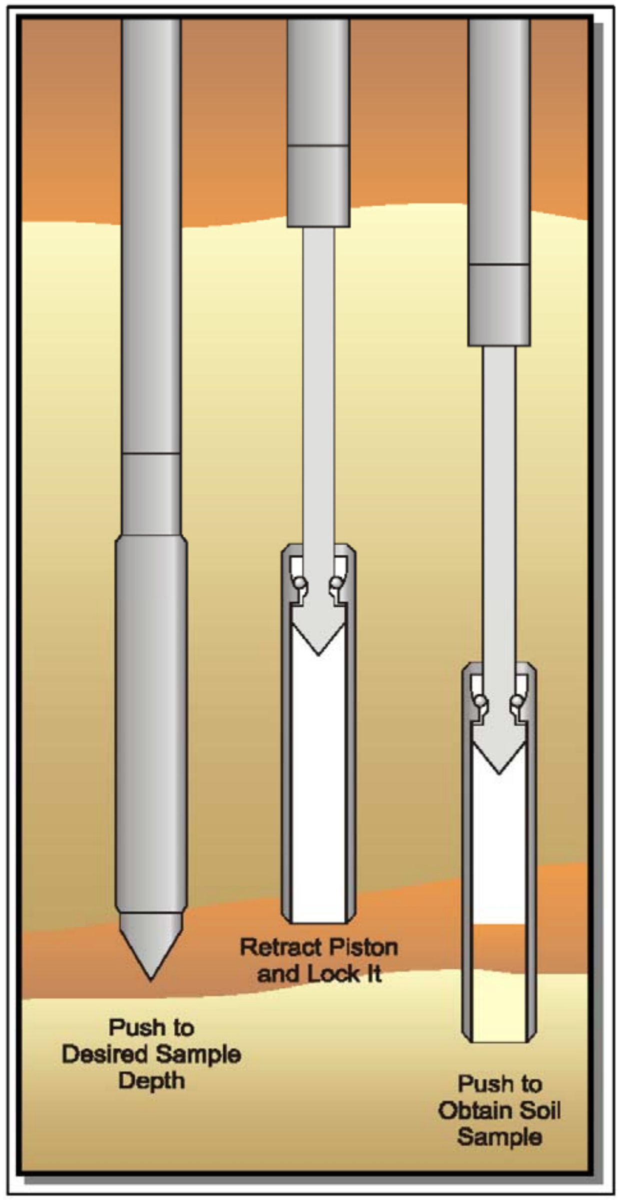


Figure SS

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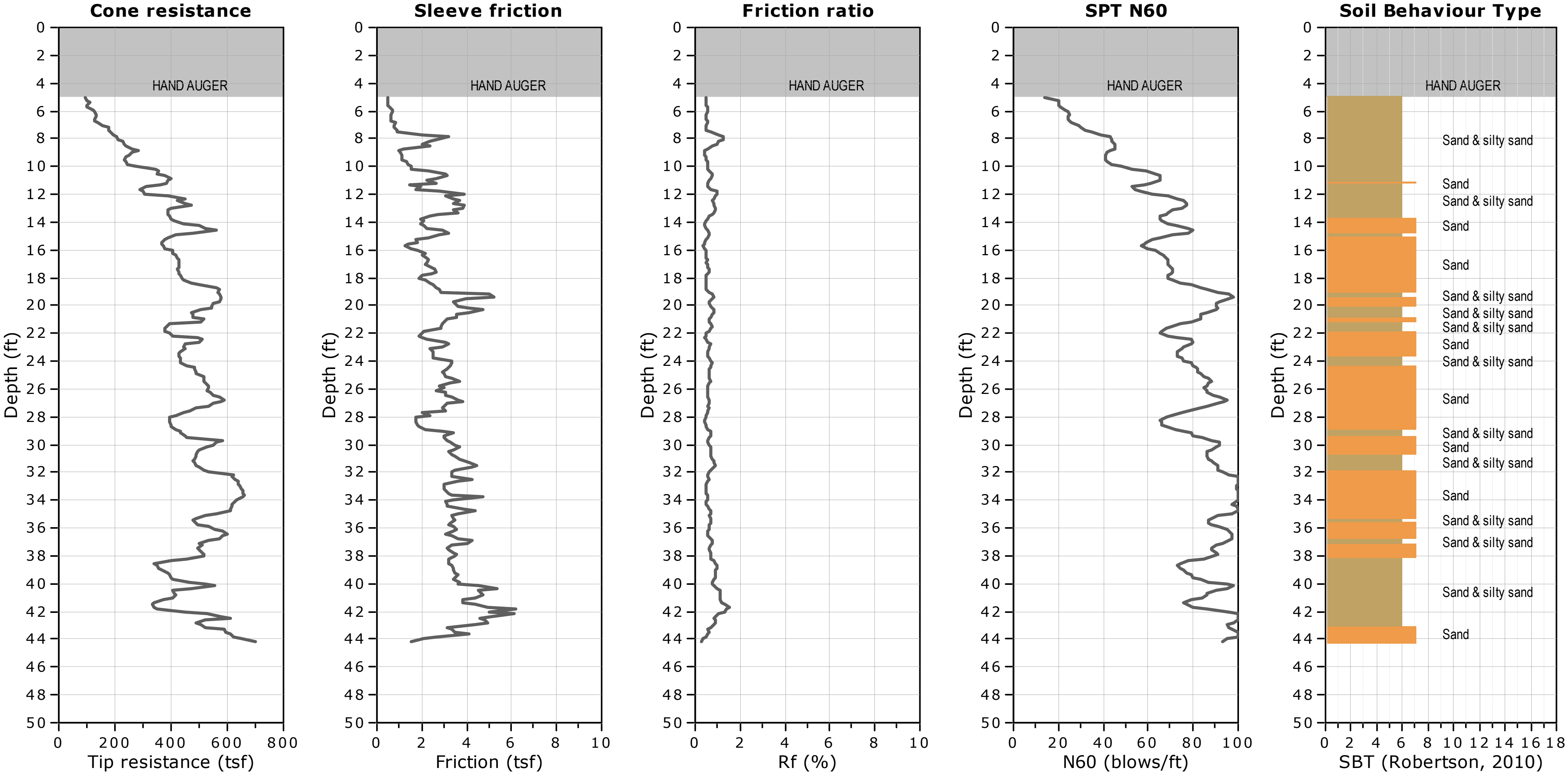
CPT: CPT-1

CLIENT: R.T. FRANKIAN & ASSOCIATES

SITE: CSC LID SITE X - SANTA CLARITA, CA

Field Rep: JIM

Total depth: 44.13 ft, Date: 10/30/2018



SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

GREGG

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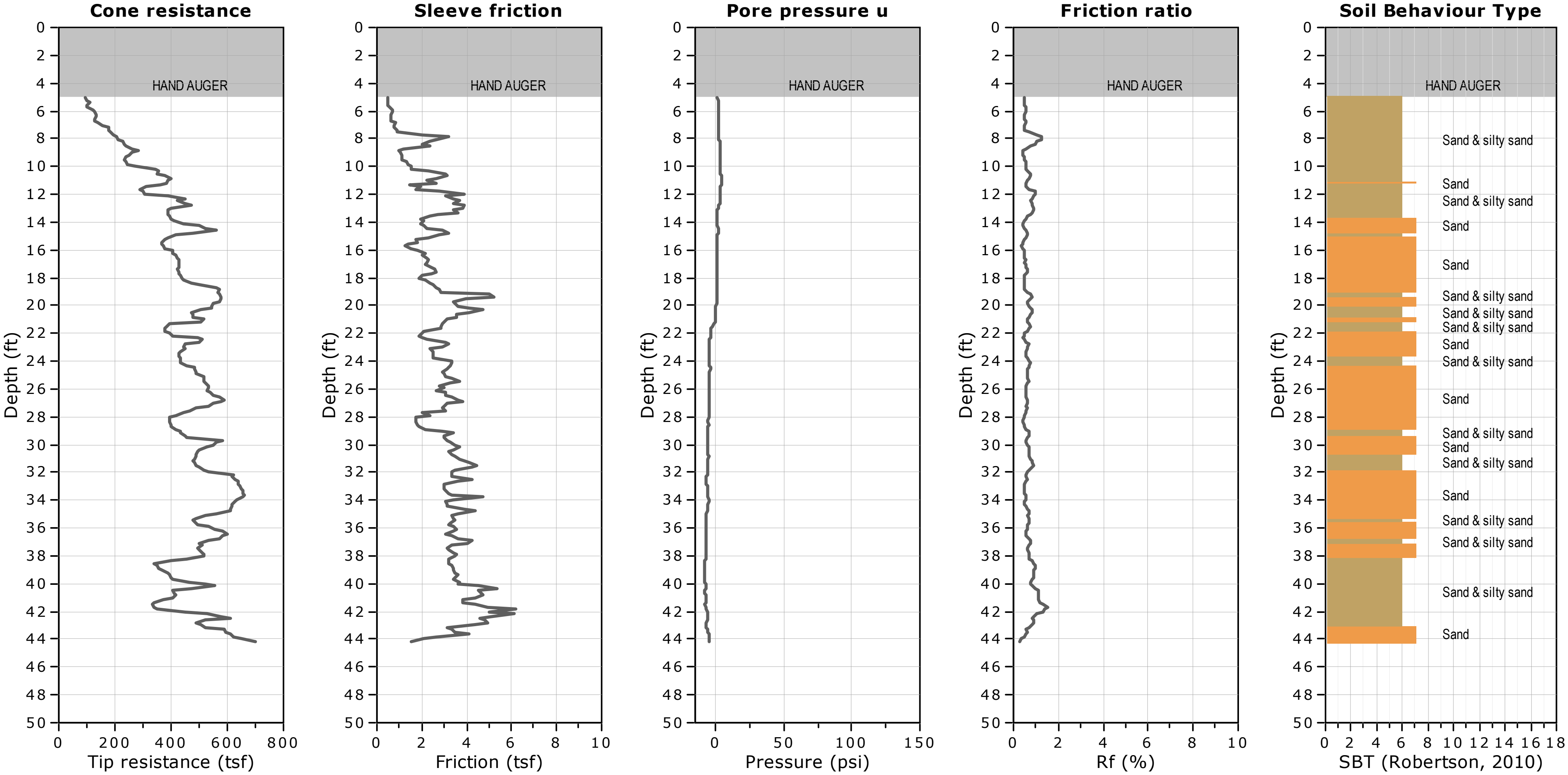
CPT: CPT-1

CLIENT: R.T. FRANKIAN & ASSOCIATES

Field Rep: JIM

SITE: CSC LID SITE X - SANTA CLARITA, CA

Total depth: 44.13 ft, Date: 10/30/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
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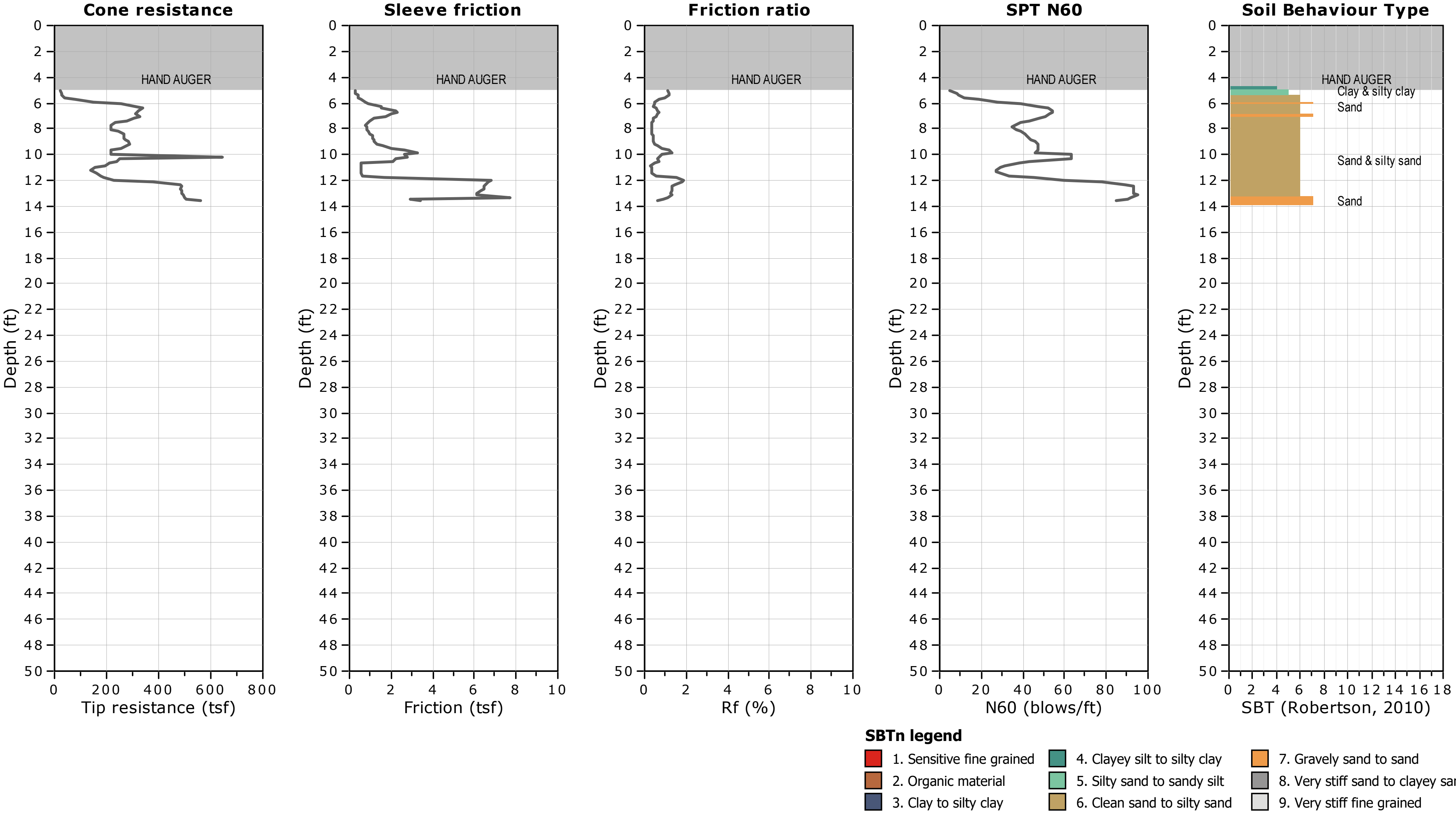
CPT: CPT-2

CLIENT: R.T. FRANKIAN & ASSOCIATES

SITE: CSC LID SITE X - SANTA CLARITA, CA

Field Rep: JIM

Total depth: 13.62 ft, Date: 10/30/2018



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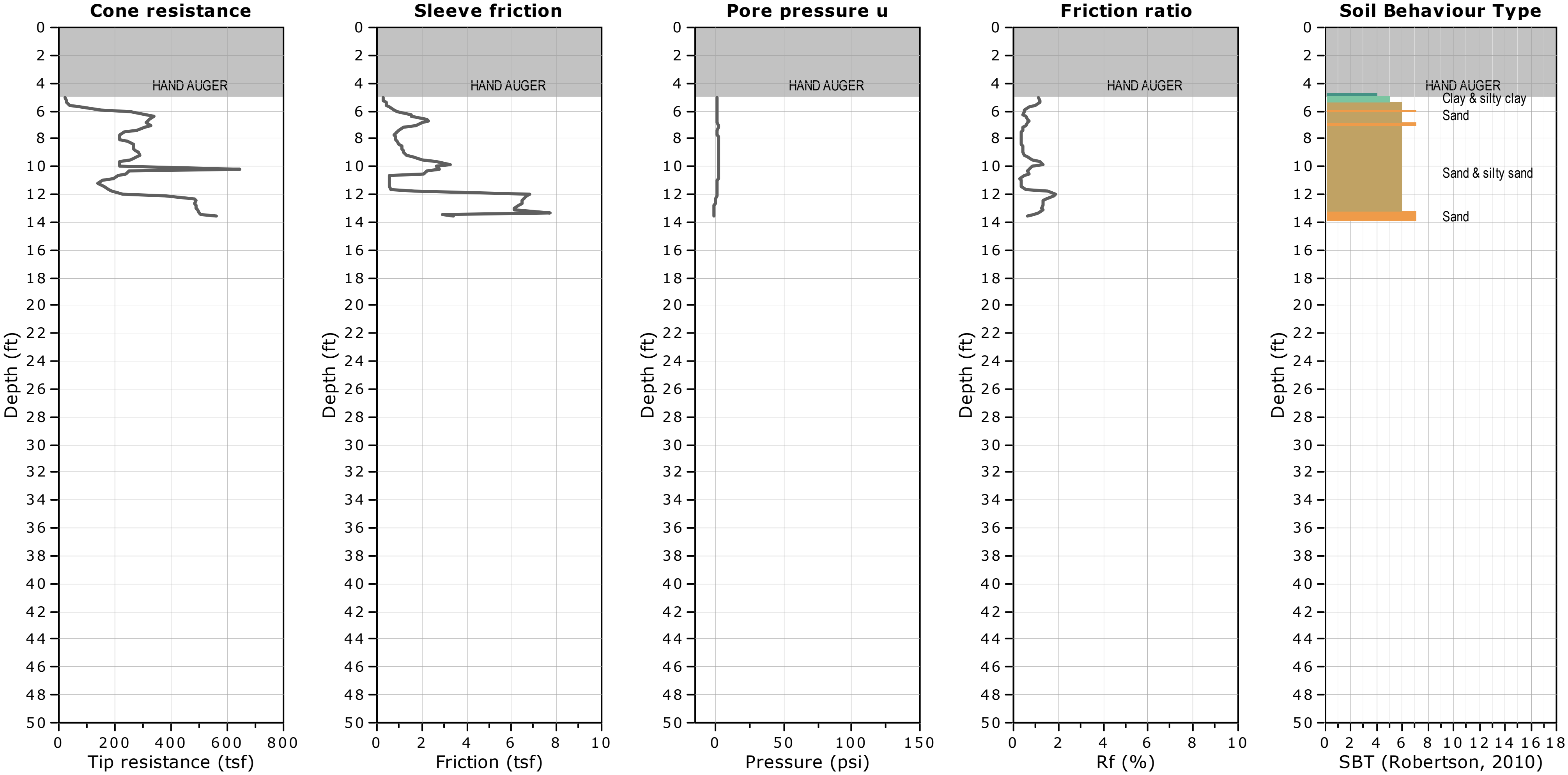
CPT: CPT-2

CLIENT: R.T. FRANKIAN & ASSOCIATES | **Field Rep: JIM**

SITE: CSC LID SITE X - SANTA CLARITA, CA | Total depth: 13.62 ft, Date: 10/30/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
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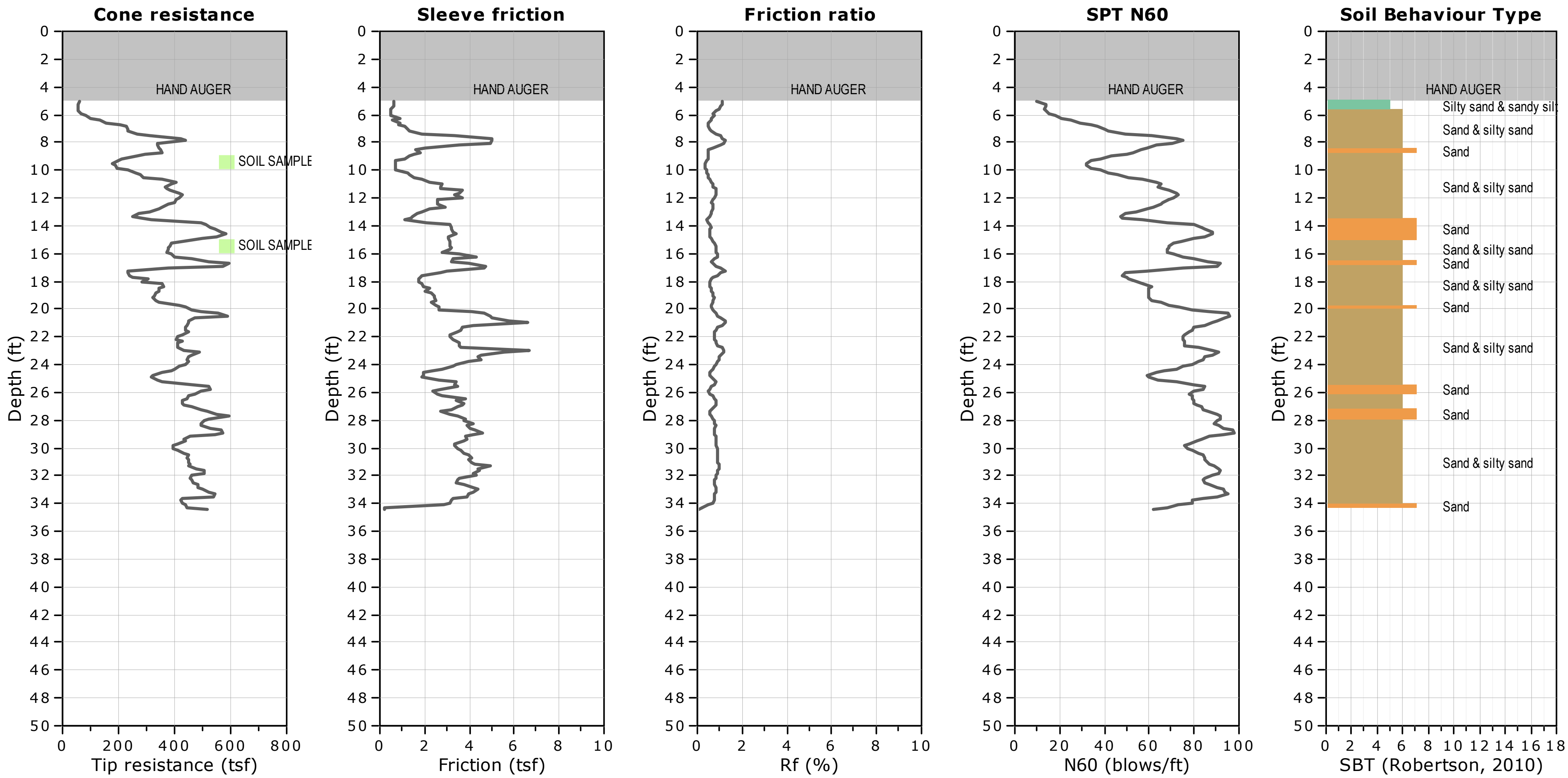
CPT: CPT-3

CLIENT: R.T. FRANKIAN & ASSOCIATES
SITE: CSC LID SITE X - SANTA CLARITA, CA

Field Rep: JIM
Total depth: 34.45 ft, Date: 10/30/2018



SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

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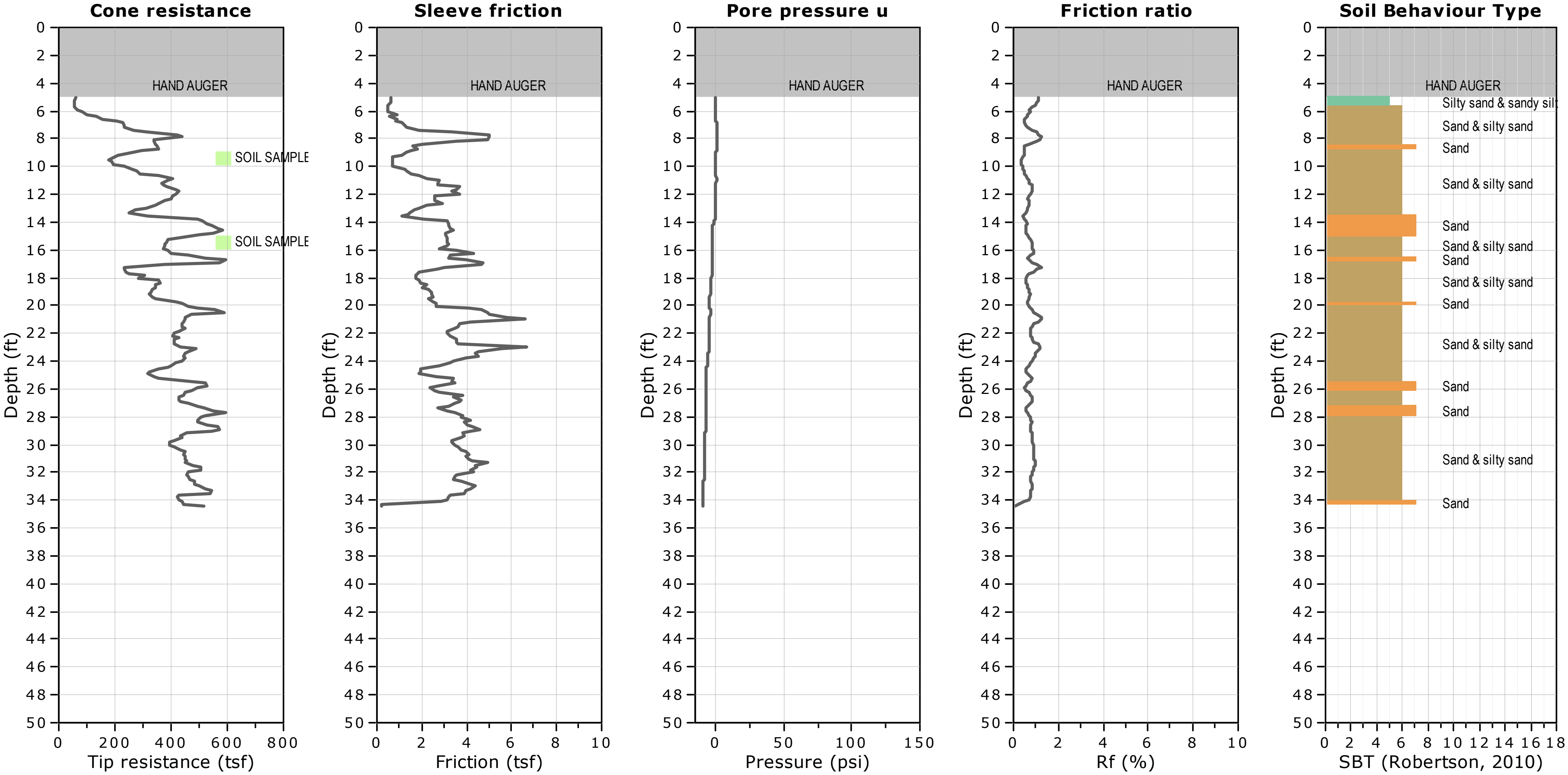
CPT: CPT-3

CLIENT: R.T. FRANKIAN & ASSOCIATES
SITE: CSC LID SITE X - SANTA CLARITA, CA

Field Rep: JIM
Total depth: 34.45 ft, Date: 10/30/2018



SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty clay	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to clayey sand
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
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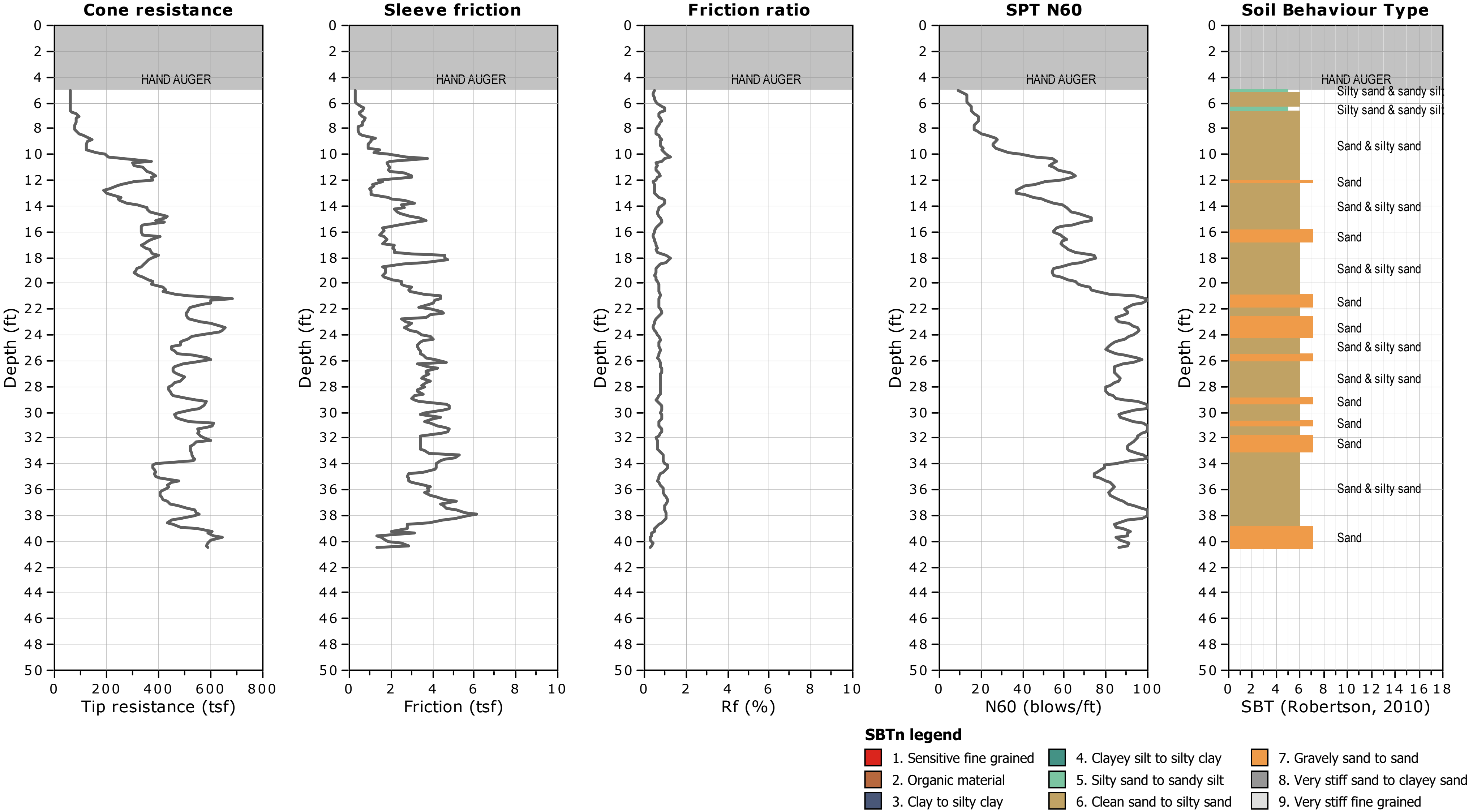
CPT: CPT-4

CLIENT: R.T. FRANKIAN & ASSOCIATES
SITE: CSC LID SITE X - SANTA CLARITA, CA

Field Rep: JIM
Total depth: 40.52 ft, Date: 10/30/2018



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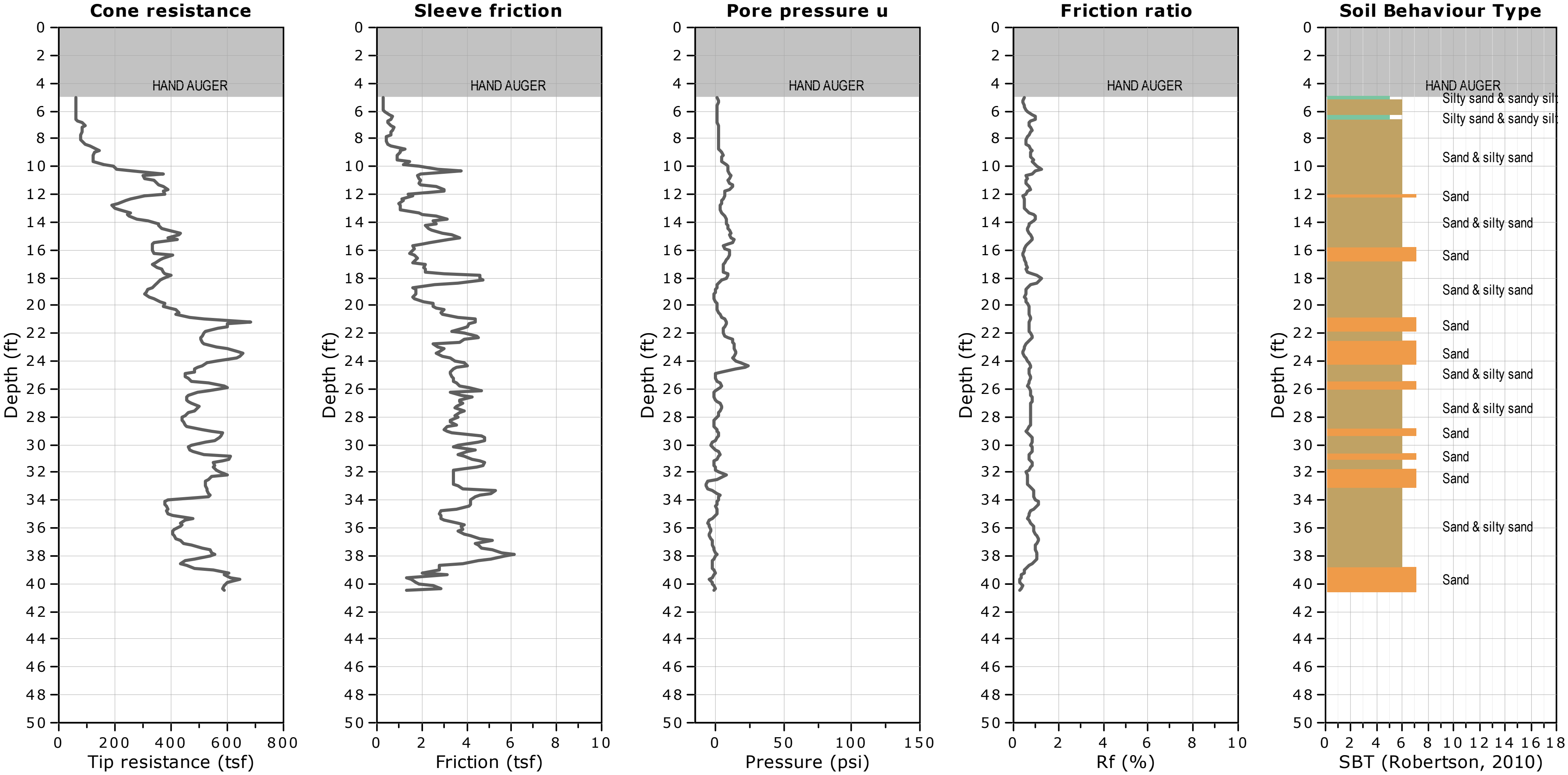
CPT: CPT-4

CLIENT: R.T. FRANKIAN & ASSOCIATES

SITE: CSC LID SITE X - SANTA CLARITA, CA

Field Rep: JIM

Total depth: 40.52 ft, Date: 10/30/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
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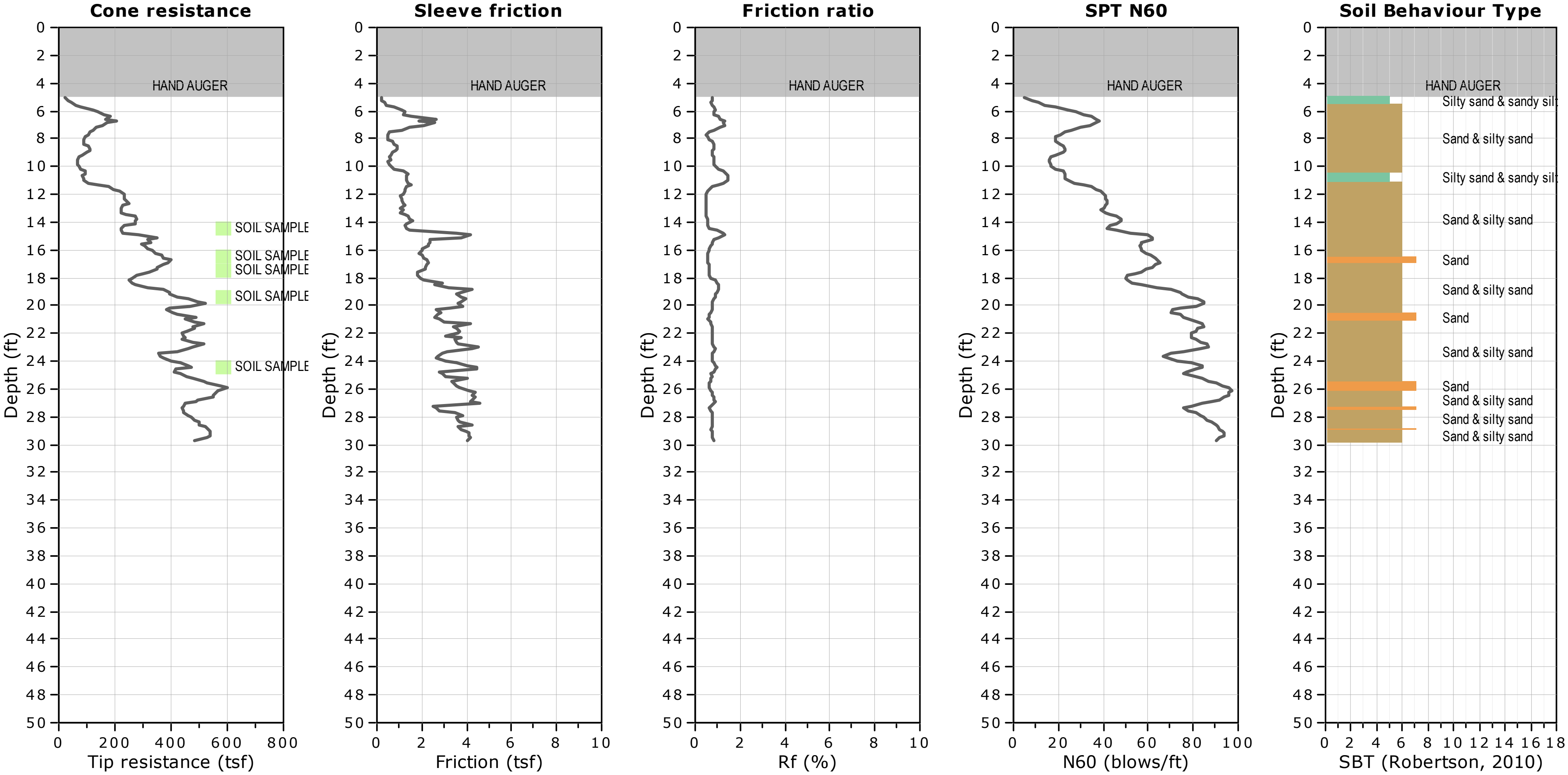
CPT: CPT-5

CLIENT: R.T. FRANKIAN & ASSOCIATES
SITE: CSC LID SITE X - SANTA CLARITA, CA

Field Rep: JIM
Total depth: 29.69 ft, Date: 10/30/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

GREGG DRILLING, INC.
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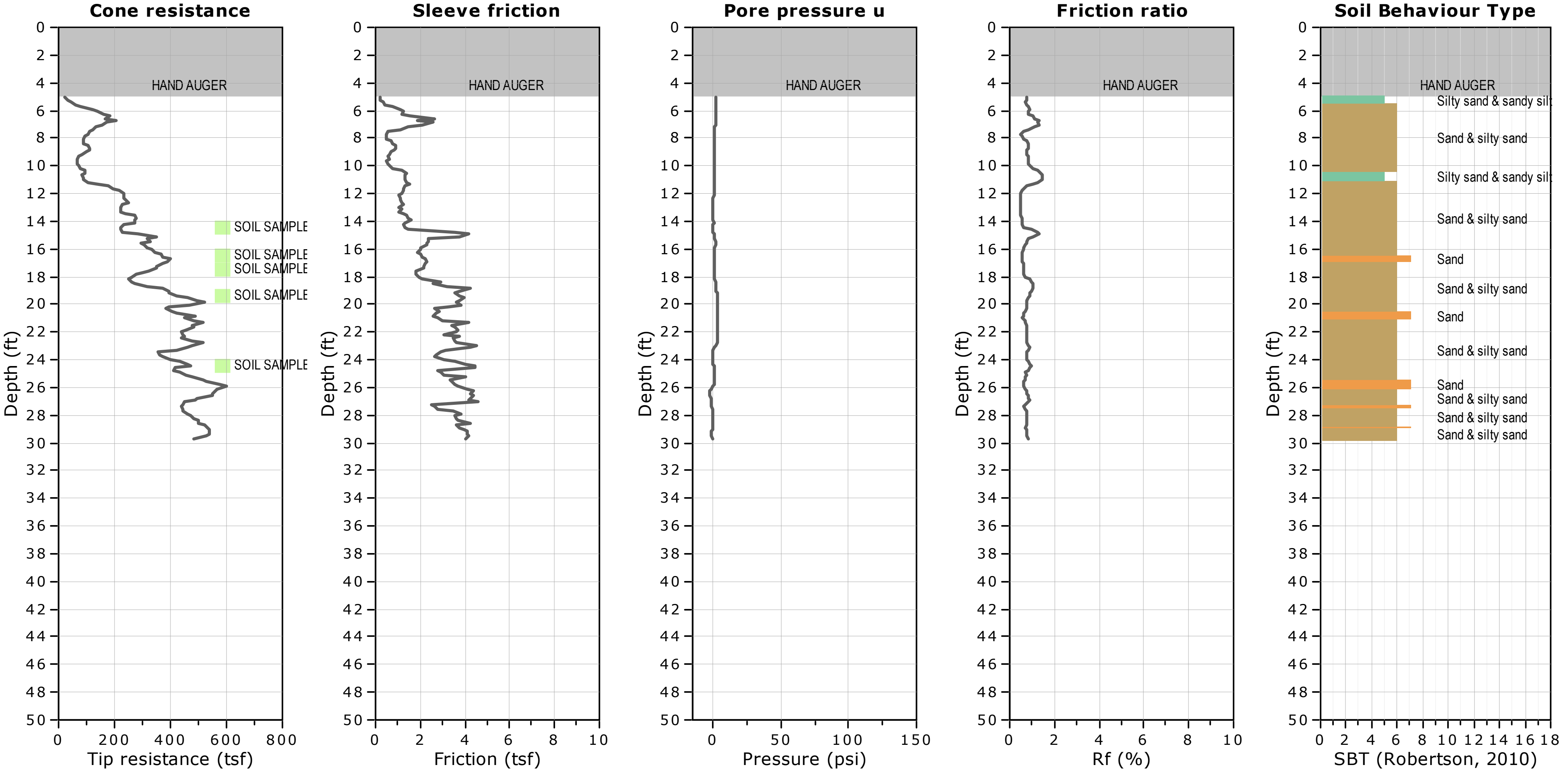
CPT: CPT-5

CLIENT: R.T. FRANKIAN & ASSOCIATES
SITE: CSC LID SITE X - SANTA CLARITA, CA

Field Rep: JIM
Total depth: 29.69 ft, Date: 10/30/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
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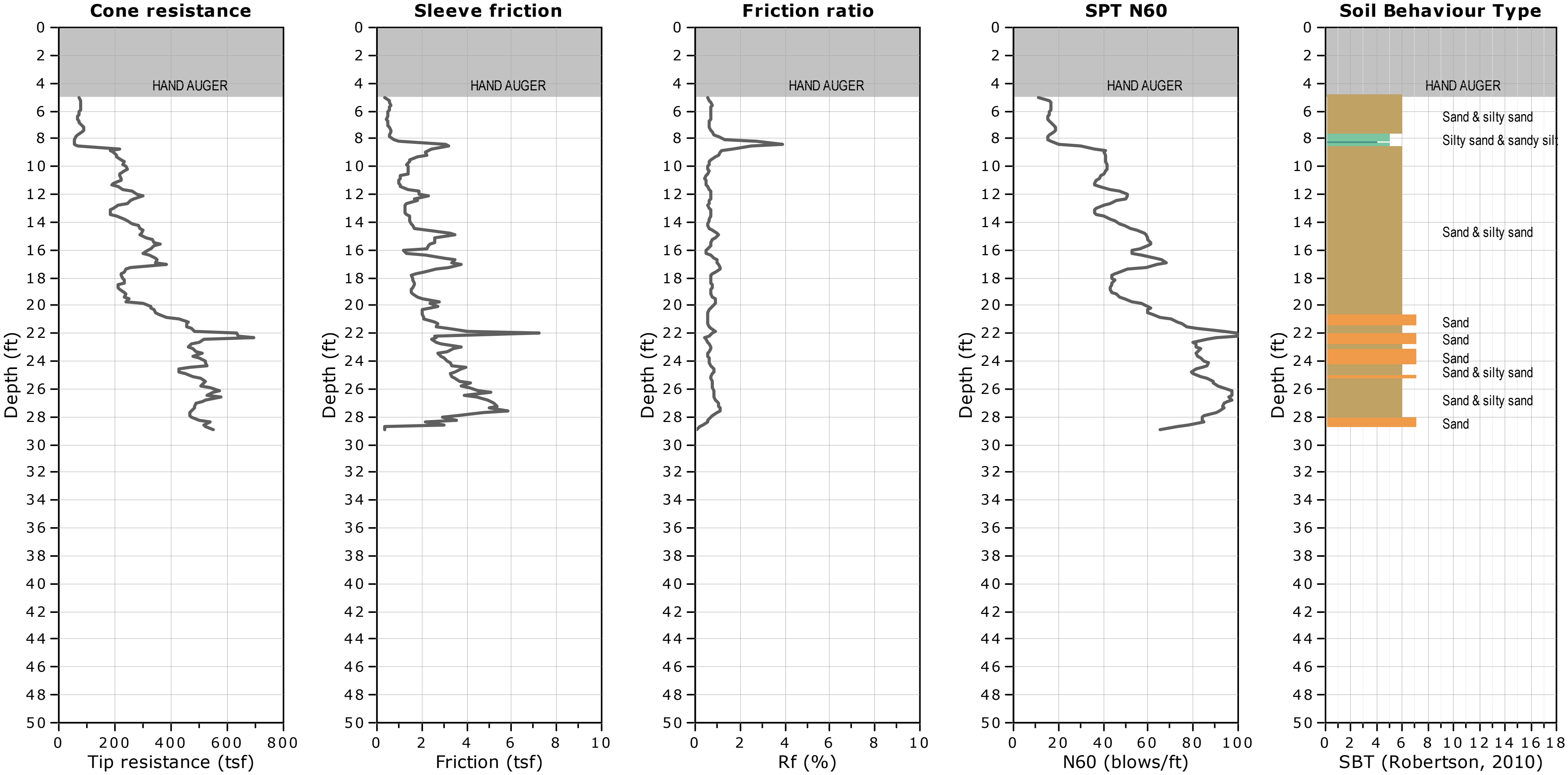
CPT: CPT-6

CLIENT: R.T. FRANKIAN & ASSOCIATES
SITE: CSC LID SITE X - SANTA CLARITA, CA

Field Rep: JIM
Total depth: 28.87 ft, Date: 10/31/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

