Hydraulic Analysis Technical Support Data Notebook

Flood Insurance Studies for the Lower Ventura River and Cañada de San Joaquin - CTP Program

Hydraulic Modeling and Inundation Mapping

Ventura River Levee VR-1, Ventura, California

VCWPD Contract AE 11-047

September 25, 2014

Ventura County Watershed Protection District

County of Ventura, California

Federal Emergency Management Agency

Department of Homeland Security

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TECHNICAL SUPPORT DATA NOTEBOOK

FOR

CITY OF VENTURA, VENTURA COUNTY, CALIFORNIA

____

(COMMUNITY NAME AND STATE)

FLOOD INSURANCE STUDY/ MAP

REVISION

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September 25, 2014

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Appendices

Appendix A TSDN Documents
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Appendix C Quality Assurance/Quality Control
Appendix D CD/DVD with All Applicable Data

BFE	Base Flood Elevation
CFS	Cubic Feet per Second
CSJ	Cañada de San Joaquin
DFIRM	Digital Flood Insurance Rate Map
FEMA	Federal Emergency Management Agency
FIS	Flood Insurance Study
GIS	Geographic Information System
HEC	Hydraulic Engineering Center
LiDAR	Light Detection and Ranging
NAVD88	North American Vertical Datum of 1988
QA/QC	Quality Assurance / Quality Control
RAS	River Analysis System
RS	River Station
TSDN	Technical Support Data Notebook
USACE	U.S. Army Corps of Engineers
VCWPD	Ventura County Watershed Protection District
WSE	Water Surface Elevation

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1 TASK SUMMARY

1.1 INTRODUCTION

This report summarizes the development of the "without levee" (Natural Valley) floodplain mapping for the Lower Ventura River along the VR-1 Levee (Figure 1) in accordance with the Federal Emergency and Management Agency (FEMA) procedures and guidelines for *Analysis and Mapping of Non-Accredited Levee Systems* (FEMA, 2013). A one-dimensional hydraulic model (HEC-RAS) was developed to analyze flows in the Ventura River. A two-dimensional flood routing model (FLO-2D) was developed for the floodplain mapping on the landward side of the levee. The inflows to the FLO-2D model were determined by laterally overtopping flows from the adjacent Ventura River.

1.2 PROJECT WORK SCOPE

FEMA is currently replacing the former levee analysis and mapping approach for non-accredited levee systems (previously known as "without levee" condition) with a suite of alternative procedures. The methodology used here for the floodplain mapping of the Special Flood Hazard Area (SFHA) landward of the VR-1 Levee is now referred to as the Natural Valley Procedure (FEMA, 2013). Guidance provided by FEMA for flood hazard mapping partners were followed from appendices C, M, and L in the flood hazard mapping program (FEMA, 2002; 2003; 2011).

<u>Scope</u> - Tetra Tech proposed an updated scope of work in February 2014 that was approved by FEMA and Ventura County Watershed Protection District (VCWPD):

1. A one-dimensional (1-D) hydraulic analysis will be performed for the lower Ventura River by developing an unsteady HEC-RAS model from the Flood Insurance Study (FIS) base model geometry (developed by HDR) downstream of River Station (RS) 20502.94. The unsteady flow hydraulic model will be used to provide flows on the landward side of the levee, using lateral structures as described below in item #3, for the "without levee" (Natural Valley) condition.
2. The 100-year and 500-year hydrographs will be provided by VCWPD for all the inflow locations (Ventura River, Cañada De San Joaquin, and Dent Drain).
3. A series of lateral structures (weirs) will be incorporated into the unsteady HEC-RAS cross sections along the VR-1 Levee to provide flows on the landward side of the levee for the Natural Valley Procedure. The lateral structure crest elevations will match the landward ground elevations or other appropriate elevations, assuming that the entire levee will fail to allow lateral conveyance. The weir coefficients will be determined according to HEC guidelines *Combined 1D and 2D modeling with HEC-RAS* (HEC, 2013). This approach will reflect the levee geometry in the unsteady HEC-RAS model, but will not interfere with conveyance, as specified in the Natural Valley Procedure.
4. The overtopping hydrographs developed in item #3 will feed the overbank FLO-2D model. The FLO-2D inflows will be uniformly distributed among the overbank grid cells adjacent to the VR-1 Levee. Any return flows (from FLO-2D back into the river) will be prevented using impervious walls at the boundary grid cells.

5. The FLO-2D overbank model will consist of 50-foot grid cells that incorporate arterial streets. Those streets wider than what will fit in the 50-foot grid cells will be accommodated by increased curb height to make up for the lost conveyance.
6. The floodway analysis along the VR-1 Levee will be performed using the steady base hydraulic model for the 100-year "without levee" conditions. Encroachments will likely be placed along the levee and no flow will be allowed on the landward side.
7. Tetra Tech will use the latest FLO-2D Pro Version, which will be verified by comparing the results with FLO-2D 2009 Version before submitting to FEMA.

2 METHODOLOGY

2.1 APPROACH

A one-dimensional hydraulic analysis was performed for the lower Ventura River using an unsteady HEC-RAS model from upstream of Shell Road (RS 20502.94) to the Pacific Ocean (RS 43.85). The unsteady hydraulic model was used to provide overbank flows (on the landward side of the levee) by a series of lateral structures along the VR-1 Levee. The lateral structure crest elevations matched the landward ground elevations, assuming that the entire levee would fail to allow for lateral conveyance. This modeling approach reflects the levee geometry in the HEC-RAS cross sections, but does not interfere with overbank conveyance, as specified in the Natural Valley Procedure.

The overtopping flows from unsteady HEC-RAS were used as lateral inflows into a two-dimensional flood routing model (FLO-2D) landward of the levee. The inflows were uniformly distributed among the FLO-2D grid cells adjacent to the VR-1 Levee. Any return flows (from FLO-2D back into the channel) were prevented by impervious walls at the boundary grid cells to provide conservative floodplain extents on the landward side of the levee. The following sections describe the modeling tools and hydraulic results used in developing the floodplain maps.

2.2 HYDRAULIC MODELS

The computation of the VR-1 Levee riverside water surface elevations (WSEs) along the Ventura River and Cañada De San Joaquin (CSJ) was performed using an unsteady HEC-RAS program Version 4.1 (HEC, 2010). The program was developed by the Hydrologic Engineering Center (HEC) of the U. S. Army Corps of Engineers (USACE). It is capable of simulating one-dimensional unsteady flow (flood propagation) through a full network of open channels by solving the continuity and momentum equations. The hydraulic calculations for cross-sections, junctions, bridges, culverts, and other hydraulic structures (originally developed for the steady flow) were incorporated into the unsteady flow module. Additionally, the unsteady flow component has the ability to dynamically simulate flow over lateral weirs (between the main channel and overbanks), which was used in this modeling approach.

The computation of the VR-1 Levee landside WSEs was performed using the two-dimensional program FLO-2D (2011). FLO-2D is a flood routing (volume conservation) model developed by Dr. Jim O'Brien. It numerically routes a flood hydrograph over a computational domain while predicting the area of inundation and simulating floodwave attenuation. The model is particularly effective for analyzing shallow flows over complex topographic domains such as the urbanized development (with blocked obstructions and street flow) on the landward side of the VR-1 Levee.

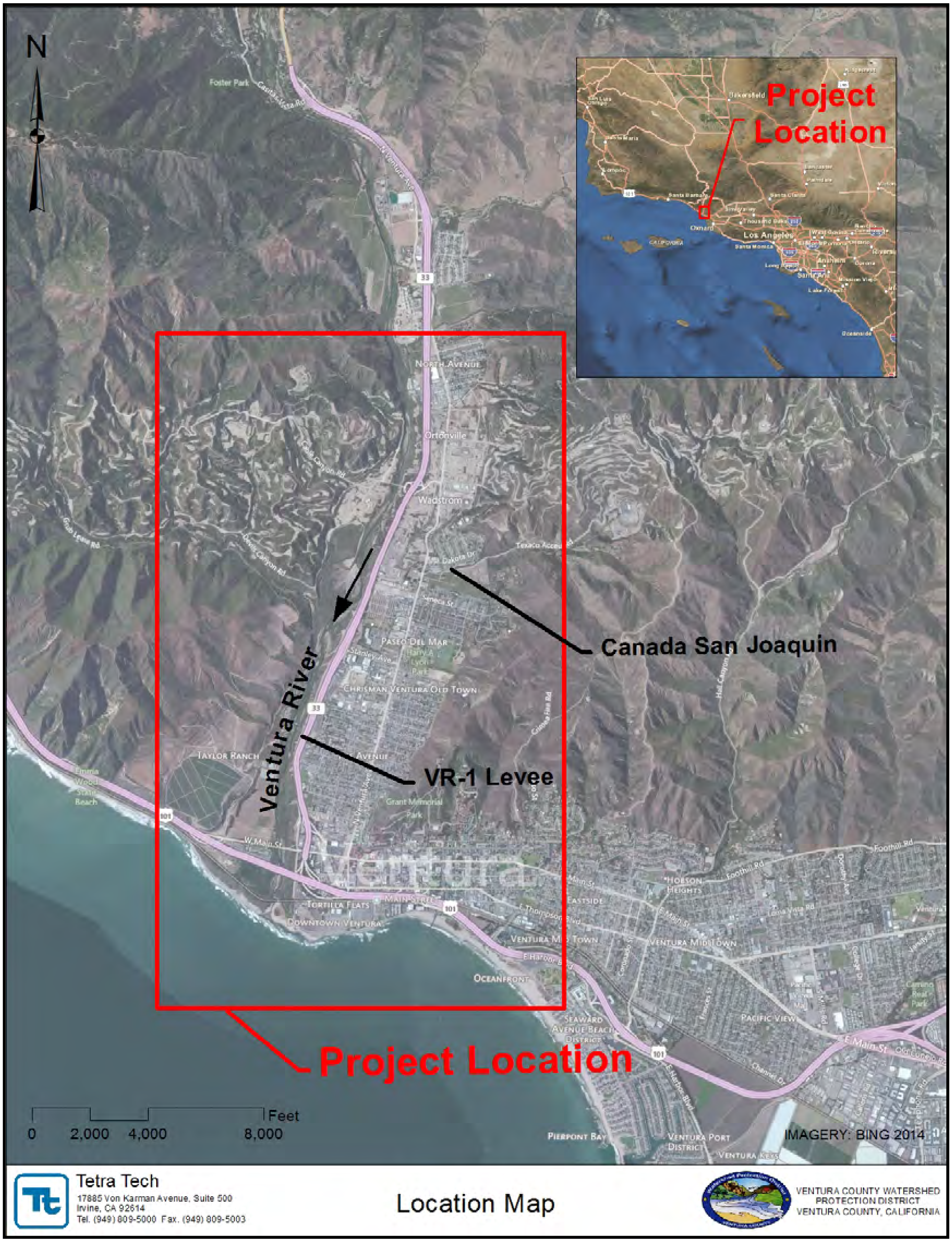

Figure 1: Location Map

2.3 PARAMETER ESTIMATION

2.3.1 HEC-RAS

The unsteady HEC-RAS model developed in this study (see Figure 8 and Figure 9 for cross section locations) required the following sets of input data: 1) hydrologic information; 2) geometric data; 3) roughness coefficients; 4) hydraulic structures; 5) boundary conditions; 6) initial conditions; and 7) lateral weirs.