GREGG DRILLING, INC.
www.greggdrilling.com

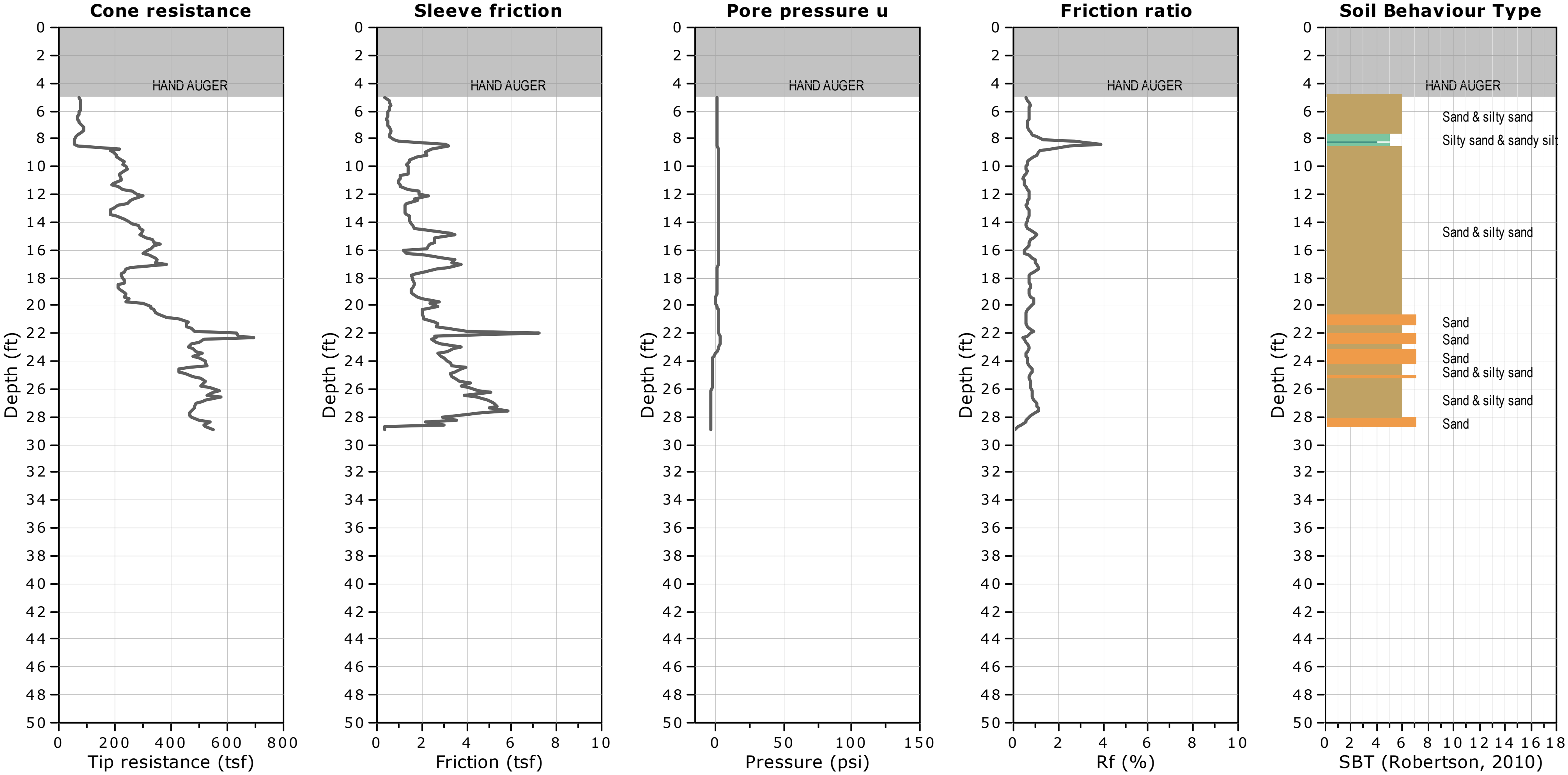
CPT: CPT-6

CLIENT: R.T. FRANKIAN & ASSOCIATES

SITE: CSC LID SITE X - SANTA CLARITA, CA

Field Rep: JIM

Total depth: 28.87 ft, Date: 10/31/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

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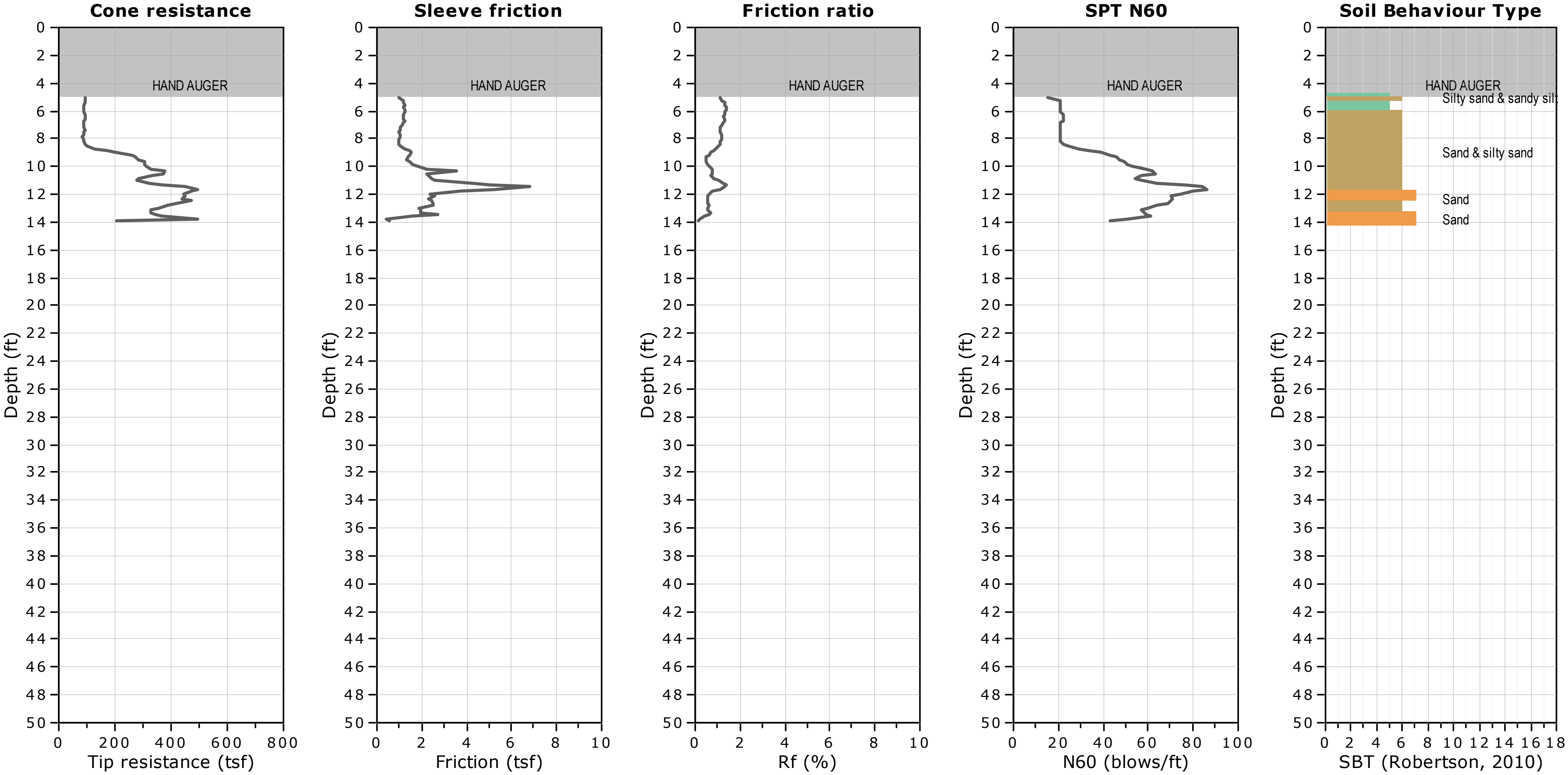
CPT: CPT-7

CLIENT: R.T. FRANKIAN & ASSOCIATES

SITE: CSC LID SITE X - SANTA CLARITA, CA

Field Rep: JIM

Total depth: 13.94 ft, Date: 10/31/2018



SBTn legend

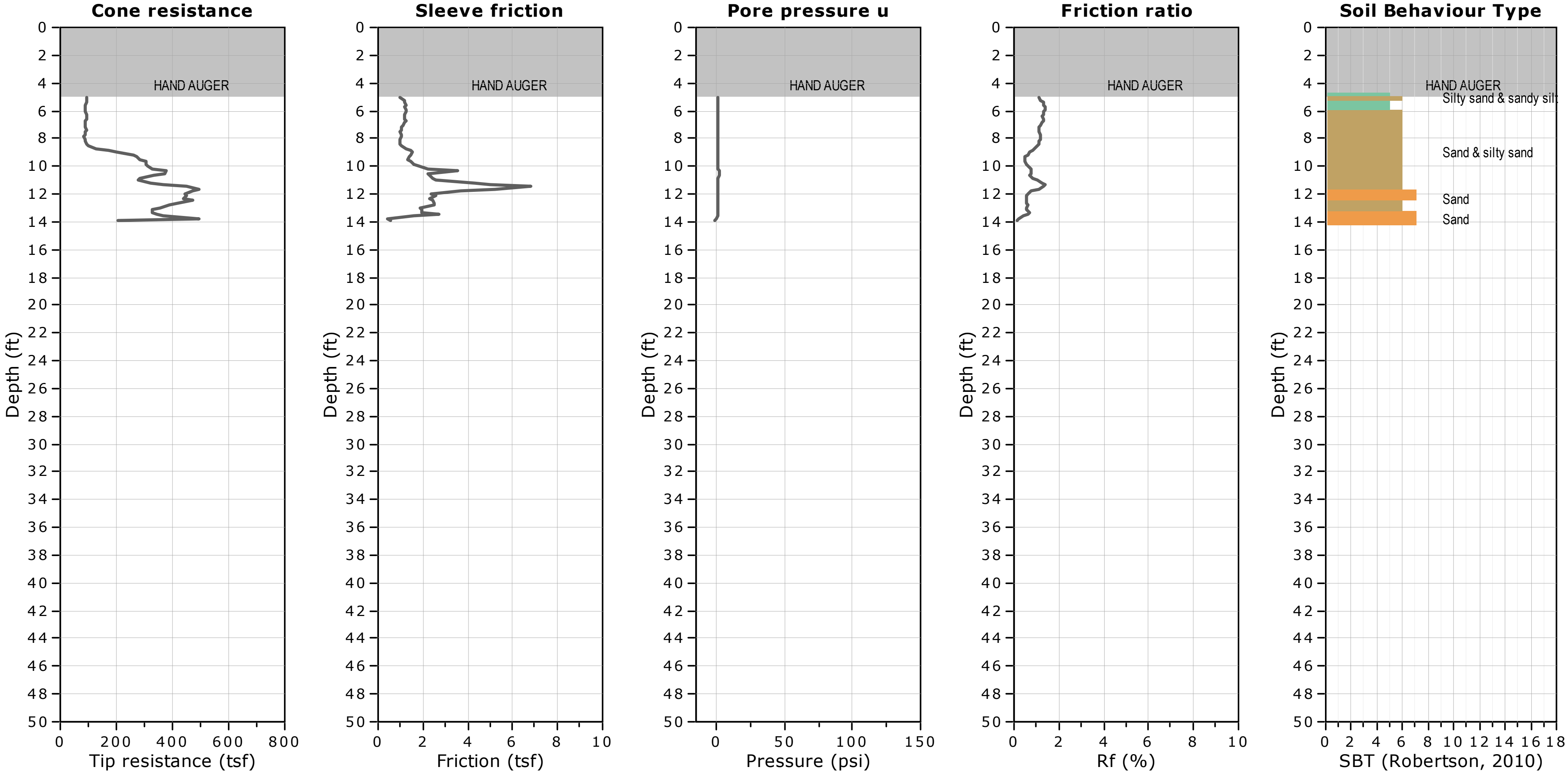
1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

GREGG DRILLING, INC.
www.greggdrilling.com

CPT: CPT-7

CLIENT: R.T. FRANKIAN & ASSOCIATES
SITE: CSC LID SITE X - SANTA CLARITA, CA

Field Rep: JIM
Total depth: 13.94 ft, Date: 10/31/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

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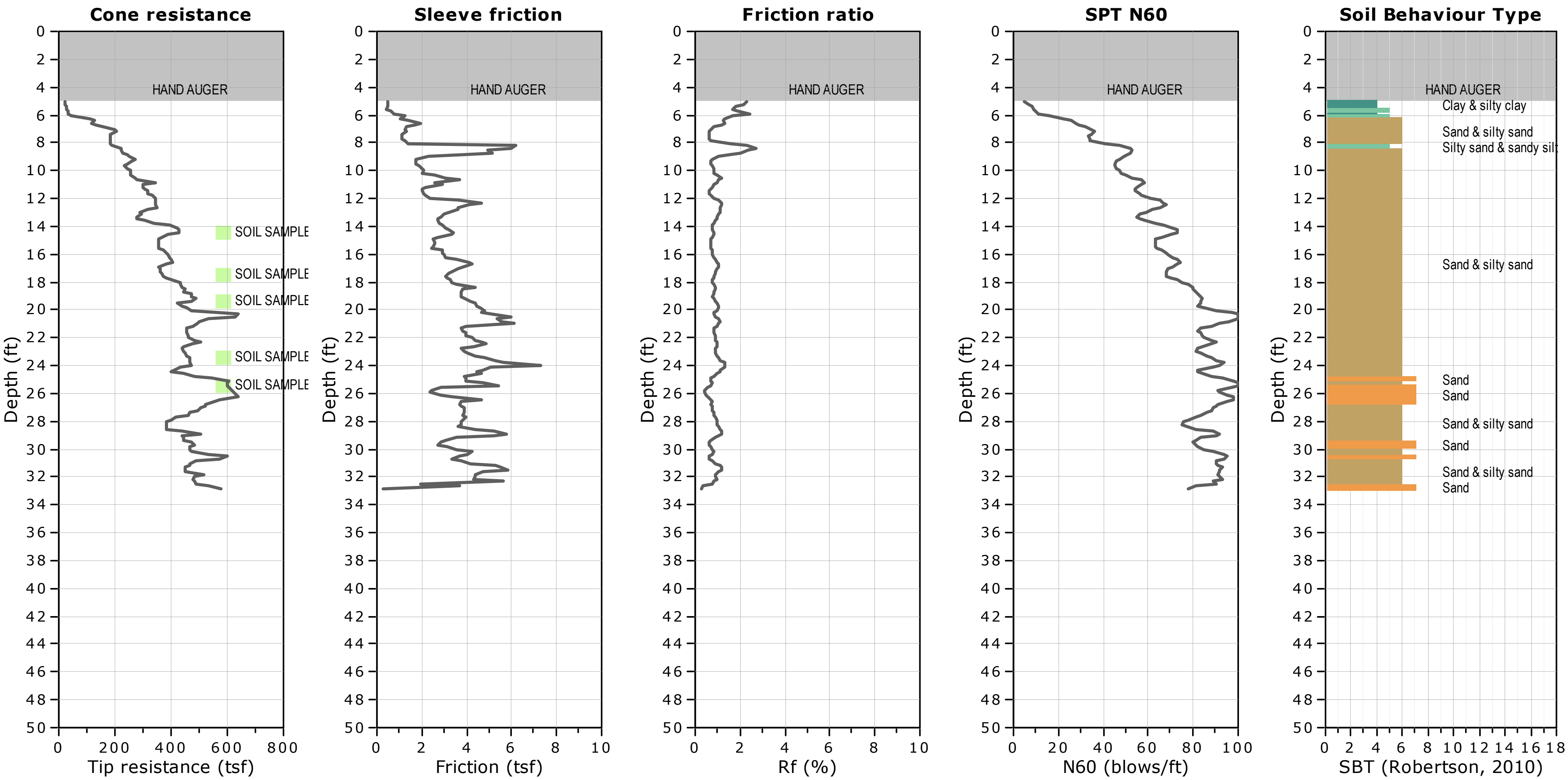
CPT: CPT-8

CLIENT: R.T. FRANKIAN & ASSOCIATES **Field Rep: JIM**

SITE: CSC LID SITE X - SANTA CLARITA, CA

Total depth: 32.81 ft, Date: 10/31/2018



SBTn legend

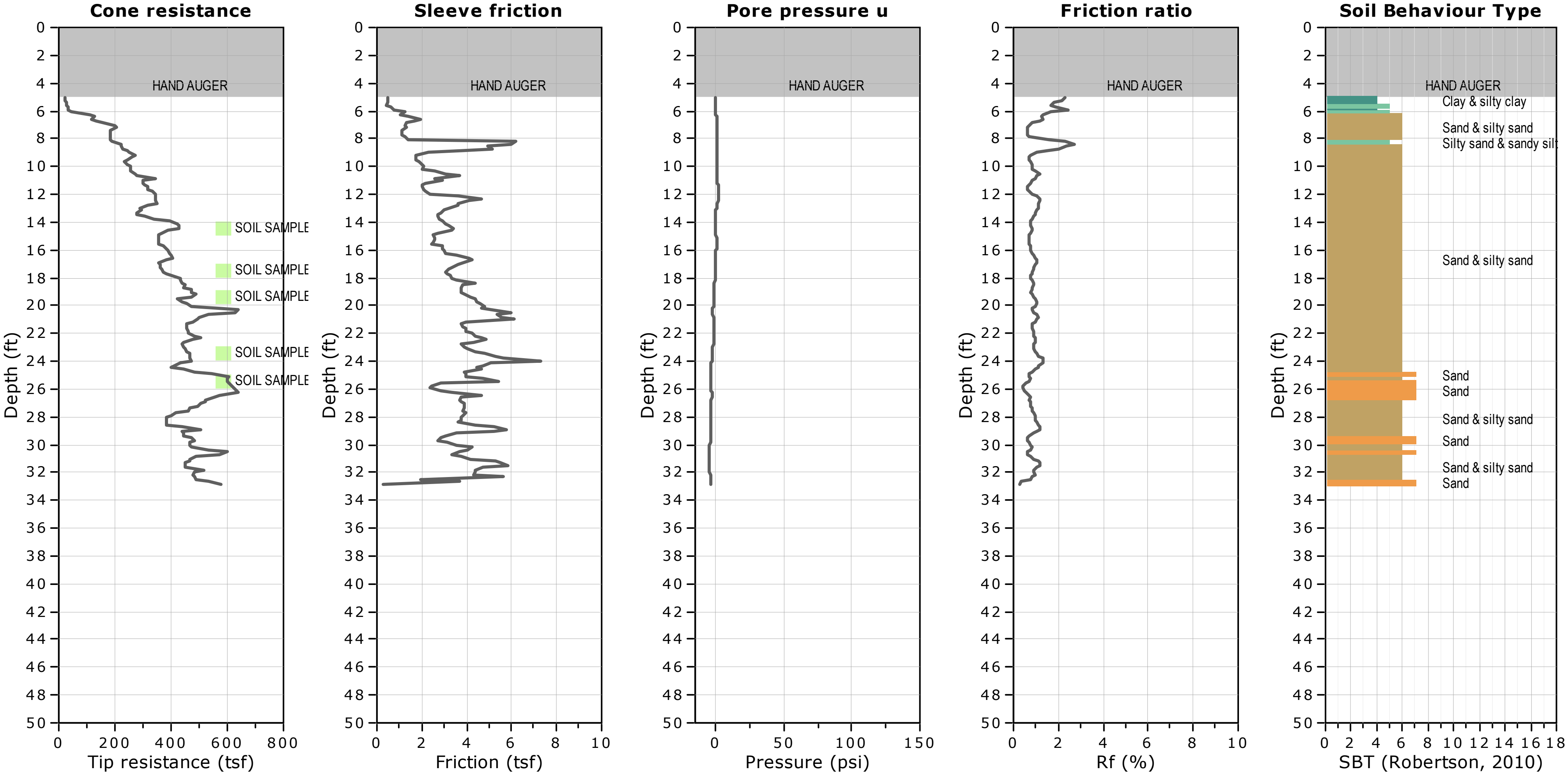
1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

GREGG DRILLING, INC.
www.greggdrilling.com

CPT: CPT-8

CLIENT: R.T. FRANKIAN & ASSOCIATES
SITE: CSC LID SITE X - SANTA CLARITA, CA

Field Rep: JIM
Total depth: 32.81 ft, Date: 10/31/2018



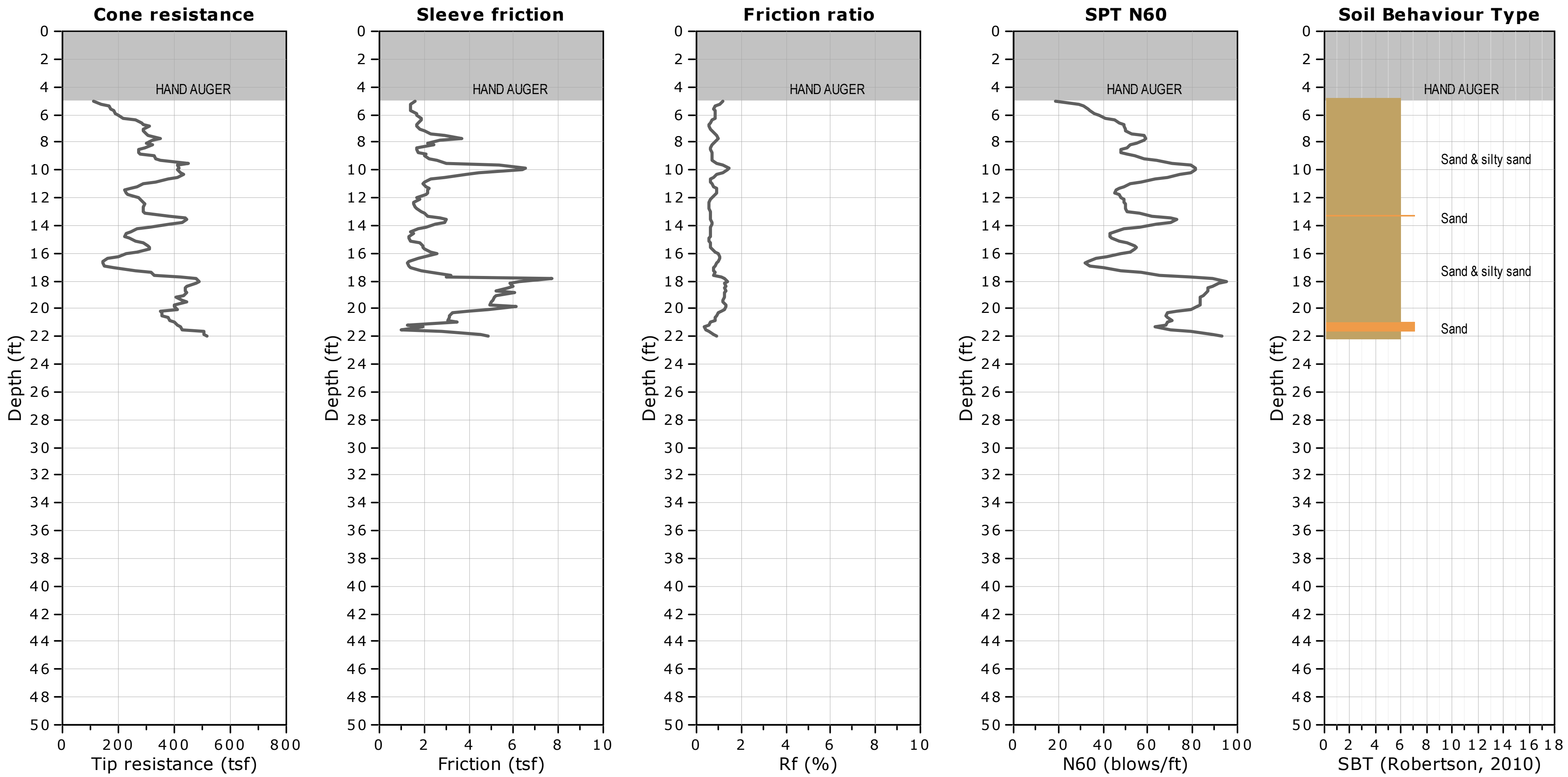
SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

CLIENT: R.T. FRANKIAN & ASSOCIATES | **Field Rep: JIM**

SITE: CSC LID SITE X - SANTA CLARITA, CA | Total depth: 21.98 ft, Date: 10/31/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

GREGG DRILLING, INC.
www.greggdrilling.com

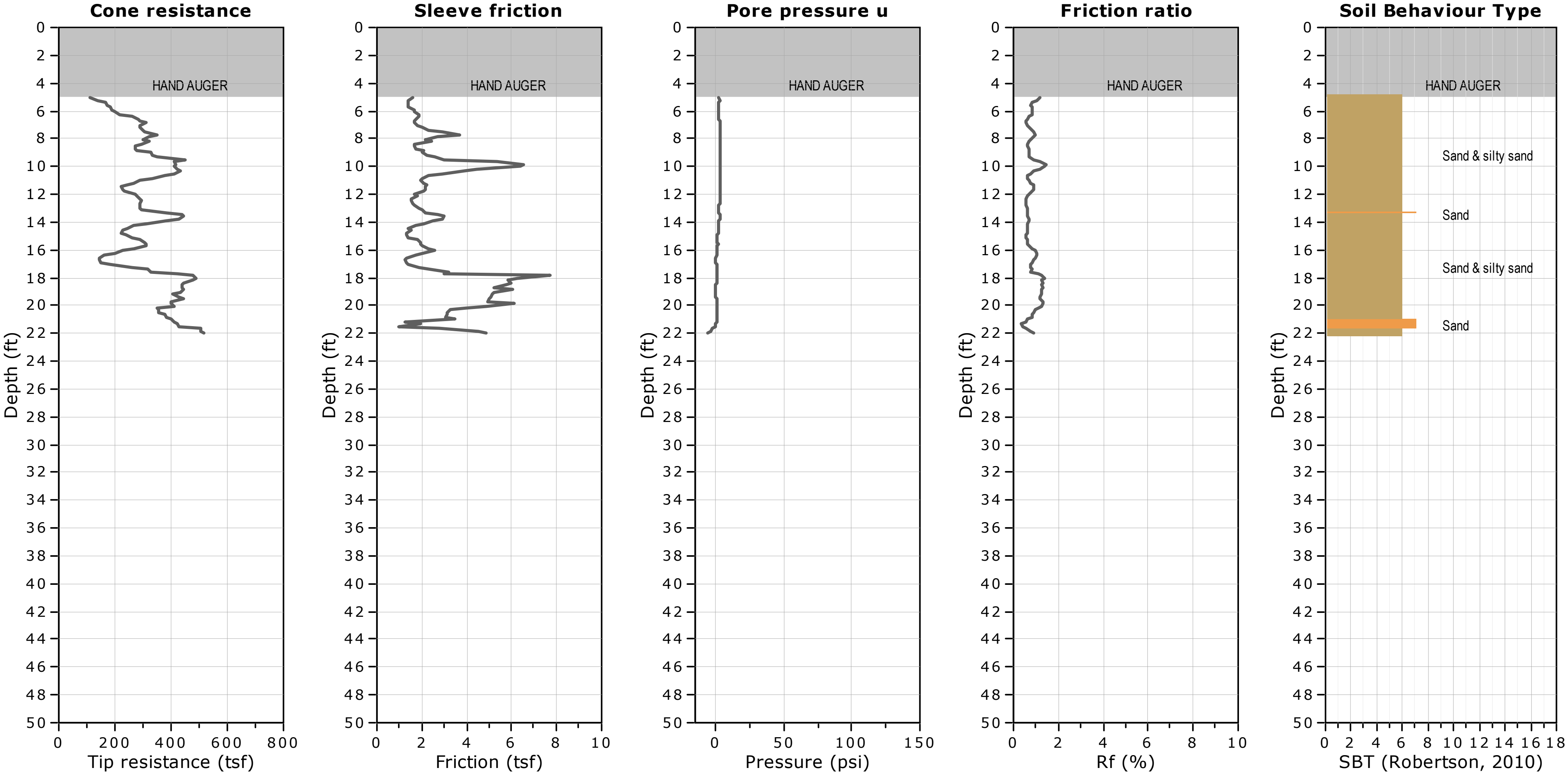
CPT: CPT-9

CLIENT: R.T. FRANKIAN & ASSOCIATES

SITE: CSC LID SITE X - SANTA CLARITA, CA

Field Rep: JIM

Total depth: 21.98 ft, Date: 10/31/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

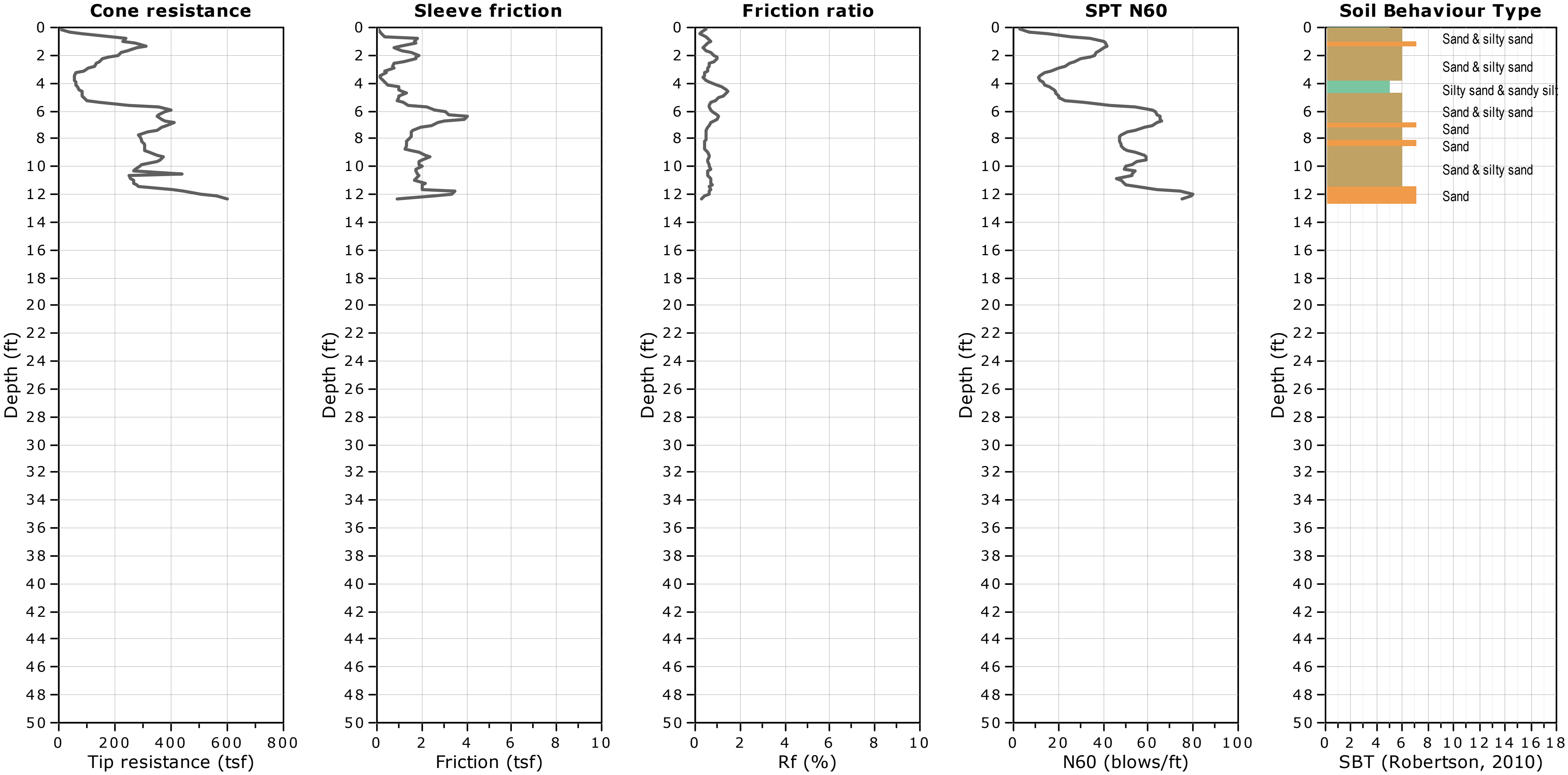
GREGG DRILLING, INC.
www.greggdrilling.com

CPT: CPT-10

CLIENT: R.T. FRANKIAN & ASSOCIATES | **Field Rep: JIM**

SITE: CSC LID SITE X - SANTA CLARITA, CA

Total depth: 12.30 ft, Date: 11/1/2018



SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

GREGG DRILLING, INC.
www.greggdrilling.com

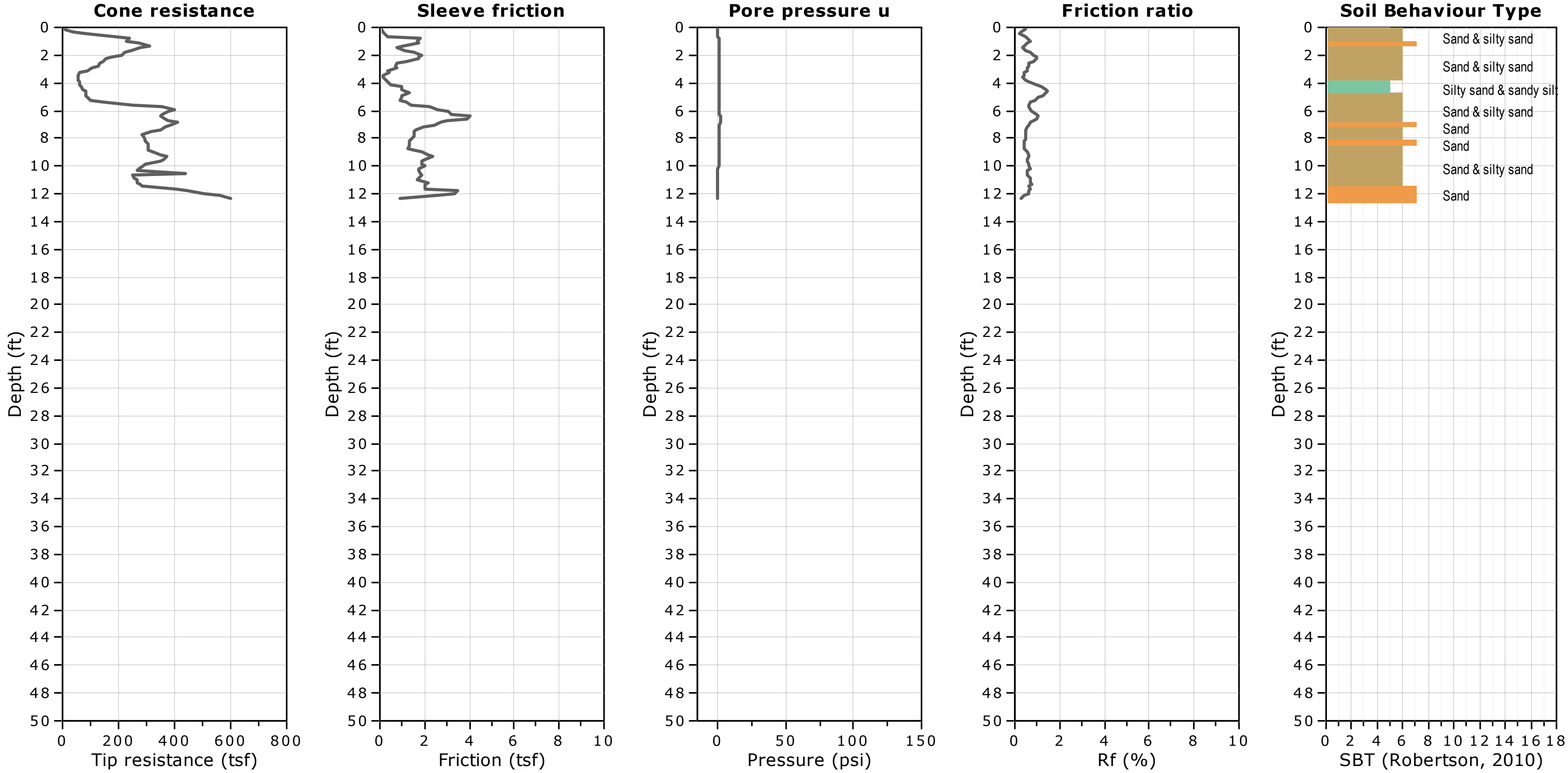
CPT: CPT-10

CLIENT: R.T. FRANKIAN & ASSOCIATES

SITE: CSC LID SITE X - SANTA CLARITA, CA

Field Rep: JIM

Total depth: 12.30 ft, Date: 11/1/2018



SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty clay	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to clayey sand
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

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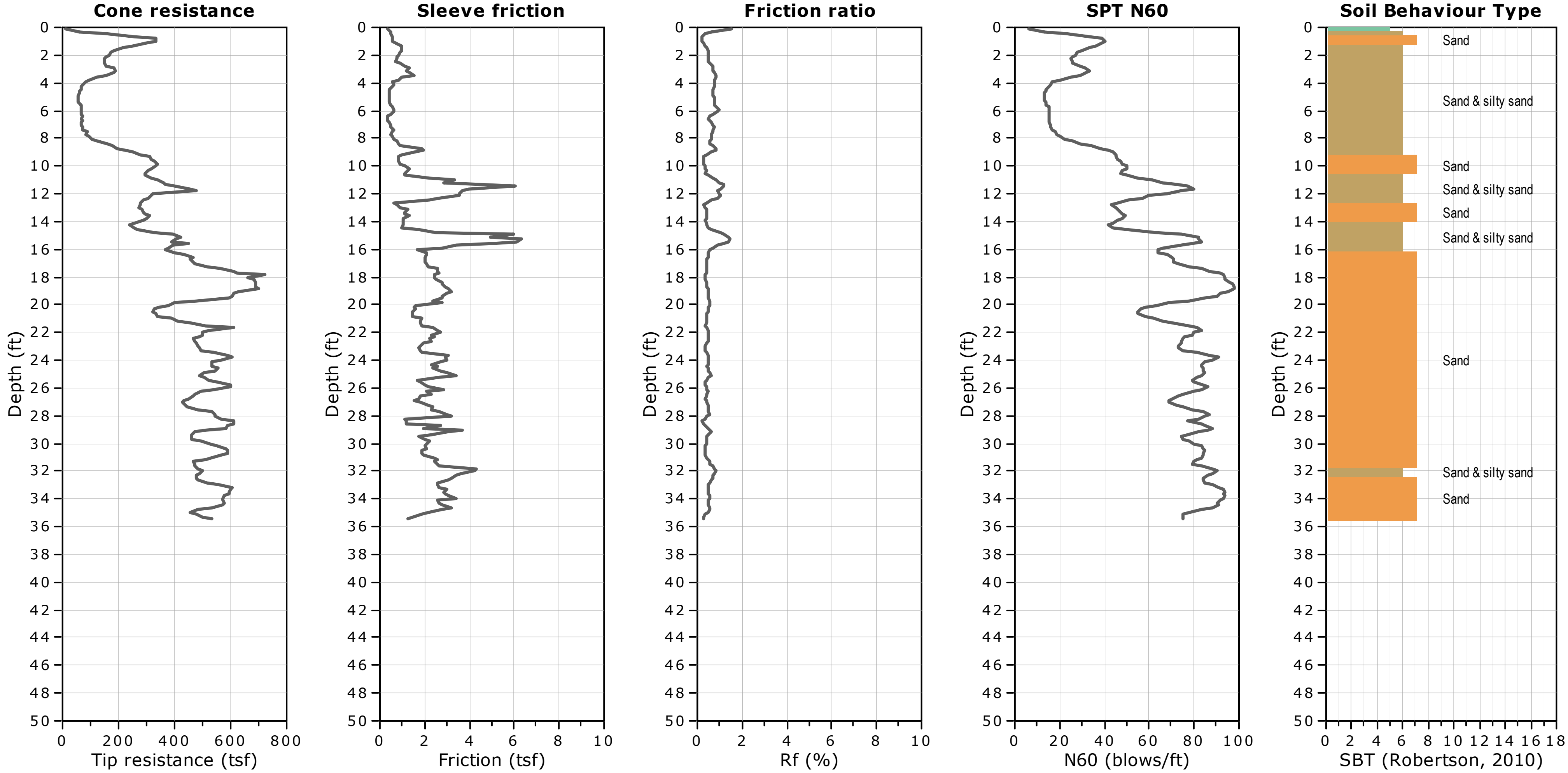
CPT: CPT-11

CLIENT: R.T. FRANKIAN & ASSOCIATES

SITE: CSC LID SITE X - SANTA CLARITA, CA

Field Rep: JIM

Total depth: 35.43 ft, Date: 11/1/2018



SBTn legend

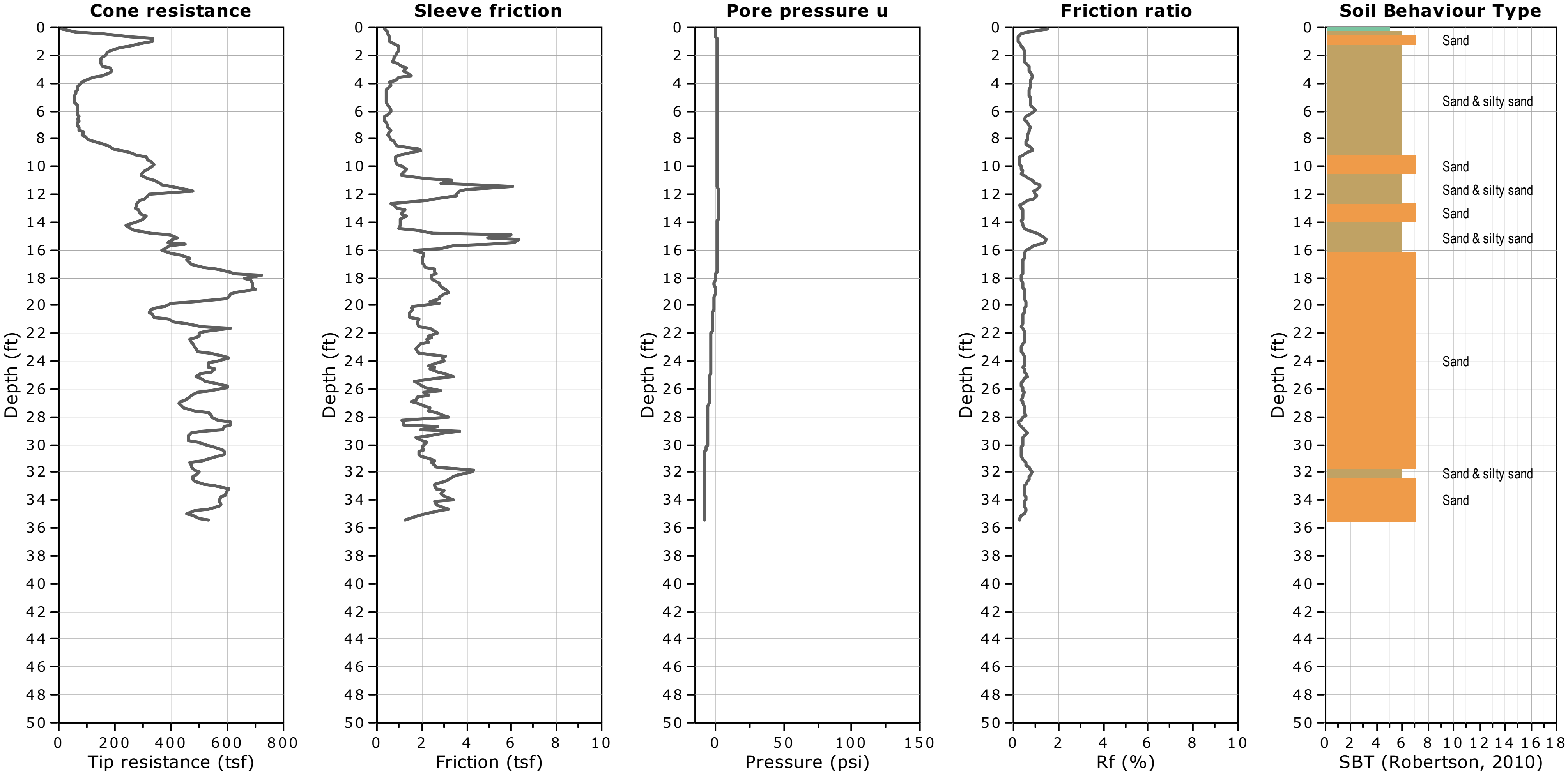
1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

GREGG DRILLING, INC.
www.greggdrilling.com

CPT: CPT-11

CLIENT: R.T. FRANKIAN & ASSOCIATES
SITE: CSC LID SITE X - SANTA CLARITA, CA

Field Rep: JIM
Total depth: 35.43 ft, Date: 11/1/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

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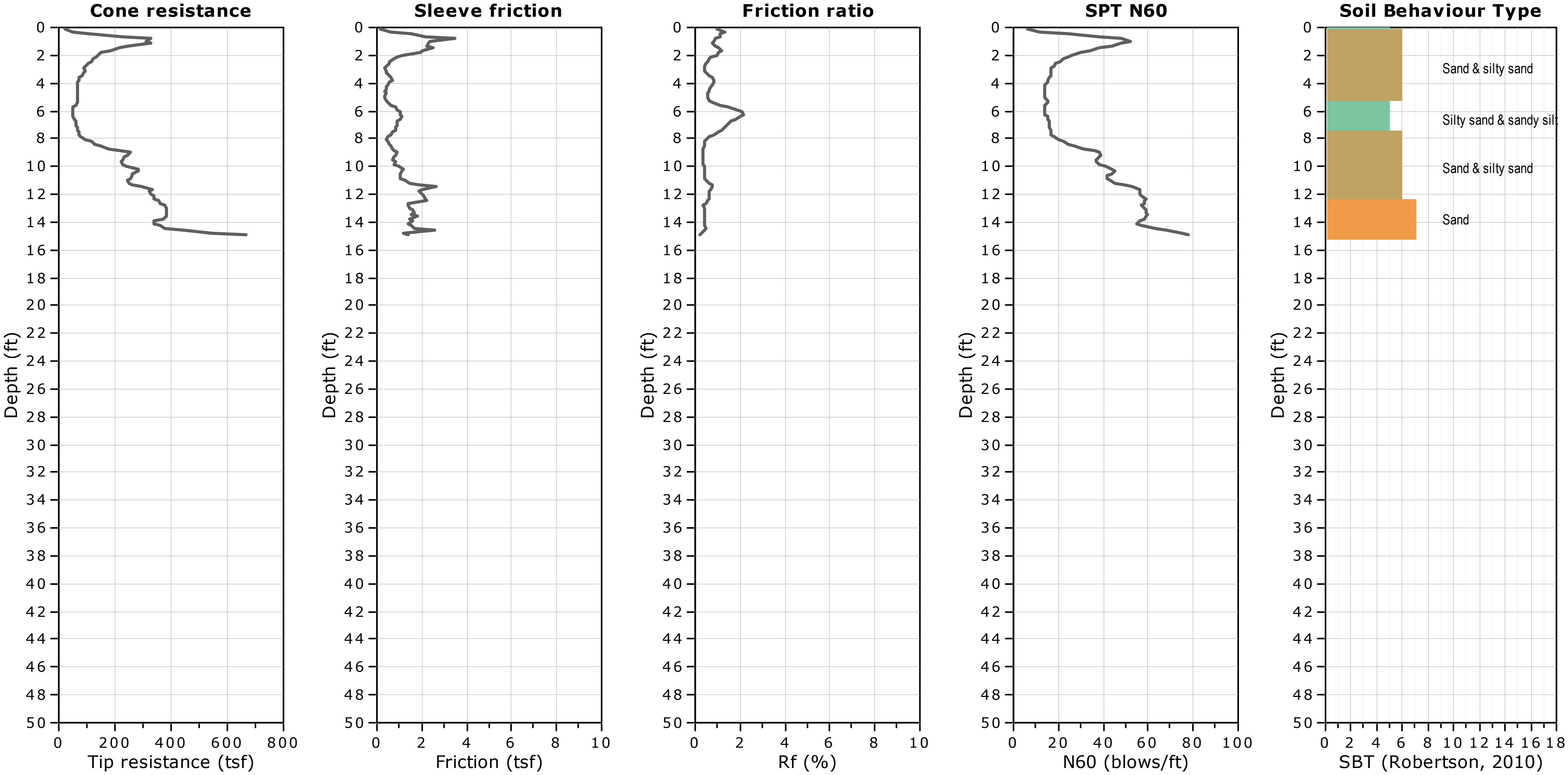
CPT: CPT-12