2.3.1.1 HYDROLOGIC INPUT

The effective hydrologic inputs for the Ventura River, Cañada de San Joaquin, and Dent Drain were provided by VCWPD based on the FEMA *Hydrologic Review for the Ventura River Watershed and Several Tributary Streams Flood Insurance Study* (HDR, 2010). The Cañada de San Joaquin peak flows had been revised by VCWPD in August 2010 (VCWPD, 2010a) and were also analyzed in the current study to develop an additional floodplain map with most recent hydrology. A summary of inflow hydrograph peaks is shown in Table 1.

Table 1: Summary of Discharges

FLOODING SOURCE	Qmax (cfs)	
	100-Year	500-Year
Ventura River at/above Shell Road	78,900	105,500
Vantura River below Shell Road	79,166	105,500
Cañada de San Joaquin	2,420	4,720
Cañada de San Joaquin (Revised)*	1,870	3,650
Dent Drain	527	790

*From *Ventura River Watershed Design Modeling – Addendum 1* (VCWPD, 2010a)

The Ventura River hydrographs (Figure 2 and Figure 3) were specified as the HEC-RAS inflows at RS 20502.94.

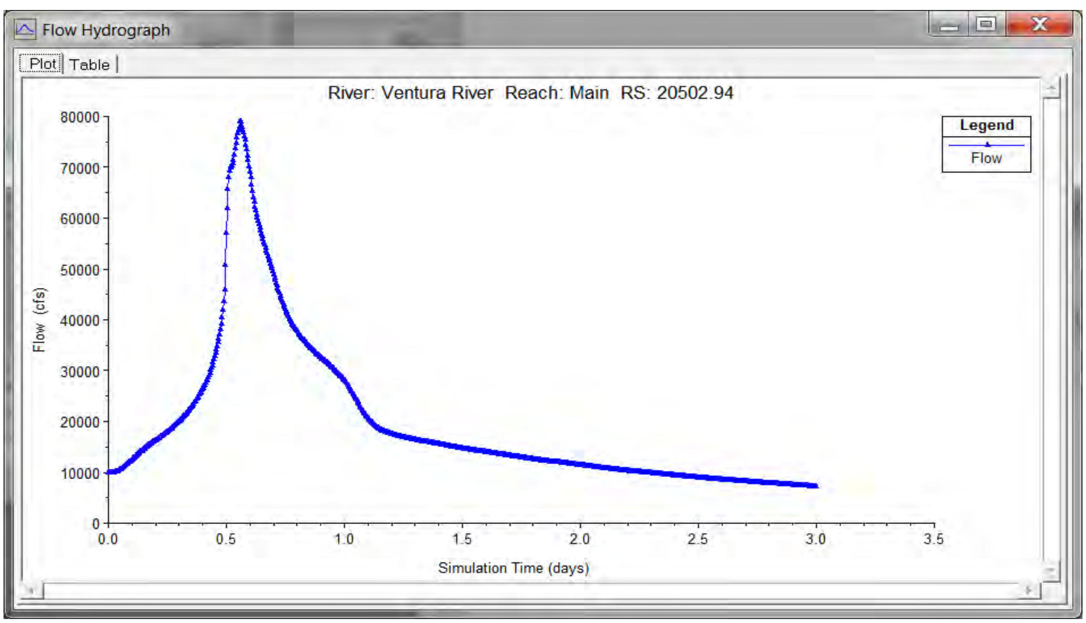

Figure 2: Ventura River 100-Year Inflow Hydrograph above Shell Road

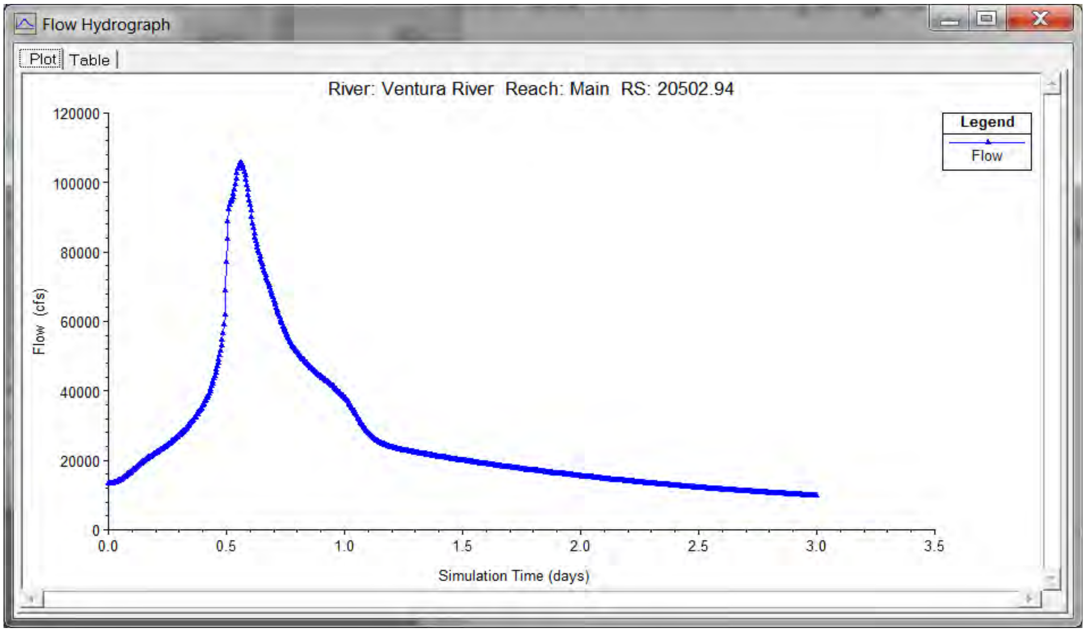

Figure 3: Ventura River 500-Year Inflow Hydrograph above Shell Road

The CSJ hydrographs (Figure 4 and Figure 5) were specified as the HEC-RAS lateral inflows at RS 13489.16.

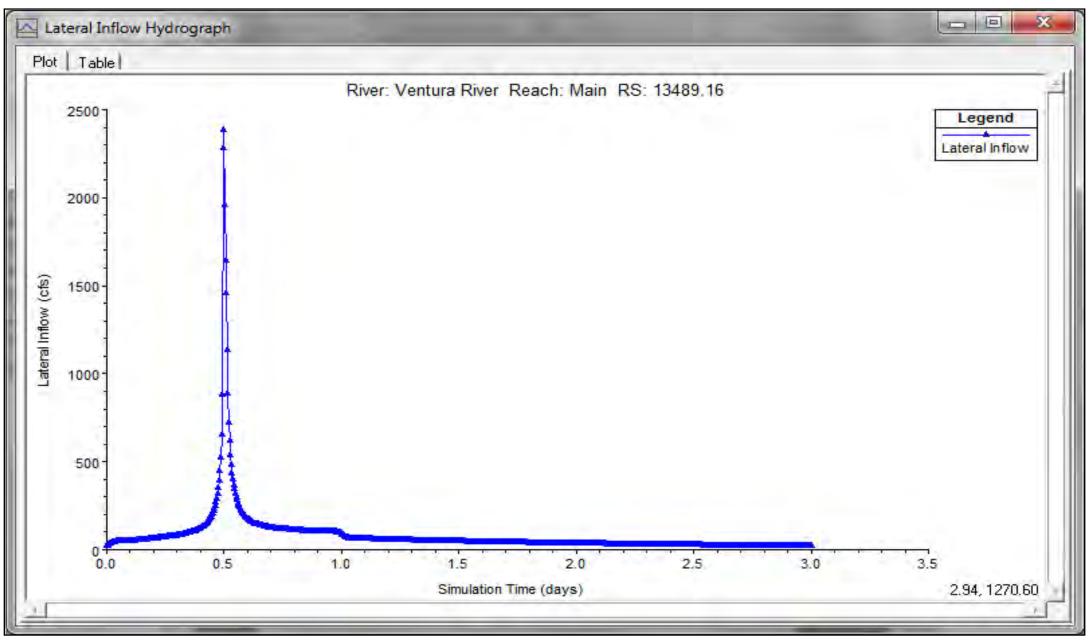

Figure 4: Cañada de San Joaquin 100-Year Inflow Hydrograph

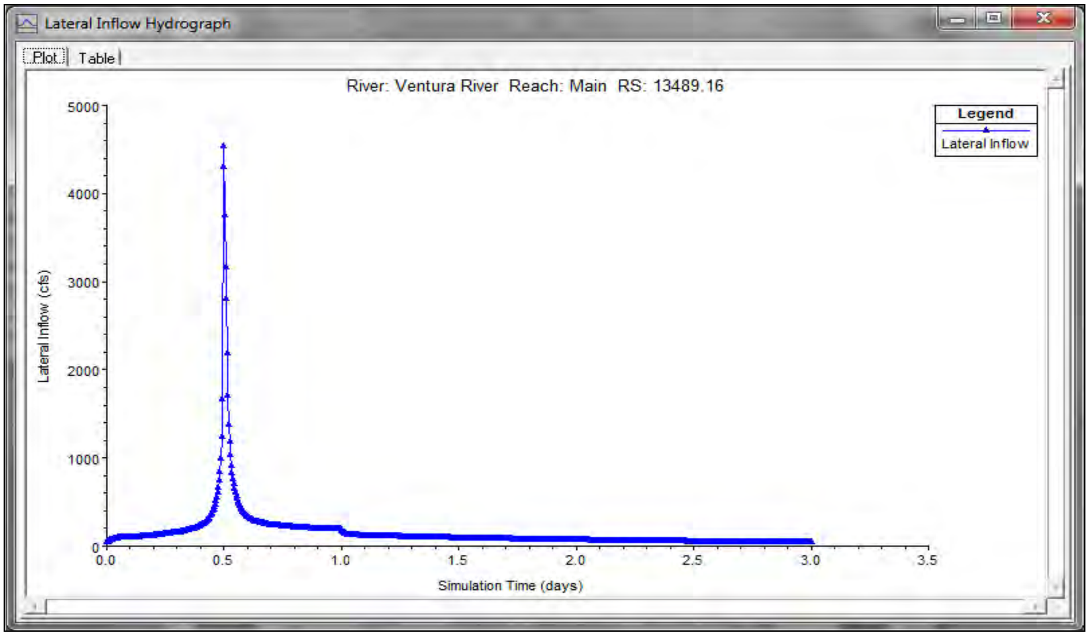

Figure 5: Cañada de San Joaquin 500-Year Inflow Hydrograph

The Dent Drain hydrographs (Figure 6 and Figure 7) were specified as the HEC-RAS lateral inflows at RS 11727.16.

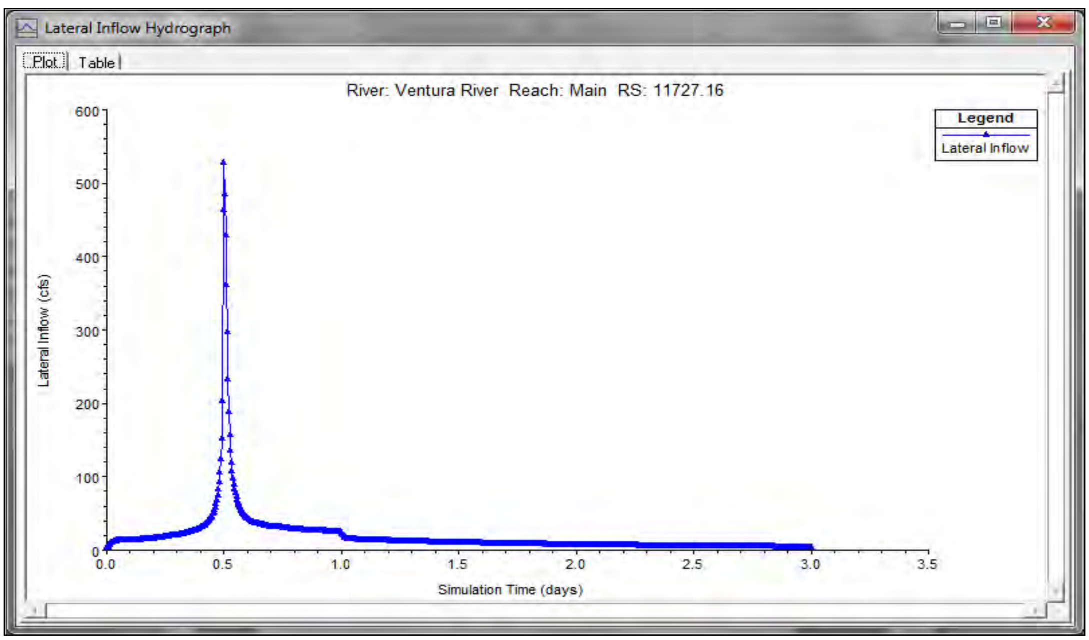

Figure 6: Dent Drain 100-Year Inflow Hydrograph

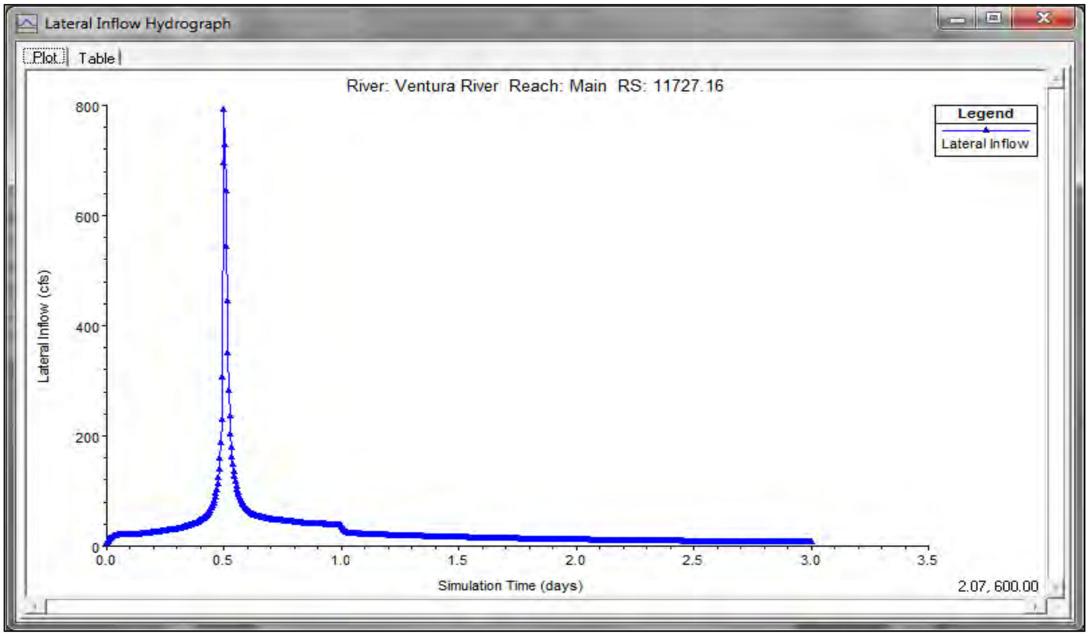

Figure 7: Dent Drain 500-Year Inflow Hydrograph

2.3.1.2 GEOMETRIC DATA

The cross-section data for the Ventura River was taken from the base hydraulic model provided by VCWPD. This steady HEC-RAS model (Figure 8) was originally developed by HDR for the *Ventura River and Tributaries Flood Insurance Study* (2010). The lower reach (approximately 3.9 miles in length) between RS 20502.94 and RS 43.85 was used to develop the unsteady HEC-RAS model in the present study. The channel spacing between the cross sections (100-500 ft) was considered adequate for unsteady flood routing.

FEMA requested that the Ventura River left overbank (landward of the VR-1 Levee) be simulated as ineffective in the present study to maximize riverine water surface elevations and laterally overtopping flows. Therefore, left ineffective flow limits were placed on top of the levee in the HEC-RAS cross sections to remove the overbank conveyance during unsteady runs.

The cross-section data for CSJ was taken from the base HEC-RAS model (Figure 9) originally developed by HDR (2010). CSJ is an open natural channel (approximately 1.5 miles in length) that has adequate capacity east of Ventura Avenue, but becomes a complex hydraulic system with multiple structures and flow diversions west of Ventura Avenue. The northern end of the VR-1 Levee is located along the left bank of CSJ between RS 775.05 and RS 1725.41.

Dent Drain was not modeled as a separate reach with geometry (due to its relatively small discharge). It was rather accounted for as lateral inflow into the Ventura River.