CLIENT: R.T. FRANKIAN & ASSOCIATES

SITE: CSC LID SITE X - SANTA CLARITA, CA

Field Rep: JIM

Total depth: 14.93 ft, Date: 11/1/2018



SBTn legend

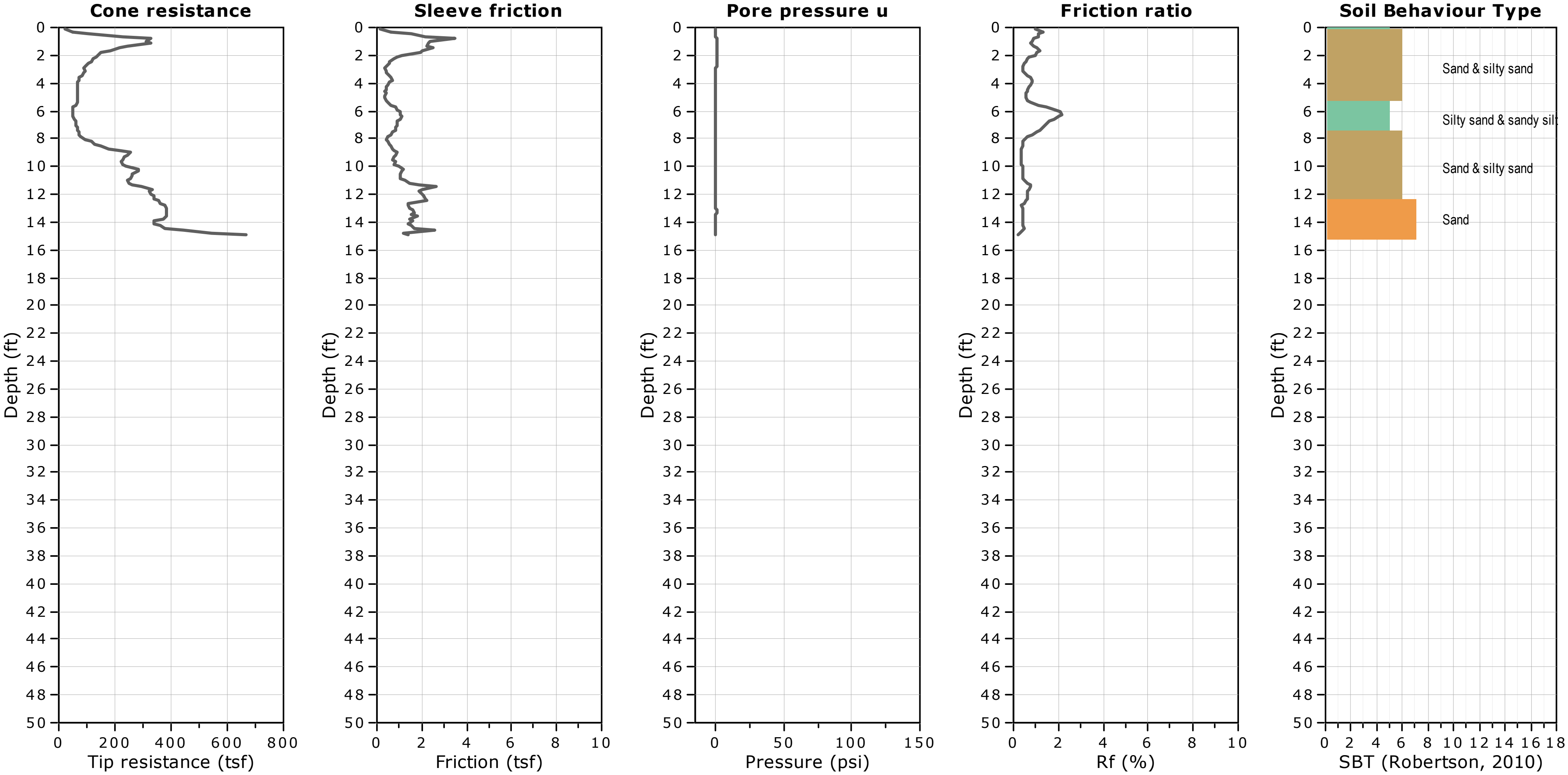
1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

GREGG DRILLING, INC.
www.greggdrilling.com

CPT: CPT-12

CLIENT: R.T. FRANKIAN & ASSOCIATES
SITE: CSC LID SITE X - SANTA CLARITA, CA

Field Rep: JIM
Total depth: 14.93 ft, Date: 11/1/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

APPENDIX B

LABORATORY TESTS

LABORATORY TESTS

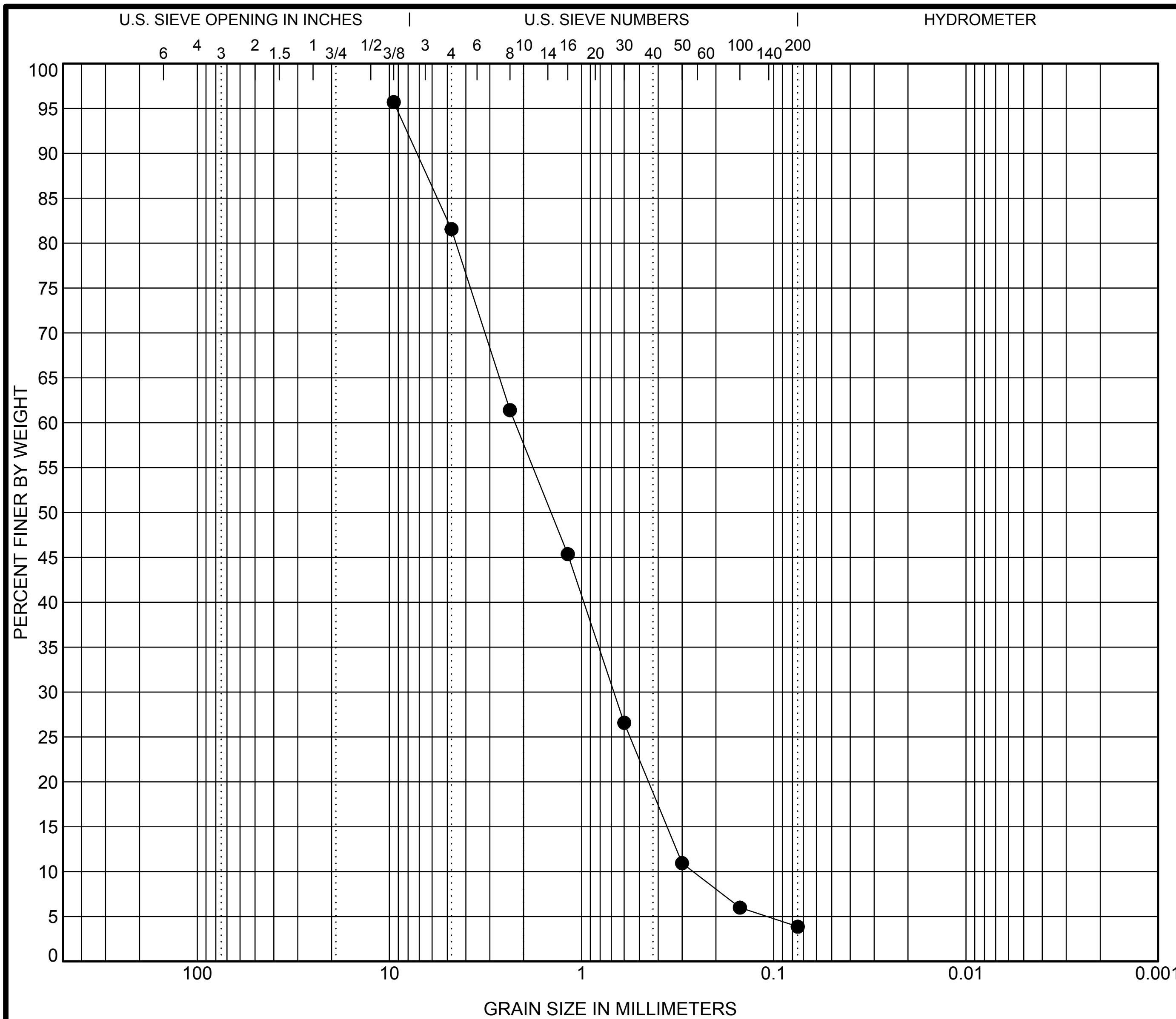
Laboratory tests were performed on selected samples, obtained from the CPT soundings and hollow-stem test borings, to aid in the classification of the soils and to determine the pertinent engineering properties of the soils. The laboratory tests performed included moisture content and dry density determinations, sieve tests, R-value tests, and corrosion tests. The results of the moisture content and dry density tests are indicated on the boring logs.

Moisture and Density Tests: Moisture content and unit dry density tests were performed on samples of undisturbed soil obtained in the test borings. Dry density and field moisture information is useful in correlating field and laboratory data and in providing an indication of the variations of soil characteristics. The results of these tests are shown on the Log of Borings in Appendix A.

Sieve Tests: Sieve tests were performed to determine the distribution of grain sizes in selected soil samples. The purpose of the tests was to assist in classifying the soil. The results of the sieve analysis tests are presented as an attachment to this report.

R-value Tests: R-value tests were performed to measure the response of a compacted sample of soil or aggregate to a vertically applied pressure under specific conditions and is used in pavement design. Samples were submitted to LaBelle Marvin, pavement engineers, for laboratory testing.

Corrosion Tests: Corrosion tests are performed to determine soil characteristics relative to potential for corrosion. Samples were submitted to HDR, corrosion engineers, for laboratory testing.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**B-4**	**15.0**	**POORLY GRADED SAND with GRAVEL(SP)**					
⊠								
▲								
★								
⊙								

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-4**	**15.0**	**9.5**	**2.222**	**0.679**	**0.263**	**14.1**	**77.7**	**3.9**	
⊠										
▲										
★										
⊙										

R. T. Frankian & Associates
26027 Huntington Lane, Suite A
Santa Clarita CA 91355
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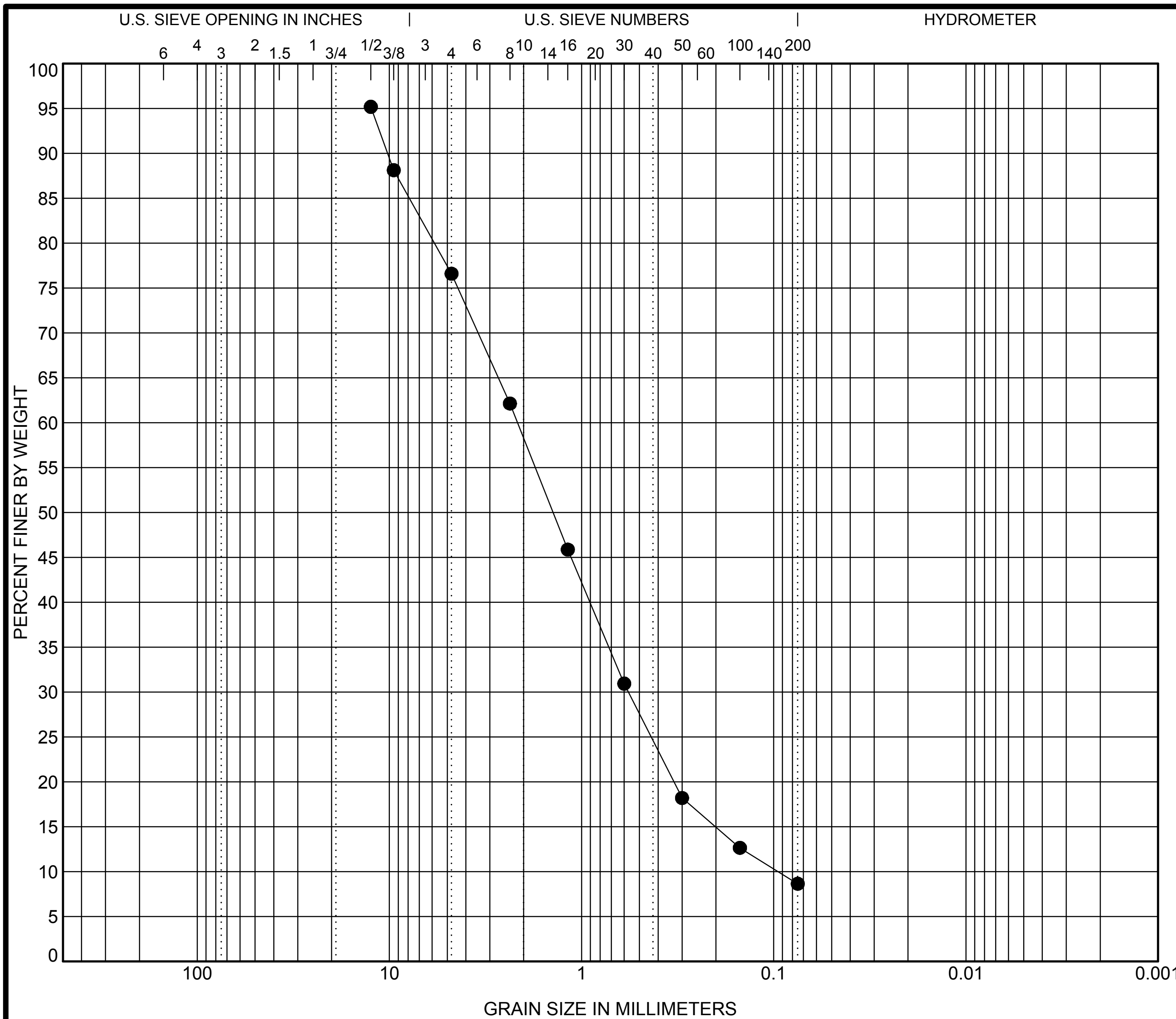
Fax: 818 531 1510

GRAIN SIZE DISTRIBUTION

JOB NUMBER: 2018-003-054

REPORT DATED:

US GRAIN SIZE 2018-003-054.GPJ FRANKIAN.GDT 2/9/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-4	18.0						
⧗								
▲								
★								
⊙								

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-4**	**18.0**	**12.5**	**2.155**	**0.57**	**0.095**	**18.6**	**67.9**	**8.6**	
⧗										
▲										
★										
⊙										

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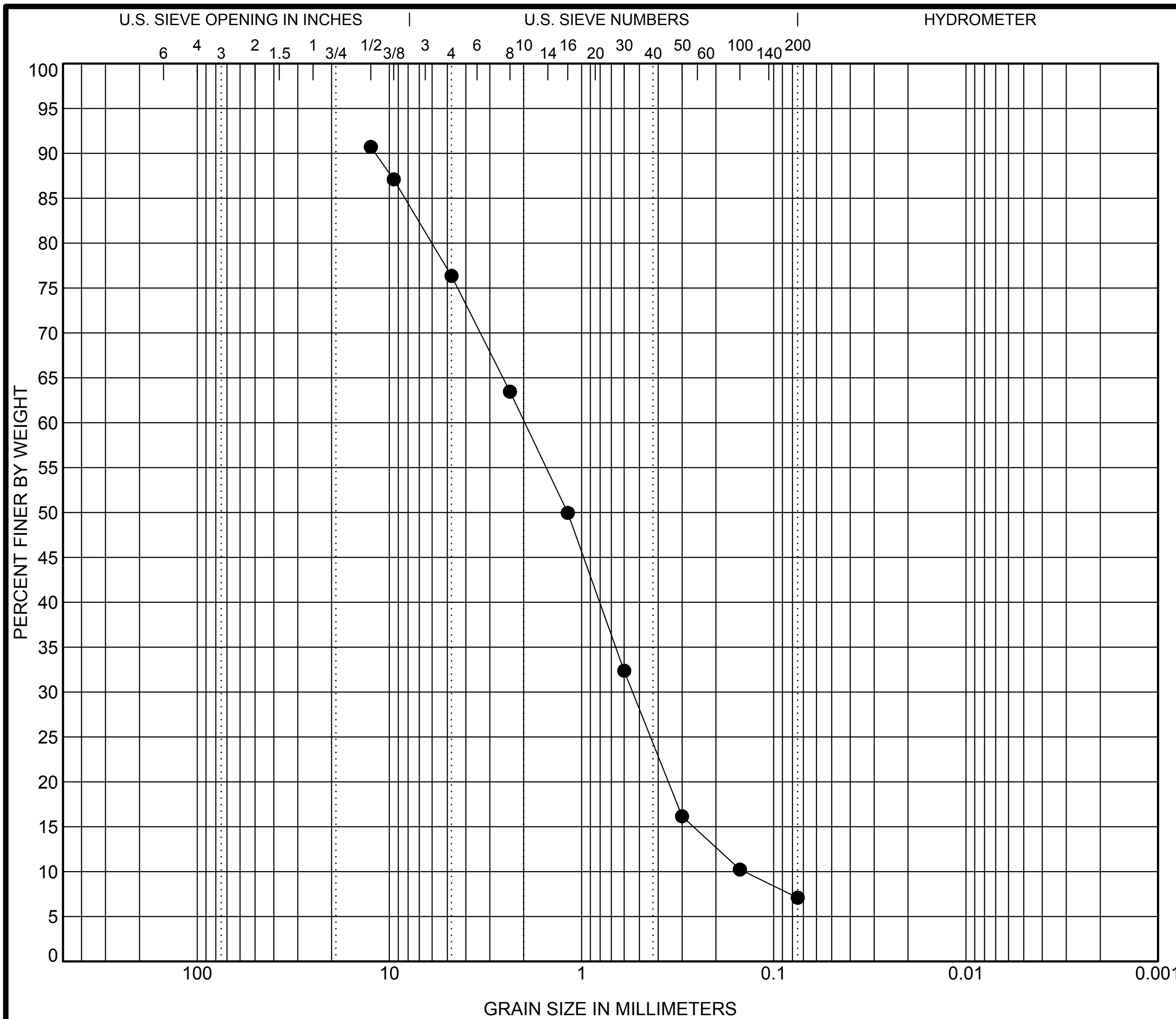
GRAIN SIZE DISTRIBUTION

JOB NUMBER: 2018-003-054

REPORT DATED:

US GRAIN SIZE 2018-003-054.GPJ FRANKIAN.GDT 2/9/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-4	30.0						
⧗								
▲								
★								
⊙								

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-4	30.0	12.5	1.976	0.542	0.143	14.4	69.3	7.1	
⧗										
▲										
★										
⊙										

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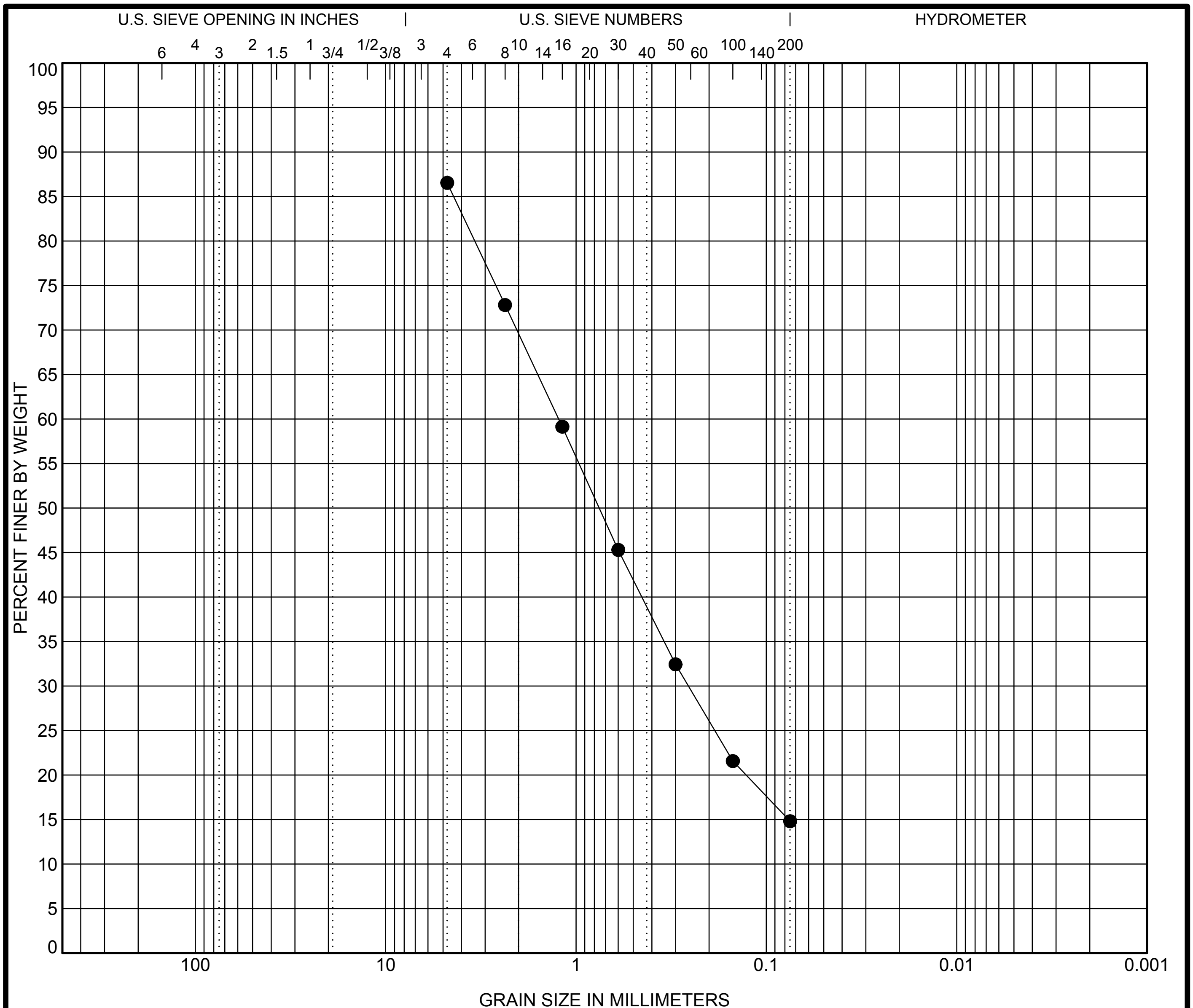
REPORT DATED:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**CPT-5**	**18.0**						
⌧								
▲								
★								
⊙								

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**CPT-5**	**18.0**	**4.75**	**1.233**	**0.257**			**71.7**	**14.8**	
⌧										
▲										
★										
⊙										

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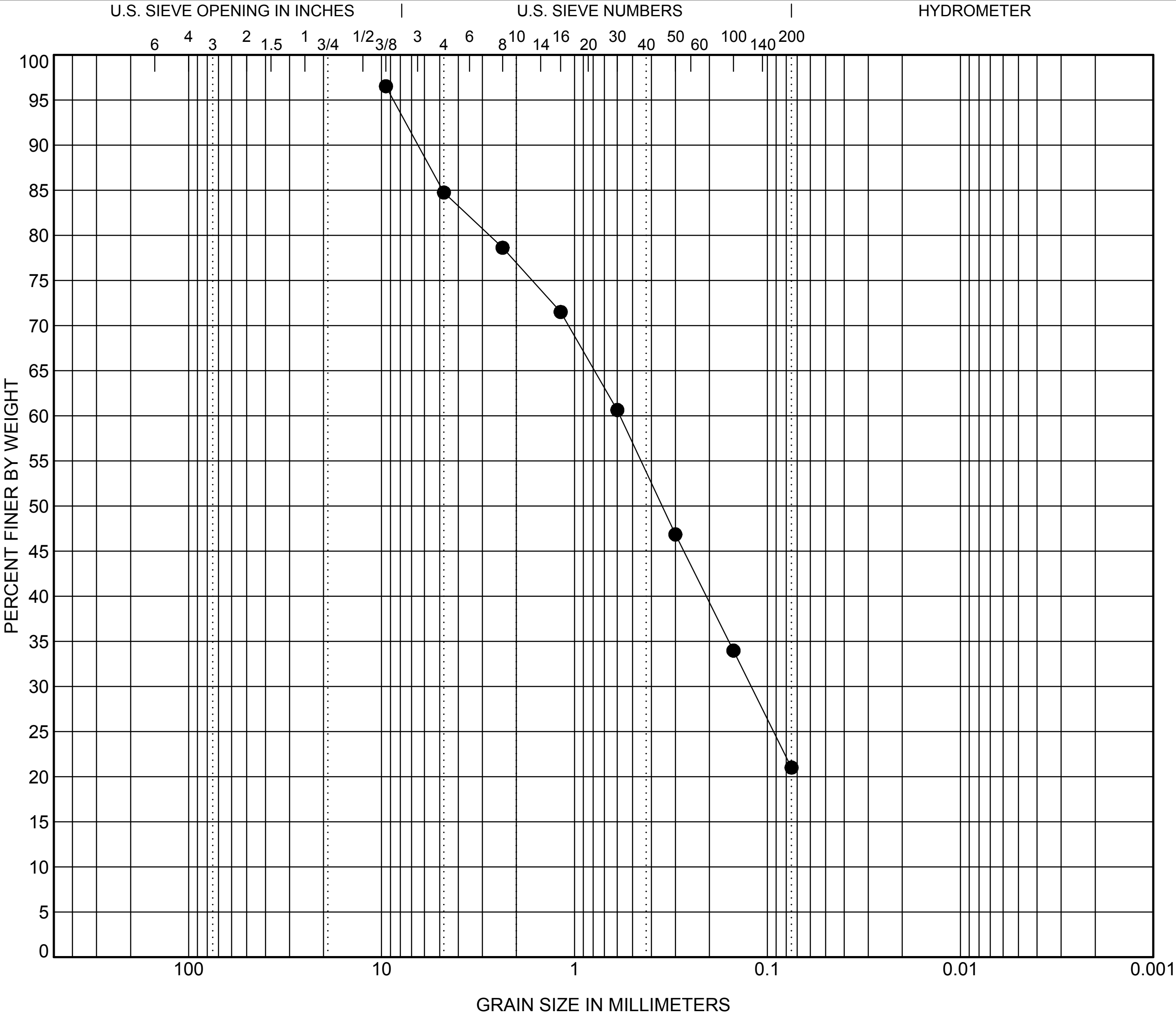

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**CPT-5**	**20.0**						
⊠								
▲								
★								
⊙								

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**CPT-5**	**20.0**	**9.5**	**0.581**	**0.121**		**11.8**	**63.7**	**21.0**	
⊠										
▲										
★										
⊙										

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GRAIN SIZE DISTRIBUTION

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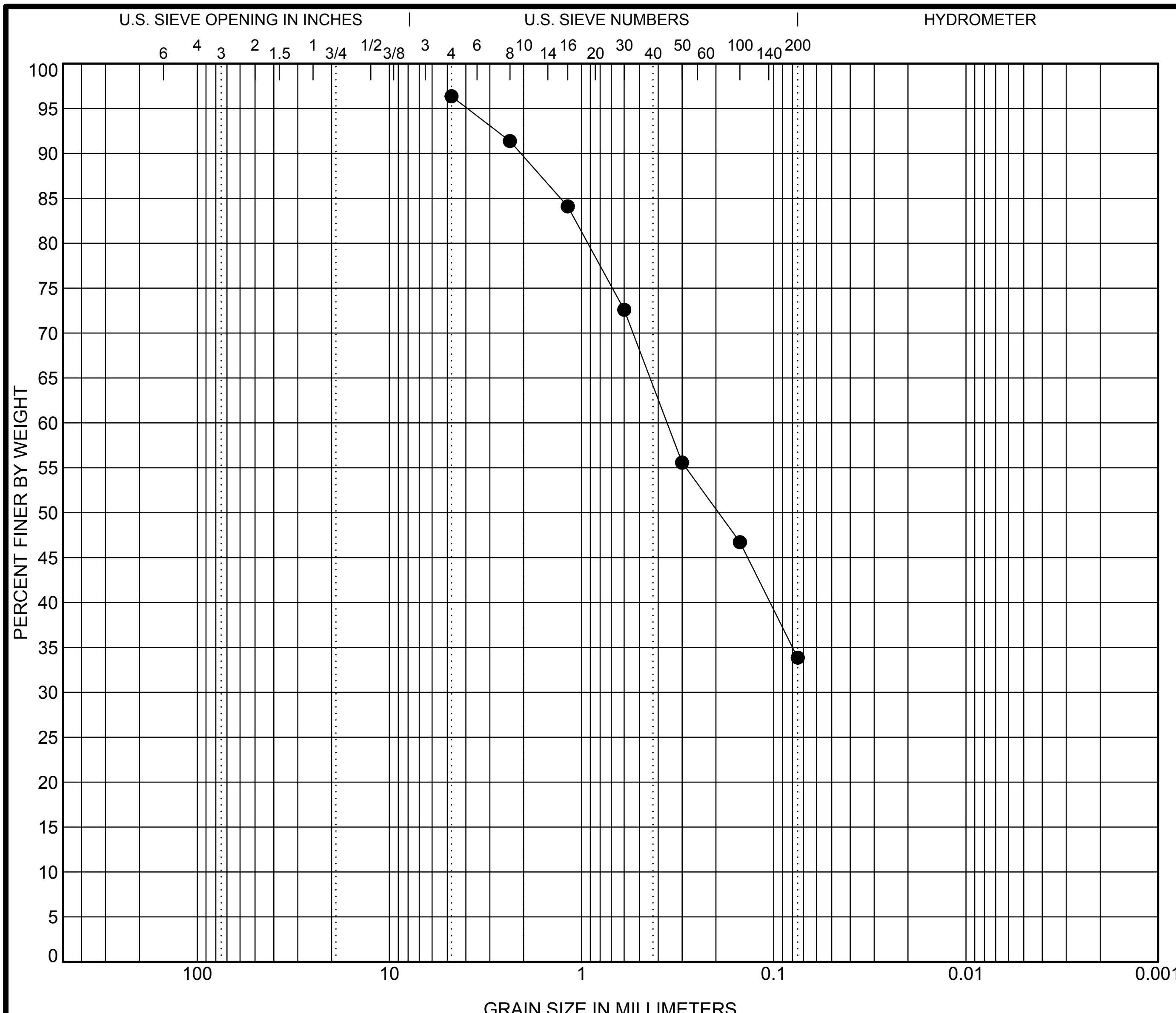
REPORT DATED:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	CPT-5	25.0						
⊠								
▲								
★								
⊙								

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	CPT-5	25.0	4.75	0.359				62.5	33.9	
⊠										
▲										
★										
⊙										

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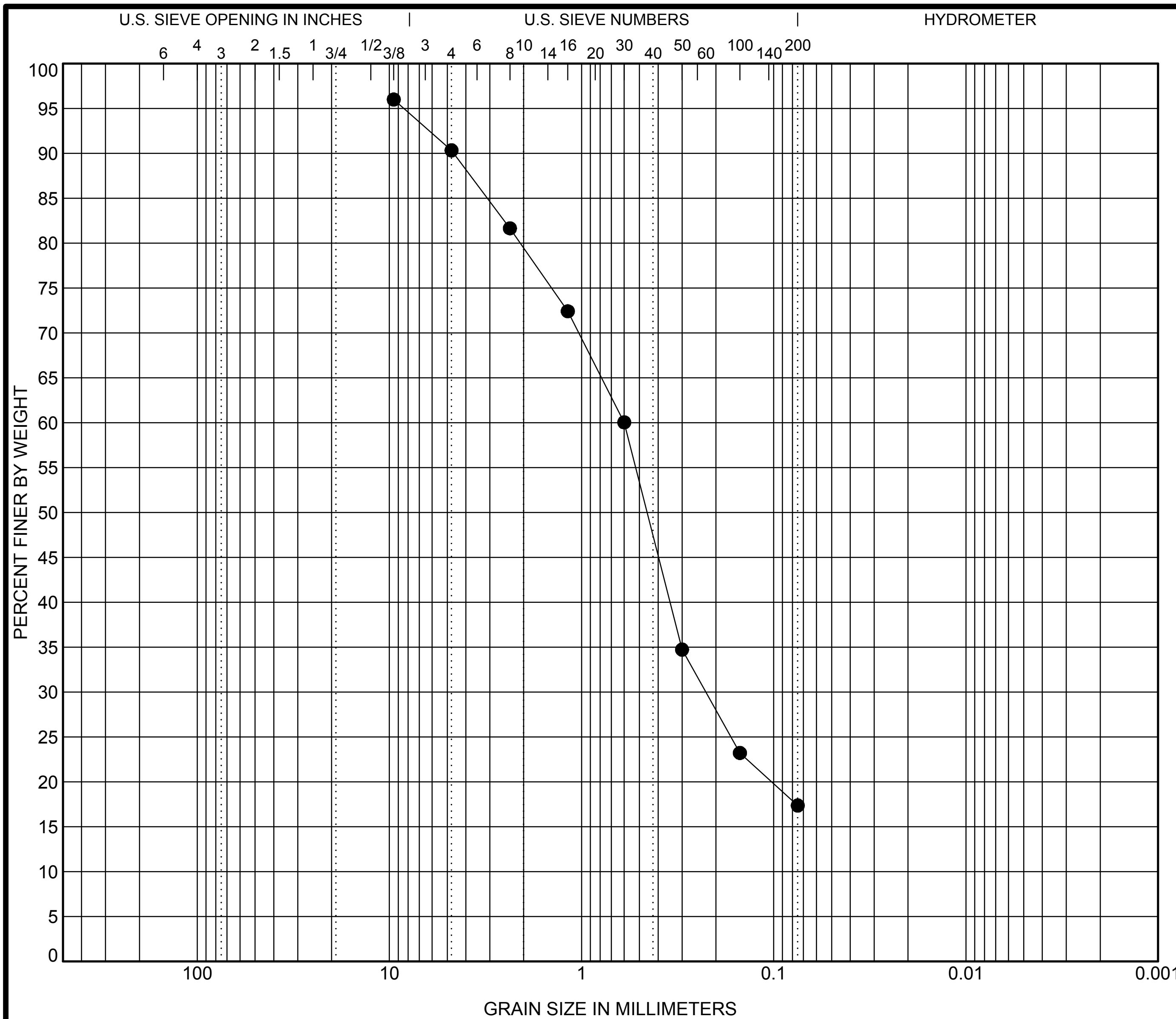

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**CPT-8**	**18.0**						
⊠								
▲								
★								
⊙								

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**CPT-8**	**18.0**	**9.5**	**0.599**	**0.226**		**5.7**	**73.0**	**17.4**	
⊠										
▲										
★										
⊙										

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GRAIN SIZE DISTRIBUTION

JOB NUMBER: 2018-003-054

REPORT DATED:

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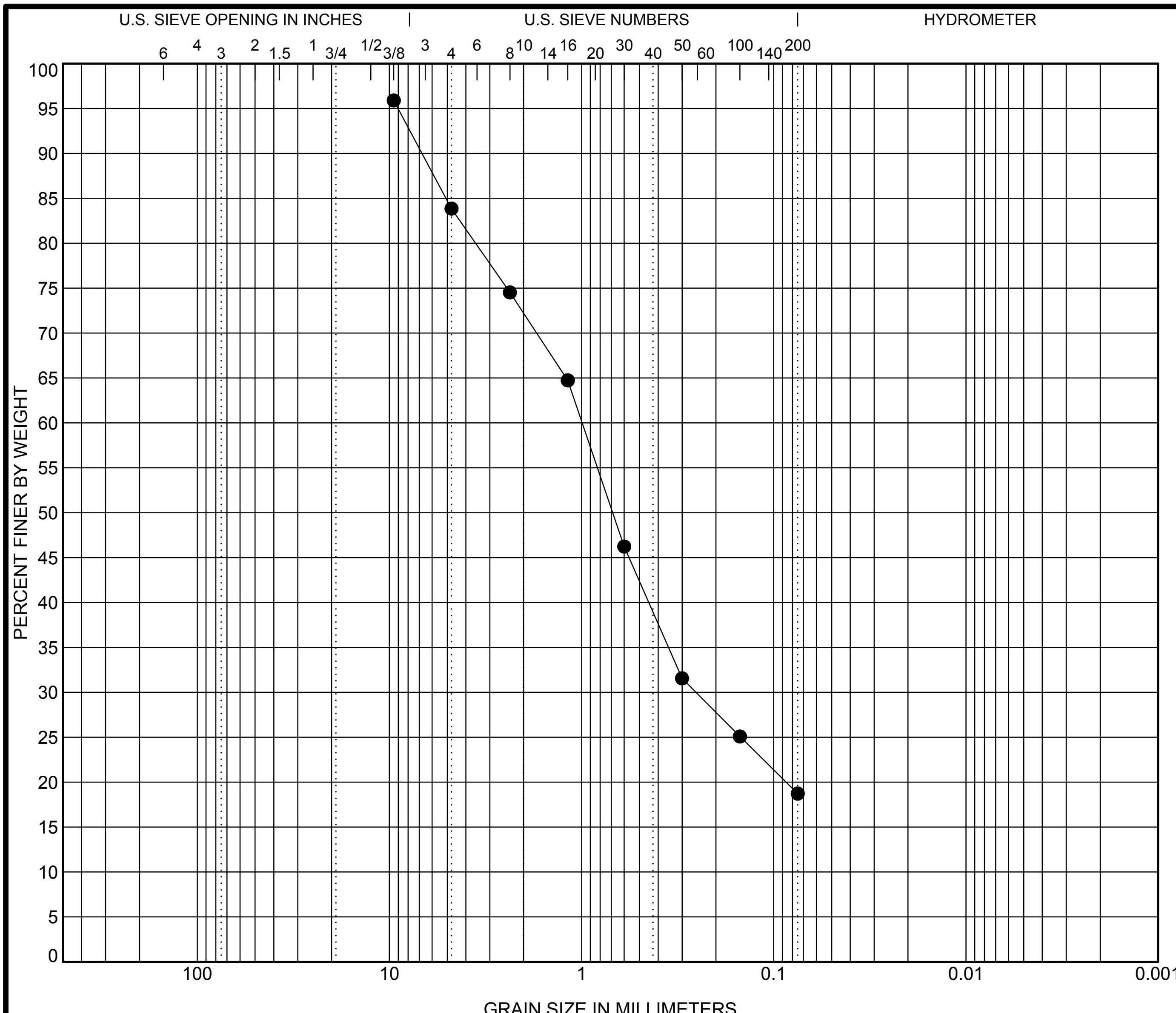

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**CPT-8**	**20.0**						
⊠								
▲								
★								
⊙								

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**CPT-8**	**20.0**	**9.5**	**0.992**	**0.254**		**12.0**	**65.1**	**18.7**	
⊠										
▲										
★										
⊙										

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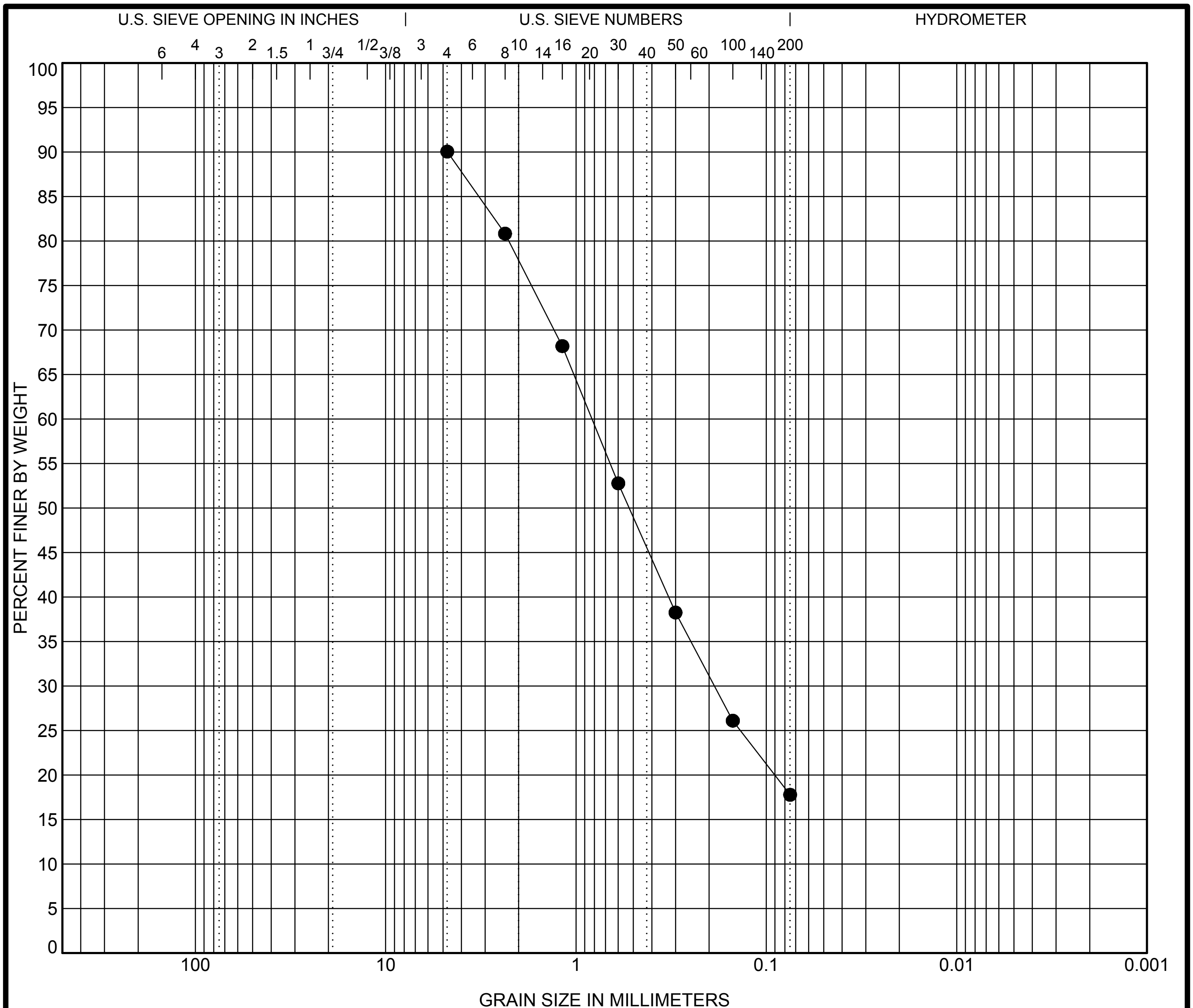
Fax: 818 531 1510

GRAIN SIZE DISTRIBUTION

JOB NUMBER: 2018-003-054

REPORT DATED:

US GRAIN SIZE 2018-003-054.GPJ FRANKIAN.GDT 2/9/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**CPT-8**	**24.0**						
⊠								
▲								
★								
⊙								

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**CPT-8**	**24.0**	**4.75**	**0.824**	**0.187**			**72.3**	**17.8**	
⊠										
▲										
★										
⊙										

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GRAIN SIZE DISTRIBUTION

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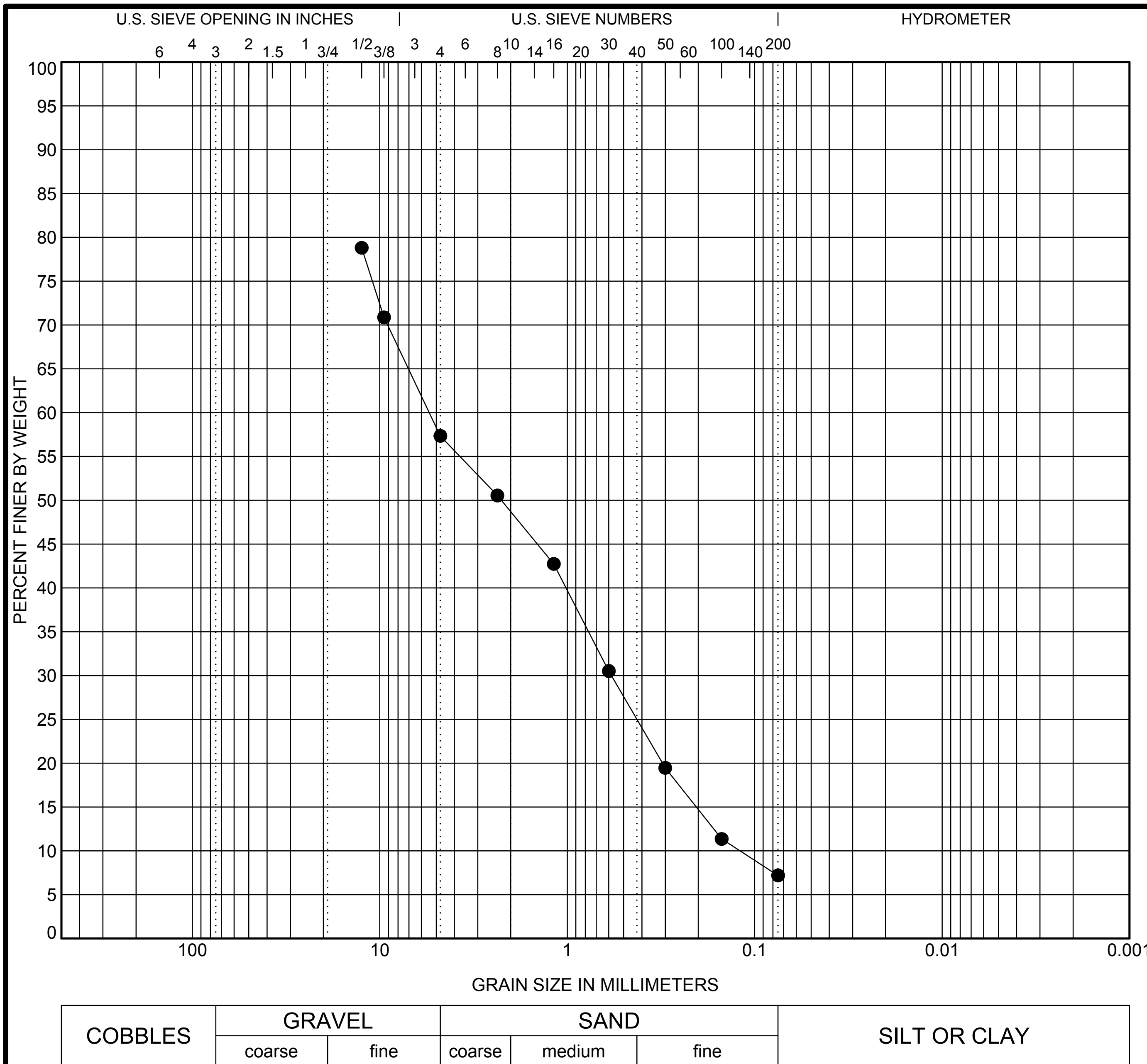
REPORT DATED:



	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**IB-1**	**15.0**						
⊠								
▲								
★								
⊙								

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**IB-1**	**15.0**	**12.5**	**5.442**	**0.581**	**0.12**	**21.5**	**50.2**	**7.2**	
⊠										
▲										
★										
⊙										