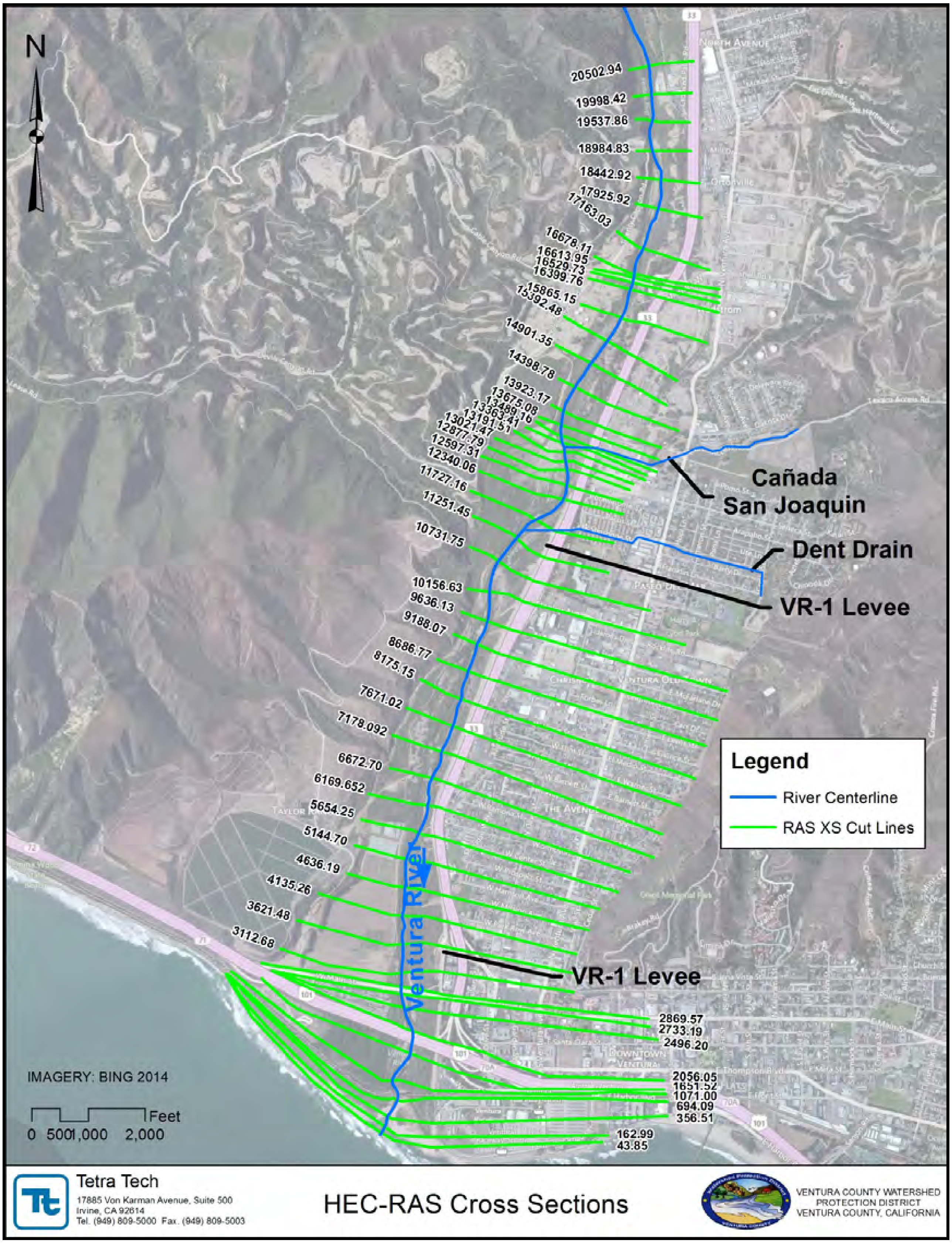

Figure 8: Lower Ventura River Base Hydraulic Model Cross Sections

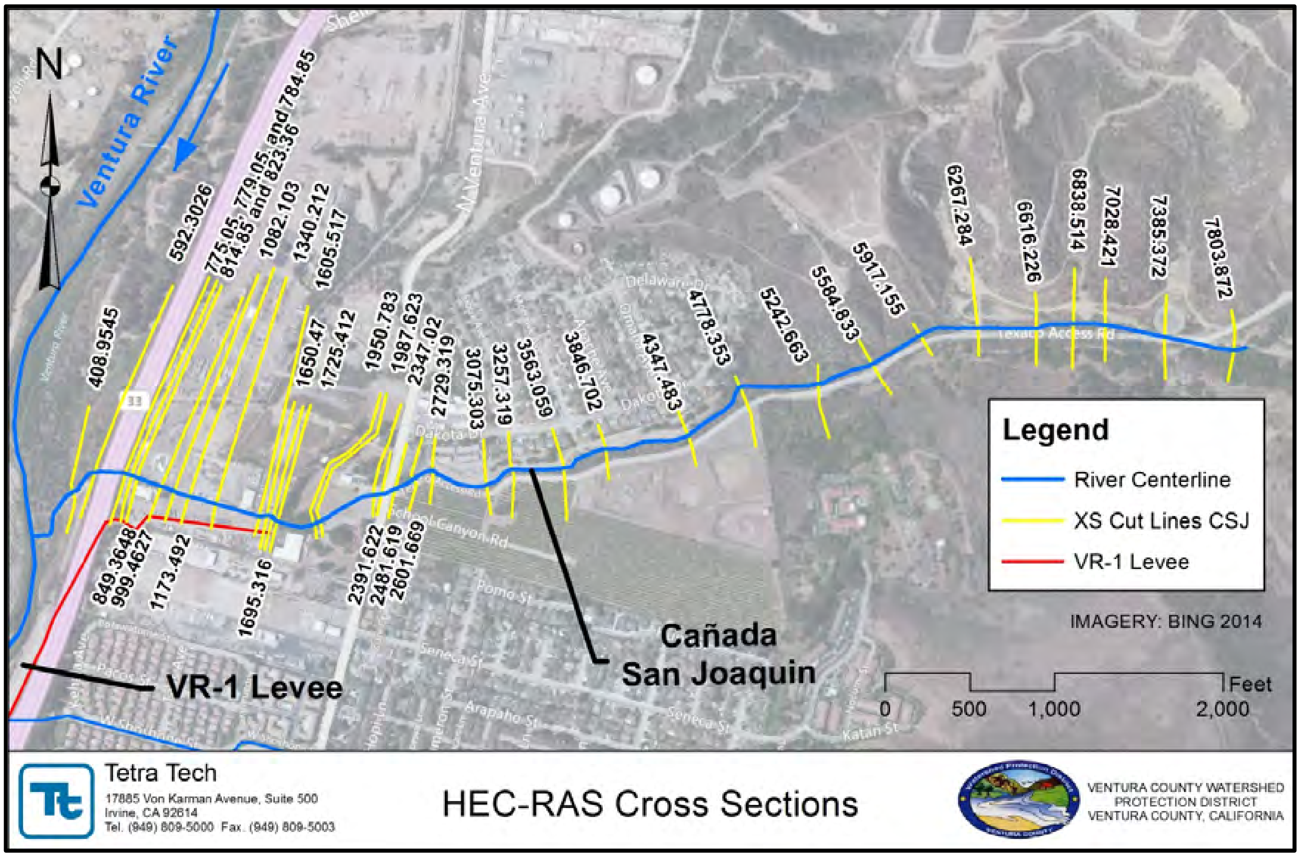

Figure 9: Cañada de San Joaquin Base Hydraulic Model Cross Sections

2.3.1.3 ROUGHNESS VALUES

The USGS *Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains* (1989) was originally used by HDR to generate Manning's *n* values for the channel and overbanks of the Ventura River and tributaries [the procedure was based on the Cowan's (1956) methodology]. The estimated roughness coefficients are shown in Table 2.

Table 2: Base HEC-RAS Model Manning's Roughness Coefficients

FLO-2D STREETS	LOB	Channel	ROB	From RS	To RS
Ventura River from Santa Ana to Pacific Ocean	0.068	0.033	0.068	50940.43	43.85
CSJ Ventura Avenue	0.068	0.031	0.068	7803.87	2481.61
CSJ Piped System	0.033	0.015	0.033	2391.62	1987.62
CSJ Ventura Avenue to OST Yard	0.033	0.032	0.033	1950.78	1695.31
CSJ OST Yard	0.034	0.030	0.034	1650.47	849.36
CSJ SR 33	0.047	0.031	0.047	814.85	408.95

The above roughness coefficients from the base model were adjusted in the present study for the purpose of unsteady flow modeling. The channel roughness was slightly increased to 0.04 at several cross sections in the Ventura River to promote computational stability around lateral structures. Also, the channel roughness for CSJ was increased to 0.075-0.090 range between Dirt Crossing 7d and Ventura Avenue Culvert to compensate for removed pressure lid in several cross sections (see Section 2.3.1.4).

2.3.1.4 HYDRAULIC STRUCTURES

There are four hydraulic structures in the Ventura River base model (HDR, 2010): Shell Road (RS 16563) is a bridge with 4 piers; Main Street (RS 2796) is an arched bridge with 20 piers; Highway 101 (RS 1975) is a bridge with 11 piers in the main channel and two additional overbank bridges/culverts; UPRR Railroad Bridge (RS 800) is a bridge with 12 piers in the main channel and a side bridge on the right overbank. The three downstream bridges were modeled as multiple openings using a combination of bridges/culverts and natural conveyances. The multiple-opening approach from the base model was improved in the present study (Figure 10 and Figure 11) by removing middle conveyances [HEC-RAS allows conveyances to be placed only at the far left or right end of a cross section (HEC, 2010)] and by repositioning stagnation points between the openings for better convergence during unsteady runs.

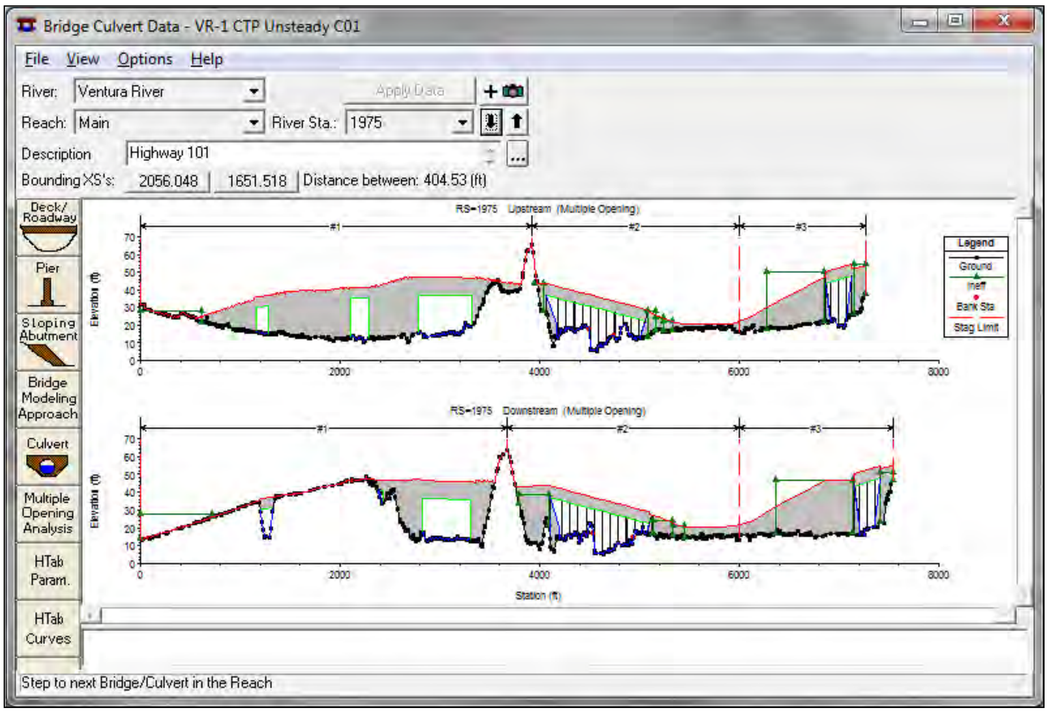

Figure 10: Highway 101 with Adjusted Multiple Openings

Figure 11: UPRR Railroad Bridge with Adjusted Multiple Openings

There are seven hydraulically significant stream crossings for Cañada de San Joaquin (four bridges and three culverts) in the base HEC-RAS model: Ventura Ave (RS 2477); Dirt Crossing 7d (RS 1674.16); Buildings over channel (RS 1563.52); Dirt Crossing 7c (RS 1136.87); Dirt Crossing 7b (RS 826.63); Bike Path Crossing 7a (RS 801.09); and SR 33 Freeway (RS 692.89). In addition, there is a box pipe conduit from Ventura Avenue to approximately 490 feet downstream. The piped reach (from RS 2391.62 to RS 1987.62) was simulated using the pressure flow option (with lidded cross sections) in the base HEC-RAS model. The lid was removed for unsteady runs and replaced with conservatively high channel roughness (0.090 for 100-year and 0.075 for 500-year event) to prevent the unsteady model from crashing. These roughness coefficients were calibrated to produce similar maximum WSEs as the base HEC-RAS model (with the lid) for peak flows. It should be noted that a pressure lid is already approximated by a Priessmann slot (i.e. narrow open channel) in unsteady HEC-RAS program to prevent a significant drop in conveyance that can cause instability in the numerical solution as it transitions from open channel to pressure flow (HEC, 2010a). Therefore, lid replacement with high roughness was deemed appropriate here.

2.3.1.5 BOUNDARY CONDITIONS

The base HEC-RAS model for the Ventura River used a starting water surface elevation of 2.53 feet at the ocean (based on a previous USBR model). This water surface elevation is too low and caused the base model to default to critical depth for each flow. In the present study, a normal depth boundary condition was used instead, with a friction slope of 0.005 (there is an adverse terrain gradient at the ocean). This slope provides stable starting water surface elevation above critical depth, which is conservatively high. It was verified that the water surface profile is not much sensitive to the selection of boundary friction slope.

2.3.1.6 INITIAL CONDITIONS

A steady flow of 500 cubic feet per second (cfs) was used as initial condition in the Ventura River and CSJ. This value provides the minimum computationally stable flow to initiate routing and does not significantly affect the overall flood volume.

2.3.1.7 LATERAL WEIRS

A series of lateral structures (weirs) were incorporated in the HEC-RAS cross sections along the VR-1 Levee to provide overtopping flows on the landward side of the levee. The lateral structure crest elevation (Figure 12) matches the landward ground elevation in each cross section (see Appendix B for all the cross sections with lateral structures – weir crest elevations were labeled with a green dot), assuming that the entire levee would fail to allow for overbank conveyance. The weir discharge coefficients were varied between 0.1 and 0.5 (see discussion in Section 3.5), according to HEC guidelines *Combined 1D and 2D modeling with HEC-RAS* (HEC, 2013).

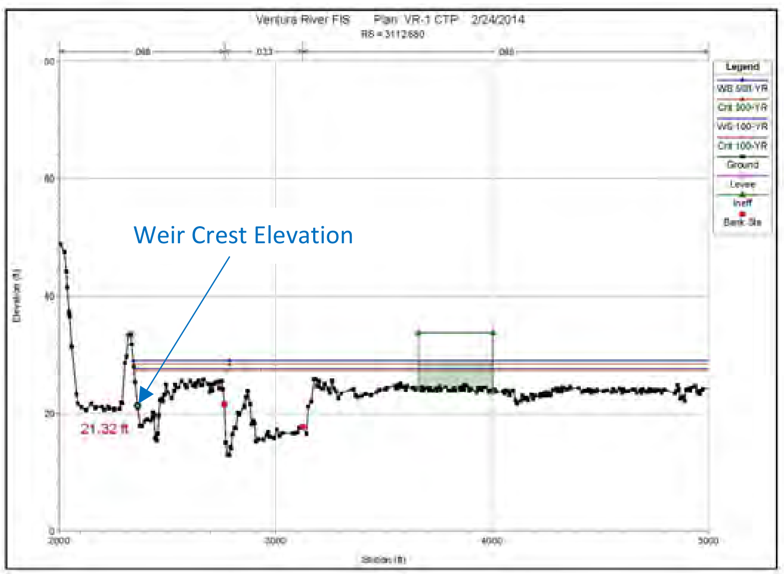

Figure 12: Typical Cross Section with Lateral Weir Elevation

The maximum flows and total volumes overtopping the lateral weirs are shown in Table 3 below. Lateral structure outflow hydrographs are provided in Appendix B.

Table 3: Lateral Structure Peak Flows and Volumes

LATERAL STRUCTURE	100-Year		500-Year	
VENTURA RIVER	Qmax (cfs)	Volume (acre-ft)	Qmax (cfs)	Volume (acre-ft)
9500	0.0	0.0	0.0	0.0
9000	0.0	0.0	0.0	0.0
8500	0.0	0.0	0.0	0.0
8000	0.0	0.0	0.0	0.0
7500	0.0	0.0	0.0	0.0
7000	16.5	1.6	355.0	56.8
6500	246.5	33.0	1011.8	216.8
6000	401.6	62.7	1211.4	291.1

LATERAL STRUCTURE	100-Year		500-Year	
5500	1540.2	595.9	2511.9	1250.3
5000	2084.9	1012.2	2918.1	1876.2
4500	1231.6	519.5	1746.7	1022.2
4000	691.9	242.9	1083.9	524.0
3500	877.3	419.2	1273.6	792.3
3000	714.0	502.6	983.0	871.0
2500	466.6	157.4	754.7	342.5
2200	1566.8	799.1	2315.5	1484.9
TOTAL	9837.9	4346.1	16165.6	8728.1
CAÑADA DE SAN JOAQUIN	Qmax (cfs)	Volume (acre-ft)	Qmax (cfs)	Volume (acre-ft)
2572	42.0	3.5	65.6	5.4
2369	118.2	9.8	805.0	66.5
1300	16.0	1.3	158.4	24.3
1000	41.1	3.8	80.2	11.3
850	228.2	38.1	321.5	67.2
TOTAL	445.5	56.5	1430.7	174.7

2.3.2 FLO-2D

The following is a discussion on the parameters used in the development of the FLO-2D flood routing model on the landward side of the VR-1 Levee.

2.3.2.1 TOPOGRAPHIC DATA

Light Detection and Ranging (LiDAR) data was obtained from VCWPD for use in generating the topography for the model. The data was flown in 2008. The LiDAR points were brought into ESRI ArcGIS geographic information system (GIS) software as a terrain, a version of a triangulated integrated network (TIN), then converted into a bare earth 10-ft DEM grid. The grid points were exported and subsequently imported into FLO-2D which used the points to interpolate elevations for 50’x50’ foot grid cells to be used in the model. All topographic data was referenced to the North American Vertical Datum of 1988 (NAVD88).

2.3.2.2 LATERAL INFLOWS

Inflow locations were created to correspond to the HEC-RAS lateral weirs where flow might potentially overtop the VR-1 levee. Once overtopping flows were determined, select lateral weirs were excluded as inflow cells due to a lack of flow. These included the most southerly laterals, 100-1500, and 7500-9500. Weir 7000 was only used for the 500-yr event. The outflow hydrographs from each lateral weir were uniformly distributed among the grid cells adjacent to the weir.

It was assumed that the levee and road embankments behind the levee would fail in the Natural Valley scenario. Therefore, inflow grid cells were generally placed on the landside of the levee (or roadway) at ground elevations that did not include the levee/roadway embankment (raised ground elevations which would place the inflows above the river flood elevations were avoided). Figure 13 and Figure 14 show the locations of the inflow cells and corresponding lateral weir segments (note that bridges for US-101 and SR-33 are not included in the topographic surface and any inflows that appear located on those bridges are actually located at ground level beneath them). Table 4 lists the lateral weir segments and associated FLO-2D grid cells.

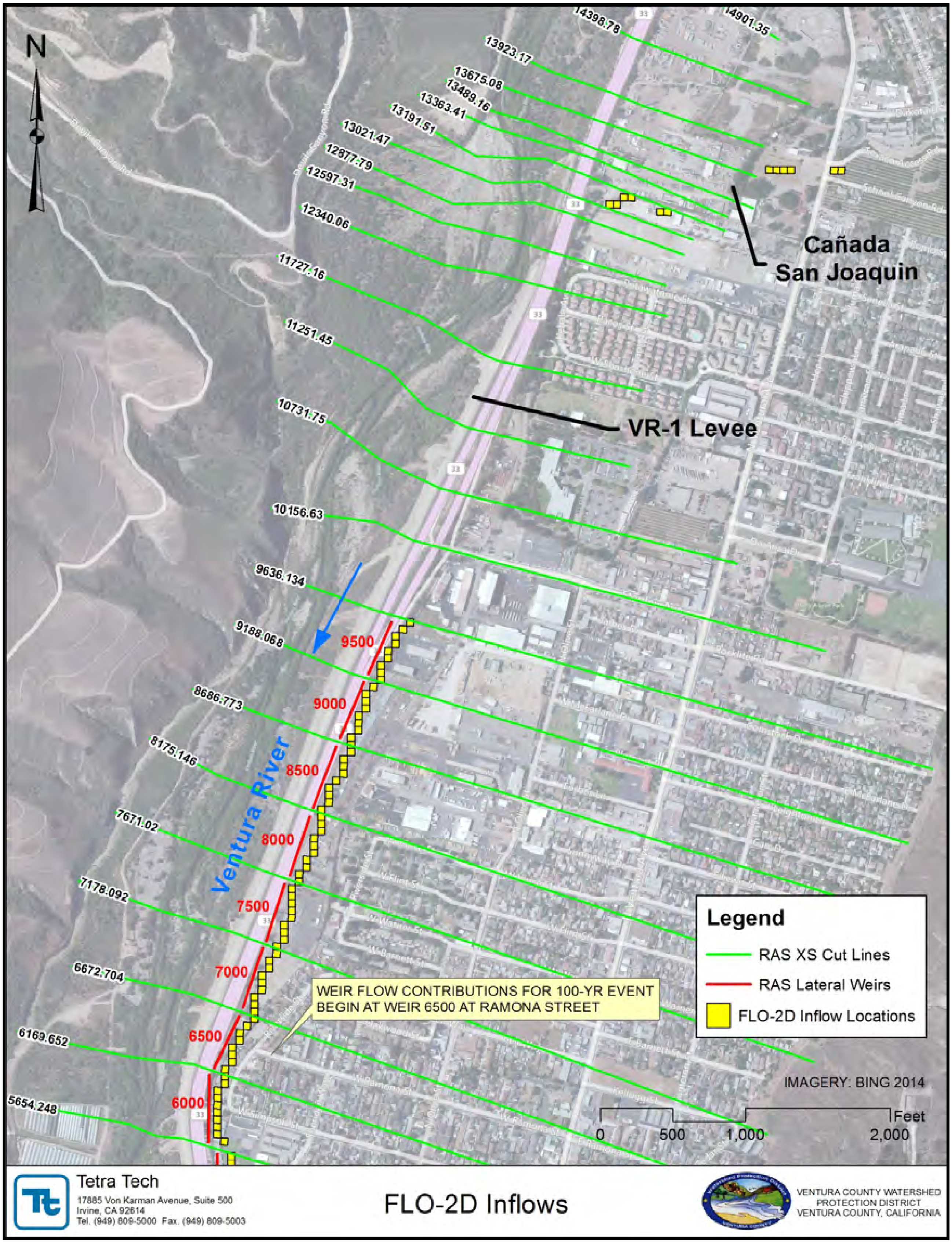

Figure 13: FLO-2D Inflow Locations

Figure 14: FLO-2D Inflow Locations (cont.)

Table 4: FLO-2D Inflow Cells

HEC-RAS Lateral Weir	FLO-2D Grid Cells
100*	21016, 20702, 20389
300*	20388, 20387, 20386, 20385, 20384
500*	20695, 20694, 20693, 20692, 20691, 20690, 20689, 20688, 20687, 20686
1500*	24445, 24759, 25072, 25385, 25698, 25697, 25696, 25695, 25694, 25693
2200	25691, 25376, 25061, 25060, 24745, 24430, 24115, 24114, 23799, 23798, 23483, 23482, 23481
2500	23480, 23479, 23478, 23477, 23476
3000	23475, 23474, 23473, 23472, 23785, 23784, 24097, 24096
3500	24095, 24094, 24093, 24092, 24091, 24090, 24089, 23774, 24087
4000	25027, 24712, 24397, 24396, 24081, 24080, 23765, 23764
4500	23448, 23447, 23446, 23131, 22816, 22815, 22500, 22499, 22498
5000	22183, 22182, 22181, 22180, 22179, 22178, 21862, 21861, 21860, 21859
5500	21858, 21857, 21856, 21541, 21540, 21539, 21538, 21537, 21536, 21535
6000	21533, 21218, 21217, 21216, 21215, 21214, 21213, 21212, 21525, 21524
6500	21523, 21836, 21835, 21834, 22147, 22146, 22459, 22772
7000	22771, 22770, 22769, 23082, 23081, 23080, 23393, 23392, 23705
7500 *	23704, 24017, 24016, 24015, 24328, 24327, 24326, 24639, 24638
8000 *	24951, 24950, 25263, 25262, 25575, 25574, 25573, 25886, 25885, 26198
8500 *	26197, 26196, 26195, 26194, 26193, 26506, 26505, 26504, 26817
9000*	26816, 27129, 27128, 27127, 27440, 27439, 27752, 27751, 27750
9500*	28063, 28062, 28375, 28688, 28687, 29000, 29313, 29312, 29624
CSJ	50154, 49788, 47597, 47232, 46867, 46502, 41386, 41018, 39538, 39167, 38797, 38425

* = Lateral weir initially tested but not used in the final model (no overtopping flow)

2.3.2.3 STREETS

Field measurement of the major streets in the project area was conducted, providing a catalog of street widths for all the major streets that could potentially act as conveyance for flood flows. Individual streets were broken into multiple segments due to the program's need to route through intersections. Most of the streets used the grid cell elevations interpolated from the terrain for their default elevation values. At two major north-south streets in the model, Ventura Avenue and Olive Street, elevations were entered directly into the street cells.