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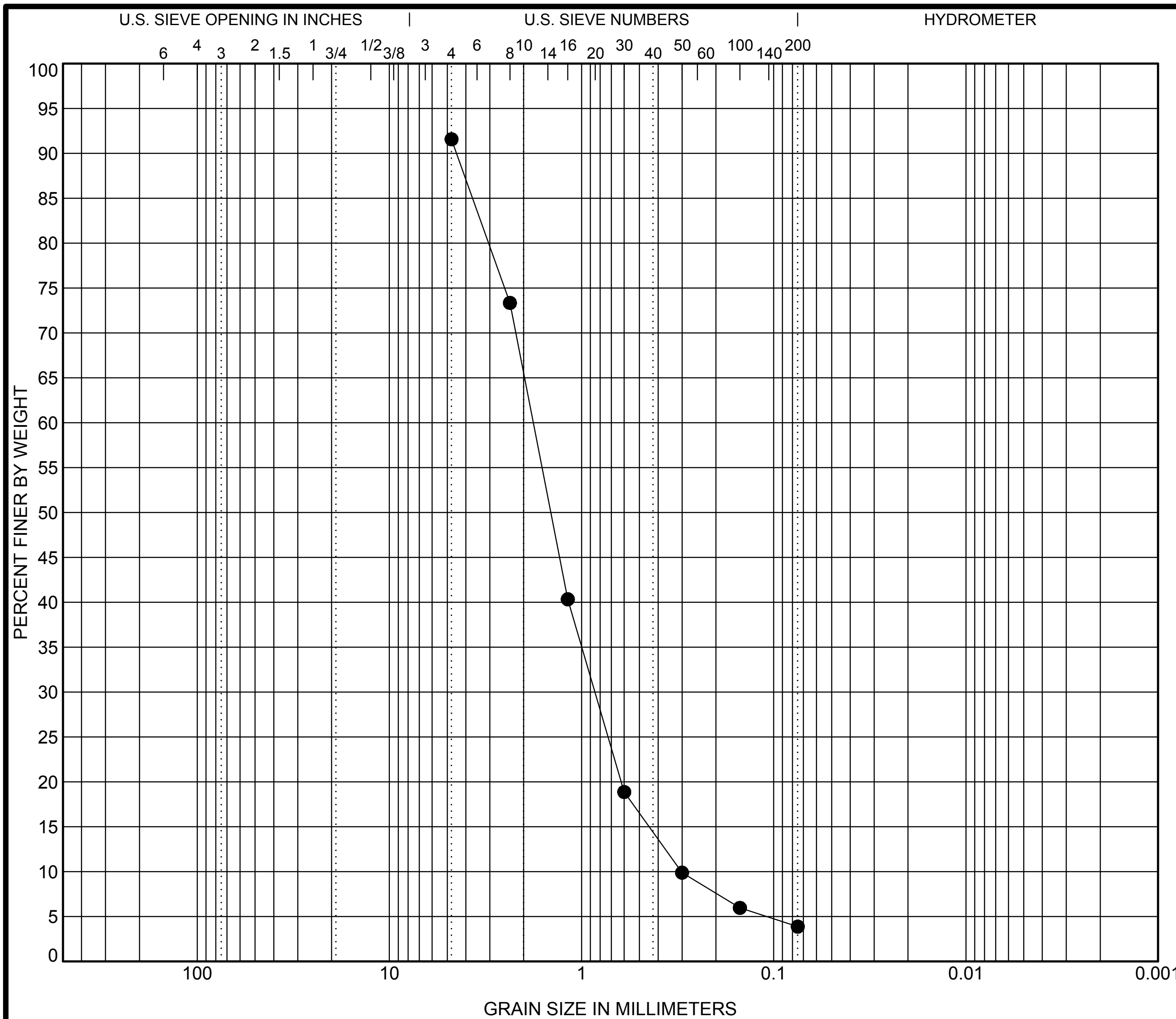
Telephone: 818 531 1501
Fax: 818 531 1510

GRAIN SIZE DISTRIBUTION

JOB NUMBER: 2018-003-054

REPORT DATED:

US GRAIN SIZE 2018-003-054.GPJ FRANKIAN.GDT 2/9/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**IB-1**	**20.0**	**POORLY GRADED SAND(SP)**					
⌧								
▲								
★								
⊙								

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**IB-1**	**20.0**	**4.75**	**1.783**	**0.852**	**0.303**		**87.7**	**3.9**	
⌧										
▲										
★										
⊙										

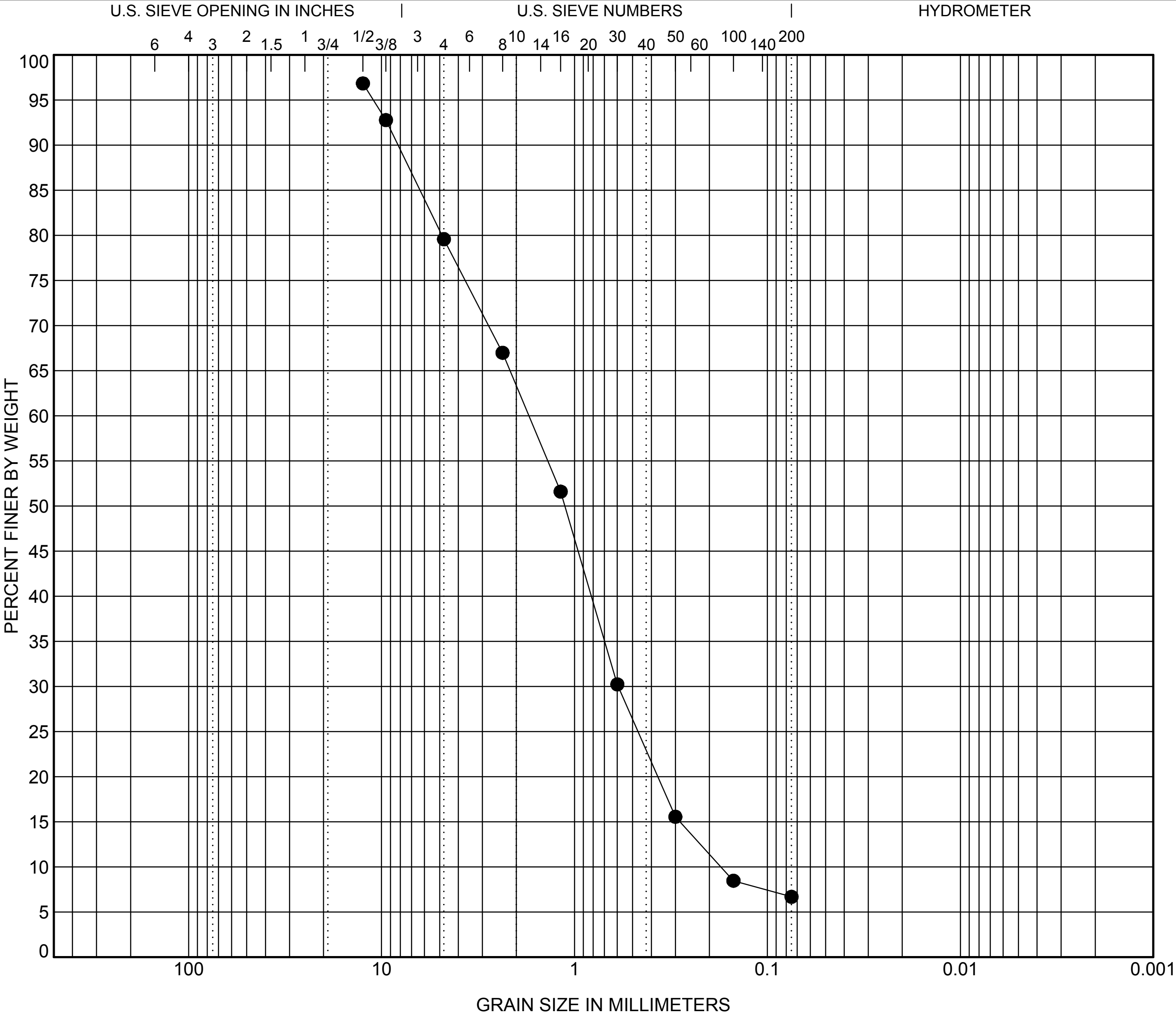
R. T. Frankian & Associates
26027 Huntington Lane, Suite A
Santa Clarita CA 91355
Telephone: 818 531 1501
Fax: 818 531 1510

GRAIN SIZE DISTRIBUTION

JOB NUMBER: 2018-003-054

REPORT DATED:

US GRAIN SIZE 2018-003-054.GPJ FRANKIAN.GDT 2/9/22



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	IB-2	15.0						
⊠								
▲								
★								
⊙								

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**IB-2**	**15.0**	**12.5**	**1.723**	**0.593**	**0.174**	**17.3**	**72.9**	**6.7**	
⊠										
▲										
★										
⊙										

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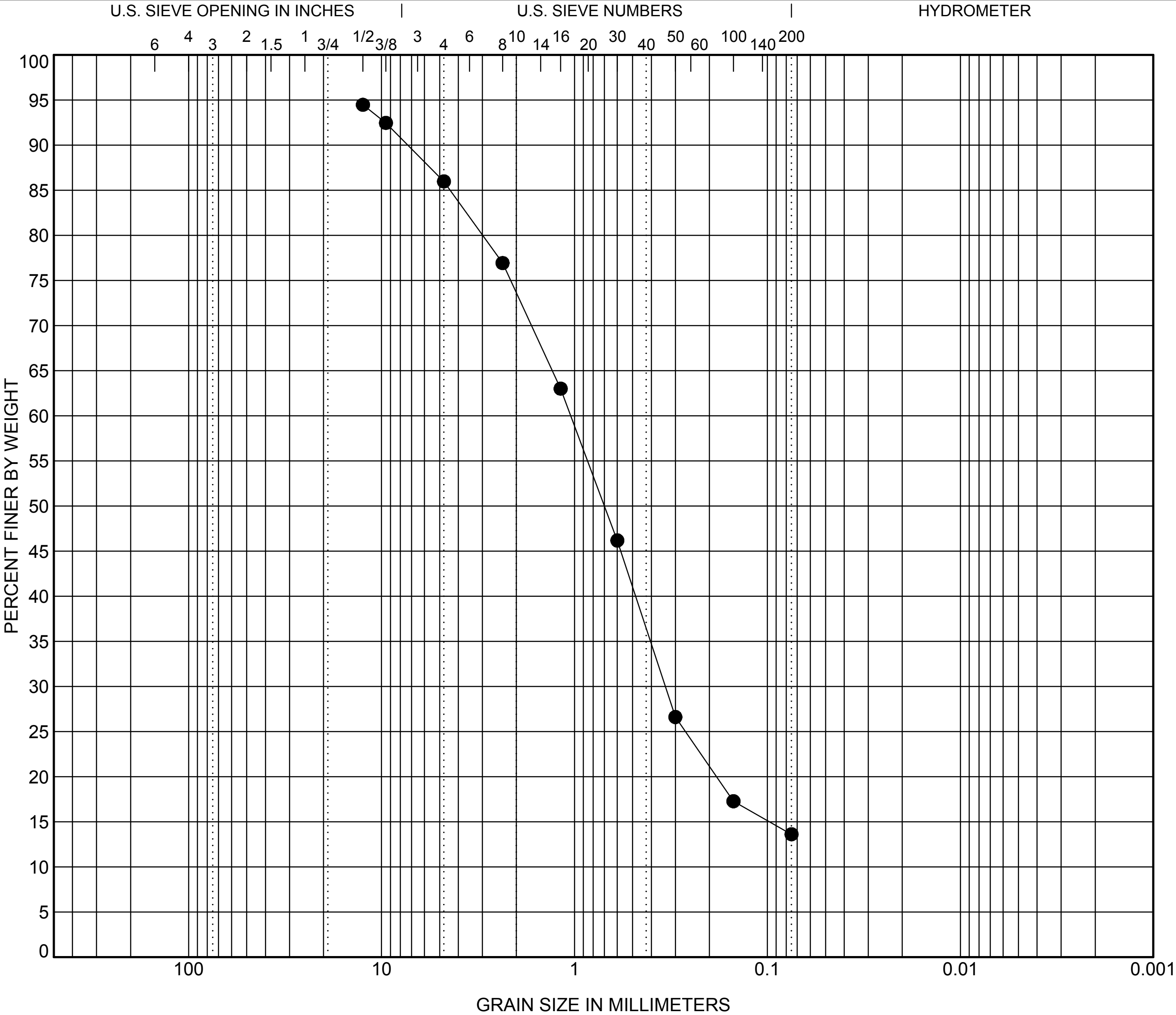
GRAIN SIZE DISTRIBUTION

JOB NUMBER: 2018-003-054

REPORT DATED:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**IB-2**	**20.0**						
⧗								
▲								
★								
⊙								

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**IB-2**	**20.0**	**12.5**	**1.046**	**0.338**		**8.5**	**72.4**	**13.6**	
⧗										
▲										
★										
⊙										

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GRAIN SIZE DISTRIBUTION

JOB NUMBER: 2018-003-054

REPORT DATED:

US GRAIN SIZE 2018-003-054.GPJ FRANKIAN.GDT 2/9/22

• ANALYSIS
• DESIGN

LaBelle • Marvin

• SOILS, ASPHALT TECHNOLOGY

PROFESSIONAL PAVEMENT ENGINEERING
A CALIFORNIA CORPORATION

February 15, 2022

Mr. Mark Frankian
R.T. Frankian & Associates
26027 Huntington Lane "A"
Santa Clarita, California 91355

Project No. 48023

Dear Mr. Frankian:

Testing of the bulk soil sample delivered to our laboratory on 2/11/2022 has been completed.

P.N.:	**2018-003-054**
Project:	**Pace**
Sample:	**1B-1, S-8 @ 1'-5'**
	1B-2, S-8 @ 1'-5'

Data sheets are attached for your use and file. Any untested portion of the sample will be retained for a period of 60 days prior to disposal. The opportunity to be of service is sincerely appreciated and should you have any questions, kindly call.

Respectfully Submitted,

REGISTERED PROFESSIONAL ENGINEER
STEVEN R. MARVIN
DocuSigned by:
NO. 30659
D9A356504F9B448...
CIVIL
STATE OF CALIFORNIA

Steven R. Marvin
RCE 30659

SRM:tw

LaBelle Marvin

R - VALUE DATA SHEET

PROJECT No. 48023

DATE: 2/15/2022

BORING NO. 1B-1, S-8 @ 1'-5'

Pace

P.N. 2018-003-054

SAMPLE DESCRIPTION: Brown Silty Sand

R-VALUE TESTING DATA | CA TEST 301			
	SPECIMEN ID		
	a	b	c
Mold ID Number	4	5	6
Water added, grams	46	31	21
Initial Test Water, %	10.9	9.5	8.6
Compact Gage Pressure,psi	65	200	305
Exudation Pressure, psi	213	441	639
Height Sample, Inches	2.57	2.51	2.46
Gross Weight Mold, grams	3120	3100	3099
Tare Weight Mold, grams	1954	1941	1952
Sample Wet Weight, grams	1166	1159	1147
Expansion, Inches x 10exp-4	20	31	62
Stability 2,000 lbs (160psi)	37 / 85	20 / 41	18 / 35
Turns Displacement	4.57	3.93	3.83
R-Value Uncorrected	33	65	70
R-Value Corrected	35	65	70
Dry Density, pcf	123.9	127.7	130.1

DESIGN CALCULATION DATA

Traffic Index Assumed:	4.0	4.0	4.0
G.E. by Stability	0.67	0.36	0.31
G. E. by Expansion	0.67	1.03	2.07

Equilibrium R-Value: **35** by EXPANSION

Examined & Checked: 2 /15/ 22

PROFESSIONAL ENGINEER STEVEN R. MARVIN NO. 30659 CIVIL STATE OF CALIFORNIA

DocuSigned by:

D9A356504F9B448...

Steven R. Marvin, RCE 30659

REMARKS:

Gf = 1.25

0.4% Retained on the

3/4" Sieve.

The data above is based upon processing and testing samples as received from the field. Test procedures in accordance with latest revisions to Department of Transportation, State of California, Materials & Research Test Method No. 301.

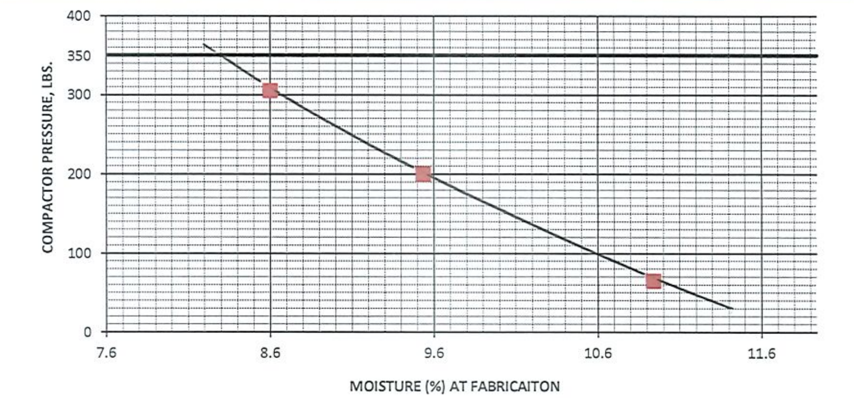
R-VALUE GRAPHICAL PRESENTATION

LaBelle Marvin

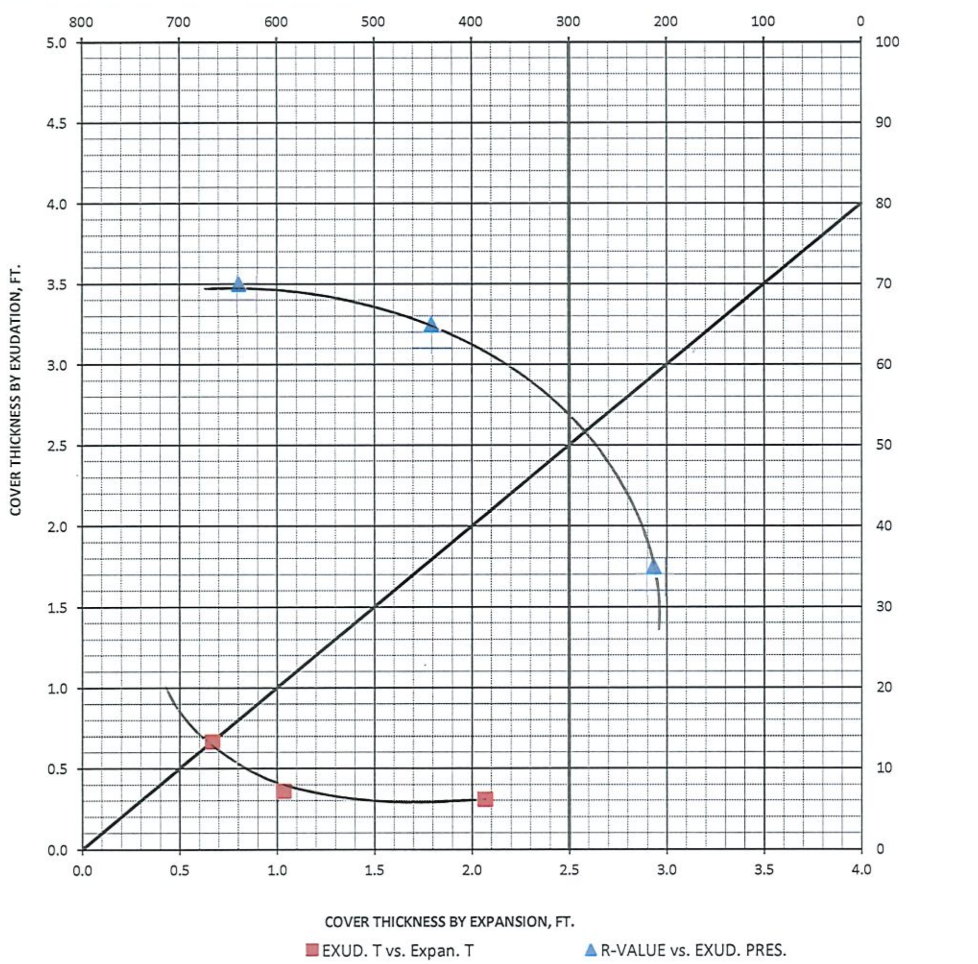
PROJECT NO. 48023
DATE: 2 /15/ 2022
BORING NO. 1B-1, S-8 @ 1'-5'
Pace
P.N. 2018-003-054

REMARKS:

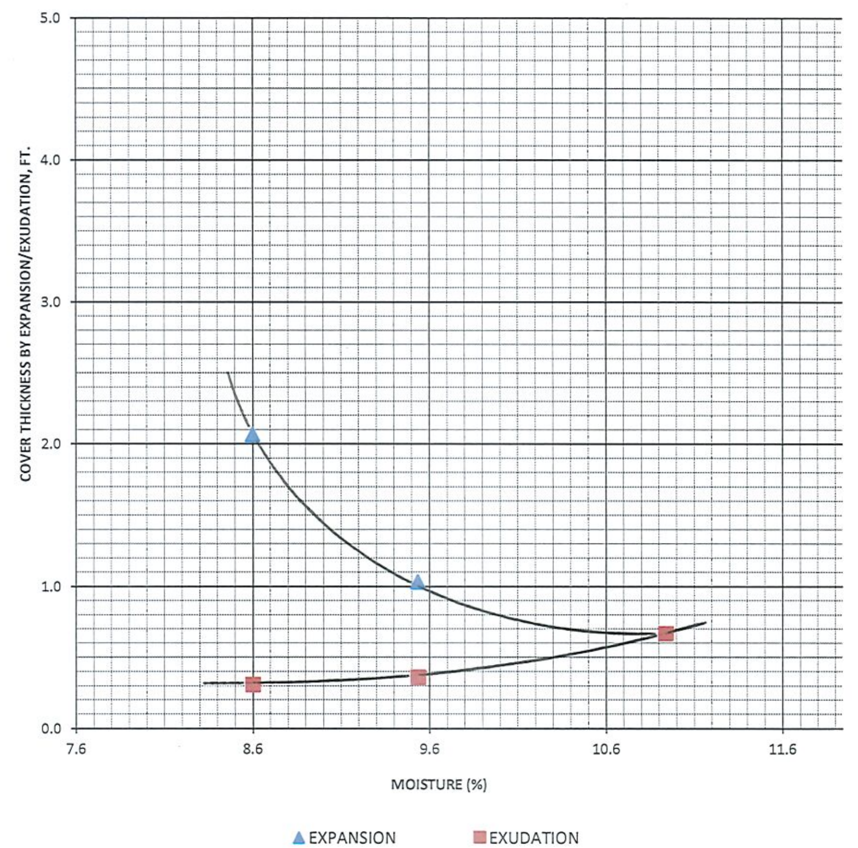
COMPACTOR PRESSURE vs MOISTURE %



COVER THICKNESS BY EXUDATION vs COVER THICKNESS BY EXPANSION



COVER THICKNESS vs MOISTURE %



LaBelle Marvin

R - VALUE DATA SHEET

PROJECT No. 48023

DATE: 2/15/2022

BORING NO. 1B-2, S-8 @ 1'-5'
Pace
P.N. 2018-003-054

SAMPLE DESCRIPTION: Brown Silty Sand

R-VALUE TESTING DATA | CA TEST 301			
	SPECIMEN ID		
	a	b	c
Mold ID Number	7	8	9
Water added, grams	51	31	16
Initial Test Water, %	13.3	11.4	10.0
Compact Gage Pressure,psi	45	100	220
Exudation Pressure, psi	143	275	501
Height Sample, Inches	2.62	2.57	2.51
Gross Weight Mold, grams	3119	3110	2916
Tare Weight Mold, grams	1951	1946	1770
Sample Wet Weight, grams	1168	1164	1146
Expansion, Inches x 10exp-4	4	23	60
Stability 2,000 lbs (160psi)	47 / 116	27 / 66	20 / 43
Turns Displacement	4.28	4.13	3.83
R-Value Uncorrected	18	46	64
R-Value Corrected	19	48	64
Dry Density, pcf	119.2	123.2	125.8

DESIGN CALCULATION DATA

Traffic Index Assumed:	4.0	4.0	4.0
G.E. by Stability	0.83	0.53	0.37
G. E. by Expansion	0.13	0.77	2.00

Equilibrium R-Value	**43** by EXPANSION
REMARKS:	Gf = 1.25 1.4% Retained on the 3/4" Sieve.

Examined & Checked: 2 /15/ 22

REGISTERED PROFESSIONAL ENGINEER STEVEN R. MARVIN NO. 30659 CIVIL STATE OF CALIFORNIA

DocuSigned by:
D9A356504F9B448...

Steven R. Marvin, RCE 30659

The data above is based upon processing and testing samples as received from the field. Test procedures in accordance with latest revisions to Department of Transportation, State of California, Materials & Research Test Method No. 301.

LaBelle Marvin

R-VALUE GRAPHICAL PRESENTATION

PROJECT NO. 48023

DATE: 2 /15/ 2022

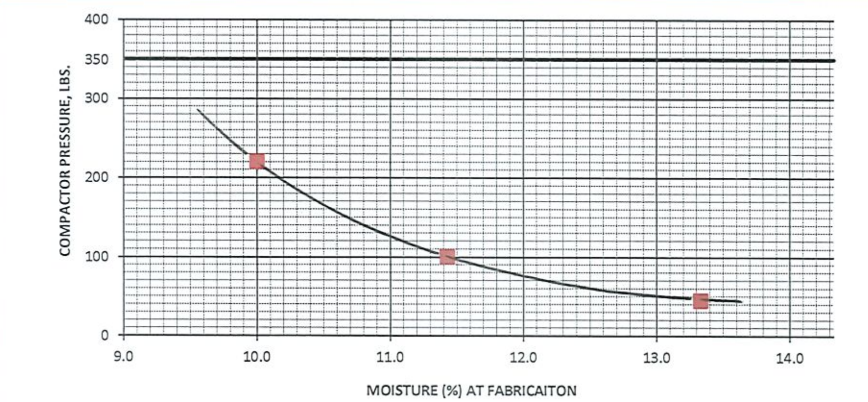
BORING NO. 1B-2, S-8 @ 1'-5'

Pace

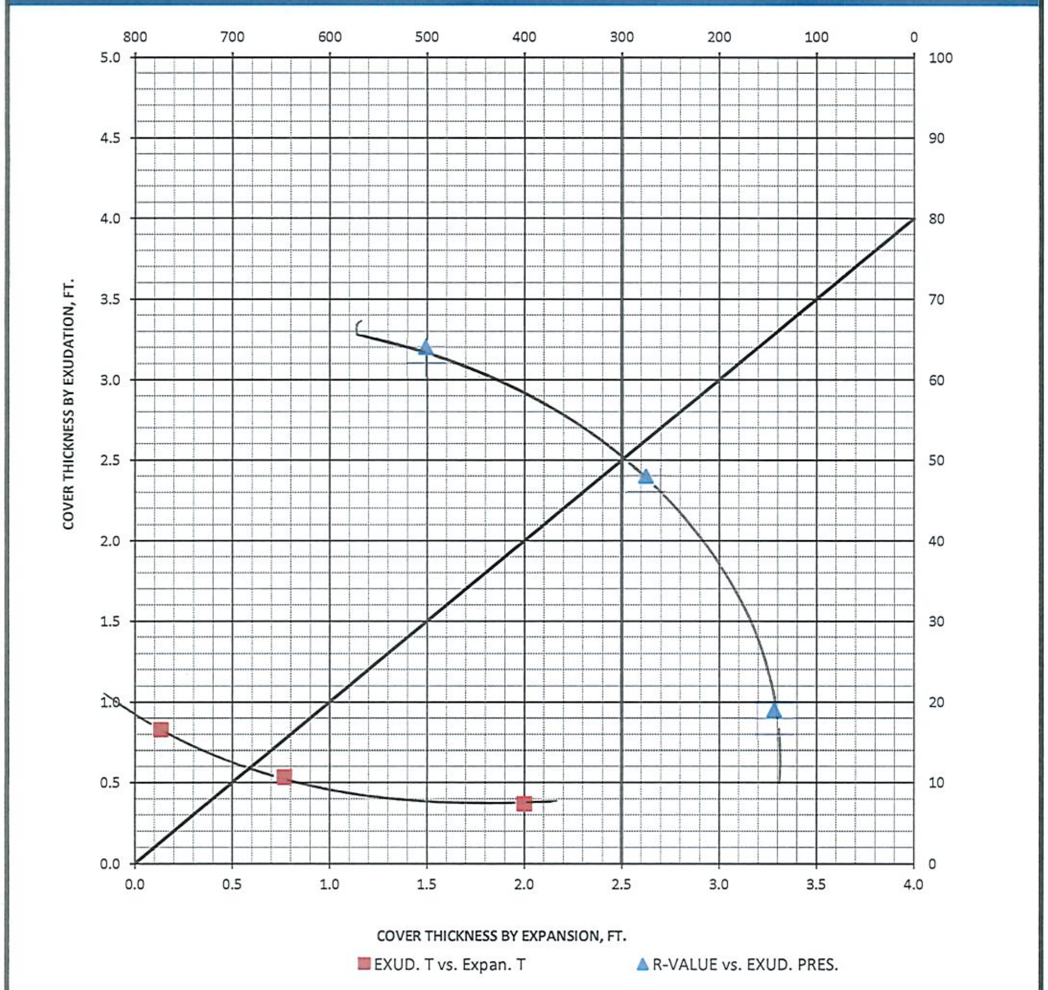
P.N. 2018-003-054

REMARKS:

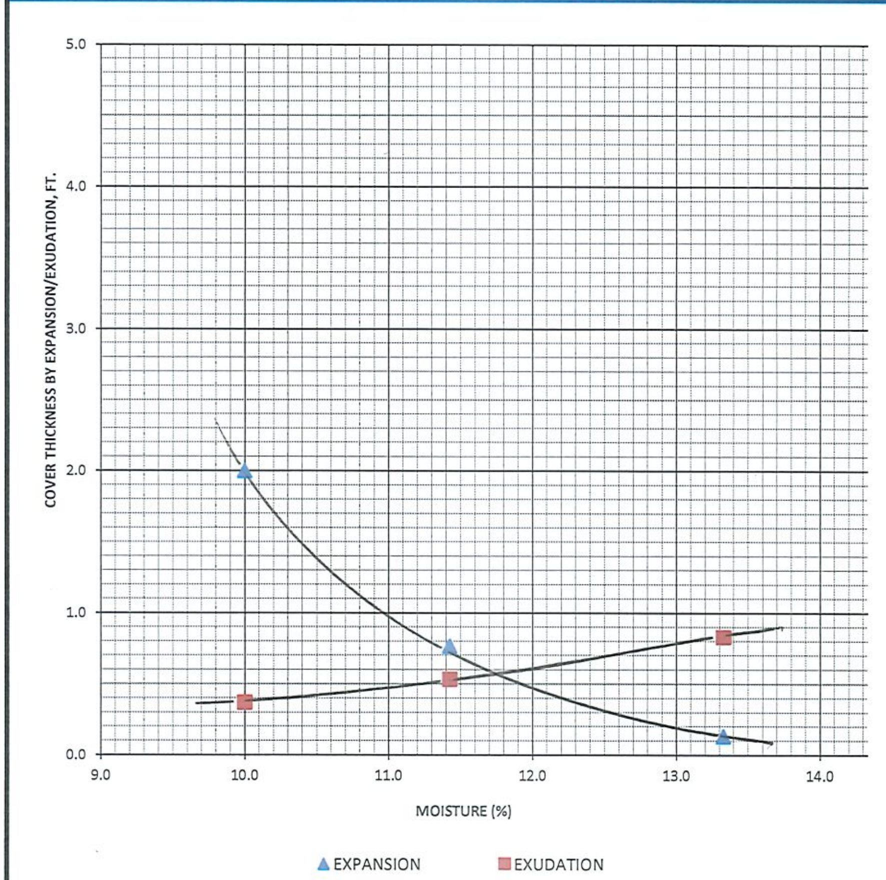
COMPACTOR PRESSURE vs MOISTURE %



COVER THICKNESS BY EXUDATION vs COVER THICKNESS BY EXPANSION



COVER THICKNESS vs MOISTURE %



TRANSMITTAL LETTER

DATE: March 22, 2022

ATTENTION: **Scott Rudd**

TO: R.T. Frankian and Assoc.
26027 Huntington Lane, Suite A
Santa Clarita, CA 91355

SUBJECT: Laboratory Test Data
Site X Via Princessa
Your #2018-003-054, HDR Lab #22-0337LAB

COMMENTS: Enclosed are the results for the subject project.

James T. Keegan, MD
Corrosion and Lab Services Section Manager

431 West Baseline Road · Claremont, CA 91711
Phone: 909.962.5485 · Fax: 909.626.3316

Table 1 - Laboratory Tests on Soil Samples

R.T. Frankian and Assoc.
Site X Via Princessa
Your #2018-003-054, HDR Lab #22-0337LAB
22-Mar-22

Sample ID			IB-1 S-6 @ 15'	IB-2 S-8 @ 1-5'	B-3 S-8 @ 1-5'
Resistivity		**Units**			
as-received		ohm-cm	400,000	16,000	>4,400,000
minimum		ohm-cm	12,000	2,520	520
pH			7.9	9.1	7.5
Electrical Conductivity		mS/cm	0.05	0.13	1.76
Chemical Analyses					
Cations					
calcium	Ca^{2+}	mg/kg	54	156	1,960
magnesium	Mg^{2+}	mg/kg	ND	ND	60
sodium	Na^{1+}	mg/kg	31	36	209
potassium	K^{1+}	mg/kg	4.6	22	104
ammonium	NH_4^{1+}	mg/kg	ND	ND	ND
Anions					
carbonate	CO_3^{2-}	mg/kg	51	60	ND
bicarbonate	HCO_3^{1-}	mg/kg	ND	37	183
fluoride	F^{1-}	mg/kg	1.0	5.3	7.3
chloride	Cl^{1-}	mg/kg	3.1	4.6	7.0
sulfate	SO_4^{2-}	mg/kg	30	138	5,960
nitrate	NO_3^{1-}	mg/kg	4.5	11	12
phosphate	PO_4^{3-}	mg/kg	ND	ND	ND
Other Tests					
sulfide	S^{2-}	qual	na	na	na
Redox		mV	na	na	na

Minimum resistivity and pH per CTM 643, Chloride per CTM 422, Sulfate per CTM 417

Electrical conductivity in millisiemens/cm and chemical analyses were made on a 1:5 soil-to-water extract.

mg/kg = milligrams per kilogram (parts per million) of dry soil.

Redox = oxidation-reduction potential in millivolts

ND = not detected

na = not analyzed

431 West Baseline Road · Claremont, CA 91711
Phone: 909.962.5485 · Fax: 909.626.3316

Pacific Advanced Civil Engineering
March 30, 2022
2018-003-054

APPENDIX C

INFILTRATION TEST DATA
AND CALCULATIONS

BORING PERCOLATION TEST PROCEDURE

The Boring Percolation Test Procedure utilized as part of the subject infiltration study was performed within an 8-inch-diameter, hollow-stem auger drill rig boring. The test was performed after presoaking the boring sidewall soils. The testing at each boring location was performed by installing a 2-inch diameter perforated casing, filling the casing with water, and allowing the water level to drop in successive cycles. The drop in the water level was recorded over a specified time period. The test cycle was performed up to eight times at each test location but was stopped when three successive cycles yielded a relatively uniform infiltration rate. The field procedures are as follows:

- The boring is initially excavated to the desired depth and then a 2-inch-diameter PVC pipe casing is installed for the full depth of the boring. The lower portion of the casing consists of perforated pipe and the bottom of the casing is capped.

- The perforated portion of the pipe is then surrounded with a filter pack consisting of washed sand or gravel. After installation of the filter materials, the boring is then pre-soaked by filling the lower portion of the casing with water and maintaining a level that is at least 12 inches above the bottom of the casing.

- The casing is then refilled with water up to a level of at least 12 inches above the bottom of the pipe. The water level is allowed to drop, and the depth of the water level is measured at regular intervals. At the completion of the test cycle, the water level is again measured and recorded, signifying the end of that test cycle.

- The casing is then refilled with water and the next test cycle is begun. The test cycles are repeated up to a total of eight times to complete the series of tests within the boring but may be stopped if three successive cycles yield a relatively uniform drop.

BORING PERCOLATION TESTING FIELD LOG

Project	PACE	Job No.	2018-003-054
Material	Native Soils	Boring Designation	IB-1
Tested by	SDR	Boring Diameter (in)	8
Pre Soak	>1-hr	Depth of Boring (ft)	20.80
Length of Pipe (ft)	20.12		

Reading Number	Elapsed Time (mins)	Water Start Depth (in)	Water End Depth (in)	Water Drop (inches)	PercolationRate For Reading (in/hr)
1	10.00	13.92	6.48	7.44	44.64
2	10.00	13.44	5.40	8.04	48.24
3	10.00	14.76	6.60	8.16	48.96
4	10.00	13.20	5.52	7.68	46.08
5	10.00	14.40	6.48	7.92	47.52
6	10.00	13.32	5.52	7.80	46.80

Average Field Percolation Last 3 Trials (in/hr)	46.80
RFt	2.0
Average RF Adjusted Percolation Last 3 Trials (in/hr)	23.40
RFv	2.0
RFs	2.0
Design Infiltration Rate (in/hr)	5.85

RTFA
GEOTECHNICAL ENGINEERING & ENGINEERING GEOLOGY

BORING PERCOLATION TESTING FIELD LOG

Job No.	2018-003-054
Boring Designation	IB-2
Boring Diameter (in)	8
Depth of Boring (ft)	20.70

Project	PACE
Material	Native Soils
Tested by	SDR
Pre Soak	>1-hr
Length of Pipe (ft)	20.10

Reading Number	Elapsed Time (mins)	Water Start Depth (in)	Water End Depth (in)	Water Drop (inches)	PercolationRate For Reading (in/hr)
1	30.00	14.76	3.96	10.80	21.60
2	30.00	13.08	1.80	11.28	22.56
3	30.00	13.56	1.68	11.88	23.76
4	30.00	13.20	2.16	11.04	22.08
5	30.00	13.32	2.16	11.16	22.32
6	30.00	13.44	2.28	11.16	22.32

Average Field Percolation Last 3 Trials (in/hr)	22.24
RFt	2.0
Average RF Adjusted Percolation Last 3 Trials (in/hr)	11.12
RFv	2.0
RFs	2.0
Design Infiltration Rate (in/hr)	2.78

RTFA
GEOTECHNICAL ENGINEERING & ENGINEERING GEOLOGY

APPENDIX D

WATER WELL RECORDS

WELL_ID	MEASURE_DATE	GS_ELEV	GS_TO_WS	WS ELEVATION	Design LID Invert Elevation	GMED Design Limit Elevation
7139E	6/1/2012	1372	85	1287	1357	1347
7139E	1/7/2012	1372	63	1309	1357	1347
7139E	6/1/2011	1372	43	1329	1357	1347
7139E	6/1/2011	1372	43	1329	1357	1347
7139E	10/1/2010	1372	74	1298	1357	1347
7139E	8/31/2009	1372	87	1285	1357	1347
7139E	4/30/2009	1372	82	1290	1357	1347
7139E	5/6/2008	1372	55	1317	1357	1347
7139E	10/31/2007	1372	44	1328	1357	1347
7139E	4/30/2007	1372	36	1336	1357	1347
7139E	9/30/2006	1372	32	1340	1357	1347
7139E	4/30/2006	1372	16	1356	1357	1347
7139E	10/31/2005	1372	25	1347	1357	1347
7139E	4/30/2005	1372	19	1353	1357	1347
7139E	11/30/2004	1372	84	1288	1357	1347
7139E	5/31/2004	1372	85	1287	1357	1347
7139E	3/31/2004	1372	74	1298	1357	1347
7139E	10/31/2003	1372	84	1288	1357	1347
7139E	10/15/2002	1372	95	1277	1357	1347
7139E	4/30/2002	1372	77	1295	1357	1347
7139E	3/31/2001	1372	50	1322	1357	1347
7139E	10/31/2000	1372	57	1315	1357	1347
7139E	5/31/2000	1372	49	1323	1357	1347
7139E	10/31/1999	1372	43	1329	1357	1347
7139E	4/30/1999	1372	36	1336	1357	1347
7139E	11/1/1998	1372	35	1337	1357	1347
7139E	4/1/1998	1372	15	1357	1357	1347
7139E	10/1/1997	1372	42	1330	1357	1347
7139E	4/1/1997	1372	29	1343	1357	1347
7139E	10/31/1996	1372	25	1347	1357	1347
7139E	4/30/1996	1372	21	1351	1357	1347
7139E	10/31/1995	1372	30	1342	1357	1347
7139E	4/28/1995	1372	16	1356	1357	1347
7139E	10/31/1994	1372	29	1343	1357	1347
7139E	4/30/1994	1372	17	1355	1357	1347
7139E	4/30/1993	1372	20	1352	1357	1347
7139E	9/30/1992	1372	69	1303	1357	1347
7139E	4/30/1992	1372	36	1336	1357	1347
7139E	10/31/1991	1372	102	1270	1357	1347
7139E	4/15/1991	1372	77	1295	1357	1347
7139E	10/15/1990	1372	89	1283	1357	1347
7139E	4/15/1990	1372	79	1293	1357	1347
7139E	10/15/1989	1372	76	1296	1357	1347
7139E	4/15/1989	1372	56	1316	1357	1347
7139E	12/30/1988	1372	55	1317	1357	1347
7139E	11/30/1988	1372	61	1311	1357	1347
7139E	10/30/1988	1372	64	1308	1357	1347
7139E	5/30/1988	1372	45	1327	1357	1347
7139E	4/30/1988	1372	39	1333	1357	1347
7139E	3/30/1988	1372	38	1334	1357	1347
7139E	2/29/1988	1372	40	1332	1357	1347
7139E	1/30/1988	1372	42	1330	1357	1347
7139E	11/25/1986	1372	36	1336	1357	1347
7139E	10/25/1986	1372	35	1337	1357	1347
7139E	9/25/1986	1372	43	1329	1357	1347
7139E	8/25/1986	1372	43	1329	1357	1347
7139E	7/25/1986	1372	38	1334	1357	1347
7139E	6/25/1986	1372	33	1339	1357	1347
7139E	5/25/1986	1372	30	1342	1357	1347
7139E	4/25/1986	1372	28	1344	1357	1347
7139E	3/25/1986	1372	24	1348	1357	1347
7139E	2/25/1986	1372	28	1344	1357	1347
7139E	1/25/1986	1372	32	1340	1357	1347
7139E	12/30/1985	1372	32	1340	1357	1347
7139E	3/30/1985	1372	17	1355	1357	1347
7139E	1/30/1985	1372	17	1355	1357	1347
7139E	11/30/1984	1372	21	1351	1357	1347
7139E	8/30/1984	1372	23	1349	1357	1347
7139E	4/30/1984	1372	19	1353	1357	1347
7139E	1/30/1984	1372	13	1359	1357	1347
7139E	11/30/1983	1372	14	1358	1357	1347
7139E	8/30/1983	1372	16	1356	1357	1347
7139E	4/30/1983	1372	13	1359	1357	1347
7139E	1/30/1983	1372	25	1347	1357	1347

WELL_ID	MEASURE_DATE	GS_ELEV	GS_TO_WS	WS ELEVATION	Design LID Invert Elevation	GMED Design Limit Elevation
7139F	6/1/2012	1375	85	1290	1360	1350
7139F	1/6/2012	1375	59	1316	1360	1350
7139F	6/1/2011	1375	39	1336	1360	1350
7139F	6/1/2011	1375	39	1336	1360	1350
7139F	10/1/2010	1375	73	1302	1360	1350
7139F	8/31/2009	1375	84	1291	1360	1350
7139F	4/30/2009	1375	84	1291	1360	1350
7139F	5/5/2008	1375	52	1323	1360	1350
7139F	10/31/2007	1375	44	1331	1360	1350
7139F	4/30/2007	1375	34	1341	1360	1350
7139F	9/30/2006	1375	28	1347	1360	1350
7139F	4/30/2006	1375	12	1363	1360	1350
7139F	10/31/2005	1375	25	1350	1360	1350
7139F	4/30/2005	1375	14	1361	1360	1350
7139F	11/30/2004	1375	82	1293	1360	1350
7139F	5/31/2004	1375	75	1300	1360	1350
7139F	3/31/2004	1375	74	1301	1360	1350
7139F	10/31/2003	1375	85	1290	1360	1350
7139F	10/15/2002	1375	84	1291	1360	1350
7139F	4/30/2002	1375	72	1303	1360	1350
7139F	3/31/2001	1375	48	1327	1360	1350
7139F	10/31/2000	1375	56	1319	1360	1350
7139F	5/31/2000	1375	46	1329	1360	1350
7139F	10/31/1999	1375	38	1337	1360	1350
7139F	4/30/1999	1375	34	1341	1360	1350
7139F	11/1/1998	1375	31	1344	1360	1350
7139F	4/1/1998	1375	14	1361	1360	1350
7139F	10/1/1997	1375	45	1330	1360	1350
7139F	4/1/1997	1375	26	1349	1360	1350
7139F	10/31/1996	1375	24	1351	1360	1350
7139F	4/30/1996	1375	18	1357	1360	1350
7139F	10/31/1995	1375	23	1352	1360	1350
7139F	4/28/1995	1375	16	1359	1360	1350
7139F	10/31/1994	1375	28	1347	1360	1350
7139F	4/30/1994	1375	18	1357	1360	1350
7139F	4/30/1993	1375	17	1358	1360	1350
7139F	9/30/1992	1375	64	1311	1360	1350
7139F	4/30/1992	1375	34	1341	1360	1350
7139F	10/31/1991	1375	97	1278	1360	1350
7139F	4/15/1991	1375	76	1299	1360	1350
7139F	10/15/1990	1375	86	1289	1360	1350
7139F	4/15/1990	1375	75	1300	1360	1350
7139F	4/15/1989	1375	54	1321	1360	1350
7139F	12/30/1988	1375	52	1323	1360	1350
7139F	11/30/1988	1375	60	1315	1360	1350
7139F	10/30/1988	1375	61	1314	1360	1350
7139F	4/30/1988	1375	35	1340	1360	1350
7139F	3/30/1988	1375	35	1340	1360	1350
7139F	2/29/1988	1375	36	1339	1360	1350
7139F	1/30/1988	1375	38	1337	1360	1350
7139F	12/30/1987	1375	40	1335	1360	1350
7139F	11/25/1987	1375	41	1334	1360	1350
7139F	10/30/1987	1375	46	1329	1360	1350
7139F	9/30/1987	1375	48	1327	1360	1350
7139F	8/25/1987	1375	45	1330	1360	1350
7139F	7/30/1987	1375	40	1335	1360	1350
7139F	6/25/1987	1375	42	1333	1360	1350
7139F	4/25/1987	1375	42	1333	1360	1350
7139F	3/25/1987	1375	32	1343	1360	1350
7139F	2/25/1987	1375	29	1346	1360	1350
7139F	1/25/1987	1375	28	1347	1360	1350
7139F	12/25/1986	1375	32	1343	1360	1350
7139F	11/25/1986	1375	33	1342	1360	1350
7139F	10/25/1986	1375	33	1342	1360	1350
7139F	9/25/1986	1375	30	1345	1360	1350
7139F	8/25/1986	1375	30	1345	1360	1350
7139F	6/25/1986	1375	32	1343	1360	1350
7139F	5/25/1986	1375	18	1357	1360	1350
7139F	4/25/1986	1375	25	1350	1360	1350
7139F	3/25/1986	1375	18	1357	1360	1350
7139F	2/25/1986	1375	26	1349	1360	1350
7139F	1/25/1986	1375	28	1347	1360	1350
7139F	12/30/1985	1375	30	1345	1360	1350
7139F	3/30/1985	1375	14	1361	1360	1350
7139F	1/30/1985	1375	13	1362	1360	1350
7139F	11/30/1984	1375	19	1356	1360	1350
7139F	8/30/1984	1375	21	1354	1360	1350
7139F	4/30/1984	1375	15	1360	1360	1350
7139F	1/30/1984	1375	11	1364	1360	1350
7139F	11/30/1983	1375	10	1365	1360	1350
7139F	8/30/1983	1375	13	1362	1360	1350
7139F	4/30/1983	1375	8	1367	1360	1350
7139F	1/30/1983	1375	23	1352	1360	1350

WELL_ID	MEASURE_DATE	GS_ELEV	GS_TO_WS	WS ELEVATION	Design LID Invert Elevation	GMED Design Limit Elevation
7139G	11/1/2012	1380	81	1299	1365	1355
7139G	6/1/2012	1380	81	1299	1365	1355
7139G	1/8/2012	1380	56	1324	1365	1355
7139G	6/1/2011	1380	39	1341	1365	1355
7139G	6/1/2011	1380	39	1341	1365	1355
7139G	10/1/2010	1380	69	1311	1365	1355
7139G	8/31/2009	1380	86	1294	1365	1355
7139G	4/30/2009	1380	79	1301	1365	1355
7139G	5/7/2008	1380	49	1331	1365	1355
7139G	10/31/2007	1380	38	1342	1365	1355
7139G	4/30/2007	1380	32	1348	1365	1355
7139G	9/30/2006	1380	29	1351	1365	1355
7139G	4/30/2006	1380	12	1368	1365	1355
7139G	10/31/2005	1380	25	1355	1365	1355
7139G	4/30/2005	1380	10	1370	1365	1355
7139G	11/30/2004	1380	81	1299	1365	1355
7139G	5/31/2004	1380	89	1291	1365	1355
7139G	3/31/2004	1380	75	1305	1365	1355
7139G	10/31/2003	1380	82	1298	1365	1355
7139G	10/15/2002	1380	89	1291	1365	1355
7139G	4/30/2002	1380	67	1313	1365	1355
7139G	3/31/2001	1380	43	1337	1365	1355
7139G	10/31/2000	1380	57	1323	1365	1355
7139G	5/31/2000	1380	42	1338	1365	1355
7139G	10/31/1999	1380	37	1343	1365	1355
7139G	4/30/1999	1380	33	1347	1365	1355
7139G	11/1/1998	1380	35	1345	1365	1355
7139G	4/1/1998	1380	14	1366	1365	1355
7139G	10/1/1997	1380	41	1339	1365	1355
7139G	4/1/1997	1380	29	1351	1365	1355
7139G	10/31/1996	1380	23	1357	1365	1355
7139G	4/30/1996	1380	17	1363	1365	1355
7139G	10/31/1995	1380	22	1358	1365	1355
7139G	4/28/1995	1380	17	1363	1365	1355
7139G	10/31/1994	1380	28	1352	1365	1355
7139G	4/30/1994	1380	17	1363	1365	1355
7139G	4/30/1993	1380	15	1365	1365	1355
7139G	9/30/1992	1380	64	1316	1365	1355
7139G	4/30/1992	1380	37	1343	1365	1355
7139G	10/30/1991	1380	91	1289	1365	1355
7139G	4/15/1991	1380	70	1310	1365	1355
7139G	10/15/1990	1380	82	1298	1365	1355
7139G	4/15/1990	1380	74	1306	1365	1355
7139G	10/15/1989	1380	63	1317	1365	1355
7139G	4/15/1989	1380	50	1330	1365	1355
7139G	12/30/1988	1380	55	1325	1365	1355
7139G	11/30/1988	1380	60	1320	1365	1355
7139G	10/30/1988	1380	65	1315	1365	1355
7139G	5/30/1988	1380	38	1342	1365	1355
7139G	4/30/1988	1380	33	1347	1365	1355
7139G	3/30/1988	1380	33	1347	1365	1355
7139G	2/29/1988	1380	38	1342	1365	1355
7139G	1/30/1988	1380	36	1344	1365	1355
7139G	12/30/1987	1380	35	1345	1365	1355
7139G	11/25/1987	1380	35	1345	1365	1355
7139G	10/30/1987	1380	45	1335	1365	1355
7139G	9/30/1987	1380	41	1339	1365	1355
7139G	8/25/1987	1380	39	1341	1365	1355
7139G	7/30/1987	1380	43	1337	1365	1355

APPENDIX E

GEOSYNTEC
TECHNCIAL MEMORANDUM

Geosyntec consultants

10875 Rancho Bernardo Road
Suite 200
San Diego, CA 92127

PH 858.674.6559
FAX 858.674.6586

www.geosyntec.com

Technical Memorandum

Date: 15 January 2019

To: Duong Do, PACE Engineers

From: Derrik Kapalla; David Parkinson PhD, Geosyntec Consultants

Subject: Desktop Analysis Site Evaluation
Stormwater Infiltration BMP facilities
Santa Clarita, California

INTRODUCTION

This memorandum summarizes the findings of a desktop review of available resources to evaluate the hydrogeologic suitability of four sites for a stormwater infiltration facility (Project) within the City of Santa Clarita, CA. This analysis included the review of hydrogeologic setting, nearby groundwater monitoring and pumping wells, and nearby contaminated sites or groundwater. The purpose of this desktop analysis was to provide support in selection of the most preferred site(s) to infiltrate 40-50 acre-feet per year (AFY) of stormwater.