Due to the relatively small grid cell size of 50-ft and the FLO-2D limitation that a street cannot occupy more than 95% of a cell's area (FLO-2D, 2011), it was necessary to assign a maximum default street width of 33.5 feet (this accounts for streets that pass diagonally through grid cells or that have multiple segments coalescing at an intersection). All the streets in the field survey generally had a curb height of 0.5 feet. To account for streets with a width greater than 33.5 feet, increased curb heights were assigned to the majority of street segments to provide an equivalent flow area with respect to actual street width. Table 5 below lists the streets and their segments with associated widths and the modified curb heights.

Table 5: FLO-2D Streets and Curb Heights

FLO-2D STREETS	Actual Street Width	Approximate Actual Curb Height	Maximum FLO2D Width	Adjusted Curb Height
Barnett Street	40	0.5	33.5	0.60
Barry Drive	30	0.5	33.5	0.45
Bell Way	34	0.5	33.5	0.51
Californian Street 1-2	57	0.5	33.5	0.85
Cameron Street 1-2	40	0.5	33.5	0.60
Cameron Street 3-5	30	0.5	33.5	0.45
Center Street	34	0.5	33.5	0.51
Dubbers Street	32	0.5	33.5	0.48
Figueroa Street 1	44	0.5	33.5	0.66
Figueroa Street 2 (a)	34	0.5	33.5	0.51
Figueroa Street 2 (b)	44	0.5	33.5	0.66
Flint Street	40	0.5	33.5	0.60
Forbes Lane	25	0.5	33.5	0.37
Franklin Lane	25	0.5	33.5	0.37
Garden Street 1	44	0.5	33.5	0.66
Garden Street 2 (a)	64	0.5	33.5	0.96
Garden Street 2 (b)	40	0.5	33.5	0.60
Harrison Avenue	40	0.5	33.5	0.60
Julian Street	51	0.5	33.5	0.76
Junipero Street	44	0.5	33.5	0.66
Kipana Avenue (a)	36	0.5	33.5	0.54
Kipana Avenue (b)	40	0.5	33.5	0.60
Main Street 1 (a)	54	0.5	33.5	0.81
Main Street 1 (b)	52	0.5	33.5	0.78
Main Street 1 (c)	38	0.5	33.5	0.57
Main Street 1 (d)	54	0.5	33.5	0.81
McFarlane Drive	30	0.5	33.5	0.45
Mission Avenue	30	0.5	33.5	0.45
Oak Street 1-2	44	0.5	33.5	0.66
Olive Street 1-2	50	0.5	33.5	0.75
Olive Street 3-5	34	0.5	33.5	0.51
Olive Street 6	42	0.5	33.5	0.63
Olive Street 7-11	34	0.5	33.5	0.51
Olive Street 12-13	37	0.5	33.5	0.55
Olive Street 14	40	0.5	33.5	0.60
Olive Street 15 (a)	54	0.5	33.5	0.81
Olive Street 15 (b)	50	0.5	33.5	0.75
Olive Street 16 (a)	52	0.5	33.5	0.78
Olive Street 16 (b)	42	0.5	33.5	0.63
Palm Street 1-2	44	0.5	33.5	0.66
Park Row	44	0.5	33.5	0.66
Prospect Street	34	0.5	33.5	0.51
Ramona Street	40	0.5	33.5	0.60
Riverside Street	34	0.5	33.5	0.51

FLO-2D STREETS	Actual Street Width	Approximate Actual Curb Height	Maximum FLO2D Width	Adjusted Curb Height
Santa Clara Street 1-3	44	0.5	33.5	0.66
Seneca Street	40	0.5	33.5	0.60
Sheridan Way 1-3	34	0.5	33.5	0.51
Shoshone Street	40	0.5	33.5	0.60
Simpson Street	34	0.5	33.5	0.51
SR33 Onramp	28	0.5	33.5	0.42
Stanley Avenue	64	0.5	33.5	0.96
Thompson Blvd 1-3	56	0.5	33.5	0.84
Ventura Ave 1-19	50	0.5	33.5	0.75
Ventura Ave 20 (a)	54	0.5	33.5	0.81
Ventura Ave 20 (b)	44	0.5	33.5	0.66
Vine Street	40	0.5	33.5	0.60
Vince Street	40	0.5	33.5	0.60
Warner Street	40	0.5	33.5	0.60

2.3.2.4 OBSTRUCTIONS

Several large buildings in the urban floodplain completely block off flood flows, forcing water to circumvent and pond in surrounding areas. This was modeled by setting Area Reduction Factors (ARF) in those areas to 1 (i.e. 100% reduction in floodplain storage). Flow obstructions were also used along the VR-1 levee and on the south side of CSJ to prevent any return flows back into the channel.

2.3.2.5 ROUGHNESS VALUES

Manning's roughness for the FLO-2D grid was set to a global value of 0.10 to represent the urban setting (residential and commercial buildings). For the streets, a global Manning's *n* value of 0.05 was used. These values were determined using guidelines from the FLO-2D Manual (FLO-2D, 2011) and are consistent with the VCWPD Design Manual.

3 ANALYSIS AND RESULTS

3.1 HEC-RAS

The maximum water surface profiles computed by unsteady HEC-RAS for the 100-year and 500-year events are shown in Figure 15 and Figure 16. These figures are also available in electronic format with this submittal. The overtopping (weir) hydrographs for each lateral structure are given in Appendix B.