PROJECT DESCRIPTION

The Project intends to infiltrate 40-50 acre-feet of stormwater via a buried infiltration basin. This underground infiltration system will allow for both storage and infiltration of stormwater runoff that may include the use of stormwater detention vaults, corrugated pipes, and other types of best management practices (BMPs). The success of the Project relies heavily on the hydrogeologic conditions at the site including but not limited to: infiltration rates, vertical and horizontal hydraulic conductivity, potential for groundwater mounding, nearby pumping wells, and nearby groundwater contamination.

REGIONAL GEOLOGY AND HYDROGEOLOGY

The sites of interest lie within the Upper Santa Clara River Groundwater Basin (Basin). The Basin is bounded by granite and granodiorite of the Angeles National Forest to the north, and the San Gabriel Mountains to the south. Between these two prominent crystalline mountain ranges is an alluvial trough consisting of multiple lithologic units of terrestrial depositional origin (USGS, 1999). The water bearing units within the basin include quaternary alluvium, older alluvial terrace deposits, and the sands and gravels of the Tertiary age Saugus Formation.

All of the sites investigated in this desktop evaluation exist within mapped Quaternary alluvium. This alluvial aquifer is considered to be the most permeable unit within the greater Santa Clarita region with transmissivity values ranging from 50,000-500,000 gallons per day per foot. Alluvium is considered to be the thickest in the center of the valleys to a maximum thickness of 200 feet. Specific yields within the alluvial aquifer unit range from 0.1 to 0.35 (CH2MHill, 2015).

The Saugus Formation is Pliocene to Pleistocene in age and underlies the Quaternary alluvium and reaches a maximum thickness of 3,500 feet in the central part of the valley. The upper member of the Saugus formation is coarser grained and consists of sand, gravel and conglomeritic beds from deposition in stream channels, flood plains and ancestral alluvial fans.

REGULATORY REQUIREMENTS

The four proposed project sites are located within Los Angeles County and are therefore subject to regulations pertaining to stormwater infiltration set forth by the Los Angeles County Department of Public Works (LACDPW) including the Low Impact Development Standards Manual (LID). Requirements set forth in the LID Manual concerning this evaluation include:

- Infiltration rates must be higher than 0.3 in/hr;
- Infiltration capacity should be such that maximum retention time is less than 96 hours; and
- Requirement that at least 10 feet of separation exist between the bottom of infiltration basin and groundwater levels.

PARAMETERS OF INTEREST

Various parameters were considered while investigating each of the four potential stormwater infiltration basin sites. These parameters include hydrologic conditions, nearby contaminated sites, and nearby municipal production wells.

Each site was previously evaluated for potential volume of available stormwater following a storm event. This was determined using the 85th percentile precipitation depth, which represents the depth of water produced by 85% of all rainfall events. For the Santa Clarita region, 85% of the storm events will produce 1.3 inches or less of precipitation per event (Los Angeles County DPW, 2004). This analysis included 24 hour periods with measurable rainfall. Each site was then evaluated for runoff volume using this 85th percentile depth. The runoff was estimated using the Soil Conservation Service (SCS) runoff curve number method based on land use types of the drainage area for each site[1].

Hydrogeologic data at each site was collected by Cone Penetration Tests (CPT) were conducted at each of the sites by R.T. Frankian and Associates (Appendix A) to characterize the soil profile and estimate the hydraulic conductivity. Measurements are made of the resistance to penetration on the cone and sleeves. This cone resistance is used to estimate the lithology of the subsurface. Once CPT data has been normalized, a soil type can be interpreted for that boring location. Based on

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[1] Information obtained in e-mail correspondence with PACE dated 19 November 2018.

the CPT survey, a hydraulic conductivity (k) can be estimated. For purposes of this Project, a site with a higher hydraulic conductivity is preferred over a site with lower hydraulic conductivity.

Using the hydrogeologic parameters estimated from the CPTs, the effect of groundwater mounding at the sites was calculated. Groundwater mounding commonly occurs beneath stormwater infiltration basins as groundwater accumulates beneath the basin. The magnitude of mounding is dependent on a multitude of hydrologic and hydrogeologic parameters and can be calculated using equations and/or numerical modeling. A spreadsheet created by the United States Geological Survey (USGS) to model groundwater mounding using the Hantush equation was used to estimate groundwater mounding[2]. Parameters required for the Hantush equation spreadsheet included: recharge rate (R), specific yield (Sy), hydraulic conductivity (k), length and width of infiltration basin (x,y), duration of infiltration period (t), and initial thickness of the saturated zone (hi). The specific yield and hydraulic conductivity are considered to be the most influential parameters to the amount of groundwater mounding at a site (Carleton, 2010). Changes in infiltration rates may have a drastic effect on groundwater mounding. Infiltration rates were estimated from the hydraulic conductivity values estimated in the CPT survey. Infiltration tests have not been conducted at these sites, therefore, groundwater mounding was modelled using the average estimated horizontal hydraulic conductivity value from the CPT survey, and 1/10th of the average horizontal hydraulic conductivity value as an estimate of vertical hydraulic conductivity (Freeze and Cherry, 1979).

Additionally, each site was evaluated for nearby contaminated or formerly contaminated groundwater sites. This was conducted through online databases including State Water Resources Control Board Geotracker[3] and Department of Toxic Substance Controls Envirostor[4]. The Project could have the potential to effect groundwater transport dynamics within the vicinity of the infiltration basin. Nearby contaminated groundwater sites should be considered when choosing a Project site. This desktop evaluation provides a high-level summary of contaminated sites near the four proposed Project sites. It is advised to conduct more detailed research on nearby contaminated sites once a Project site has been chosen, but prior to construction.

Nearby municipal groundwater production wells were also considered in this evaluation. Municipal wells were located using online databases, previous groundwater investigations, and public documents.

SITES INVESTIGATED

Four sites have been chosen as prospective locations for the stormwater infiltration project (Figure 1). This technical memorandum addresses the hydrogeologic conditions at each site to assists in the selection of the most appropriate site for the Project. The four sites, identified by PACE, and assessed in this memorandum include:

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[2] https://pubs.usgs.gov/sir/2010/5102/support/Hantush_USGS_SIR_2010-5102-1110.xlsm
[3] https://geotracker.waterboards.ca.gov/
[4] https://www.envirostor.dtsc.ca.gov/public/

- **Site "X"** - Located on the southern bank of the Santa Clara River near the intersection of Whites Canyon Road and Via Princessa. The total drainage area contributing stormwater runoff to this site is estimated to be 998 acres. This site exists in a seismic hazard/liquefaction zone [5].
- **Santa Clarita Park** – Located approximately one mile north of the Santa Clara River along Seco Canyon Road. The total drainage area contributing stormwater runoff to this site is estimated to be 245 acres. This site exists in a Seismic hazard/liquefaction zone [6].
- **Valencia Glen Park** - Located approximately 1/2 mile northwest of the Newhall Creek/Placerita Creek confluence near Orchard Village Road. The total drainage area contributing stormwater runoff to this site is estimated to be 78 acres. Not within California Geological Survey (CGS) designated seismic hazard zone.
- **Newhall Park** - Located approximately 1/2 mile South of the Newhall Creek/Placerita Creek confluence near along Newhall Road. The total drainage area contributing stormwater runoff to this site is estimated to be 1,025 acres. Not within CGS designated seismic hazard zone.

DATA GAPS AND ASSUMPTIONS

Where data was not available estimations, assumptions, and interpretations were made based on known nearby data, local knowledge within the Santa Clarita Basin, and widely accepted geologic assumptions. These include:

- Infiltration data are not available and therefore estimated from CPT survey;
- Assumptions as to depth of saturated zone;
    - Where available, nearby well logs were used to estimate the depth of the saturated zone. If data were not available, the saturated zone was conservatively estimated to be 200 feet thick.
- Assumes homogenous lithology of saturated zone;
- All of the stormwater captured is infiltrated;
- Estimations of size and depth of infiltration basins from conceptual designs by PACE;
- Hydraulic conductivities are estimated from CPT data and soil type;
- No site visit was conducted for this evaluation; and
- No directly measured aquifer properties available for any of the proposed sites.

SITE "X"

Geology

Site "X" exists along the southern flank of the Santa Clara River channel. The site is relatively topographically flat with hills to the south of the site. The geology at Site "X" is composed of

[5] http://gmw.conservation.ca.gov/SHP/EZRIM/Maps/MINT_CANYON_EZRIM.pdf
[6] http://gmw.conservation.ca.gov/SHP/EZRIM/Maps/NEWHALL_EZRIM.pdf

recent Quaternary unconsolidated sands and gravels of primarily fluvial deposition. Groundwater flow in the site vicinity is interpreted to be toward the northwest, influenced by the gentle topographic profile and proximity to the Sant Clara River channel. CPT surveys were conducted throughout the site to characterize the soil type. The deepest CPT boring at the site was 45 feet below ground surface. Groundwater was not encountered in any of the CPT borings. Soil type, based on the CPT survey, indicates the site is primarily sand and silty sand. Some CPT boring locations showed sections of sand as thick as 16 feet. In general, the CPT data indicates interbedded sands and silty sands with the occasional thin bed of sandy silt.

Hydrology

The 85th percentile stormwater runoff volume for the site was estimated to be 35.7 acre-feet. This means that 85% of the storm events will produce 35.7 acre-feet or less of stormwater runoff available for capture per event. Based on this estimation, it appears the site is likely to receive enough runoff available for capture to accomplish the 40-50 acre-feet per year requirement.

Hydrogeologic Conditions

Hydraulic conductivity (K) at the site ranged from 36 to 131 in/hr with an average hydraulic conductivity of ~95 in/hr. For purposes of estimating groundwater mounding at the site, the infiltration basin dimensions were estimated to be 360 ft long, 360 ft wide, and 10 ft deep. Infiltration rate was estimated from the average hydraulic conductivity, and by dividing the average hydraulic conductivity by a factor of 10 (Carleton, 2010). This produced infiltration rates of 95 in/hr and 9.5 in/hr respectively. The duration of infiltration is a function of the basin capacity and infiltration rate. When infiltration is estimated to be 95 in/hr, the infiltration duration was calculated to be 0.06 days. Infiltration duration increases to 0.63 days when infiltration rates are 9.5 in/hr. The specific yield was conservatively estimated to be 0.25. For purposes of estimating groundwater mounding, it was estimated that the saturated zone is 410 feet thick based on a well log from a nearby groundwater well (Appendix B). Maximum groundwater mounding was modeled to be approximately 32 ft beneath the center of the infiltration basin. Depth to groundwater in the vicinity of the site range up to 97 feet below ground surface (bgs) with an average depth to groundwater of ~44 feet bgs from 1983-2012 (Appendix C). The conceptual bottom of the infiltration basin is 17 ft bgs. Using the 10 feet of clearance between the bottom of the basin and highest groundwater, the recurrence interval for high groundwater that may reach this elevation is 7 to 10 years. If groundwater level fluctuations are consistent with past trends, groundwater may come within 10 feet of the bottom of the infiltration basin periodically following particularly wet winters that receive periods of prolonged and heavy precipitation.

Environmental Resources

A search of online groundwater contamination databases including California GeoTracker and Envirostor was conducted to asses for nearby contaminated sites. This analysis indicated that the following sites occur within ½ mile the proposed infiltration site.

- Four closed leaking underground storage tank (LUST) sites exist within ½ mile of Site "X". Three of these sites are cross or down-gradient and one is up-gradient of Site "X".

All four of these sites have been closed by DTSC and are no longer considered contaminated. Based on information immediately available, the impacts of these closed LUST site appear to be insignificant and do not pose a risk to the potential stormwater infiltration project at Site "X".

- Roughly two miles up gradient to the east is a Wastewater Discharge Requirement (WDR) site. This is the proposed Vista Canyon Water factory Project, which is a proposed water treatment plant to produce non-potable water for irrigation from wastewater from a proposed development. Neither the development, nor the wastewater treatment plant have been built. There are currently nine groundwater monitoring wells associated with this facility. It is unknown if this project will influence groundwater levels within the Santa Clara River Basin once constructed and in use. Given the distance and upgradient location, combined with irrigation use of recycled water rather than direct infiltration, it is unlikely that this site will have an effect on groundwater elevations at Site X.

Water Supply Wells

Three water supply groundwater production wells are located roughly 2000 feet northeast of Site "X". These wells are named; North Oaks West, North Oaks Central, North Oaks East. These three wells are located on the northern bank of the Santa Clara River channel upgradient from Site "X". Pump tests from these wells were not able to be located for these three wells and therefor their influence on hydrogeologic conditions in the vicinity of the Project is unknown. Based on hydraulic conductivities from the CPT, anticipated groundwater flow direction, and historic groundwater levels, it is unlikely the water supply wells would have a significant effect on groundwater conditions at Site "X" and the infiltration basin is unlikely to have any impact on the water supply production wells. If Site "X" is determined to be the Project site, it is advised that further investigation be conducted to confirm stormwater infiltration will not adversely impact water supply wells.

SANTA CLARITA PARK

Geology

Santa Clarita Park exists in a small valley roughly 1.5 miles North of the Santa Clara river. The geology is mapped as unconsolidated Quaternary alluvium. CPT surveys were conducted throughout the site to characterize the soil type. The deepest CPT boring at the site was 50 feet. Groundwater was not encountered in any of the CPT borings. CPT surveys indicate the site is primarily sand and silty sand. A few CPT boring locations indicated interbedded layers of sand and silt with occasional thin clay beds of less than two feet thick. Clay content appears to increase on the southeast portion of the project site, while the western portion of the site was interpreted to consist primarily of sands. A well log was obtained from the installation of a monitoring well roughly ½ mile downgradient in which groundwater was encountered at roughly 80 feet bgs. (Appendix B). The lithology appears to be primarily medium dense sands, silty sands, and trace silt layers.

Hydrology

The 85th percentile stormwater runoff volume for the site is 9.7 acre-feet. The proposed infiltration basin has the capacity to capture up to 10.5 acre-feet, which allows the basin to capture all of the estimated runoff in the drainage. Additionally, an existing stormwater channel exists within close proximity of the project site to the west. Stormwater runoff from this channel may become available to increase the available water for infiltration. Based on the estimated stormwater available, it appears the Santa Clarita Park site would be able to meet the needed 40-50 acre feet per year requirement for the Project.

Hydrogeologic Conditions

Hydraulic conductivity (K) at the site ranged from 2.6 to 93.6 in/hr with an average hydraulic conductivity of ~41 in/hr. For purposes of estimating groundwater mounding at the site, the infiltration basin dimensions were estimated to be 210 ft by 210 ft by 10 ft deep. Infiltration rate was estimated to equal the average hydraulic conductivity value from the CPT survey, as well as by dividing the average hydraulic conductivity by a factor of 10 (Carleton, 2010). This produced infiltration rates of 41 in/hr and 4.1 in/hr respectively. The duration of infiltration was estimated to be 0.11 days and 1.13 days based on the volume of water available to be infiltrated. At the Santa Clarita Park site, the basin design is estimated to hold up to 10.5 acre-feet of water, however, the 85th percentile storm will only produce 9.7 acre-feet of runoff. Therefore, for purposes of estimated duration of infiltration, the lesser value of 9.7 acre-feet was used and it was assumed that all the water was infiltrated. The specific yield was conservatively estimated to be 0.25. Based on these parameters the maximum mounding at the site was estimated to be approximately 23 feet above the static water table when infiltration rate equals hydraulic conductivity, and approximately 6 feet when infiltration equals 1/10th hydraulic conductivity. Depth to groundwater in the vicinity of the site range from 56 to 92 feet bgs. Based on historic groundwater elevations and the calculated maximum groundwater mounding potential, it appears unlikely that the groundwater mound will come within ten feet of the bottom of the infiltration basin. Site specific infiltration testing is recommended prior to construction to more accurately estimate hydrogeologic conditions.

Environmental Resources

A search of online groundwater contamination databases including California GeoTracker and Envirostor was conducted to asses for nearby contaminated sites.

- Two leaking underground storage tank (LUST) sites exist down gradient within one mile of Santa Clarita Park. Both sites are still open and involve gasoline storage tanks. Groundwater monitoring wells have been installed at both sites and groundwater monitoring is currently in effect. Both sites exist more than ½ mile downgradient of Santa Clarita Park and therefore it is unlikely the Project will influence groundwater conditions at the LUST sites. It is possible that the infiltration of stormwater upgradient of the LUST sites may increase upgradient hydraulic head, thus increasing hydraulic gradient, which has the potential to further mobilize contaminants. If Santa Clarita Park is chosen for a stormwater infiltration basin site, it is recommended that a complete groundwater model be created to evaluate the potential for contaminant mobilization due to stormwater infiltration upgradient.

Water Supply Wells

A search of the California Water Boards' Groundwater Information System yielded the nearest public water supply well is located roughly 1.5 miles downgradient of Santa Clarita Park on the northern bank of the Santa Clara River. This water supply well is not expected to be impacted by the proposed upgradient infiltration basin.

VALENCIA GLEN PARK

Geology

Valencia Glen park exists in a relatively topographically flat area with surface geology mapped as unconsolidated to semi-consolidated Quaternary alluvium of terrestrial origin. Groundwater flow in the site vicinity is generally to the East influenced by the gentle topographic profile. CPT surveys were conducted throughout the site to characterize the soil behavior type (SBT). The deepest CPT boring at the site was 50 feet below ground surface. Groundwater was not encountered in any of the CPT borings. SBT based on the CPT survey shows the site is primarily silty sand and sandy silt. Some CPT boring locations showed up to 12' thick sections of sand, as well as interbedded sand and silt with occasional clay lens.

Hydrology

The 85th percentile stormwater runoff volume for the site is 3.8 acre-feet. Based on this number, if the infiltration basin was able to capture 100% of the runoff through the site, there would need to be a minimum of 11 storm events per year to meet the 40-50 acre-feet per year demand of the project.

Hydrogeologic Conditions

Hydraulic conductivity (K) at the site ranged from 0.0 to 2.7 in/hr with an average hydraulic conductivity of 0.25 in/hr. Based on this infiltration rate, this site does not meet the requirements of the LID Manual and therefore is not recommended for development of an infiltration basin. Due to the low infiltration rate and historic groundwater levels, groundwater mounding is not considered to be a significant factor at this site. It appears unlikely that the groundwater mound will come within ten feet of the bottom of the infiltration basin.

Environmental Resources

A search of online groundwater contamination databases including California GeoTracker and Envirostor was conducted to asses for nearby contaminated sites.

- A closed LUST site exists ¼ mile northeast of the site. This case involved an underground diesel storage tank at a Henry Mayo Memorial Hospital. This LUST site was cleaned up and the case was closed in 2012 and will not impact the site.

This site is not recommended for construction of an infiltration basin at this time. Low values for hydraulic conductivity preclude this site from development as a viable option for an infiltration basin. However, the hydraulic conductivity values at this site were estimated from CPT results. If this site is selected in the future for construction of an infiltration basin, it is recommended that further testing to confirm hydrogeologic parameters occurs.

NEWHALL PARK

Geology

Newhall Park exists in a relatively topographically flat area with surface geology mapped as unconsolidated to semi-consolidated Quaternary alluvium. Groundwater flow in the site vicinity is generally to the North influenced by the gentle topographic profile. CPT surveys were conducted throughout the site to characterize the soil behavior type (SBT). The deepest CPT boring at the site was 50 feet below ground surface. Groundwater was not encountered in any of the CPT borings. SBT based on the CPT survey shows the site is primarily silty sand with interbedded layers of silt and occasional lenses of clay. The clay and silt beds do not appear to be continuous in the CPT survey and are therefore interpreted as laterally discontinuous lenses. These layers have the capability of limiting infiltration rates at the site. Additionally, "Very dense/stiff soil" was encountered in multiple borings in the western portion of the site around 25 feet bgs.

Hydrology

The 85th percentile volume for the site is 21.6 acre-feet. Based on this volume, it appears Newhall Park will have enough stormwater runoff available to meet the 40-50 AFY requirement.

Hydrogeologic Conditions

Hydraulic conductivity (K) at the site ranged from 0.0 to 3.9 in/hr with an average hydraulic conductivity of 1.18 in/hr. For purposes of estimating groundwater mounding at the site, the infiltration basin dimensions were estimated to be 350 ft by 150 ft by 10 ft deep. Infiltration rates were estimated to equal the average hydraulic conductivity value from the CPT survey, as well as by dividing the average hydraulic conductivity by a factor of 10 (Carleton, 2010). This produced infiltration rates of 1.18 in/hr and 0.12 in/hr respectively. The duration of infiltration was estimated to be approximately four days if infiltration rates equal hydraulic conductivity, and 41 days if infiltration is 1/10th hydraulic conductivity based on the volume of water and infiltration rates. The specific yield was conservatively estimated to be 0.25. The maximum amount of groundwater mounding is estimated to be 14 feet at the center of the basin. Depth to groundwater in the vicinity of the site appears to be approximately 175 feet below ground surface. Based on historic groundwater elevations and the calculated maximum groundwater mounding potential, it appears unlikely for the potential for groundwater mound to rise to within ten feet of the bottom of the infiltration basin.

Environmental Resources

A search of online groundwater contamination databases including California GeoTracker and Envirostor was conducted to asses for nearby contaminated sites.

- A search of The Department of Toxic Substance Control (DTSC) EnviroStor database showed an open cleanup site named "Old Orchard Shopping Center" less than ¼ mile to the southwest of Newhall Park. This cleanup site is topographically upgradient of Newhall Park. The DTSC cleanup site appears to have historically been operated as a dry cleaner (EnviroStor ID: 19720018). Concentration of PCE and TCE are at elevated levels in groundwater at the site as of 2014 at a maximum concentration of 160 ug/L. Additionally, there are concerns of indoor air quality as a result of contaminated soil and groundwater. Indoor air is monitored quarterly at the site and concentrations have been reducing over time. The proposed infiltration basin would be constructed ¼ mile downgradient of the DTSC open cleanup site. The effects of the infiltration basin on the groundwater contaminant plume is unknown at this time. It is plausible that the infiltration of stormwater in the vicinity of the contaminant plume could have an effect on the depth, flow direction, velocity, and concentration of the contaminant plume. Further analysis may be warranted to determine the extent of this influence.
- Open but inactive cleanup site upgradient of Newhall park to the East by approx. ¾ mile. There is only one document, but it references TPH as high as 40,000,000 mg/kg in the soil and that groundwater is likely effected.
- There are multiple closed LUST sites upgradient of the park by less than ½ mile. All of the LUST sites are closed. Approx. 9 monitoring wells exist in the vicinity.

SUMMARY AND RECOMMENDATIONS

Groundwater mound height from infiltration is illustrated in Figure 2, and hydrogeologic conditions are summarized below in Table 1.

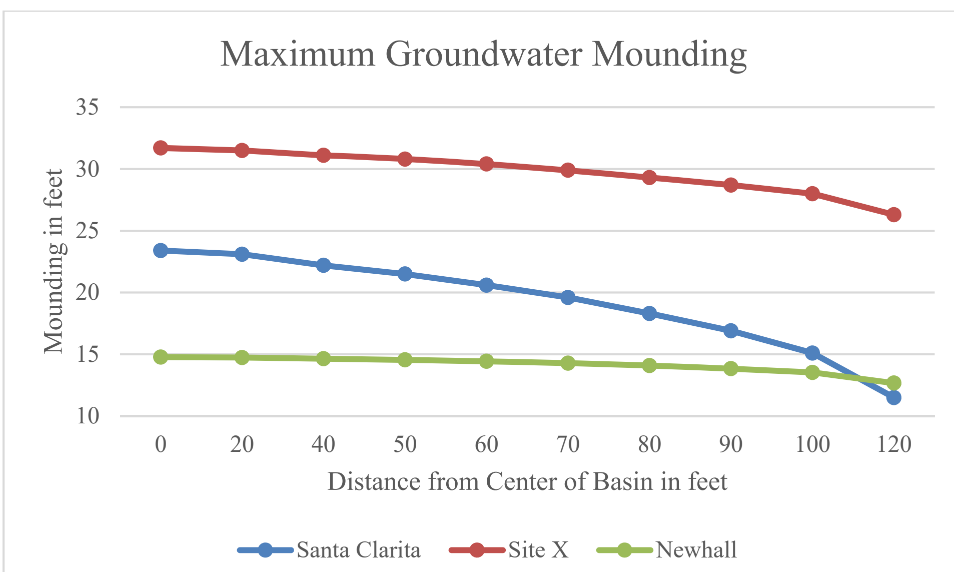


Figure 2

Table 1

	Site X	Santa Clarita Park	Newhall Park	Valencia Glen Park
Average Infiltration Rate[7] (in/hr)	95	41	1.18	0.25
Average Infiltration Rate (1/10th) (in/hr)	9.5	4.1	0.12	0.03
Duration of infiltration (days)	0.06	0.11	4	NA
Duration of infiltration (1/10th) (days)	0.63	1.13	41	NA
Minimum depth to water (ft)	9	56	175	168
Maximum groundwater mounding (ft)	32	23	14	NA
Minimum distance between invert and groundwater (ft)	0*	16	145	NA
85th percentile volume infiltrated per event (acre-feet)	35.7	9.7	21.6	3.8

- Valencia Glen - not recommended based on low hydraulic conductivities. Additionally, contaminated sites exist nearby and should be considered.
- Newhall Park - it is recommended that further infiltration testing occur before choosing this site. At the current infiltration rates, stormwater has the potential to infiltrate slowly which may cause a concern for vectors.
- Site “X” - appears to have the best infiltration, however, during exceptionally wet winters (likely approximately 7-10 years) bypass of stormwater may be required.
- Santa Clarita Park - good infiltration, deeper groundwater, with open LUST site down gradient.
- Need to conduct infiltration testing at chosen site to better understand the hydrology.
- A complete groundwater model is advised to better understand the hydrogeologic conditions prior to construction of infiltration basin.

* * * * *

[7] Average infiltration rates obtained from estimated hydraulic conductivity from CPT survey.
* Bypass of stormwater may be required during exceptionally wet winters when groundwater levels may be shallow.

References:

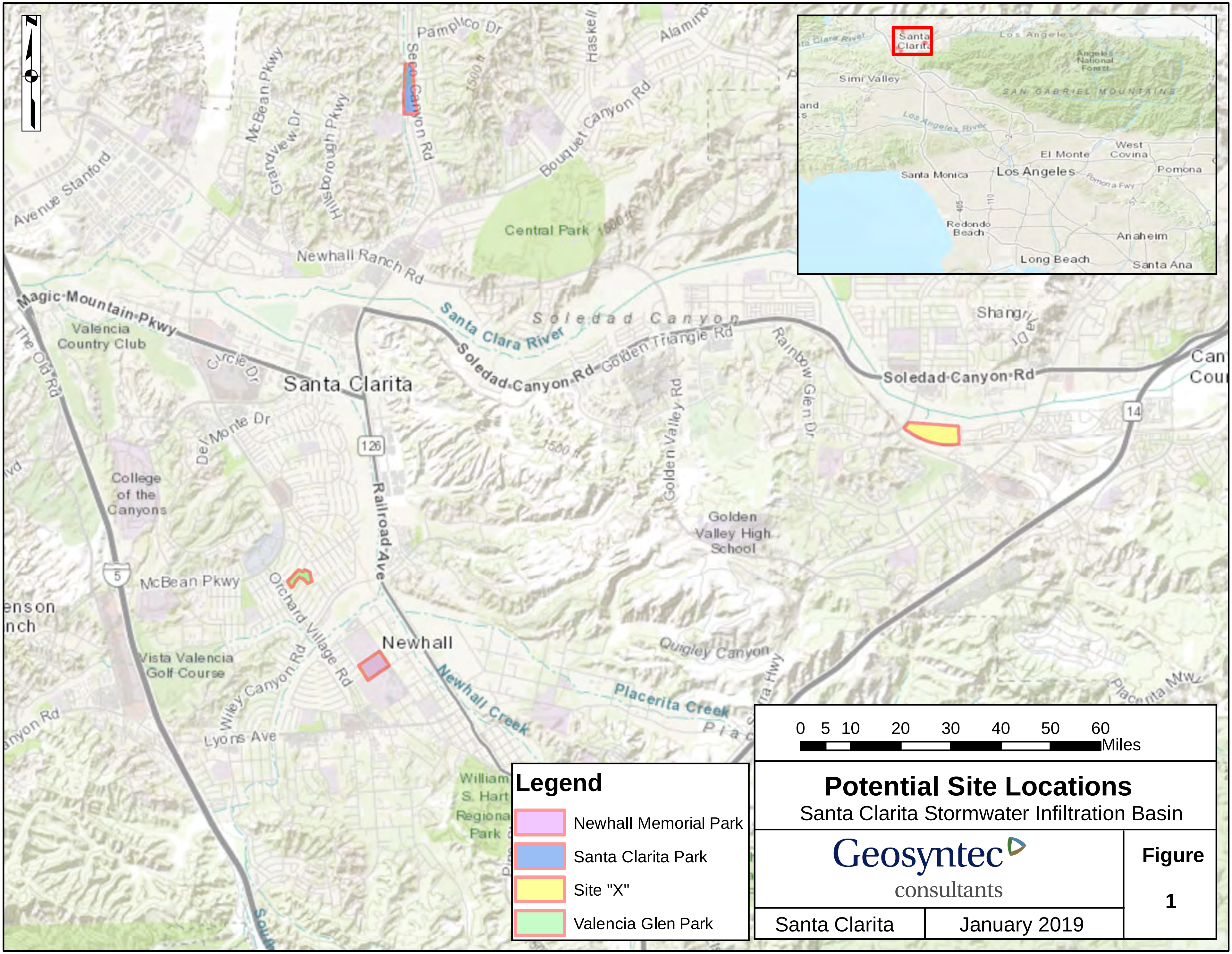
Carleton, G.B., 2010, *Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins*. U.S. Geological Survey Scientific Investigations Report 2010-5102, 64 p.CH2MHill, et. Al., 2006, *Task 2A – Conceptual Model Development East and Piru Subbasins*, Prepared for Sanitation Districts of Los Angeles County, Los Angeles Regional Water Quality Control Board. October 2006

Freeze, R.A., and Cherry, J.A., 1979, Groundwater: Englewood Cliffs, N.J., Prentice-Hall, Pg. 32-33.

Los Angeles County Department of Public Works, 2004, *Analysis of 85th Percentile 24-hour Rainfall Depth Analysis Within the County of Los Angeles.* Water Resources Division Hydrology Section. February 2004.

United States Geological Survey (USGS). 1999. *Evaluation of Surface-Water/Ground-Water Interactions in the Santa Clara River Valley, Ventura County, California.* Water-Resources Investigations Report 98-4208. Prepared in cooperation with the United Water Conservation District.

ATTACHMENTS



Potential Site Locations

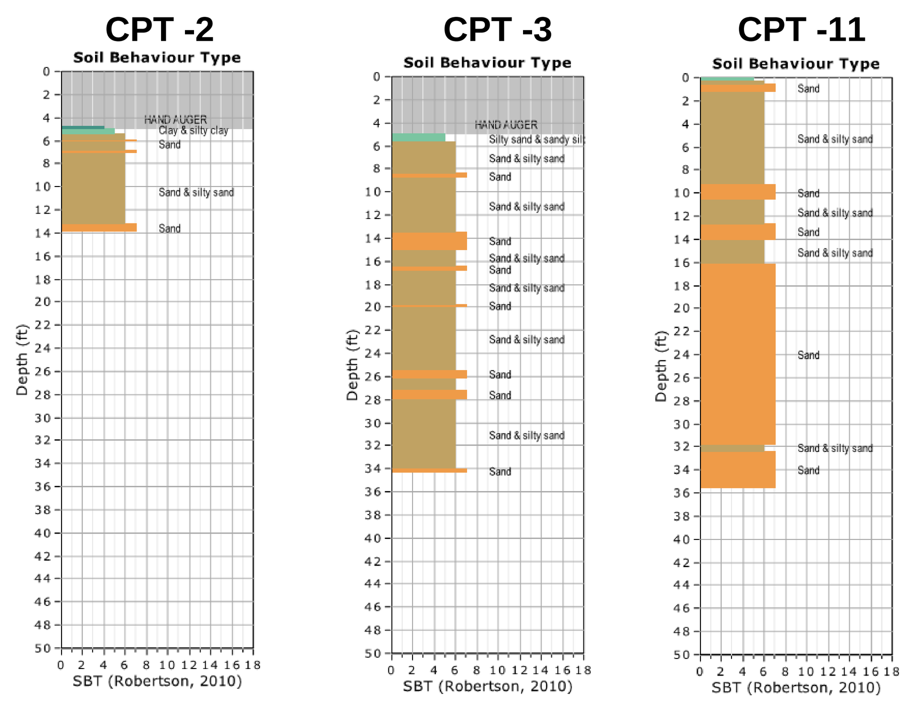
Santa Clarita Stormwater Infiltration Basin

Santa Clarita	January 2019	Figure 1

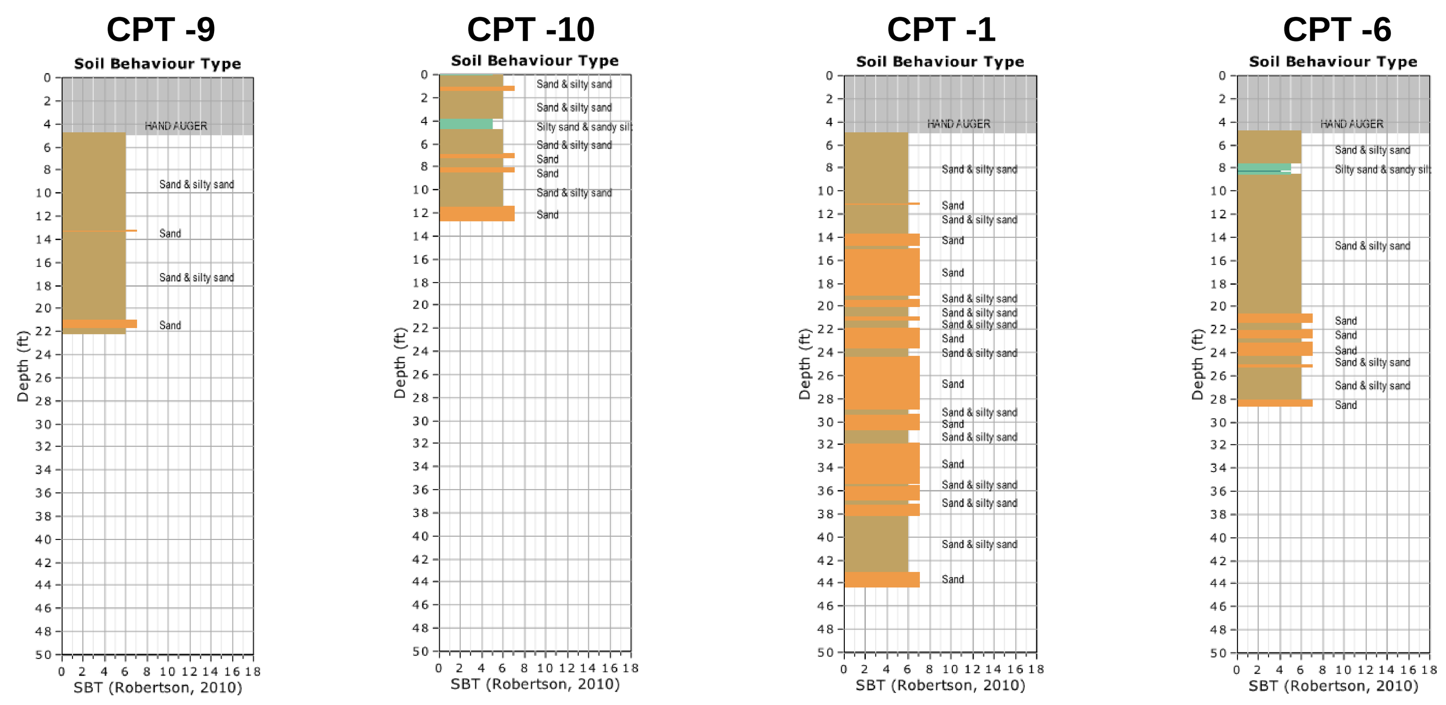
APPENDIX A

CPT Survey Results

A-A'

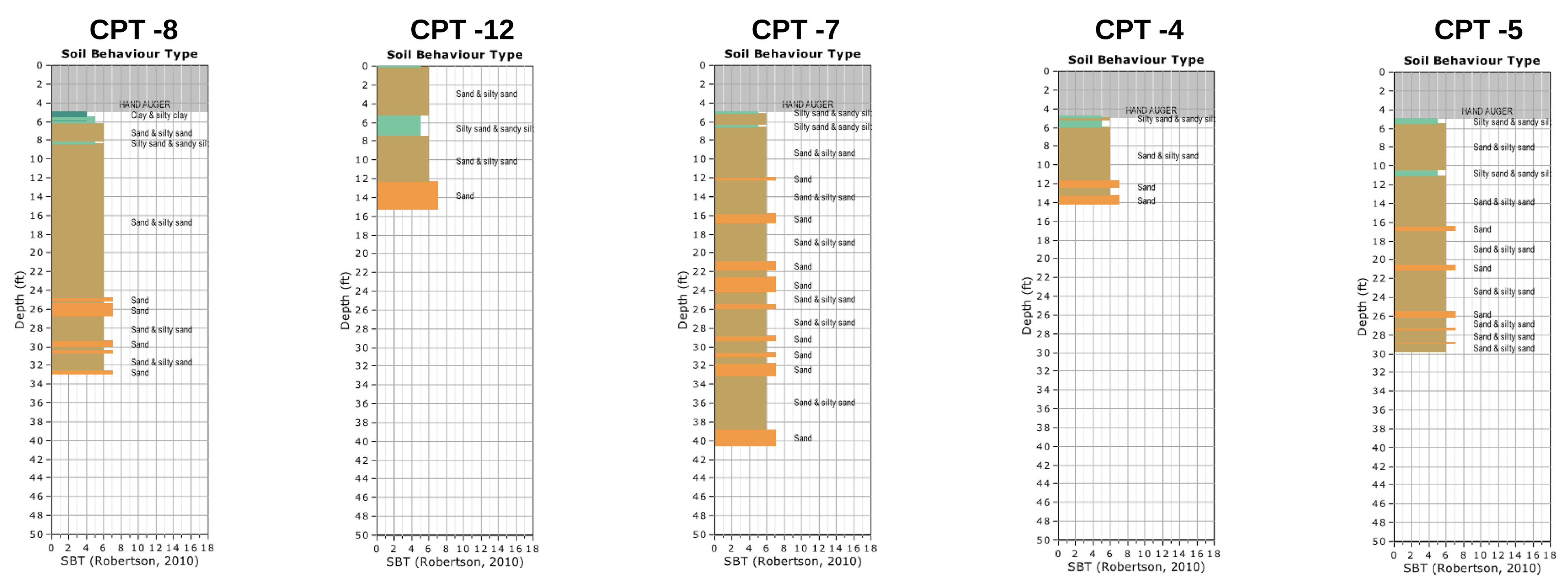


B-B'



RTFA
GEOTECHNICAL ENGINEERING & ENGINEERING GEOLOGY

C-C'



EXPLANATION

◉ CPT-1	Approximate Location and Number of CPT
STK # 1001	Staked Identifier
1388.0'	Surface Elevation at CPT Location
R @ 15'	Refusal/Depth of CPT

Site X				
CPT#	Preliminary Corrected k, ave (in/hr)			End of CPT (ft bgs)
	Depth (ft bgs)			
	15-25	25-end	15-end	
1	162.0	110.4	128.1	44
2	na	na	na	14
3	115.4	73.5	95.2	34
4	151.7	85.2	110.9	40
5	120.6	151.3	130.6	30
6	110.3	121.9	113.5	29
7	na	na	na	14
8	89.6	88.5	89.1	32
9	**52.7**	na	**52.7**	**21**
10	na	na	na	12
11	39.5	33.2	36.3	35
12	na	na	na	15

Job No. 2018-003-052 8/23/2018

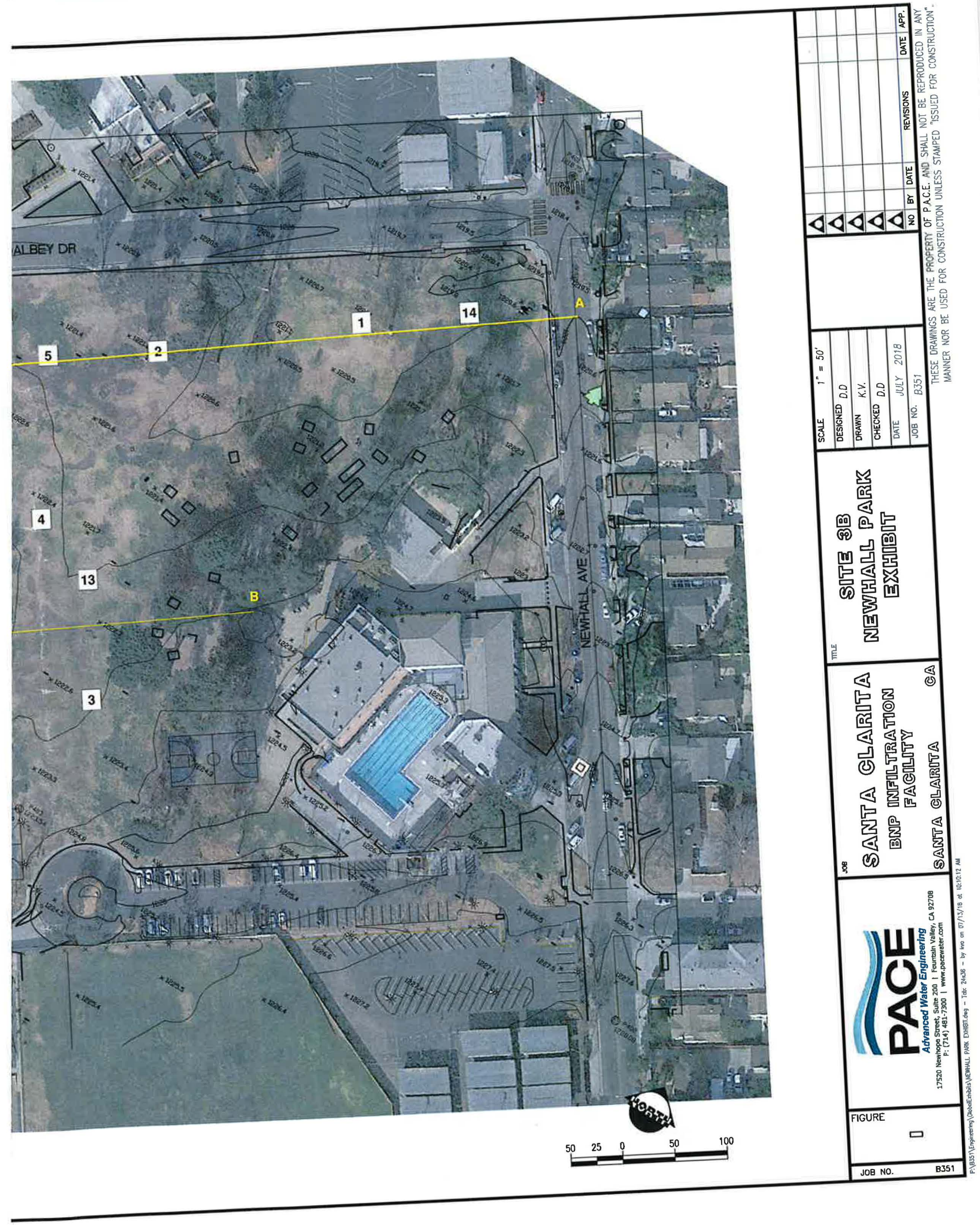
Compare to 0.3 in/hr value

CPT#	Corrected k, ave (in/hr) Depth (ft bgs) 15-25	25-end	15-end	End of CPT (ft bgs)
Newhall Memorial Park				
1	4.1	0.1	2.8	30
2	3.1	0.0	2.1	30
3	1.0	0.6	0.9	30
4	5.8	0.1	3.9	30
5	0.9	0.0	0.6	30
6	1.9	0.0	1.3	30
7	1.5	0.1	1.0	30
8	0.9	0.0	0.9	25
9	0.4	0.0	0.3	30
10	0.2	1.1	0.3	27
11	1.4	0.2	0.8	35
12	0.7	0.0	0.7	30
13	0.8	0.1	0.6	30
14	1.0	0.1	0.4	50

Silty sand is more sand

CPT#	Corrected k, ave (in/hr) Depth (ft bgs) 15-25	25-end	15-end	End of CPT (ft bgs)
Valencia Glen Park				
1	0.2	0.0	0.2	30
2	0.4	1.0	0.6	30
3	1.1	0.7	1.0	30
4	3.3	1.1	2.6	30
5	0.1	0.4	0.3	50
6	0.0	0.0	0.0	30
7	0.2	0.1	0.2	30
8	0.1	0.0	0.0	50
9	0.7	2.0	1.6	50
10	0.2	0.0	0.2	30
11	0.1	0.0	0.1	30
12	0.2	0.0	0.1	30
13	0.1	0.0	0.0	30
14	0.7	6.8	2.7	30

Silty sand is more silt



EXPLANATION

14 Approximate Location and Number of CPT Exploration

RTF&A
GEOTECHNICAL ENGINEERING & ENGINEERING GEOLOGY

NORTH

50 25 0 50 100

NO	BY	DATE	REVISIONS	DATE	APP.