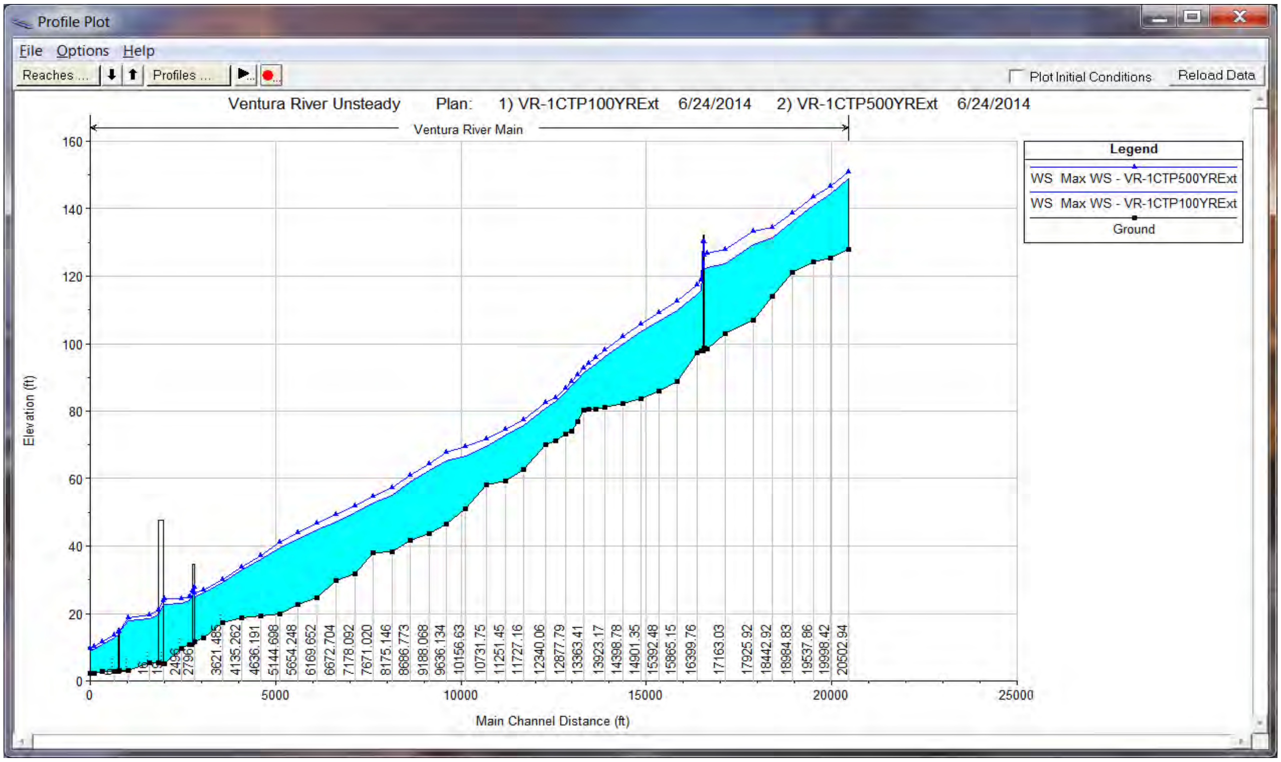

Figure 15: Ventura River Maximum Water Surface Elevations

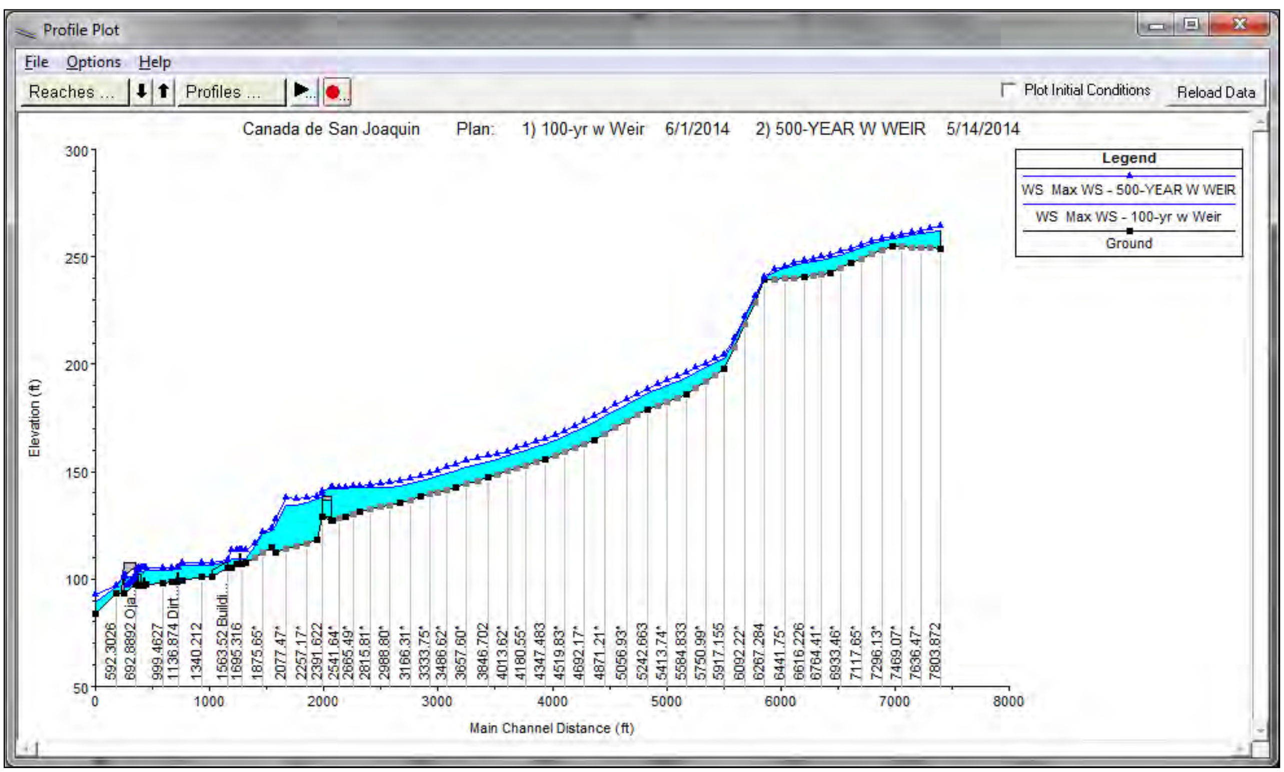

Figure 16: Cañada de San Joaquin Maximum Water Surface Elevations

3.2 Floodway Analysis

The evaluation of the impact of floodplain encroachments on water surface profiles can be of substantial interest to planner, land developers, and engineers. The floodway is defined as the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation by more than a designed height (FEMA, 2002). Normally, the base flood is the one-percent chance event (100-year recurrence interval), and the designated height is one foot.

In this study, the floodway analysis was performed using the base (steady) HEC-RAS model (without VR-1 Levee) for the Ventura River 100-year peak flows listed in Table 1, with a designated height of one foot.

3.2.1 HEC-RAS Model Setup

The 2010 FIS model was used as the basis of the floodway analysis. The model contains the reach from downstream of Matilija Dam to the Pacific Ocean. The reach upstream from VR-1 Levee (above Station 205+02.94) was excluded in this analysis.

3.2.2 Methodology

The floodway is usually determined by an encroachment analysis, using an equal loss of conveyance on opposite sides of the stream when flow is confined within the channel banks. For flow breaks out onto the adjacent floodplain, one-side encroachment is recommended to restrict the flow within the existing channel bed or uninhabitable areas if possible.

Currently, the HEC-RAS steady flow program has 5 methods to conduct floodplain encroachment. These methods are:

Method 1 – User enters right and left encroachment stations
Method 2 – Use enters fixed top width
Method 3 – User specifies the percent reduction in conveyance
Method 4 – User specified a target water surface increase
Method 5 – User specified a target water surface increase and maximum change in energy

Methods 4 and 5 were initially used in this study and the results were reviewed. The best possible right and left encroachment stations for each cross section were selected and coded with Method 1 into HEC-RAS for the final determination of the floodway limits.

3.2.3 Floodway Results

The floodway map is depicted in Figure 17 and the summary results presented in Table 6. In order to not exceed the maximum designated surcharge (one foot) for the entire VR-1 Levee reach, the computed floodway water surface elevations were slightly lower than the base water surface elevations in some cross sections. Those river stations where WSE surcharges were 0.75 ft or more were assigned cross section lettering and shown in the HEC-RAS profiles and floodway table (Appendix B) as well as on the workmaps.

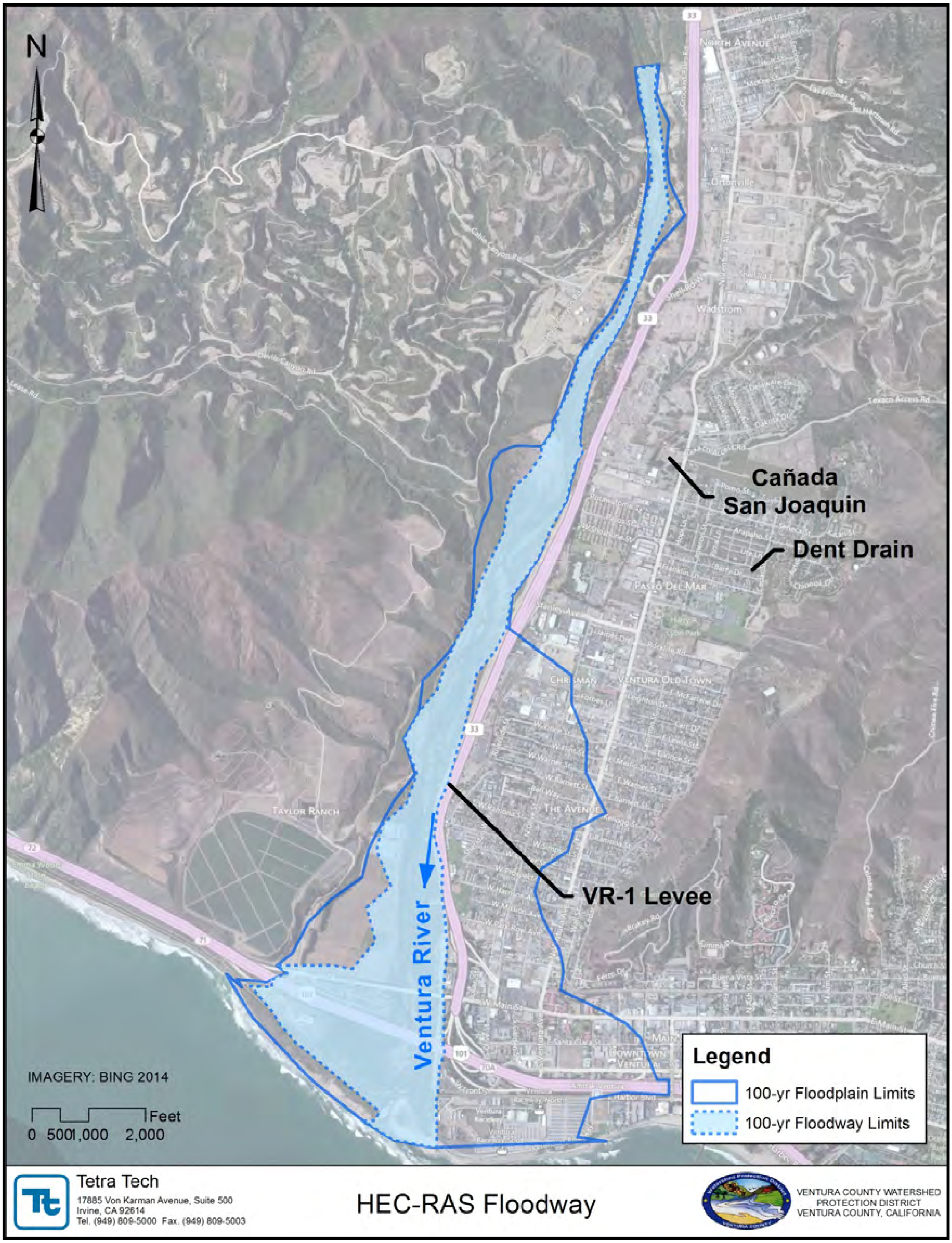

Figure 17: VR-1 Floodway Map for Without-Levee Condition

Table 6: Floodway Data for Without-Levee Condition

River Station	Profile	Width (ft)	Section Area (sq ft)	Mean Velocity (fps)	Water Surface Elevation (ft)	Base Water Surface Elevation (ft)	Profile Delta Water Surface Elevation (ft)
205+02.94	100-yr	429.69	4948.92	15.94	148.77	148.77	
205+02.94	Encroachment	383.76	4983.73	15.83	149.06	148.77	0.29
199+98.42	100-yr	293.35	4094.82	19.27	144.70	144.70	
199+98.42	Encroachment	230.20	3770.62	20.92	144.67	144.70	-0.03
195+37.86	100-yr	314.37	4899.69	16.32	143.95	143.95	
195+37.86	Encroachment	274.12	4917.81	16.04	144.93	143.95	0.98
189+84.83	100-yr	303.87	4179.37	18.88	138.72	138.72	
189+84.83	Encroachment	257.50	3878.83	20.34	139.00	138.72	0.28
184+42.92	100-yr	366.35	5149.88	15.32	133.61	133.61	
184+42.92	Encroachment	306.35	4891.01	16.13	134.31	133.61	0.70
179+25.92	100-yr	451.47	6848.54	12.01	132.52	132.52	
179+25.92	Encroachment	435.35	6817.51	11.57	133.46	132.52	0.94
171+63.03	100-yr	303.23	4465.19	17.67	124.88	124.88	
171+63.03	Encroachment	253.23	4161.68	18.96	125.06	124.88	0.18
166+78.11	100-yr	248.25	4693.60	16.81	123.70	123.70	
166+78.11	Encroachment	218.24	4576.35	17.24	123.74	123.70	0.04
166+13.95	100-yr	240.36	4482.58	17.60	122.31	122.31	
166+13.95	Encroachment	225.36	4606.12	17.13	123.01	122.31	0.70
			Shell Road Bridge				
165+29.73	100-yr	224.36	4234.36	18.63	121.23	121.23	
165+29.73	Encroachment	224.37	4458.85	17.70	122.23	121.23	1.00
163+99.76	100-yr	210.77	3483.80	22.65	117.48	117.48	
163+99.76	Encroachment	185.77	3372.20	23.40	117.40	117.48	-0.08
158+65.15	100-yr	260.65	3853.06	20.55	110.96	110.96	
158+65.15	Encroachment	237.72	3738.07	21.18	110.99	110.96	0.03
153+92.48	100-yr	354.32	4369.99	18.12	107.47	107.47	
153+92.48	Encroachment	334.32	4346.67	18.21	107.55	107.47	0.08
149+01.35	100-yr	340.71	5312.87	14.90	107.11	107.11	
149+01.35	Encroachment	320.71	5164.88	15.33	107.06	107.11	-0.05
143+98.78	100-yr	346.04	4410.11	17.95	101.40	101.40	
143+98.78	Encroachment	326.05	4362.99	18.14	101.43	101.40	0.03
139+23.17	100-yr	464.90	5029.45	15.74	96.88	96.88	
139+23.17	Encroachment	464.90	5054.22	15.66	96.94	96.88	0.06
136+75.08	100-yr	514.66	5420.97	14.60	95.42	95.42	
136+75.08	Encroachment	476.91	5257.68	15.06	95.38	95.42	-0.04
134+89.16	100-yr	555.77	5468.07	14.48	93.43	93.43	
134+89.16	Encroachment	514.32	5287.27	14.97	93.57	93.43	0.14
133+63.41	100-yr	576.11	5410.08	14.63	92.48	92.48	
133+63.41	Encroachment	564.69	5387.03	14.70	92.50	92.48	0.02