SCALE 1" = 50'
DESIGNED D.D.
DRAWN K.V.
CHECKED D.D.
DATE AUG 2018
JOB NO. B351

TITLE
SANTA CLARITA PARK EXHIBIT

JOB
SANTA CLARITA
SANTA CLARITA PARK
SANTA CLARITA CA

PACE
Advanced Water Engineering
17520 Newhope Street, Suite 200 | Fountain Valley, CA 92708
P: (714) 481-7300 | www.pacewater.com

FIGURE 1

JOB NO. B351

GREGG DRILLING, INC.
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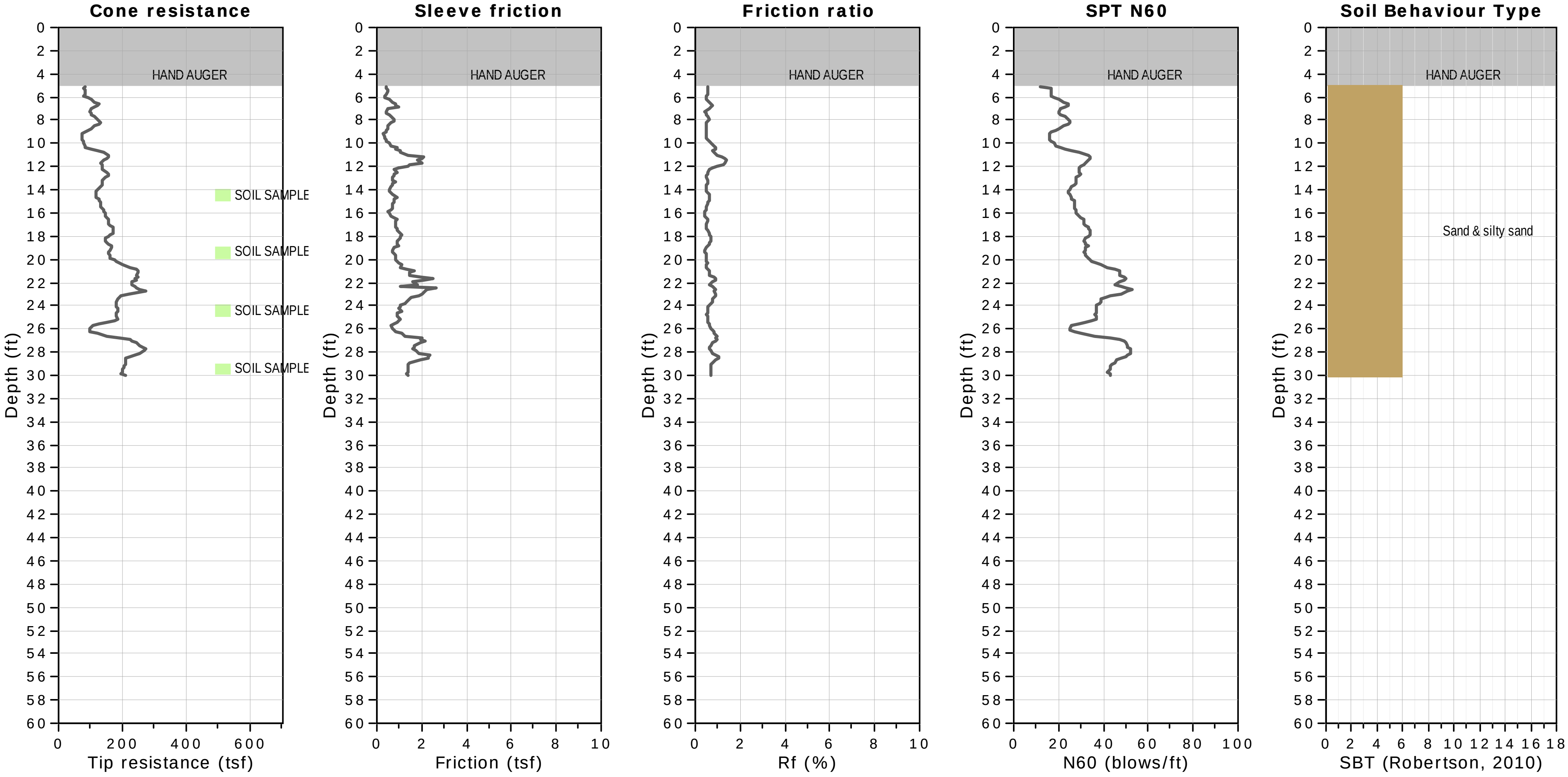
CPT: CPT-01

CLIENT: R.T. FRANKIAN & ASSOCIATES

SITE: SANTA CLARITA PARK INFILTRATION - 27285 SECO CANYON ROAD, SANTA CLARITA, CA

Field Rep: JIM F.

Total depth: 30.02 ft, Date: 8/28/2018



SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

GREGG DRILLING, INC.
www.greggdrilling.com

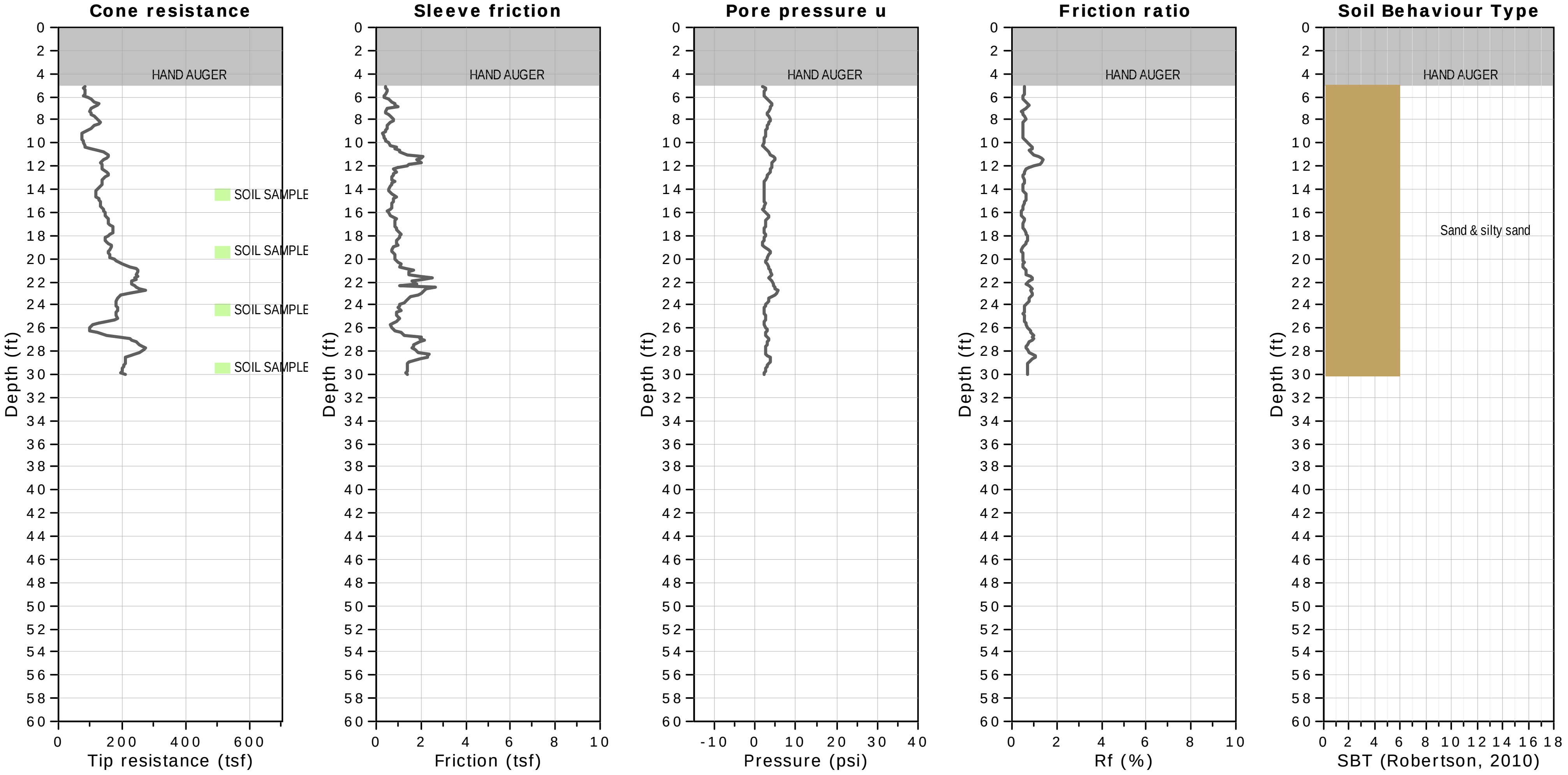
CPT: CPT-01

CLIENT: R.T. FRANKIAN & ASSOCIATES

Field Rep: JIM F.

SITE: SANTA CLARITA PARK INFILTRATION - 27285 SECO CANYON ROAD, SANTA CLARITA, CA

Total depth: 30.02 ft, Date: 8/28/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
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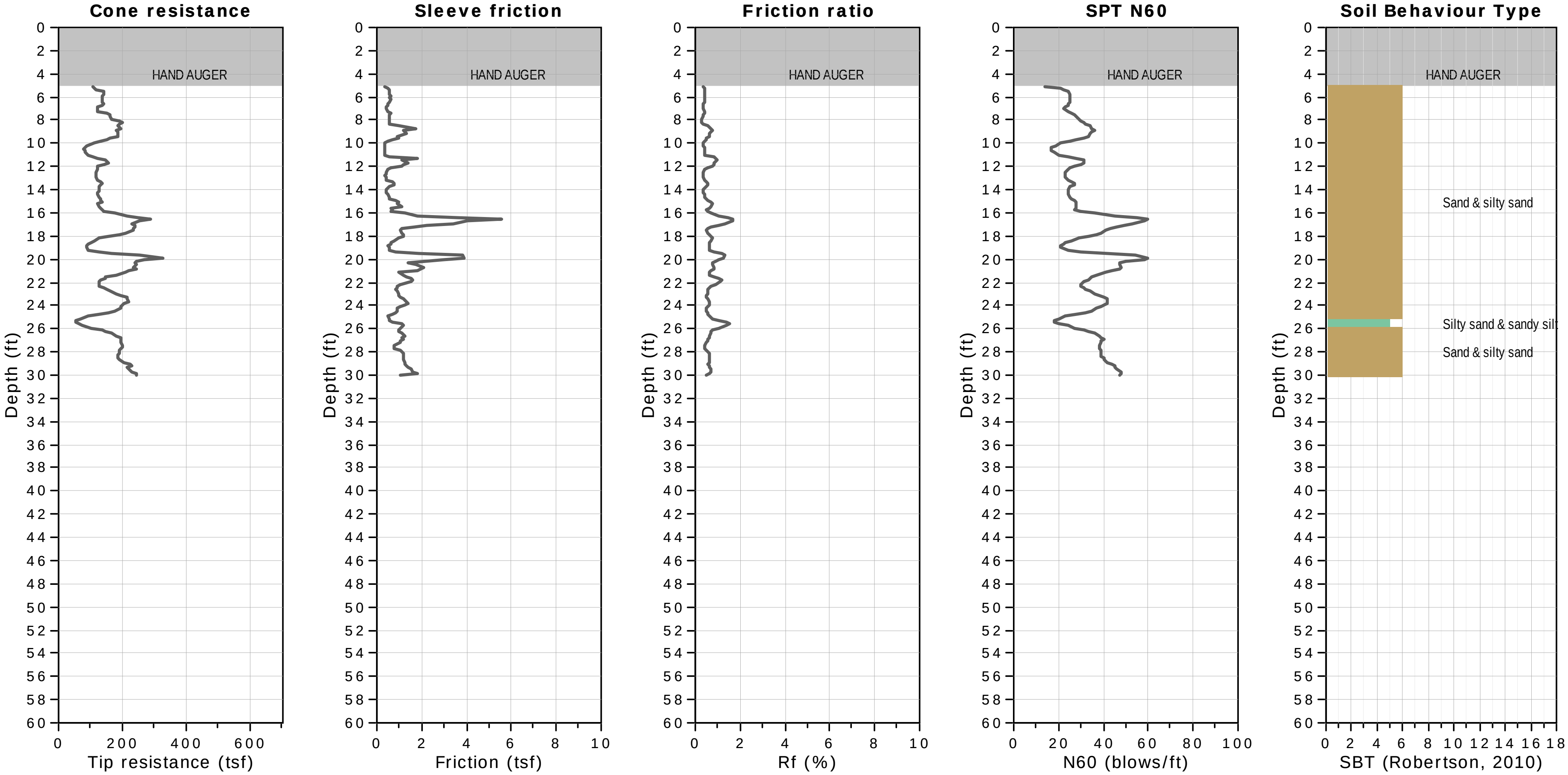
CPT: CPT-02

CLIENT: R.T. FRANKIAN & ASSOCIATES **Field Rep: JIM F.**

SITE: SANTA CLARITA PARK INFILTRATION - 27285 SECO CANYON ROAD, SANTA CLARITA, CA

Total depth: 30.02 ft, Date: 8/28/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

GREGG DRILLING, INC.
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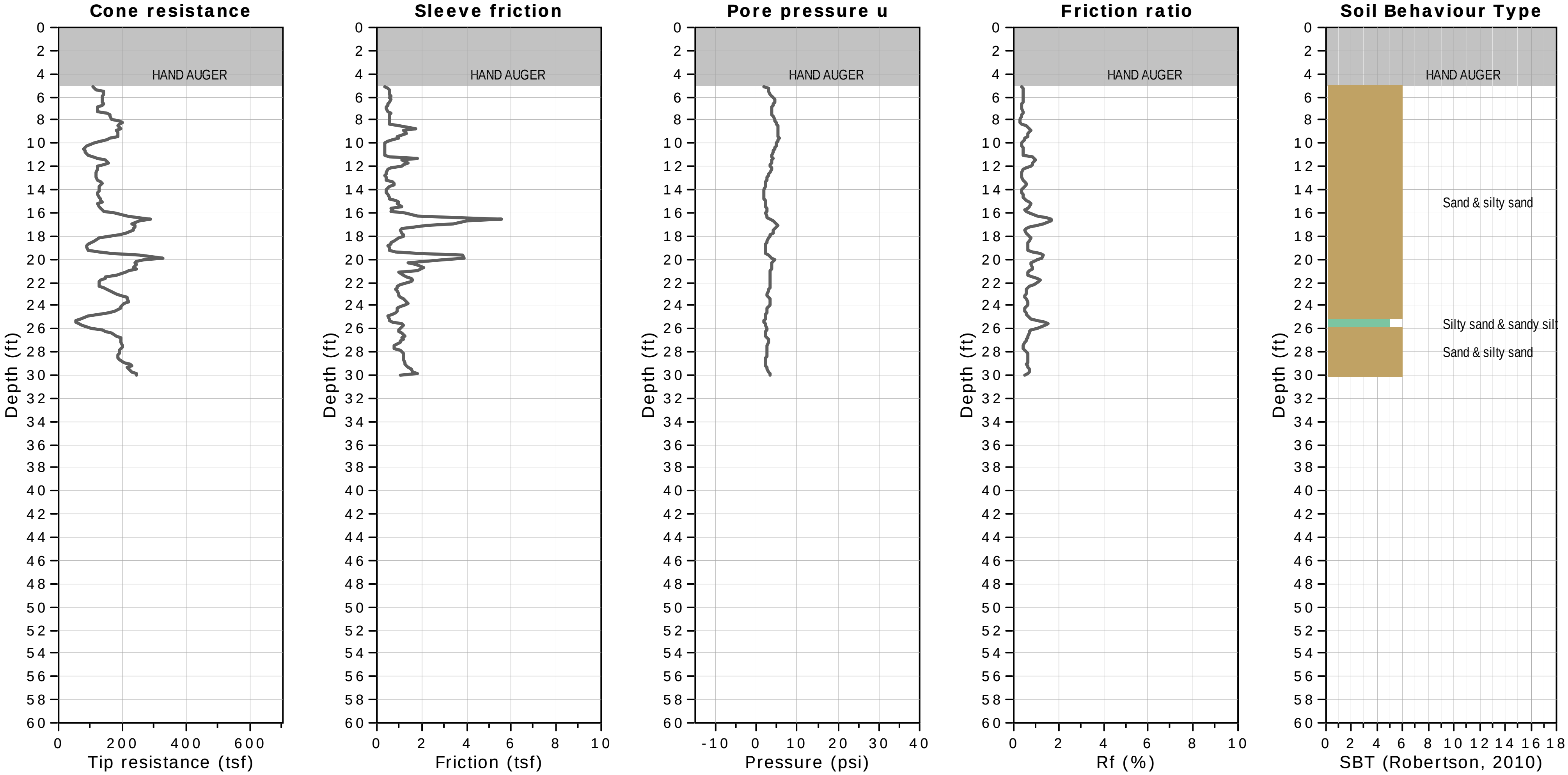
CPT: CPT-02

CLIENT: R.T. FRANKIAN & ASSOCIATES

SITE: SANTA CLARITA PARK INFILTRATION - 27285 SECO CANYON ROAD, SANTA CLARITA, CA

Field Rep: JIM F.

Total depth: 30.02 ft, Date: 8/28/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
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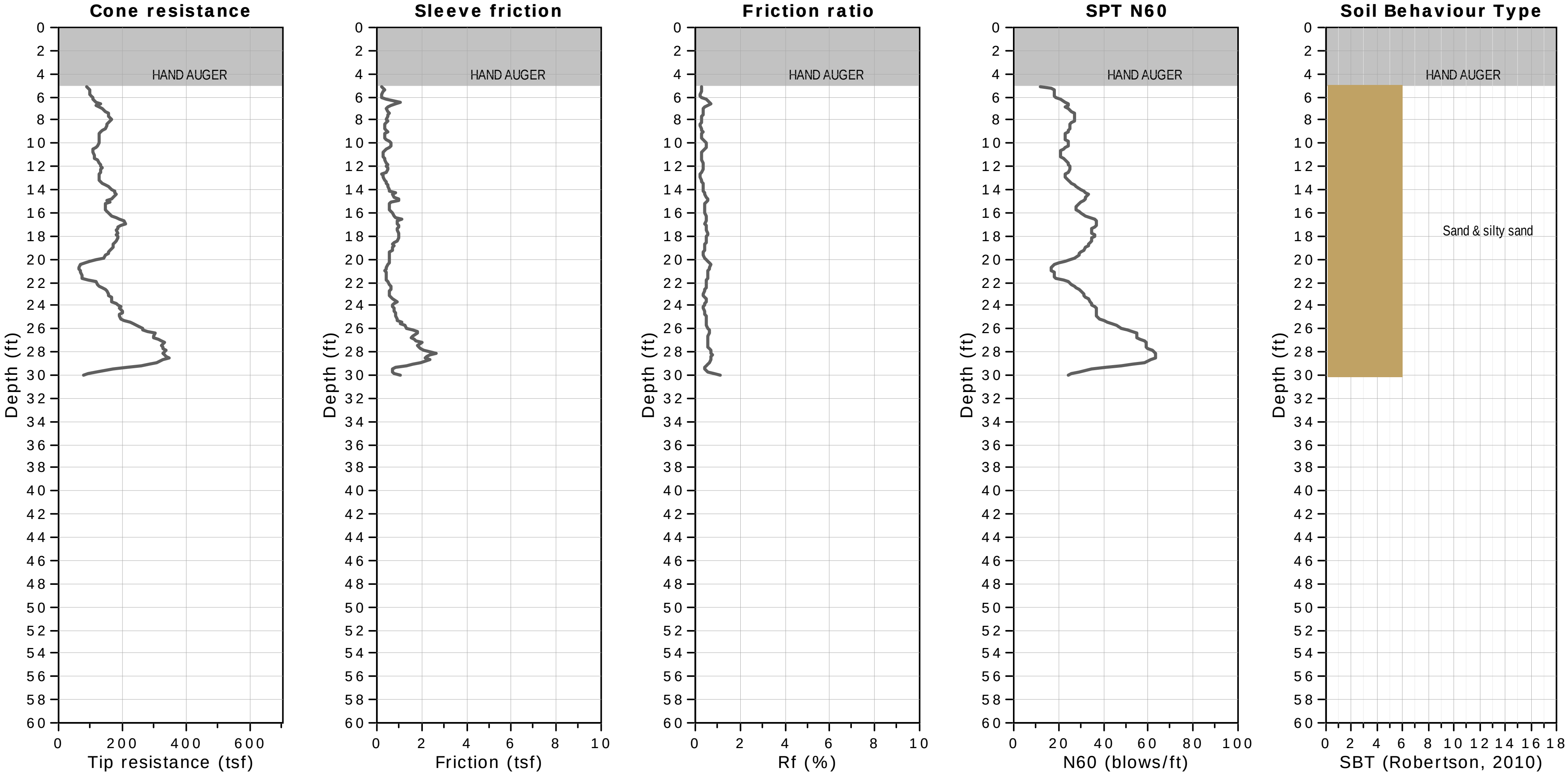
CPT: CPT-03

CLIENT: R.T. FRANKIAN & ASSOCIATES **Field Rep: JIM F.**

SITE: SANTA CLARITA PARK INFILTRATION - 27285 SECO CANYON ROAD, SANTA CLARITA, CA

Total depth: 30.02 ft, Date: 8/28/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

GREGG DRILLING, INC.
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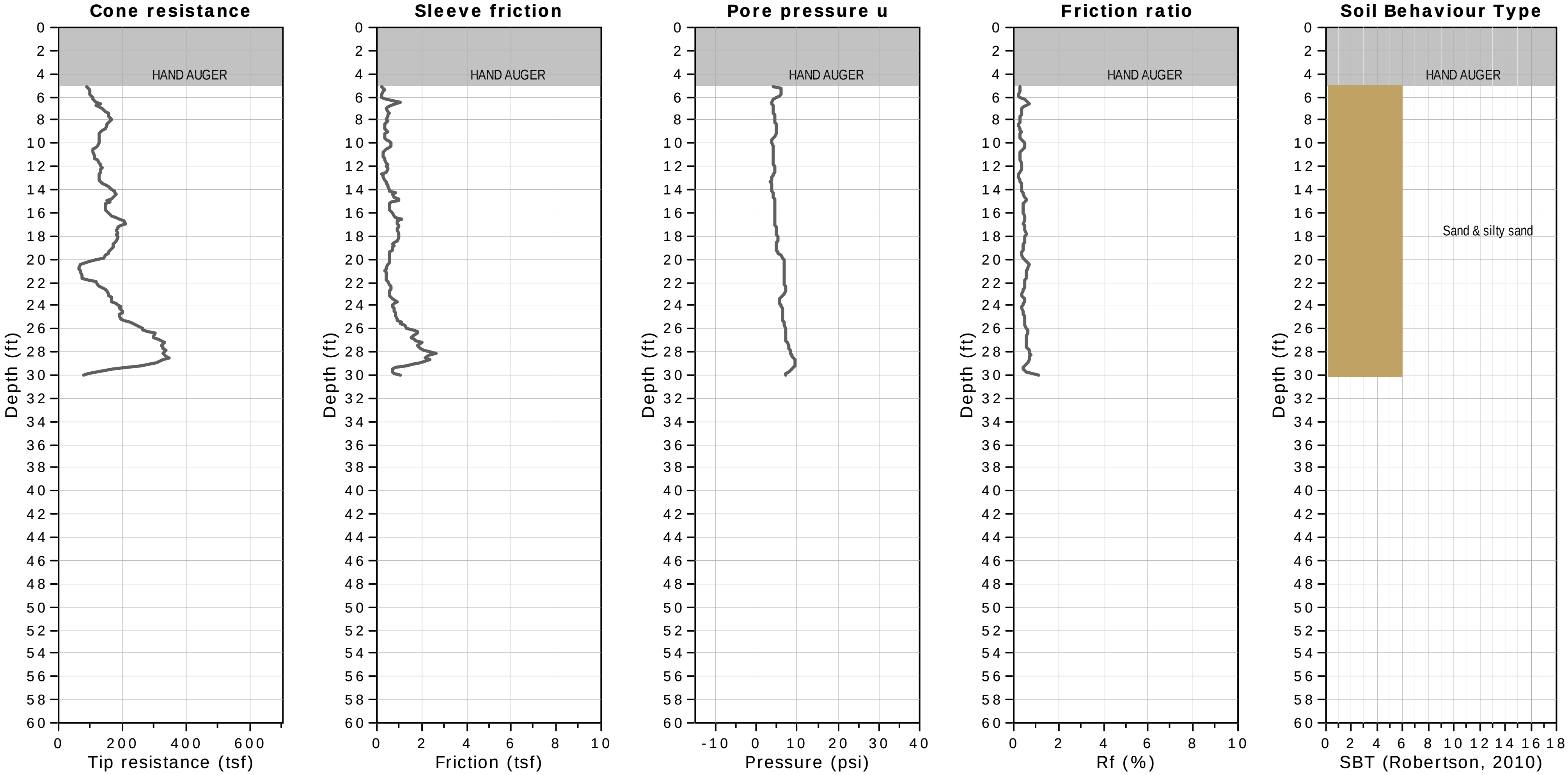
CPT: CPT-03

CLIENT: R.T. FRANKIAN & ASSOCIATES

SITE: SANTA CLARITA PARK INFILTRATION - 27285 SECO CANYON ROAD, SANTA CLARITA, CA

Field Rep: JIM F.

Total depth: 30.02 ft, Date: 8/28/2018



SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty clay	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to clayey sand
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
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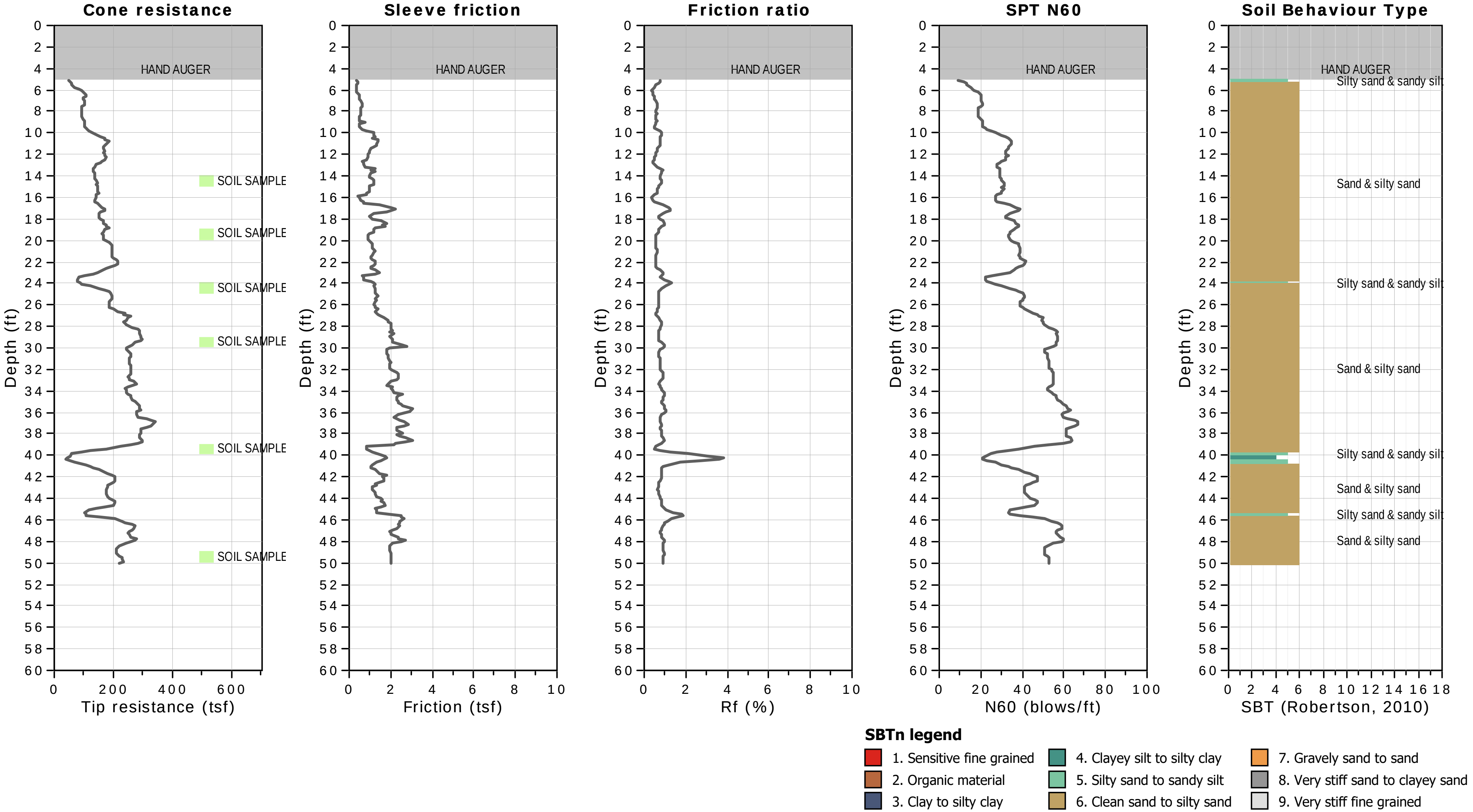
CPT: CPT-04

CLIENT: R.T. FRANKIAN & ASSOCIATES **Field Rep: JIM F.**

SITE: SANTA CLARITA PARK INFILTRATION - 27285 SECO CANYON ROAD, SANTA CLARITA, CA

Total depth: 50.03 ft, Date: 8/28/2018



GREGG DRILLING, INC.
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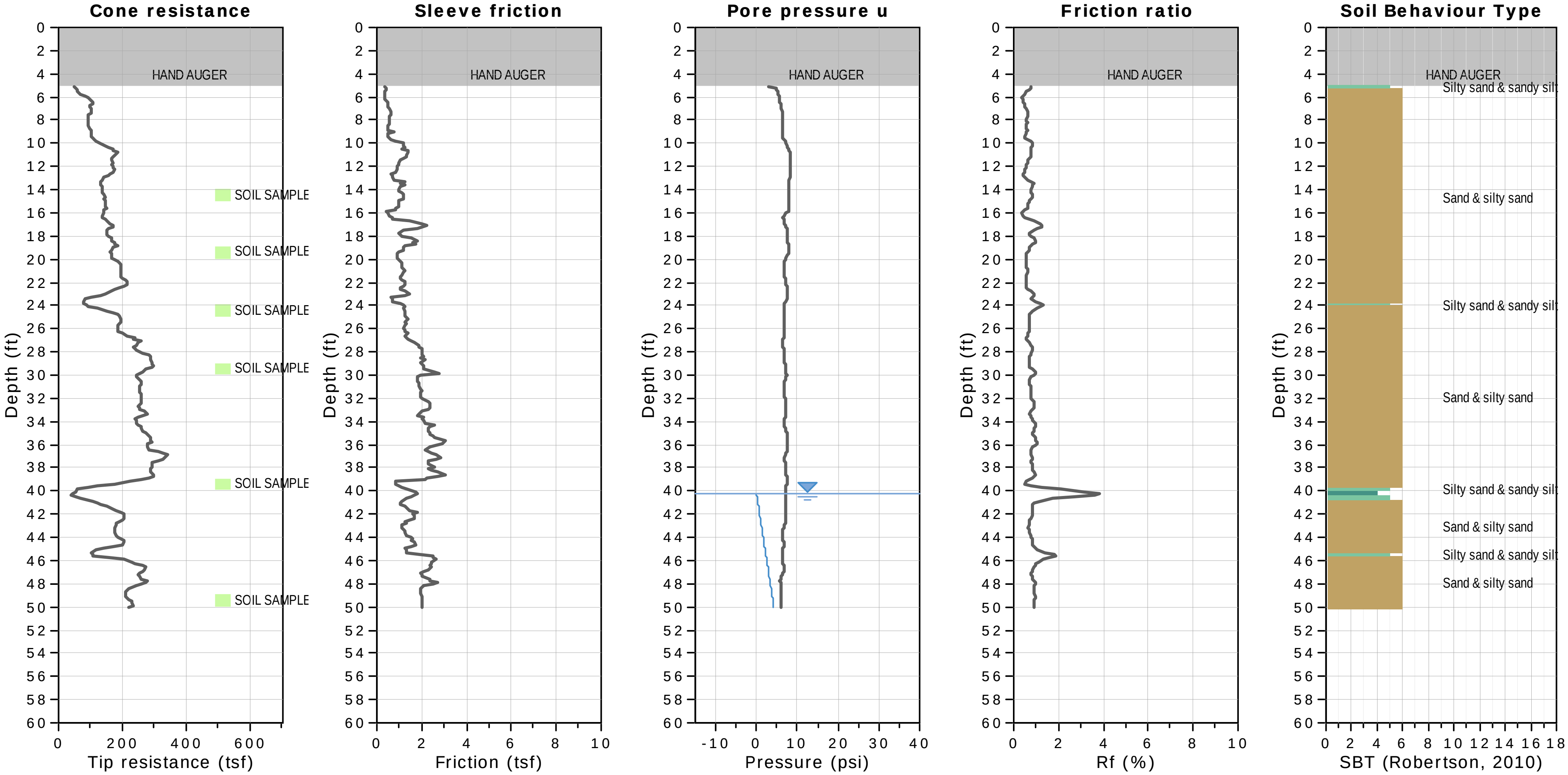
CPT: CPT-04

CLIENT: R.T. FRANKIAN & ASSOCIATES

Field Rep: JIM F.

SITE: SANTA CLARITA PARK INFILTRATION - 27285 SECO CANYON ROAD, SANTA CLARITA, CA

Total depth: 50.03 ft, Date: 8/28/2018



SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
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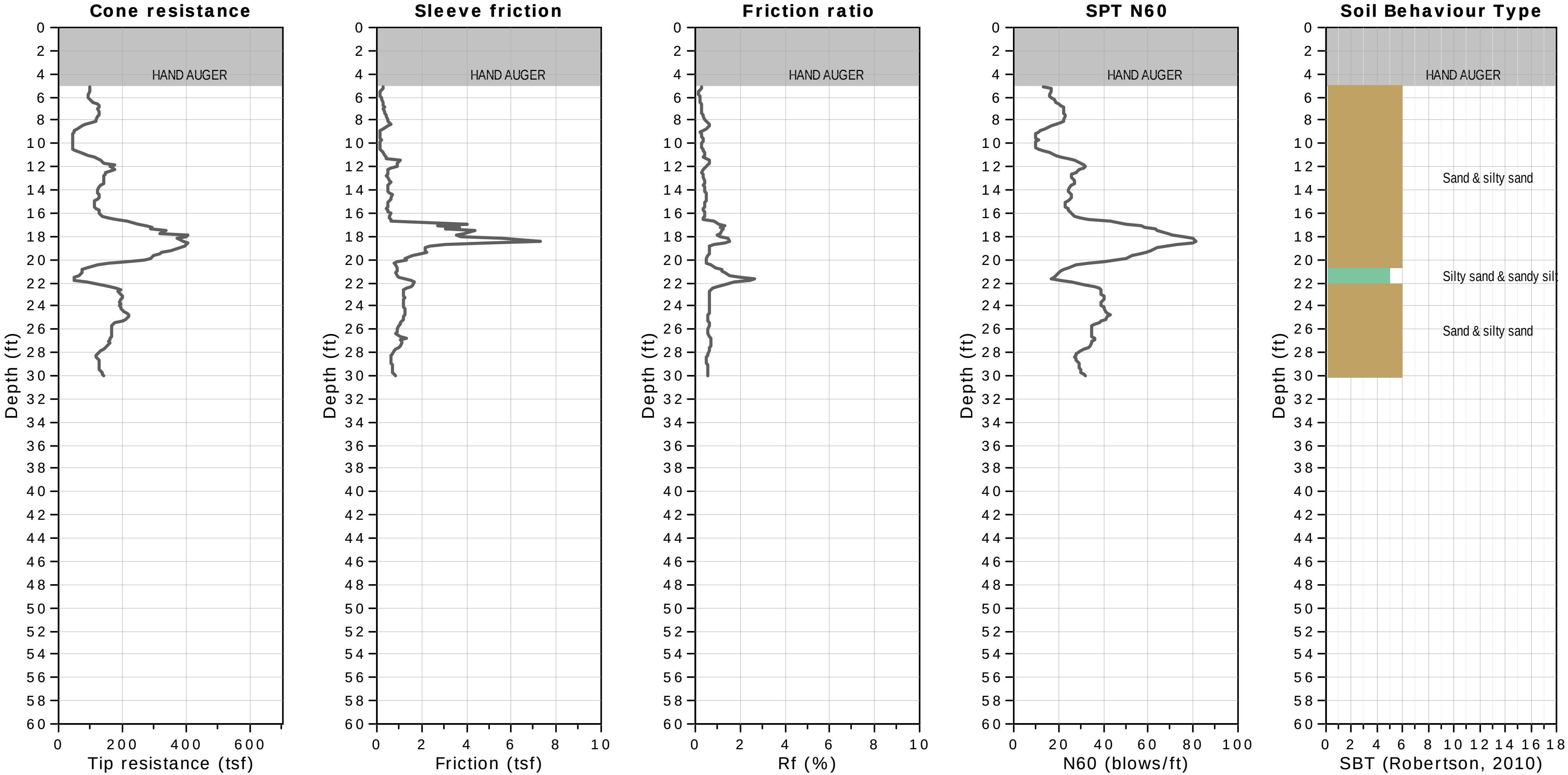
CPT: CPT-05

CLIENT: R.T. FRANKIAN & ASSOCIATES | **Field Rep: JIM F.**

SITE: SANTA CLARITA PARK INFILTRATION - 27285 SECO CANYON ROAD, SANTA CLARITA, CA

Total depth: 30.02 ft, Date: 8/28/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

GREGG DRILLING, INC.
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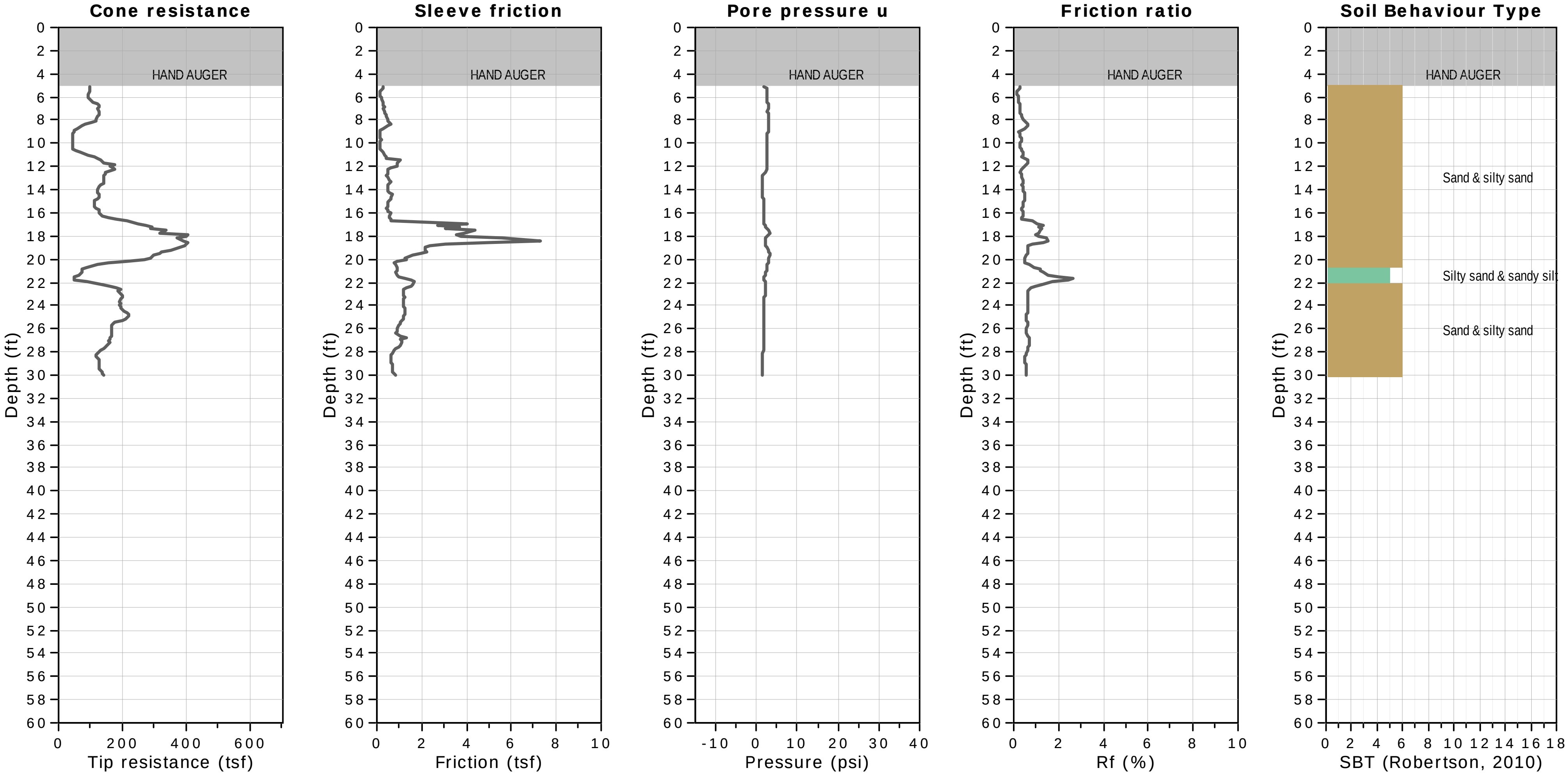
CPT: CPT-05

CLIENT: R.T. FRANKIAN & ASSOCIATES

SITE: SANTA CLARITA PARK INFILTRATION - 27285 SECO CANYON ROAD, SANTA CLARITA, CA

Field Rep: JIM F.

Total depth: 30.02 ft, Date: 8/28/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG

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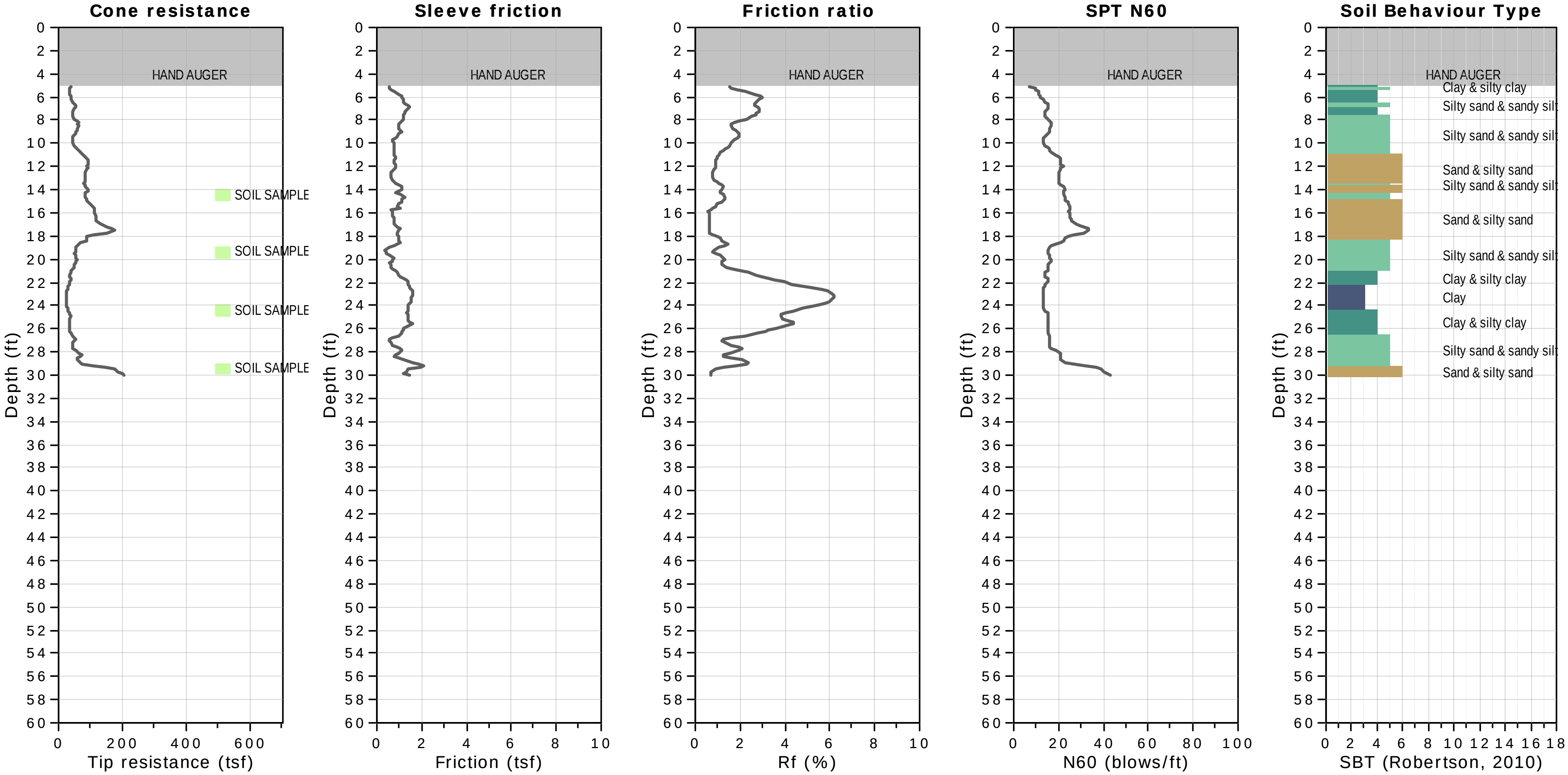
CPT: CPT-06

CLIENT: R.T. FRANKIAN & ASSOCIATES

Field Rep: JIM F.

SITE: SANTA CLARITA PARK INFILTRATION - 27285 SECO CANYON ROAD, SANTA CLARITA, CA

Total depth: 30.02 ft, Date: 8/28/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

GREGG DRILLING, INC.
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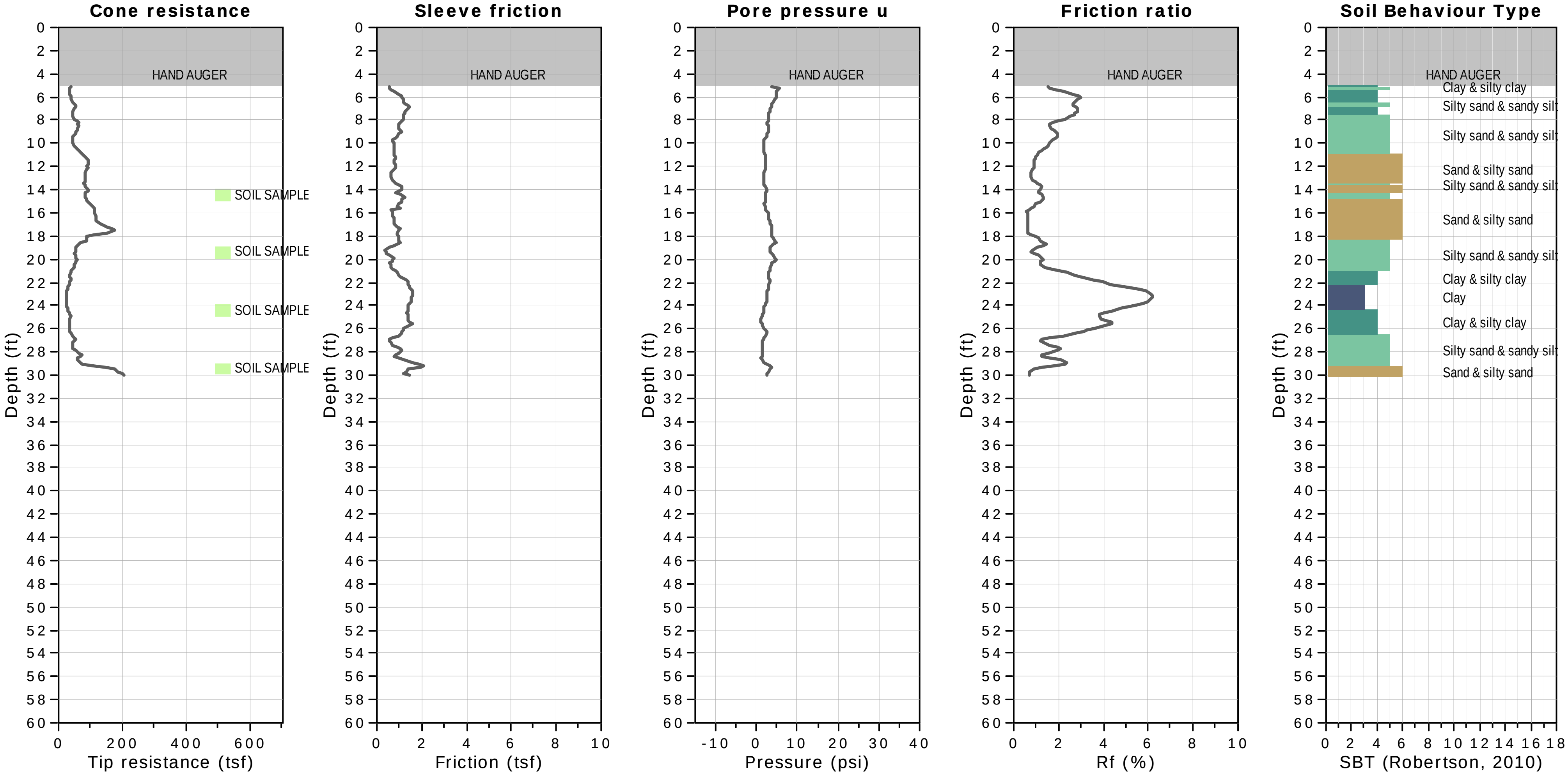
CPT: CPT-06

CLIENT: R.T. FRANKIAN & ASSOCIATES | **Field Rep: JIM F.**

SITE: SANTA CLARITA PARK INFILTRATION - 27285 SECO CANYON ROAD, SANTA CLARITA, CA

Total depth: 30.02 ft, Date: 8/28/2018



SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
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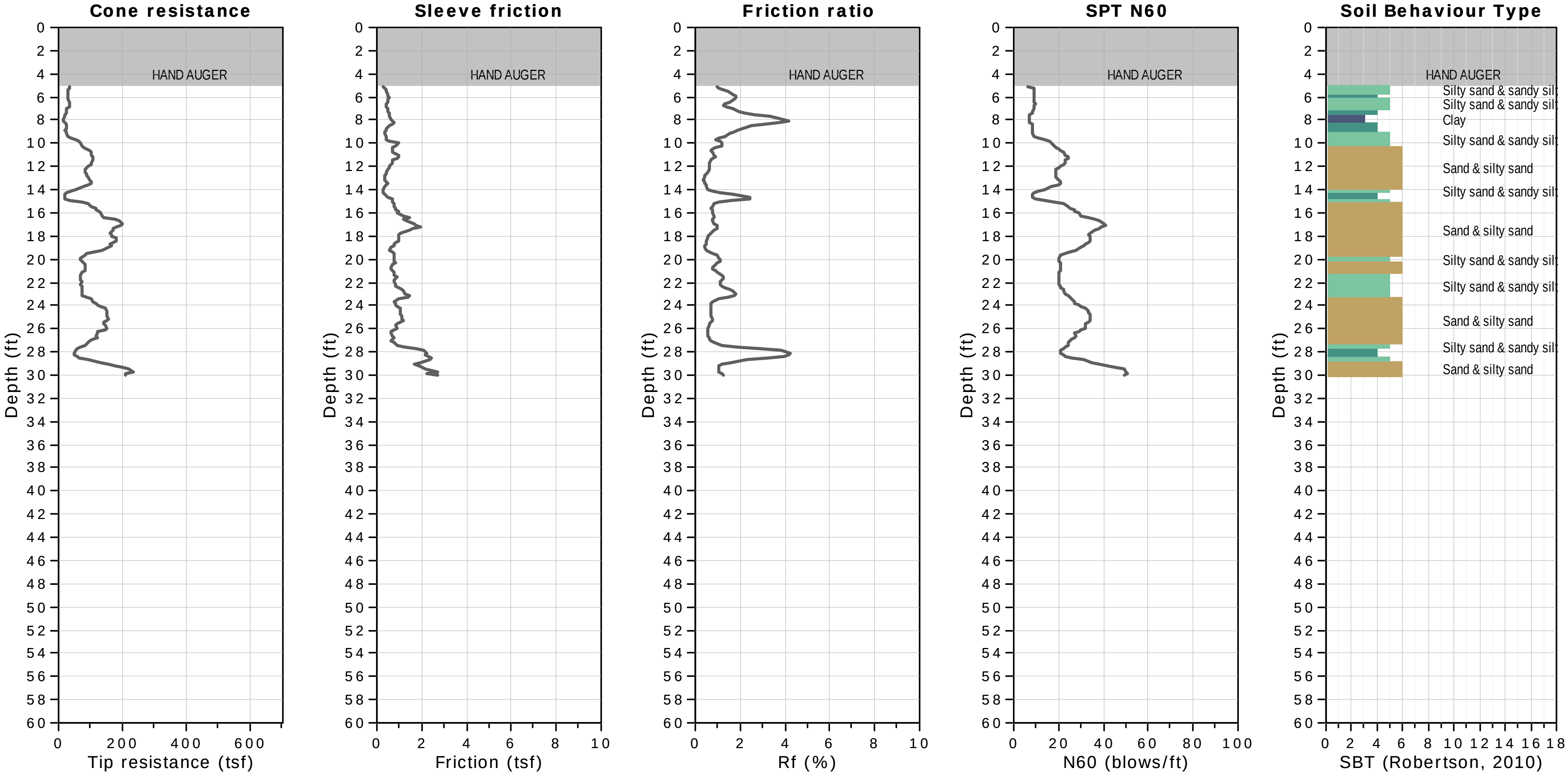
CPT: CPT-07

CLIENT: R.T. FRANKIAN & ASSOCIATES

SITE: SANTA CLARITA PARK INFILTRATION - 27285 SECO CANYON ROAD, SANTA CLARITA, CA

Field Rep: JIM F.

Total depth: 30.02 ft, Date: 8/28/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

GREGG DRILLING, INC.
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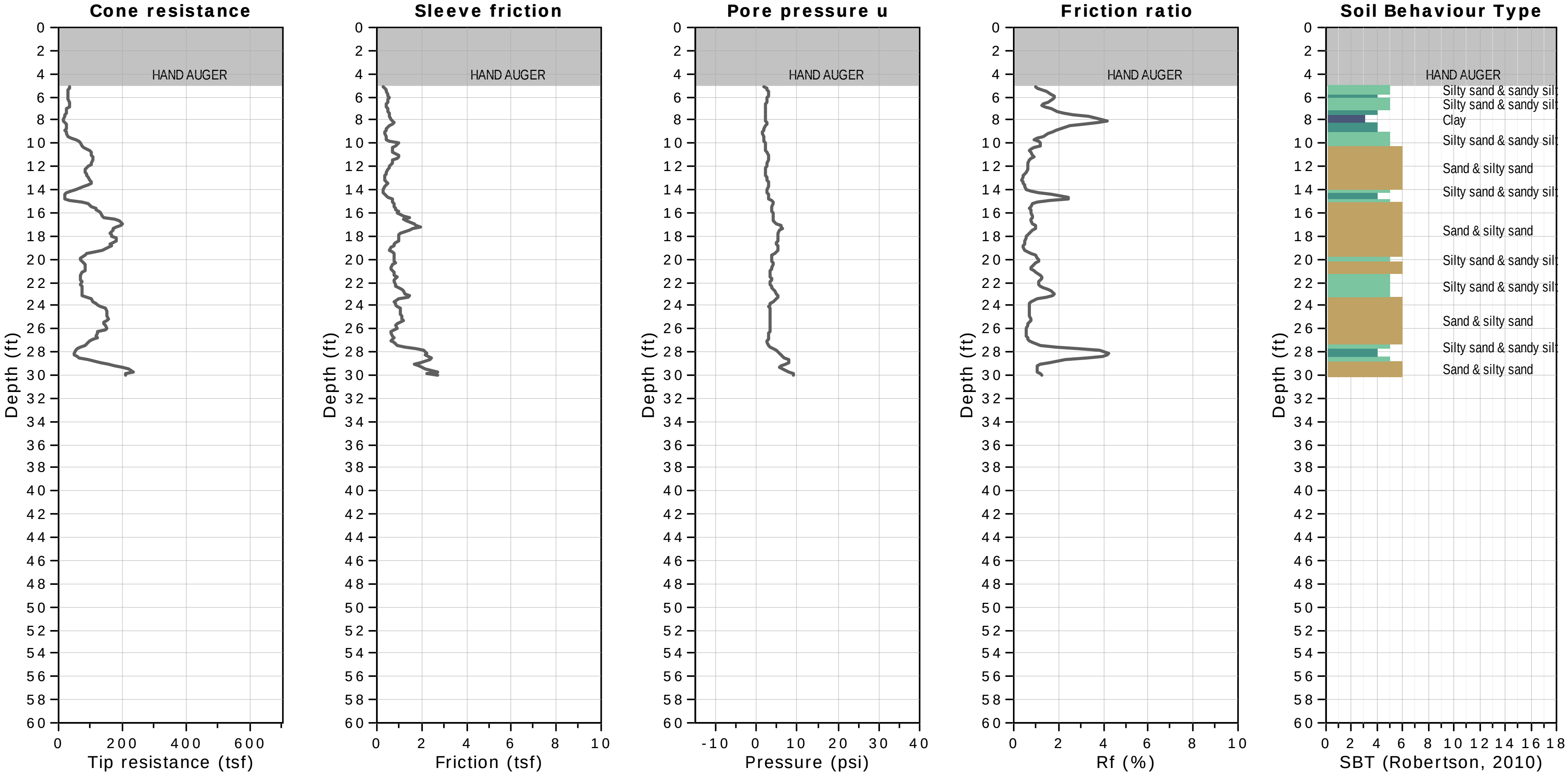
CPT: CPT-07

CLIENT: R.T. FRANKIAN & ASSOCIATES

Field Rep: JIM F.

SITE: SANTA CLARITA PARK INFILTRATION - 27285 SECO CANYON ROAD, SANTA CLARITA, CA

Total depth: 30.02 ft, Date: 8/28/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
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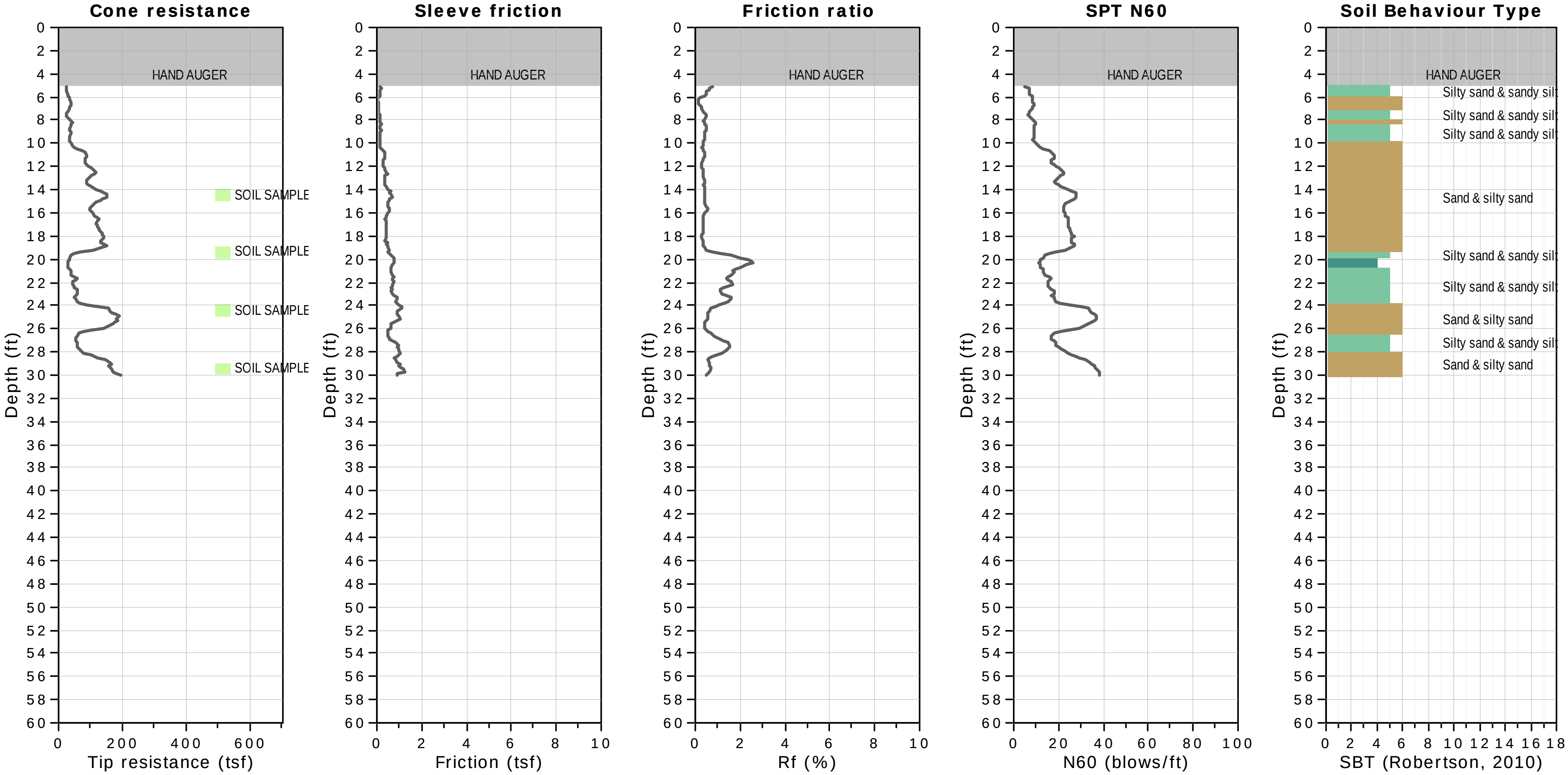
CPT: CPT-08

CLIENT: R.T. FRANKIAN & ASSOCIATES **Field Rep: JIM F.**

SITE: SANTA CLARITA PARK INFILTRATION - 27285 SECO CANYON ROAD, SANTA CLARITA, CA

Total depth: 30.02 ft, Date: 8/28/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

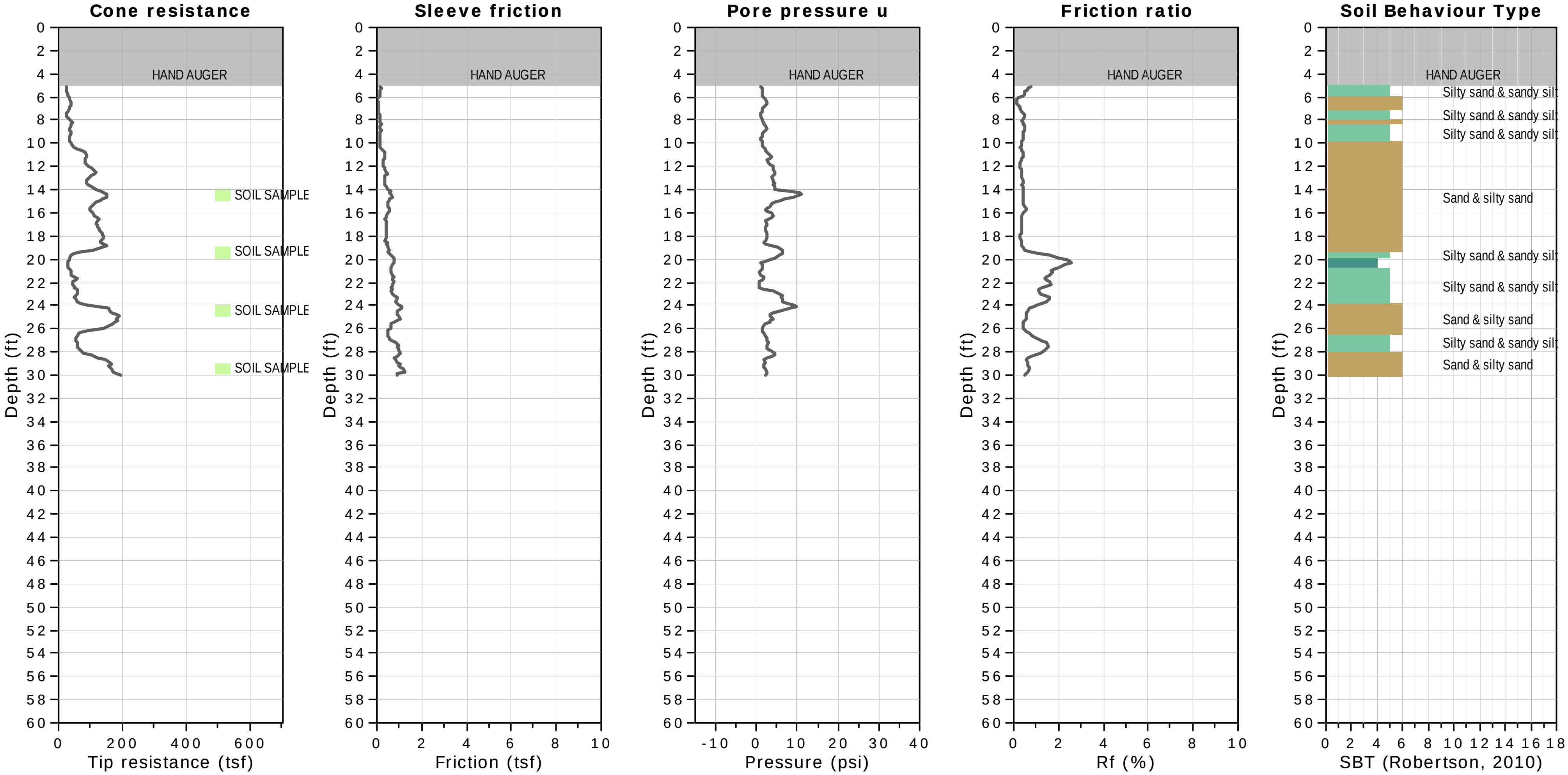
GREGG DRILLING, INC.
www.greggdrilling.com

CPT: CPT-08

CLIENT: R.T. FRANKIAN & ASSOCIATES — **Field Rep: JIM F.**

SITE: SANTA CLARITA PARK INFILTRATION - 27285 SECO CANYON ROAD, SANTA CLARITA, CA

Total depth: 30.02 ft, Date: 8/28/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
www.greggdrilling.com

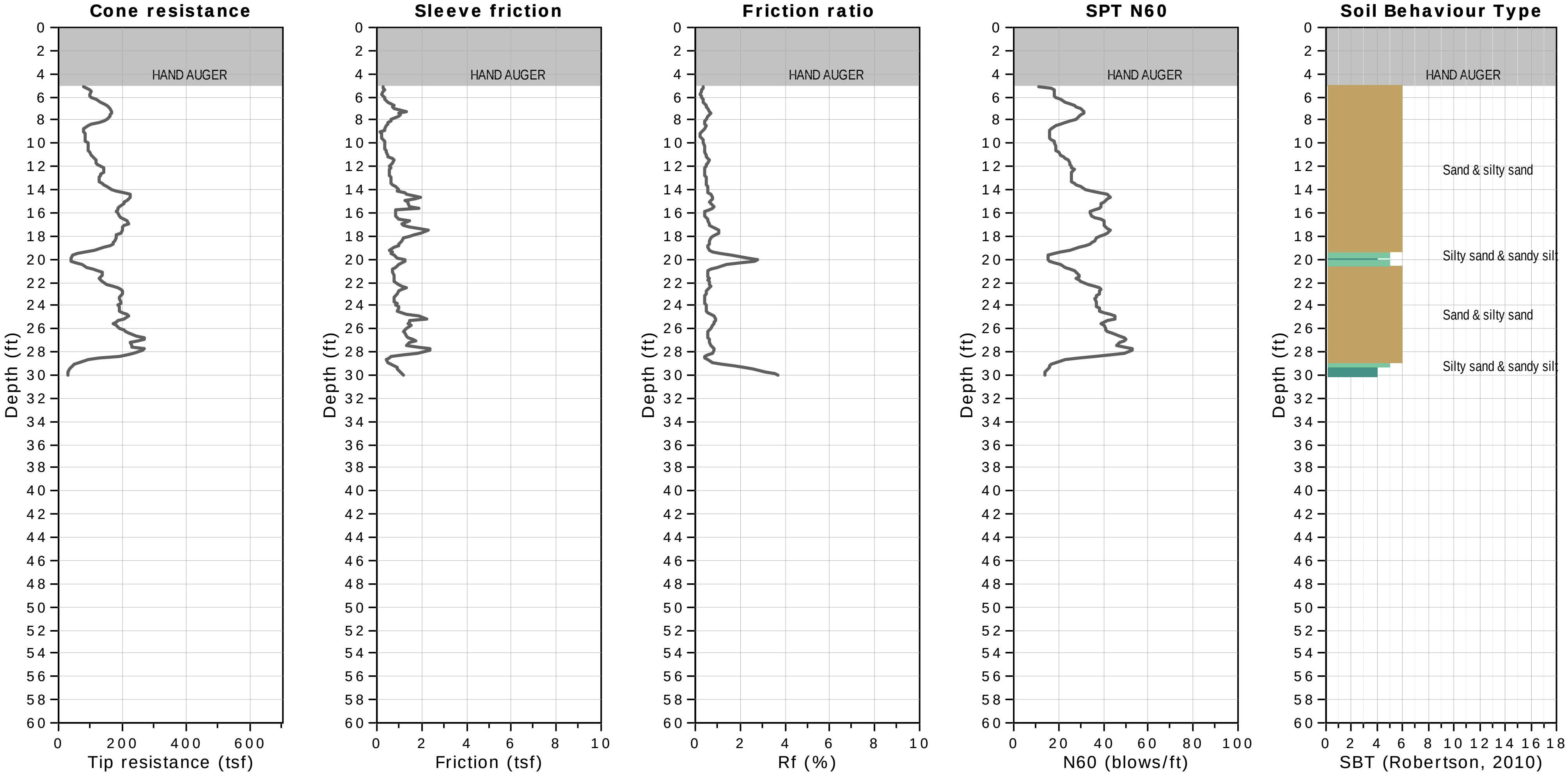
CPT: CPT-09

CLIENT: R.T. FRANKIAN & ASSOCIATES

SITE: SANTA CLARITA PARK INFILTRATION - 27285 SECO CANYON ROAD, SANTA CLARITA, CA

Field Rep: JIM F.

Total depth: 30.02 ft, Date: 8/28/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

GREGG DRILLING, INC.
www.greggdrilling.com

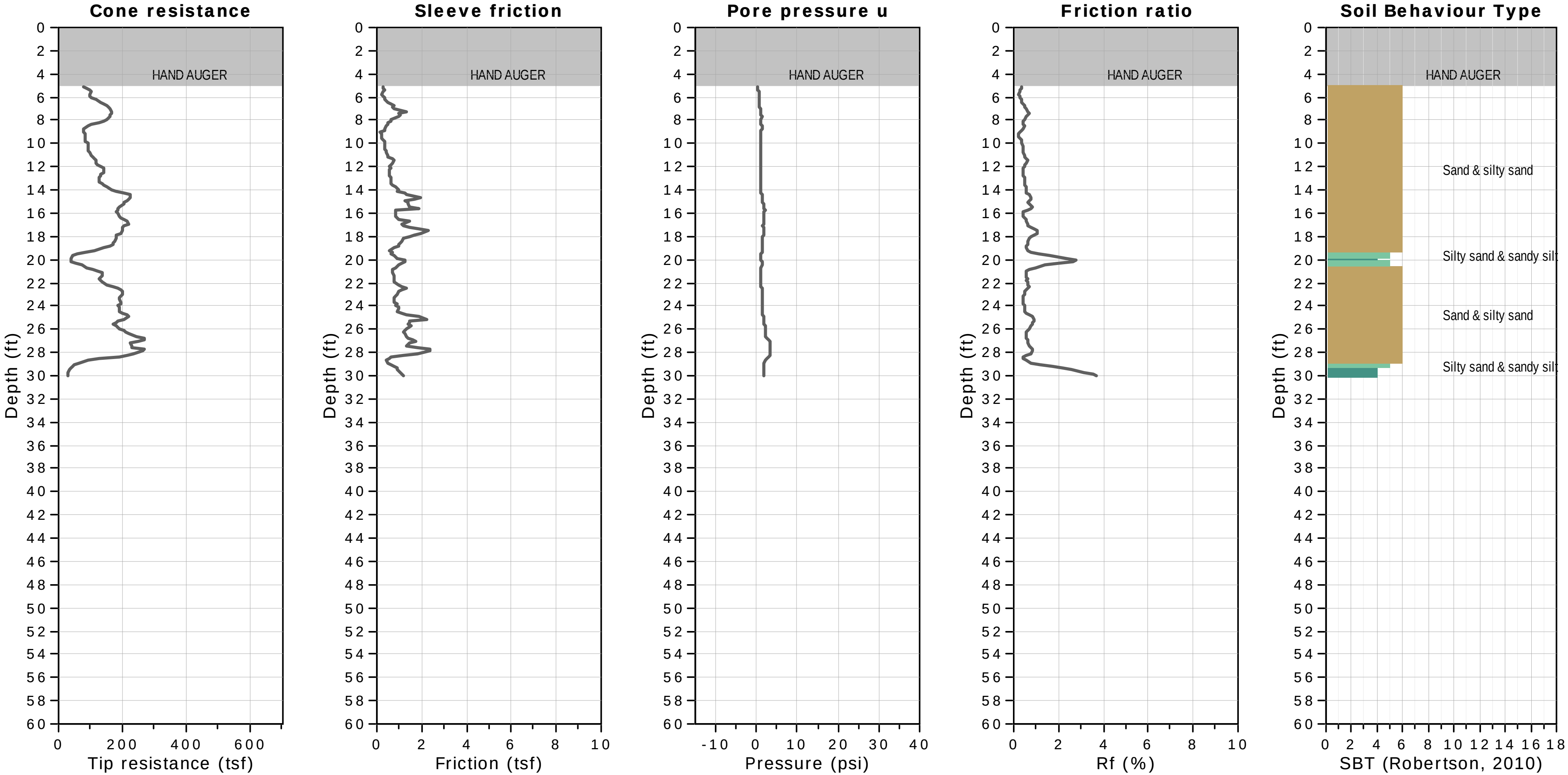
CPT: CPT-09

CLIENT: R.T. FRANKIAN & ASSOCIATES

Field Rep: JIM F.

SITE: SANTA CLARITA PARK INFILTRATION - 27285 SECO CANYON ROAD, SANTA CLARITA, CA

Total depth: 30.02 ft, Date: 8/28/2018



SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty clay	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to clayey sand
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

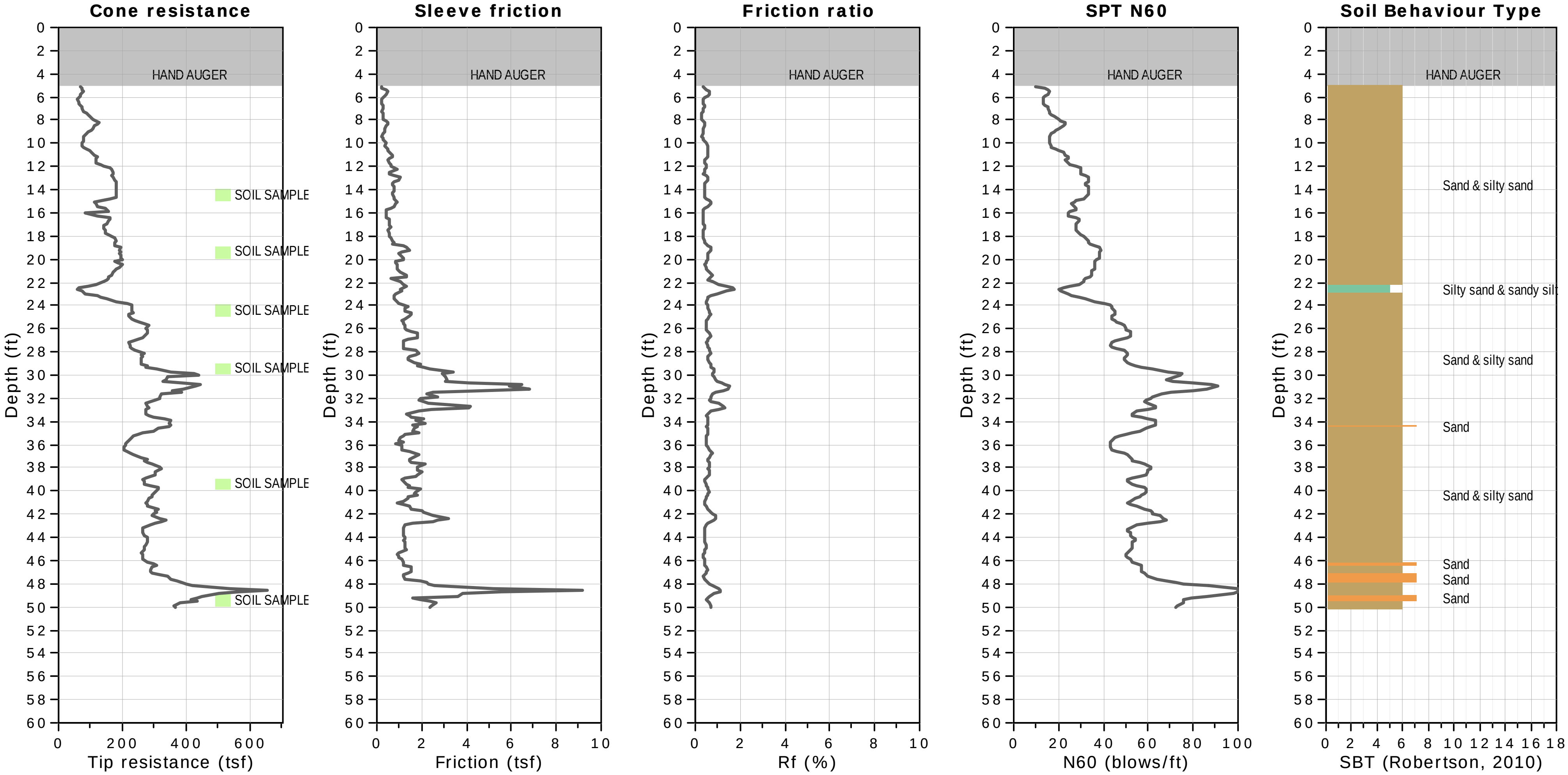
GREGG DRILLING, INC.
www.greggdrilling.com

CPT: CPT-10

CLIENT: R.T. FRANKIAN & ASSOCIATES **Field Rep: JIM F.**

SITE: SANTA CLARITA PARK INFILTRATION - 27285 SECO CANYON ROAD, SANTA CLARITA, CA

Total depth: 50.03 ft, Date: 8/28/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

GREGG DRILLING, INC.
www.greggdrilling.com

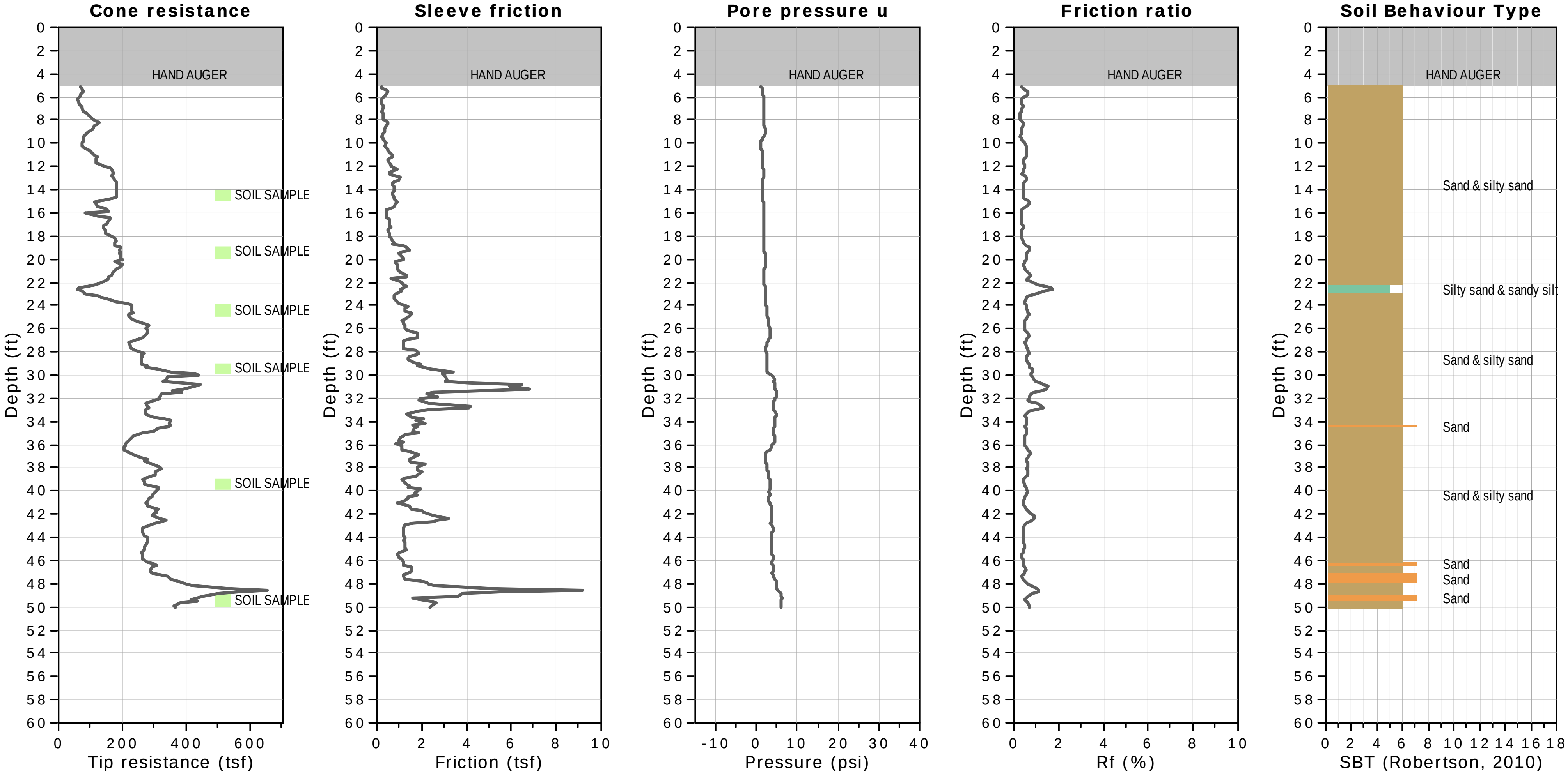
CPT: CPT-10

CLIENT: R.T. FRANKIAN & ASSOCIATES

SITE: SANTA CLARITA PARK INFILTRATION - 27285 SECO CANYON ROAD, SANTA CLARITA, CA

Field Rep: JIM F.

Total depth: 50.03 ft, Date: 8/28/2018



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

Xrefs: Site-4 Dalbey and Newhall 3d.dwg
Dimscale = 20; LTscale = 1; PSltscale = 1; ACAD Ver. = 21.0s (LMS Tech); Wireframe = 1

EXPLANATION

14 Approximate Location and Number of CPT Exploration

RTFA

FIGURE		JOB	TITLE		
JOB NO. B351	PACE Advanced Water Engineering 17520 Newhope Street, Suite 200 | Fountain Valley, CA 92708 P: (714) 481-7300 | www.pacewater.com	SANTA CLARITA BNP INFILTRATION FACILITY SANTA CLARITA CA	SITE 3B NEWHALL PARK EXHIBIT	SCALE 1" = 50'	
				DESIGNED D.D	
				DRAWN K.V.	
				CHECKED D.D	
				DATE JULY 2018	
				JOB NO. B351	

NO	BY	DATE	REVISIONS	DATE	APP.

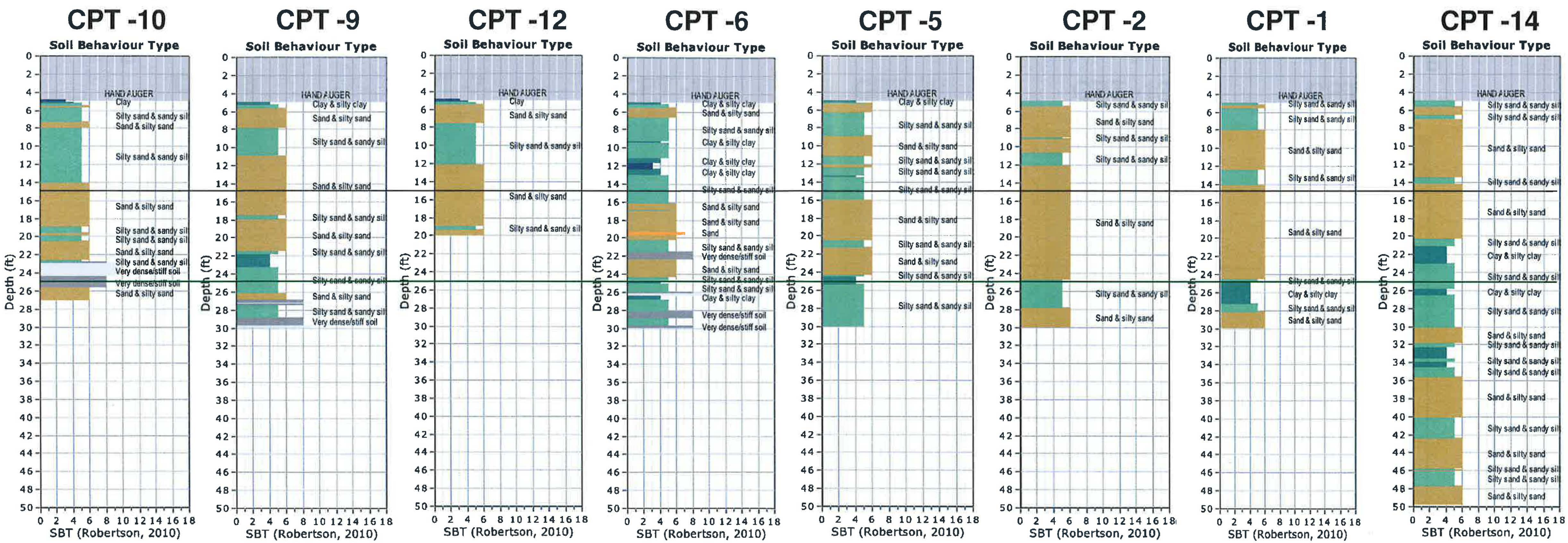
P:\B351\Engineering\Global\Exhibits\NEWHALL PARK EXHIBIT.dwg - Tab: 24x36 - by kvo on 07/13/18 at 10:10:12 AM

NEWHALL PARK

"Favorable"

A'

A



GREGG

SBTn legend

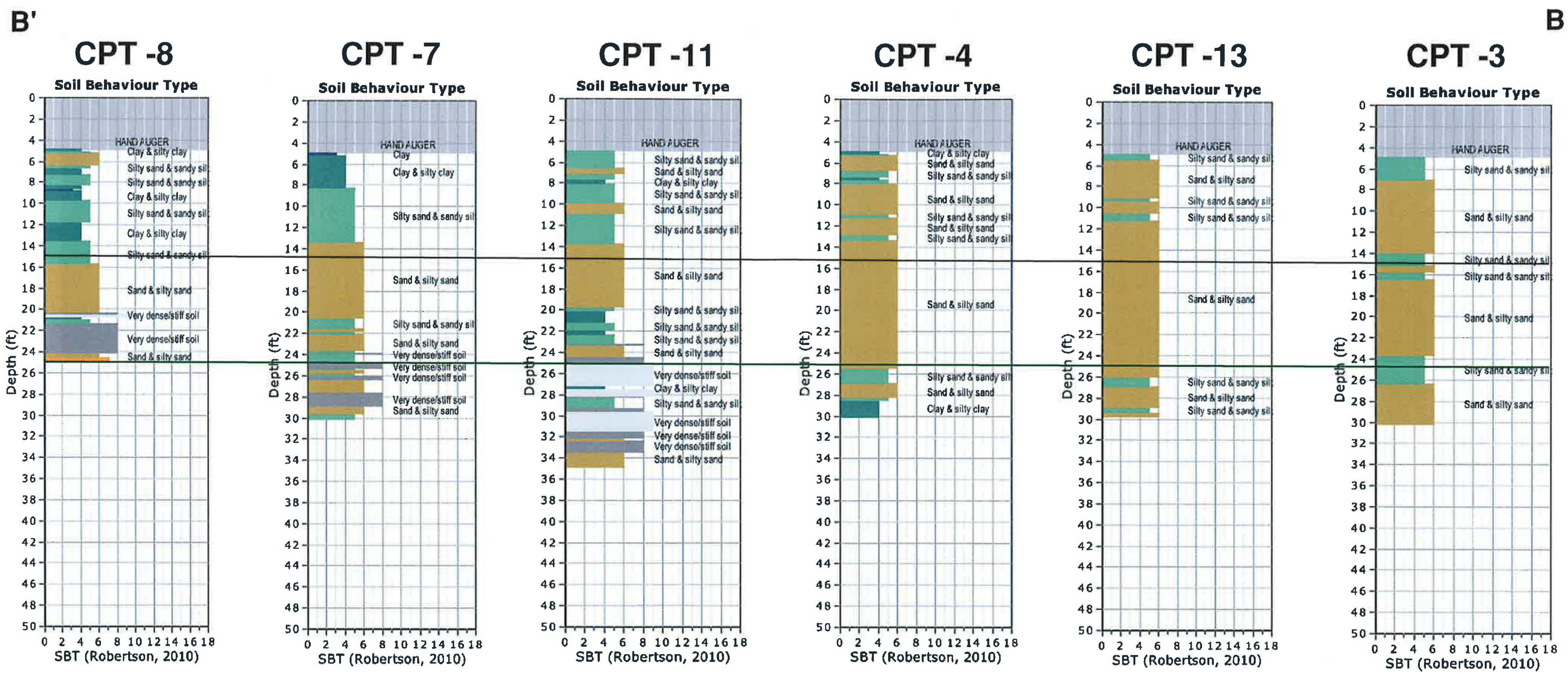
- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

good for infiltration

RTFA

GEOTECHNICAL ENGINEERING & ENGINEERING GEOLOGY

NEWHALL PARK



GREGG

SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand → prob. gravel. Not necessarily excluded but not ideal
9. Very stiff fine grained

RTF&A

GEOTECHNICAL ENGINEERING & ENGINEERING GEOLOGY

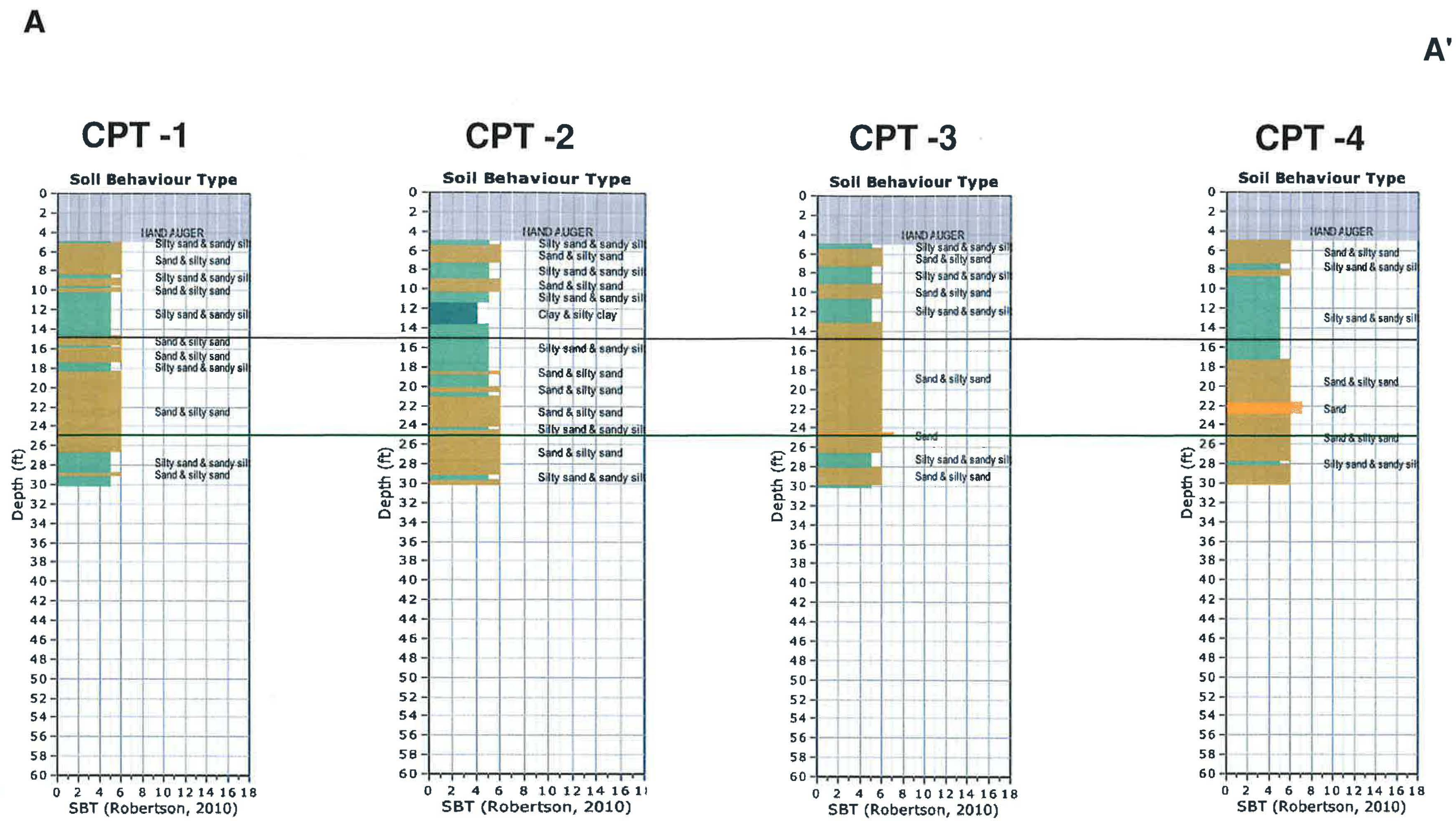
Xrefs: Site-3 Valencia Glen Park-3d.dwg; Valencia Glen Park Utility Point As Built xpld.dwg; Site-3 Valencia Glen Park-DTM.dwg; 18-0192 City of Santa Clarita GPR and Utility Map_PRELIMINARY.dwg
Dimscale = 20; LTscale = 1; PSltscale = 1; ACAD Ver. = 21.0s (LMS Tech); Visretain = 1

FIGURE		JOB	TITLE		
1	PACE Advanced Water Engineering 17520 Newhope Street, Suite 200 | Fountain Valley, CA 92708 P: (714) 481-7300 | www.pacewater.com	SANTA CLARITA VALENCIA GLEN PARK SANTA CLARITA CA	VALENCIA GLEN PARK EXHIBIT	SCALE 1" = 50' DESIGNED D.D. DRAWN K.V. CHECKED D.D. DATE JULY 2018 JOB NO. B351	
JOB NO. B351					

NO	BY	DATE	REVISIONS	DATE	APP.

P:\B351\Engineering\GlobalExhibits\VALENCIA GLEN EXHIBIT.dwg - Tab: 24x36 - by kva on 07/31/18 at 8:23:49 AM

VALENCIA GLEN PARK



GREGG

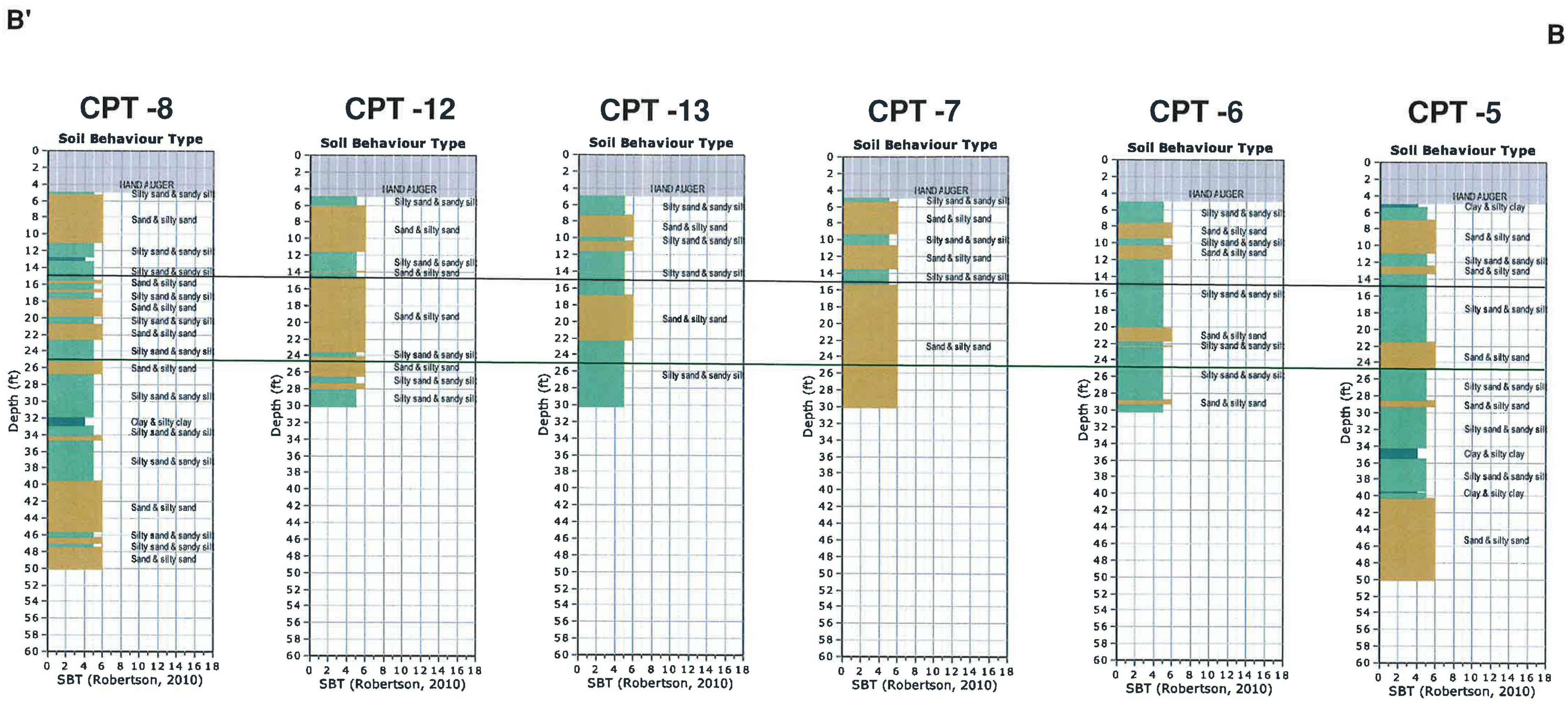
SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

RT&A

GEOTECHNICAL ENGINEERING & ENGINEERING GEOLOGY

VALENCIA GLEN PARK



GREGG

SBTn legend

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2. Organic material
3. Clay to silty clay
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5. Silty sand to sandy silt
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7. Gravely sand to sand
8. Very stiff sand to clayey sand
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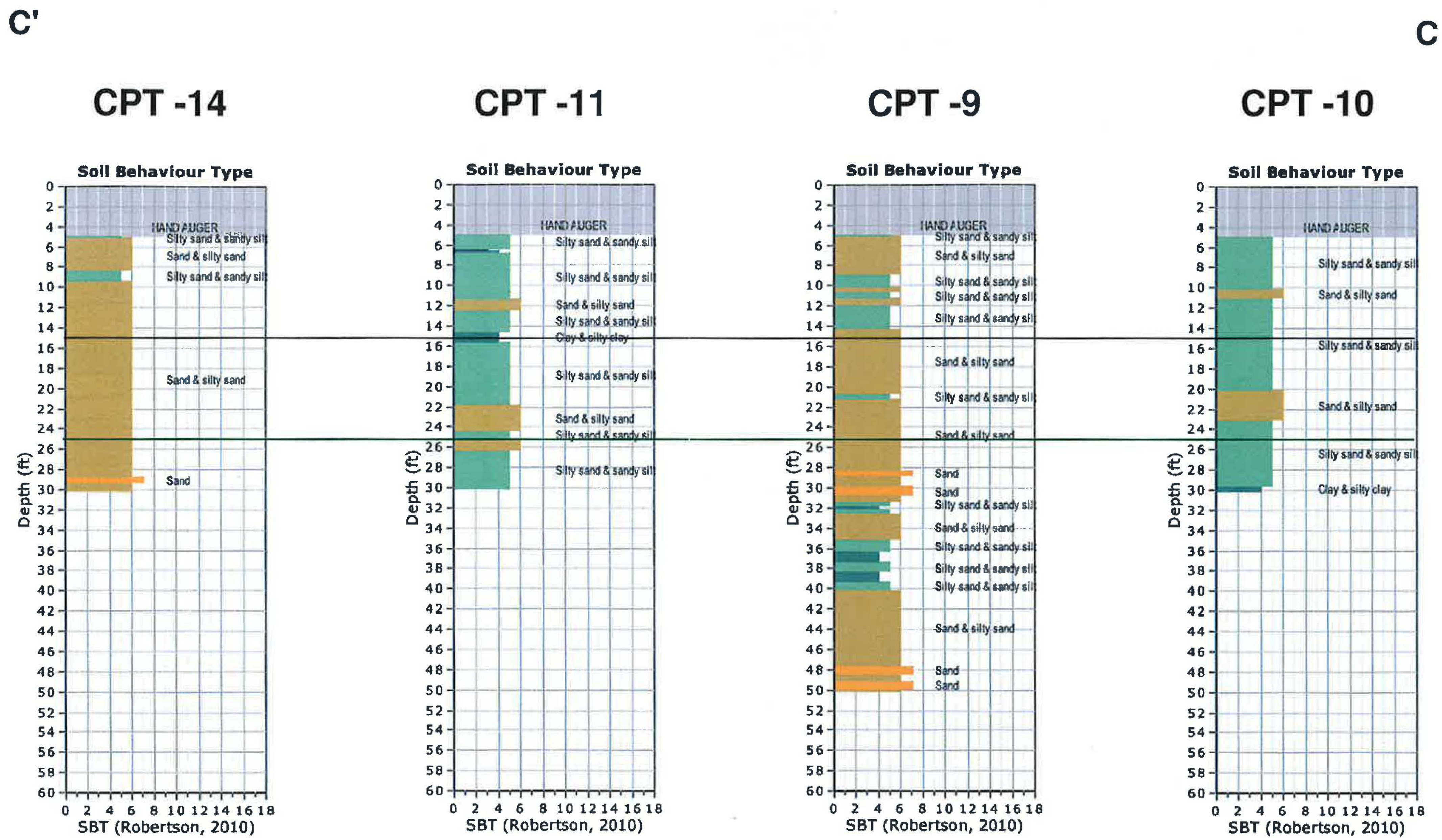
RT&A

GEOTECHNICAL ENGINEERING & ENGINEERING GEOLOGY

VALENCIA GLEN PARK



GREGG

SBTn legend

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3. Clay to silty clay
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6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

RT&A

GEOTECHNICAL ENGINEERING & ENGINEERING GEOLOGY

Santa Clarita Park				
CPT#	Preliminary Corrected k, ave (in/hr)			End of CPT (ft bgs)
	Depth (ft bgs)			
	15-25	25-end	15-end	
1	51.6	11.3	37.4	30
2	93.6	84.2	90.3	30
3	51.6	11.3	37.4	30
4	17.4	2.6	6.7	50
5	46.2	11.3	34.0	30
6	3.5	10.2	5.9	30
7	19.9	20.7	20.2	30
8	43.2	11.0	31.9	30
9	46.2	20.7	37.2	30
10	69.9	34.7	44.7	50

APPENDIX B

Well Logs

ORIGINAL
File with DWR

JB1787

Page ____ of ____
Owner's Well No. ____
Date Work Began 8-12-05, Ended 8-23-05
Local Permit Agency Los Angeles
Permit No. ____ Permit Date 6-24-05

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet
No. 0906412

DWR USE ONLY — DO NOT FILL IN
STATE WELL NO./STATION NO.
LATITUDE | LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD ____ FLUID ____

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0	21	SAND & GRAVEL
21	62	SAND GRAVEL W/COBBLES
62	85	GRAVEL & COBBLES
85	105	FRACTURED ROCK W/SOME BROWN CLAY
105	121	ROCK GRANITE
121	128	FRACTURED ROCK GRANITE
128	165	FRACTURED ROCK W/BROWN CLAY
165	195	CEMENTED SAND
195	210	FRACTURED ROCK GRANITE
210	285	CEMENTED SAND
285	292	GREEN CLAY
292	310	CEMENTED SAND
310	315	ROCK GRANITE
315	325	CEMENTED SAND
325	336	ROCK GRANITE
336	355	CEMENTED SAND
355	360	GREEN CLAY
360	410	CEMENTED SAND

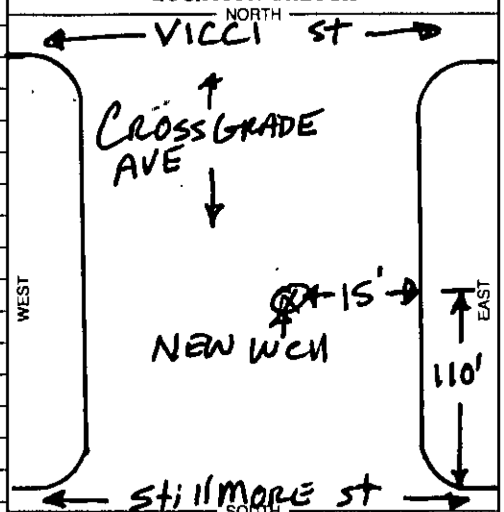
TOTAL DEPTH OF BORING 410 (Feet)
TOTAL DEPTH OF COMPLETED WELL 410 (Feet)

WELL OWNER

WELL LOCATION

Address CROSSGLADE AVE. N/STILLMORE
City SANTA CLARITA
County LOS ANGELES
APN Book ____ Page ____ Parcel ____
Township 04N Range 15W Section 21
Lat ____ DEG. MIN. SEC. N Long ____ DEG. MIN. SEC. W

LOCATION SKETCH



Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. **PLEASE BE ACCURATE & COMPLETE.**

ACTIVITY (✓)

X NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (*Describe Procedures and Materials Under "GEOLOGIC LOG"*)

USES (✓)

WATER SUPPLY
___ Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL ___
CATHODIC PROTECTION X
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER ____ (Ft.) BELOW SURFACE
DEPTH OF STATIC WATER LEVEL ____ (Ft.) & DATE MEASURED ____
ESTIMATED YIELD * ____ (GPM) & TEST TYPE ____
TEST LENGTH ____ (Hrs.) TOTAL DRAWDOWN ____ (Ft.)
* *May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	180	9 7/8	X				PVC	2	SCH 40	---
180	410	9 7/8		X			PVC	2	SCH 40	

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
4	198	X			10 Sack Sand Slurry
198	410			X	Coke Breeze

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other ____
ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME FARWEST CORROSION CONTROL COMPANY
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

4114 ARMOUR AVENUE BAKERSFIELD CA 93308
ADDRESS CITY STATE ZIP

Signed [signature] C-57 LICENSED WATER WELL CONTRACTOR 8-30-05 DATE SIGNED 248232 C-57 LICENSE NUMBER

LOG OF MW-6

SHEET 1 OF 1

Project: Saugus	Location: 26954 Seco Canyon Drive		
Client: Wortman Oil Company	Drill Method: Holow Stem Auger	Elevation (ft amsl): 1220.29	
Prj. No.: Z079SAUGUS	Drilling Started: 12/20/17	Ended: 12/20/17	Total Depth (ft): 94
Logged By: CN	Drill Contractor: Cascade Drilling	Depth To Water (ft): ATD 80, AD 77	

DEPTH (feet)	SAMPLE NO.	BLOWS/6"	PID (ppm)	USCS	LITHOLOGY	DESCRIPTION	COMPLETION DETAILS	ELEVATION (feet amsl)
						Asphalt at Surface.	Traffic rated, flush well box	
						Air knife to 5' below surface. Backfill with native.		
10	GRAB	7 7 8	0.3	SP		Sand, brown (10 YR, 4/3), dry, medium dense, fine with 10% medium, trace silt.	Portland Grout with Gel, 95% Portland	1210
	GRAB	5 6 6	0.1	SP		same as above.		
20	GRAB	9 11 12	0.0	SM		Silty Sand, dark brown (10YR, 3/3), damp, medium dense, 20% coarse, 20% medium, 20% fine, 40% silt.	60 Feet Blank casing schedule 40	1200
	GRAB	8 9 11	0.0	SW		Well Graded Sand, dark yellowish brown (10 YR, 4/4), medium dense, fine to coarse, trace silt.		
30	GRAB	7 8 9	0.2	SW		same as above		1190
	GRAB	6 8 11	0.0	SW		same as above		
40	GRAB	11 13 17	0.0	SP		Sand, yellowish brown (10 YR, 5/4), dry, medium dense, fine, trace medium.		1180
	GRAB	19 22 24	0.0	SP		same as above.		
50	GRAB	21 23 26	0.0	SP		same as above, trace silt.		1170
	GRAB	13 16 18	0.0	SP		same as above with trace fine gravel.		
60	GRAB	16 17 23	0.0	SP		Sand, Yellowish brown (10YR, 5/4), dry, dense, fine sand with trace medium and coarse sand, trace silt.	3 Feet, Bentonite plug	1160
	GRAB	16 22 33	0.0	SP		same as above, trace silt.	33 Feet, Monterey Sand #3	
70	GRAB	13 14 15	0.4	SM		Silty Sand, yellowish brown (10 YR, 5/4), damp, medium dense, approximately 30% silt, fine sand, trace medium sand, rare fines.	30 Feet, slotted casing 0.020, schedule 40	1150
	GRAB	37 50 3	0.0	SP		Sandy, yellowish brown (10 YR, 5/4), damp, very dense, fine sand, trace gravel.		
80	GRAB	32 50	0.7	GM		Silty Gravelly Sand, dark yellowish brown (10 YR, 3/4), wet, very dense, well graded, fine to coarse sand and fine to coarse gravel, approximately 20% silt, 40% sand, 40% gravel, gravel is, sub rounded, granite and other igneous.		1140
	GRAB	14 17 19		GM		same as above, increase silt to 30%		
90	GRAB	4 10 7	0.3	GC		Clayey Gravelly Sand, dark yellowish brown (10 YR, 3/4), wet, stiff, approximately 60% fine sand, 40% silt/clay, trace fine gravel.		1130
						Bottom of hole at 94 feet		

ATC
1330 Marsh Street
San Luis Obispo, CA 93401
Phone: 805-543-7007
Fax: 805-543-0727

Remarks:

See key sheet for symbols and abbreviations used above.

WELL NUMBER B1

PROJECT NUMBER Z079SAUGUS
PROJECT NAME Wortmann Oil
DRILLING CONTRACTOR Cascade Drilling L.P.
DRILLING METHOD Hollow Stem Auger
SAMPLING METHOD Continuous Core
GROUND ELEVATION
LOGGED BY C. Nevison
CHECKED BY Chris Nevison

DATE STARTED 3/14/17
DATE COMPLETED 3/14/17
LOCATION 26954 Seco Canyon Road, Santa Clarita, CA
BACKFILL / SEAL TYPE 95% Portland Cement with 5% Bentonite Gel
DEPTH TO WATER (ft) 71.0
GROUND WATER ELEVATION
TOTAL DEPTH (ft) 75
COMMENT

PID (ppm)	SAMPLE ID.	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
					ASPHALT	0.5
		5	SM		SM, SILTY SAND, BROWN (10YR 5/3), DRY, FINE TO COARSE, NO ODOR, NO HYDROCARBON STAIN.	5.0
0.0	GRAB B1@10'	10	SM		ENCOUNTERED 2 INCH BY 4 INCH COBBLES	8.0
0.0	GRAB B1@15'	15	SW		SW, WELL GRADED SAND WITH GRAVEL, LIGHT YELLOWISH BROWN (10YR 4/4), APPROXIMATELY 40 % FINE SAND, 30% MEDIUM SAND, 20% COARSE SAND, 7% GRAVEL, NO HYDROCARBON ODOR, NO HYDROCARBON STAIN.	11.0 15.0
0.0	GRAB B1@20'	20	SP		SP, SAND, BROWN (10YR 5/3), FINE, NO HYDROCARBON ODOR, NO HYDROCARBON STAIN.	20.0
0.0	GRAB B1@25'	25	SW		SW, WELL GRADED SAND WITH GRAVEL, LIGHT YELLOWISH BROWN (10YR 6/4), DRY, APPROXIMATELY 50 % FINE SAND, 20% MEDIUM SAND, 20% COARSE SAND, 10% GRAVEL, NO HYDROCARBON ODOR, NO HYDROCARBON STAIN.	22.0
			CL		CLAY, STRONG BROWN (7.5YR 5/6), DRY, NO HYDROCARBON ODOR, NO HYDROCARBON STAIN.	27.0
0.0	GRAB B1@30'	30	SM		SM, SILTY SAND, LIGHT YELLOWISH BROWN (2.5YR 6/3), MOIST, APPROXIMATELY 30% FINES, 60% FINE SAND, 10% MEDIUM SAND, TRACE CLAY, NO HYDROCARBON ODOR, NO HYDROCARBON STAIN.	30.0
0.0	GRAB B1@35'	35	SM		SM, SILTY SAND, YELLOWISH BROWN (10YR 5/4), MOIST, APPROXIMATELY 40% SILT/CLAY, 60% FINE SAND, NO HYDROCARBON ODOR, NO HYDROCARBON STAIN.	36.0
0.0	GRAB B1@40'	40	SM			40.0

PROJECT NUMBER Z079SAUGUS **DATE STARTED** 3/14/17
PROJECT NAME Wortmann Oil **DATE COMPLETED** 3/14/17

Continued from Previous Page

PID (ppm)	SAMPLE ID.	DEPTH (ft. BGL)	U.S.C.S.	GRAPHIC LOG	LITHOLOGIC DESCRIPTION	CONTACT DEPTH
			SM		SM, SILTY SAND, YELLOWISH BROWN (10YR 5/4), MOIST, APPROXIMATELY 30% FINES, 30% FINE SAND, 20% MEDIUM-COARSE SAND, NO HYDROCARBON ODOR, NO HYDROCARBON STAIN. *(continued)*	43.0
0.0	GRAB B1@45'	45	SW		SW, WELL-GRADED SAND, YELLOWISH BROWN (10YR 5/4), SLIGHTLY MOIST, APPROXIMATELY 35% FINE SAND, 30% MEDIUM SAND, 30% COARSE SAND, 5% SILT/CLAY, NO HYDROCARBON ODOR, NO HYDROCARBON STAIN.	
0.0	GRAB B1@50'	50	SW		SAME AS ABOVE	50.0
0.0	GRAB B1@55'	55				58.0
0.0	GRAB B1@60'	60	GW		GW, WELL-GRADED GRAVELLY SAND, BROWN (10YR 5/3), MOIST, FINE TO COARSE SAND, HIGHLY WEATHERED GRANITE, NO HYDROCARBON ODOR, NO HYDROCARBON STAIN.	65.0
0.0	GRAB B1@65'	65	CL		CL, CLAY, STRONG BROWN (7.5YR 5/6), DRY, HARD, NO HYDROCARBON ODOR, NO HYDROCARBON STAIN.	67.0
			GW		GW, WELL GRADED GRAVELLY SAND, BROWN (10YR 5/3), MOIST, FINE TO COARSE SAND, NO HYDROCARBON ODOR, NO HYDROCARBON STAIN.	70.0
0.0	GRAB B1@70'	70	SM		SM, SILTY SAND, BROWN (10YR 5/3), WET, NO HYDROCARBON ODOR, NO HYDROCARBON STAIN. ∇	74.0
0.0	GRAB B1@75'	75	GW		GW, GRAVELLY SAND, WET.	75.0

Bottom of borehole at 75.0 feet.

APPENDIX C

Site X Data

Department of Public Works
dpw.lacounty.gov

Search By: Address/Intersection ▼ Search Buffer: None ▼ Active Wells Inactive Wells

High Groundwater Exhbit

Prepared For:

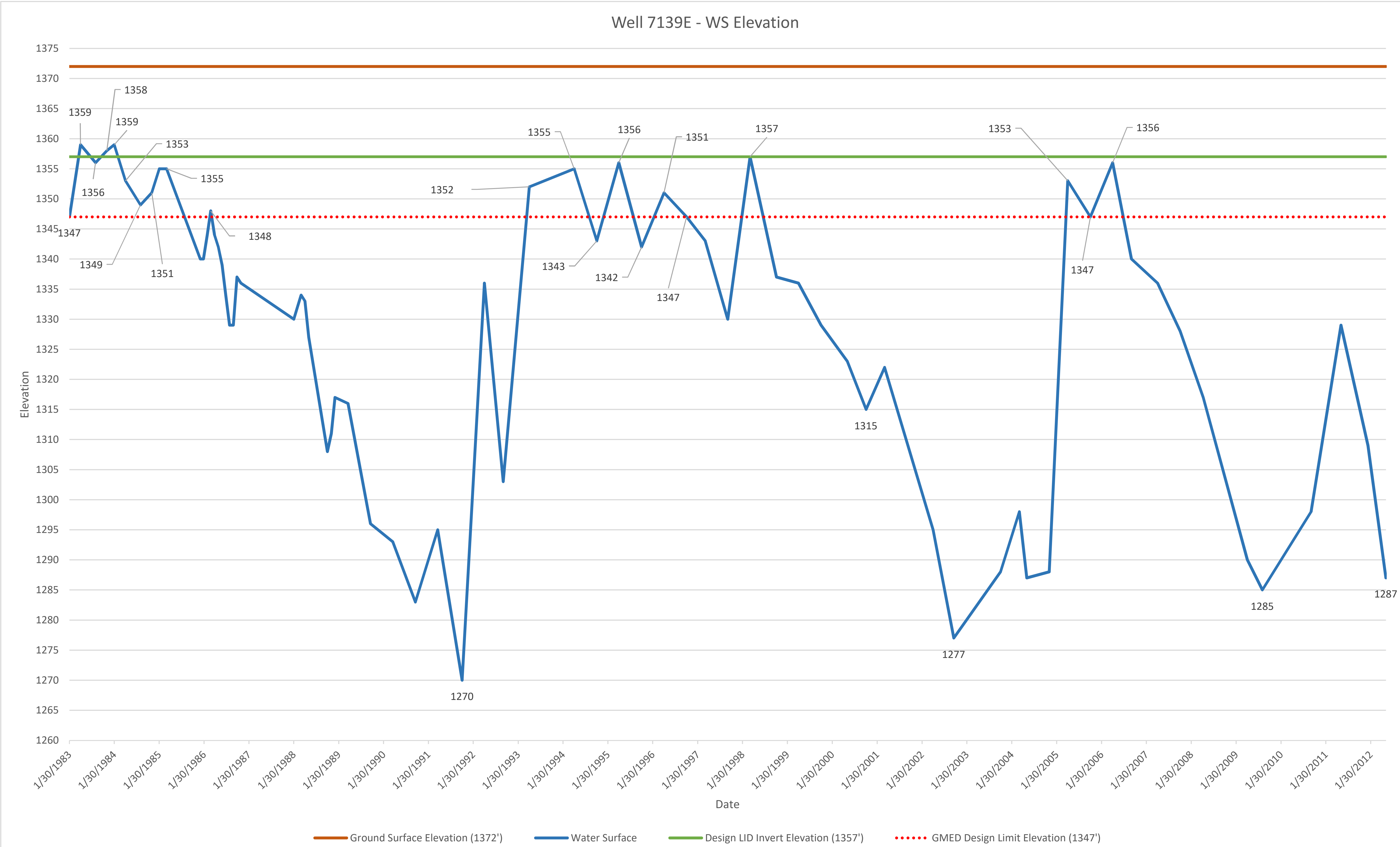
PACE

Proposed LID - Site X
Whites Canyon Road & Via Princessa
Santa Clarita, California

Scale: As Shown	Drawn By: JH	Checked By: JAF
Date: 6/26/2018		2018-003-052

R. T. FRANKIAN & ASSOCIATES
26027 Huntington Lane, Unit A
Santa Clarita, California 91355
(818) 531-1501
www.RTFrankian.com

RTFA GEOTECHNICAL ENGINEERING & ENGINEERING GEOLOGY



Well 7139E - WS Elevation
Elevation
Date
1375
1370
1365
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Ground Surface Elevation (1372')
Water Surface
Design LID Invert Elevation (1357')
GMED Design Limit Elevation (1347')

Well 7139F - WS Elevation
Elevation
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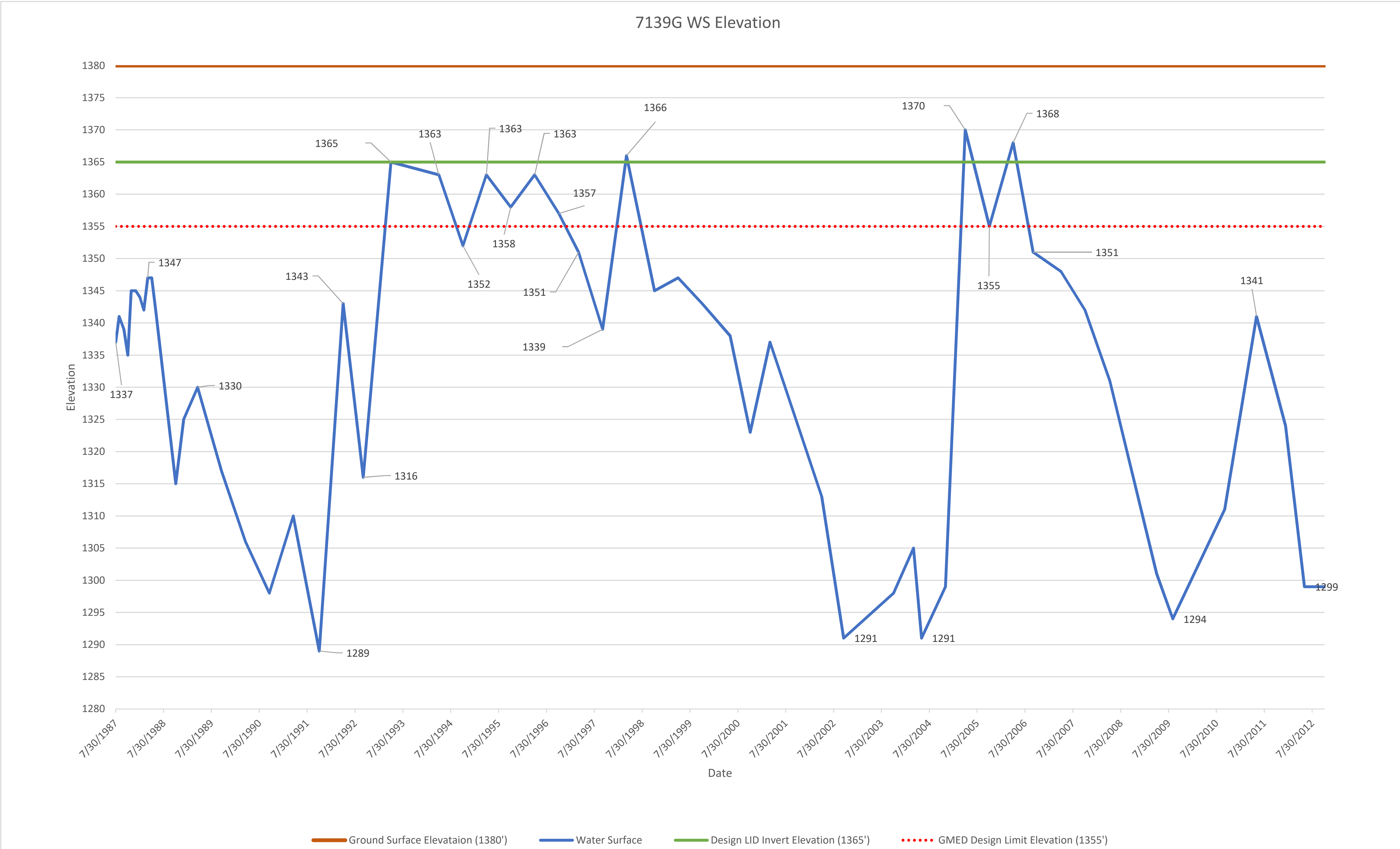
Ground Surface Elevation (1375')
Water Surface
Design LID Invert Elevation (1360')
GMED Design Limit Elevation (1350')



7139G WS Elevation
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Ground Surface Elevataion (1380')
Water Surface
Design LID Invert Elevation (1365')
GMED Design Limit Elevation (1355')

WELL_ID	MEASURE_DATE	GS_ELEV	GS_TO_WS	WS ELEVATION	Design LID Invert Elevation	GMED Design Limit Elevation
7139E	6/1/2012	1372	85	1287	1357	1347
7139E	1/7/2012	1372	63	1309	1357	1347
7139E	6/1/2011	1372	43	1329	1357	1347
7139E	6/1/2011	1372	43	1329	1357	1347
7139E	10/1/2010	1372	74	1298	1357	1347
7139E	8/31/2009	1372	87	1285	1357	1347
7139E	4/30/2009	1372	82	1290	1357	1347
7139E	5/6/2008	1372	55	1317	1357	1347
7139E	10/31/2007	1372	44	1328	1357	1347
7139E	4/30/2007	1372	36	1336	1357	1347
7139E	9/30/2006	1372	32	1340	1357	1347
7139E	4/30/2006	1372	16	1356	1357	1347
7139E	10/31/2005	1372	25	1347	1357	1347
7139E	4/30/2005	1372	19	1353	1357	1347
7139E	11/30/2004	1372	84	1288	1357	1347
7139E	5/31/2004	1372	85	1287	1357	1347
7139E	3/31/2004	1372	74	1298	1357	1347
7139E	10/31/2003	1372	84	1288	1357	1347
7139E	10/15/2002	1372	95	1277	1357	1347
7139E	4/30/2002	1372	77	1295	1357	1347
7139E	3/31/2001	1372	50	1322	1357	1347
7139E	10/31/2000	1372	57	1315	1357	1347
7139E	5/31/2000	1372	49	1323	1357	1347
7139E	10/31/1999	1372	43	1329	1357	1347
7139E	4/30/1999	1372	36	1336	1357	1347
7139E	11/1/1998	1372	35	1337	1357	1347
7139E	4/1/1998	1372	15	1357	1357	1347
7139E	10/1/1997	1372	42	1330	1357	1347
7139E	4/1/1997	1372	29	1343	1357	1347
7139E	10/31/1996	1372	25	1347	1357	1347
7139E	4/30/1996	1372	21	1351	1357	1347
7139E	10/31/1995	1372	30	1342	1357	1347
7139E	4/28/1995	1372	16	1356	1357	1347
7139E	10/31/1994	1372	29	1343	1357	1347
7139E	4/30/1994	1372	17	1355	1357	1347
7139E	4/30/1993	1372	20	1352	1357	1347
7139E	9/30/1992	1372	69	1303	1357	1347
7139E	4/30/1992	1372	36	1336	1357	1347
7139E	10/31/1991	1372	102	1270	1357	1347
7139E	4/15/1991	1372	77	1295	1357	1347
7139E	10/15/1990	1372	89	1283	1357	1347
7139E	4/15/1990	1372	79	1293	1357	1347
7139E	10/15/1989	1372	76	1296	1357	1347
7139E	4/15/1989	1372	56	1316	1357	1347
7139E	12/30/1988	1372	55	1317	1357	1347
7139E	11/30/1988	1372	61	1311	1357	1347
7139E	10/30/1988	1372	64	1308	1357	1347
7139E	5/30/1988	1372	45	1327	1357	1347
7139E	4/30/1988	1372	39	1333	1357	1347
7139E	3/30/1988	1372	38	1334	1357	1347
7139E	2/29/1988	1372	40	1332	1357	1347
7139E	1/30/1988	1372	42	1330	1357	1347
7139E	11/25/1986	1372	36	1336	1357	1347
7139E	10/25/1986	1372	35	1337	1357	1347
7139E	9/25/1986	1372	43	1329	1357	1347
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7139E	1/30/1985	1372	17	1355	1357	1347
7139E	11/30/1984	1372	21	1351	1357	1347
7139E	8/30/1984	1372	23	1349	1357	1347
7139E	4/30/1984	1372	19	1353	1357	1347
7139E	1/30/1984	1372	13	1359	1357	1347
7139E	11/30/1983	1372	14	1358	1357	1347
7139E	8/30/1983	1372	16	1356	1357	1347
7139E	4/30/1983	1372	13	1359	1357	1347
7139E	1/30/1983	1372	25	1347	1357	1347

WELL_ID	MEASURE_DATE	GS_ELEV	GS_TO_WS	WS ELEVATION	Design LID Invert Elevation	GMED Design Limit Elevation
7139F	6/1/2012	1375	85	1290	1360	1350
7139F	1/6/2012	1375	59	1316	1360	1350
7139F	6/1/2011	1375	39	1336	1360	1350
7139F	6/1/2011	1375	39	1336	1360	1350
7139F	10/1/2010	1375	73	1302	1360	1350
7139F	8/31/2009	1375	84	1291	1360	1350
7139F	4/30/2009	1375	84	1291	1360	1350
7139F	5/5/2008	1375	52	1323	1360	1350
7139F	10/31/2007	1375	44	1331	1360	1350
7139F	4/30/2007	1375	34	1341	1360	1350
7139F	9/30/2006	1375	28	1347	1360	1350
7139F	4/30/2006	1375	12	1363	1360	1350
7139F	10/31/2005	1375	25	1350	1360	1350
7139F	4/30/2005	1375	14	1361	1360	1350
7139F	11/30/2004	1375	82	1293	1360	1350
7139F	5/31/2004	1375	75	1300	1360	1350
7139F	3/31/2004	1375	74	1301	1360	1350
7139F	10/31/2003	1375	85	1290	1360	1350
7139F	10/15/2002	1375	84	1291	1360	1350
7139F	4/30/2002	1375	72	1303	1360	1350
7139F	3/31/2001	1375	48	1327	1360	1350
7139F	10/31/2000	1375	56	1319	1360	1350
7139F	5/31/2000	1375	46	1329	1360	1350
7139F	10/31/1999	1375	38	1337	1360	1350
7139F	4/30/1999	1375	34	1341	1360	1350
7139F	11/1/1998	1375	31	1344	1360	1350
7139F	4/1/1998	1375	14	1361	1360	1350
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7139F	10/31/1995	1375	23	1352	1360	1350
7139F	4/28/1995	1375	16	1359	1360	1350
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7139F	4/30/1994	1375	18	1357	1360	1350
7139F	4/30/1993	1375	17	1358	1360	1350
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7139F	4/15/1990	1375	75	1300	1360	1350
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7139F	3/30/1988	1375	35	1340	1360	1350
7139F	2/29/1988	1375	36	1339	1360	1350
7139F	1/30/1988	1375	38	1337	1360	1350
7139F	12/30/1987	1375	40	1335	1360	1350
7139F	11/25/1987	1375	41	1334	1360	1350
7139F	10/30/1987	1375	46	1329	1360	1350
7139F	9/30/1987	1375	48	1327	1360	1350
7139F	8/25/1987	1375	45	1330	1360	1350
7139F	7/30/1987	1375	40	1335	1360	1350
7139F	6/25/1987	1375	42	1333	1360	1350
7139F	4/25/1987	1375	42	1333	1360	1350
7139F	3/25/1987	1375	32	1343	1360	1350
7139F	2/25/1987	1375	29	1346	1360	1350
7139F	1/25/1987	1375	28	1347	1360	1350
7139F	12/25/1986	1375	32	1343	1360	1350
7139F	11/25/1986	1375	33	1342	1360	1350
7139F	10/25/1986	1375	33	1342	1360	1350
7139F	9/25/1986	1375	30	1345	1360	1350
7139F	8/25/1986	1375	30	1345	1360	1350
7139F	6/25/1986	1375	32	1343	1360	1350
7139F	5/25/1986	1375	18	1357	1360	1350
7139F	4/25/1986	1375	25	1350	1360	1350
7139F	3/25/1986	1375	18	1357	1360	1350
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WELL_ID	MEASURE_DATE	GS_ELEV	GS_TO_WS	WS ELEVATION	Design LID Invert Elevation	GMED Design Limit Elevation
7139G	11/1/2012	1380	81	1299	1365	1355
7139G	6/1/2012	1380	81	1299	1365	1355
7139G	1/8/2012	1380	56	1324	1365	1355
7139G	6/1/2011	1380	39	1341	1365	1355
7139G	6/1/2011	1380	39	1341	1365	1355
7139G	10/1/2010	1380	69	1311	1365	1355
7139G	8/31/2009	1380	86	1294	1365	1355
7139G	4/30/2009	1380	79	1301	1365	1355
7139G	5/7/2008	1380	49	1331	1365	1355
7139G	10/31/2007	1380	38	1342	1365	1355
7139G	4/30/2007	1380	32	1348	1365	1355
7139G	9/30/2006	1380	29	1351	1365	1355
7139G	4/30/2006	1380	12	1368	1365	1355
7139G	10/31/2005	1380	25	1355	1365	1355
7139G	4/30/2005	1380	10	1370	1365	1355
7139G	11/30/2004	1380	81	1299	1365	1355
7139G	5/31/2004	1380	89	1291	1365	1355
7139G	3/31/2004	1380	75	1305	1365	1355
7139G	10/31/2003	1380	82	1298	1365	1355
7139G	10/15/2002	1380	89	1291	1365	1355
7139G	4/30/2002	1380	67	1313	1365	1355
7139G	3/31/2001	1380	43	1337	1365	1355
7139G	10/31/2000	1380	57	1323	1365	1355
7139G	5/31/2000	1380	42	1338	1365	1355
7139G	10/31/1999	1380	37	1343	1365	1355
7139G	4/30/1999	1380	33	1347	1365	1355
7139G	11/1/1998	1380	35	1345	1365	1355
7139G	4/1/1998	1380	14	1366	1365	1355
7139G	10/1/1997	1380	41	1339	1365	1355
7139G	4/1/1997	1380	29	1351	1365	1355
7139G	10/31/1996	1380	23	1357	1365	1355
7139G	4/30/1996	1380	17	1363	1365	1355
7139G	10/31/1995	1380	22	1358	1365	1355
7139G	4/28/1995	1380	17	1363	1365	1355
7139G	10/31/1994	1380	28	1352	1365	1355
7139G	4/30/1994	1380	17	1363	1365	1355
7139G	4/30/1993	1380	15	1365	1365	1355
7139G	9/30/1992	1380	64	1316	1365	1355
7139G	4/30/1992	1380	37	1343	1365	1355
7139G	10/30/1991	1380	91	1289	1365	1355
7139G	4/15/1991	1380	70	1310	1365	1355
7139G	10/15/1990	1380	82	1298	1365	1355
7139G	4/15/1990	1380	74	1306	1365	1355
7139G	10/15/1989	1380	63	1317	1365	1355
7139G	4/15/1989	1380	50	1330	1365	1355
7139G	12/30/1988	1380	55	1325	1365	1355
7139G	11/30/1988	1380	60	1320	1365	1355
7139G	10/30/1988	1380	65	1315	1365	1355
7139G	5/30/1988	1380	38	1342	1365	1355
7139G	4/30/1988	1380	33	1347	1365	1355
7139G	3/30/1988	1380	33	1347	1365	1355
7139G	2/29/1988	1380	38	1342	1365	1355
7139G	1/30/1988	1380	36	1344	1365	1355
7139G	12/30/1987	1380	35	1345	1365	1355
7139G	11/25/1987	1380	35	1345	1365	1355
7139G	10/30/1987	1380	45	1335	1365	1355
7139G	9/30/1987	1380	41	1339	1365	1355
7139G	8/25/1987	1380	39	1341	1365	1355
7139G	7/30/1987	1380	43	1337	1365	1355

SITE REQUIREMENTS FOR STORMWATER INFILTRATION

1. Subsurface materials shall have a design infiltration rate equal to or greater than 0.3 inches per hour. Procedures for performing in-situ percolation tests and application of reduction factors are described later in these guidelines.

2. The invert of stormwater infiltration shall be at least 10 feet above the groundwater elevation. Procedures for determining the groundwater elevation are described later in these guidelines.

3. Stormwater infiltration is not allowed in areas that pose a risk of causing pollutant mobilization, such as on sites identified on environmental regulatory databases or similar files maintained by local agencies, or on properties with other documented environmental concerns.

4. Stormwater infiltration is not allowed in areas that pose a risk of causing sewage effluent mobilization from septic pits, seepage lines, or other sewage disposal.

5. Stormwater infiltration BMPs shall not be placed on steep slopes and shall not create the condition or potential for slope instability.

6. Stormwater infiltration shall not increase the potential for static settlement of structures on or adjacent to the site. Laboratory testing should be performed to evaluate the anticipated settlement and hydrocollapse potential of soils 10 feet below the proposed invert of infiltration.

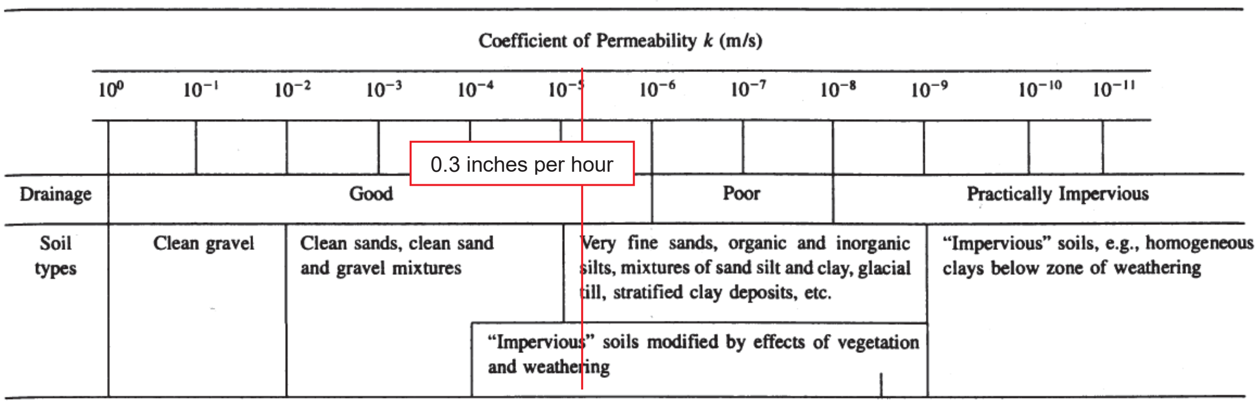
7. Stormwater infiltration shall not increase the potential for seismic settlement of structures on or adjacent to the site. Liquefaction potential shall be evaluated considering the design volume of stormwater infiltration.

8. Stormwater infiltration shall not place an increased surcharge on structures or foundations on or adjacent to the site. The pore-water pressure shall not be increased on soil retaining structures on or adjacent to the site.

9. The invert of stormwater infiltration shall be set back at least 15 feet and outside a 1:1 plane drawn up from the bottom of adjacent foundations, unless otherwise recommended by the geotechnical consultant.

10. Stormwater infiltration shall not be located near utility lines where the introduction of stormwater could cause damage to utilities or settlement of trench backfill.

11. Stormwater infiltration is not allowed within 100 feet of any groundwater production wells used for drinking water.



Permeability and Drainage Characteristics of Soils from Terzaghi and Peck (1996)

Groundwater Investigation

Historic high groundwater maps may be used to verify the seasonal high groundwater elevation is greater than 10 feet below the proposed invert of infiltration. Historic high groundwater elevations may be available in the Seismic Hazard Evaluation Open-File Reports prepared by the California Geological Survey at the following link: https://goo.gl/VIESFZ.

Existing groundwater data may also be used to verify the seasonal high groundwater elevation is greater than 10 feet below the proposed invert of infiltration. Recent data from Geotracker, Envirostar, local water companies, and other resources may be used to establish a seasonal high groundwater elevation. Current groundwater data and historical publications are available online through the State's Department of Water Resources Website (https://goo.gl/qu8JsG), the Water Replenishment District of Southern California (https://goo.gl/enVgJG), and others. Groundwater data for a given project may be used from sites that are within 1,000 feet of the proposed project and have been collected within the last 5 years. Existing groundwater data must be clearly presented in the report and will be subject to review and approval by GMED.

If historic high groundwater maps and existing data are not available, site-specific exploration can be performed to establish the seasonal high groundwater elevation. At least two borings must be drilled a minimum of 10 feet below the proposed invert. The borings must be monitored for a period of at least 24 hours to verify the seasonal high groundwater elevation is greater than 10 feet below the proposed invert of infiltration.

Hydrogeology

Sites proposing to infiltrate a SWQDv of 10,000 gallons or more must have the geotechnical report signed and stamped by a State of California certified professional geologist. It is highly recommended that reports for large projects also be signed and stamped by a certified hydrogeologist. The consulting geologist of record should provide findings and conclusions regarding the local and regional geologic and hydrogeologic conditions and their effect on the proposed stormwater infiltration project. Features including but not limited to water tables, aquifers, past groundwater issues, confining units, stratigraphy, depth of bedrock, rock type, lithology, landslides, and faults should be discussed. Conclusions must be made regarding depth to seasonal high groundwater elevation.