River Station	Profile	Width (ft)	Section Area (sq ft)	Mean Velocity (fps)	Water Surface Elevation (ft)	Base Water Surface Elevation (ft)	Profile Delta Water Surface Elevation (ft)
131+91.51	100-yr	698.37	5883.48	14.08	90.16	90.16	
131+91.51	Encroachment	629.79	5708.96	13.87	90.99	90.16	0.83
130+21.47	100-yr	834.06	8794.05	12.81	88.77	88.77	
130+21.47	Encroachment	637.60	5356.60	14.78	89.23	88.77	0.46
128+77.79	100-yr	1030.58	9242.63	11.97	86.07	86.07	
125+97.31	100-yr	1142.67	8828.50	11.45	83.49	83.49	
125+97.31	Encroachment	768.17	5607.88	14.12	84.42	83.49	0.93
123+40.06	100-yr	1391.99	10343.16	7.94	81.39	81.39	
123+40.06	Encroachment	953.12	7523.93	10.52	82.19	81.39	0.80
117+27.16	100-yr	1109.60	7738.08	10.23	76.70	76.70	
117+27.16	Encroachment	818.88	6632.02	11.94	77.37	76.70	0.67
112+51.45	100-yr	1060.96	7170.67	11.04	73.04	73.04	
112+51.45	Encroachment	716.53	5734.40	13.81	73.66	73.04	0.62
107+31.75	100-yr	1057.06	6626.47	11.95	69.72	69.72	
107+31.75	Encroachment	696.31	5467.45	14.48	69.64	69.72	-0.08
101+56.63	100-yr	701.97	6942.68	11.40	68.23	68.23	
101+56.63	Encroachment	603.57	6684.52	11.84	68.23	68.23	0.00
96+36.13	100-yr	651.07	7573.19	10.45	67.40	67.40	
96+36.13	Encroachment	635.21	7448.70	10.63	67.37	67.40	-0.03
91+88.07	100-yr	607.00	5060.01	15.65	62.11	62.11	
91+88.07	Encroachment	635.78	5249.67	15.08	62.42	62.11	0.31
86+86.77	100-yr	704.33	6584.57	12.02	58.88	58.88	
86+86.77	Encroachment	584.12	5761.86	13.74	58.80	58.88	-0.08
81+75.15	100-yr	821.83	7786.31	11.83	55.37	55.37	
81+75.15	Encroachment	717.53	6527.13	12.13	55.33	55.37	-0.04
76+71.02	100-yr	911.96	9988.92	10.21	53.68	53.68	
76+71.02	Encroachment	850.96	7704.52	10.28	53.67	53.68	-0.01
71+78.09	100-yr	995.71	15232.24	8.90	52.60	52.60	
71+78.09	Encroachment	966.71	8745.11	9.05	52.54	52.60	-0.06
66+72.7	100-yr	558.24	10898.92	15.86	47.49	47.49	
66+72.7	Encroachment	551.58	5046.76	15.69	47.59	47.49	0.10
61+69.65	100-yr	752.29	14373.67	11.48	46.32	46.32	
61+69.65	Encroachment	549.25	6710.63	11.80	46.28	46.32	-0.04
56+54.25	100-yr	926.99	15208.79	10.11	44.48	44.48	
56+54.25	Encroachment	905.31	7758.31	10.20	44.41	44.48	-0.07
51+44.7	100-yr	1255.37	14283.64	9.36	42.11	42.11	
51+44.7	Encroachment	1130.17	8338.73	9.49	42.12	42.11	0.01
46+36.19	100-yr	1442.47	13531.55	8.37	38.26	38.26	
46+36.19	Encroachment	910.36	7581.04	10.44	38.27	38.26	0.01
41+35.26	100-yr	2034.12	14660.59	6.99	34.84	34.84	

River Station	Profile	Width (ft)	Section Area (sq ft)	Mean Velocity (fps)	Water Surface Elevation (ft)	Base Water Surface Elevation (ft)	Profile Delta Water Surface Elevation (ft)
41+35.26	Encroachment	1401.10	9376.11	8.44	34.83	34.84	-0.01
36+21.49	100-yr	2507.27	16348.32	6.39	30.99	30.99	
36+21.49	Encroachment	1301.44	8879.83	8.92	31.05	30.99	0.06
31+12.68	100-yr	2723.20	18759.49	5.59	28.00	28.00	
31+12.68	Encroachment	1654.65	9985.55	7.93	28.21	28.00	0.21
28+69.57	100-yr	2639.37	24123.39	4.88	27.70	27.70	
28+69.57	Encroachment	2610.05	20065.57	4.33	28.49	27.70	0.79
			Main Street Bridge				
27+33.19	100-yr	2211.51	25090.78	5.30	26.99	26.99	
27+33.19	Encroachment	1626.76	16964.76	5.72	27.52	26.99	0.53
24+96.2	100-yr	2618.93	41738.71	4.16	26.69	26.69	
24+96.2	Encroachment	2403.84	23039.71	3.94	27.34	26.69	0.65
20+56.05	100-yr	2407.95	60320.59	3.38	26.50	26.50	
20+56.05	Encroachment	2387.12	30325.34	3.16	27.18	26.50	0.68
			Highway 101 Bridge				
16+51.52	100-yr	2312.22	32766.29	4.79	21.74	21.74	
16+51.52	Encroachment	1194.14	11430.51	7.74	21.74	21.74	0.00
10+71.01	100-yr	3977.11	57275.88	2.32	21.66	21.66	
10+71.01	Encroachment	3563.12	34580.05	2.29	22.08	21.66	0.42
			UPRR Bridge				
6+94.09	100-yr	3507.93	20652.52	5.49	13.96	13.96	
6+94.09	Encroachment	3167.97	16438.55	4.82	14.75	13.96	0.79
3+56.51	100-yr	1630.00	11722.48	10.12	11.28	11.28	
3+56.51	Encroachment	1038.83	6732.63	11.76	11.70	11.28	0.42
1+62.99	100-yr	1870.20	10864.19	9.49	9.99	9.99	
1+62.99	Encroachment	1107.58	7046.39	11.23	10.47	9.99	0.48
0+43.85	100-yr	2757.66	16442.12	6.54	9.43	9.43	
0+43.85	Encroachment	1513.68	9631.66	8.22	9.97	9.43	0.54

Cross Section A @ 0+43.85; Cross Section B @ 6+94.09; Cross Section C @ 28+69.57; Cross Section D @ 123+40.06; Cross Section E @ 125+97.31; Cross Section F @ 128+77.79; Cross Section G @ 131+91.51; Cross Section H @ 165+29.73; Cross Section I @ 179+25.92; Cross Section J @ 195+37.86

3.3 FLO-2D

The following is a discussion of the general flow patterns as predicted by FLO-2D velocity and depth results.

3.3.1 Flow Paths

CSJ's upstream breakout flows create shallow sheet flows across the industrial park south of the VR-1 levee, moving west to State Route 33 (SR-33) where it eventually backwaters. From here south, the flows work their way along the landside of SR-33, paralleling the Ventura River. At Stanley Avenue, some of this flow breaks out as shallow flooding, crossing over to Olive Street and flowing south as well. There is more flow moving east again at Sunnyway Drive. Shallow flow covers the entire reach from Sunnyway Drive south to

Bell Way and Oakwood Street, before diverging again to two paths along SR-33 and Olive Street. One branch continues down Olive Street, flooding adjacent residences. This branch becomes shallow flow once more at West Prospect Street before merging with the second branch at Mission Avenue. The second branch continues its way along SR-33, flooding neighborhoods particularly along Sheridan Way. Additional flows overtop the levee from the Ventura River in this location at the HEC-RAS lateral weir 6500, increasing flooding further at Sheridan Elementary School and Westpark Recreation Area. As the two branches merge at Mission Avenue, they spread east toward Ventura Avenue. Flow paths generally follow the north-south streets until reaching US Highway 101 (US-101), including Olive Street, Garden Street, and Ventura Avenue, eventually spreading east to Junipero Street, Figueroa Street, with flooding reaching as far as South Palm Street. This entire area of the City is inundated. Flooding is restricted to passing south under the overpasses of US-101 at Olive and Garden Streets, and at Figueroa Street. Once through these constrictions, the flooding spreads from the levee to the west, just east of Figueroa Street. Flows drop down to the ocean after exiting this area.

3.3.2 Flood Depths

At the upstream end of the study area, on the landside of SR-33 near CSJ, ponding creates depths over 3 ft along the highway. At West Lewis Street, the merging shallow flows flood an industrial area (up to 3 ft). The branch of flooding down Olive Street reaches 3 ft in some locations along the street and adjacent residences. The branch that continues flooding along SR-33 has flood depths at Sheridan Elementary School and the Westpark Recreation Area reaching 3 to 6 ft. South of Main Street, flood depths quickly grow as the water ponds behind US-101, reaching 6-10 feet. Depths are greatest in the area south of US-101, from the Youth Expo to the levee, exceeding 6 ft over the entire area. Depths to the east of the Youth Expo range from 1-5 feet.

3.3.3 Velocities

Velocities in the flooded areas are greatest at constrictions and at inflow locations (see Figure 18 and Figure 19). In general, velocities are generally low, with the vast majority of the flooded areas experiencing velocities less than 1 foot per second (fps). A few places exhibit higher velocities, from 2-6 fps. Some of these areas include locations where CSJ breaks out of its channel as it turns from south to west towards the Ventura River (where it enters a culvert under the industrial open space), as well as all along SR-33 (particularly Sheridan Elementary School and the Westpark Recreation Area), then continuing all the way down through the Olive Street underpass of US-101, particularly between Olive Street and SR-33. The highest velocities are found adjacent to the SR-33 onramp at Olive Street and at the downstream end under the Olive Street underpass of US-101.

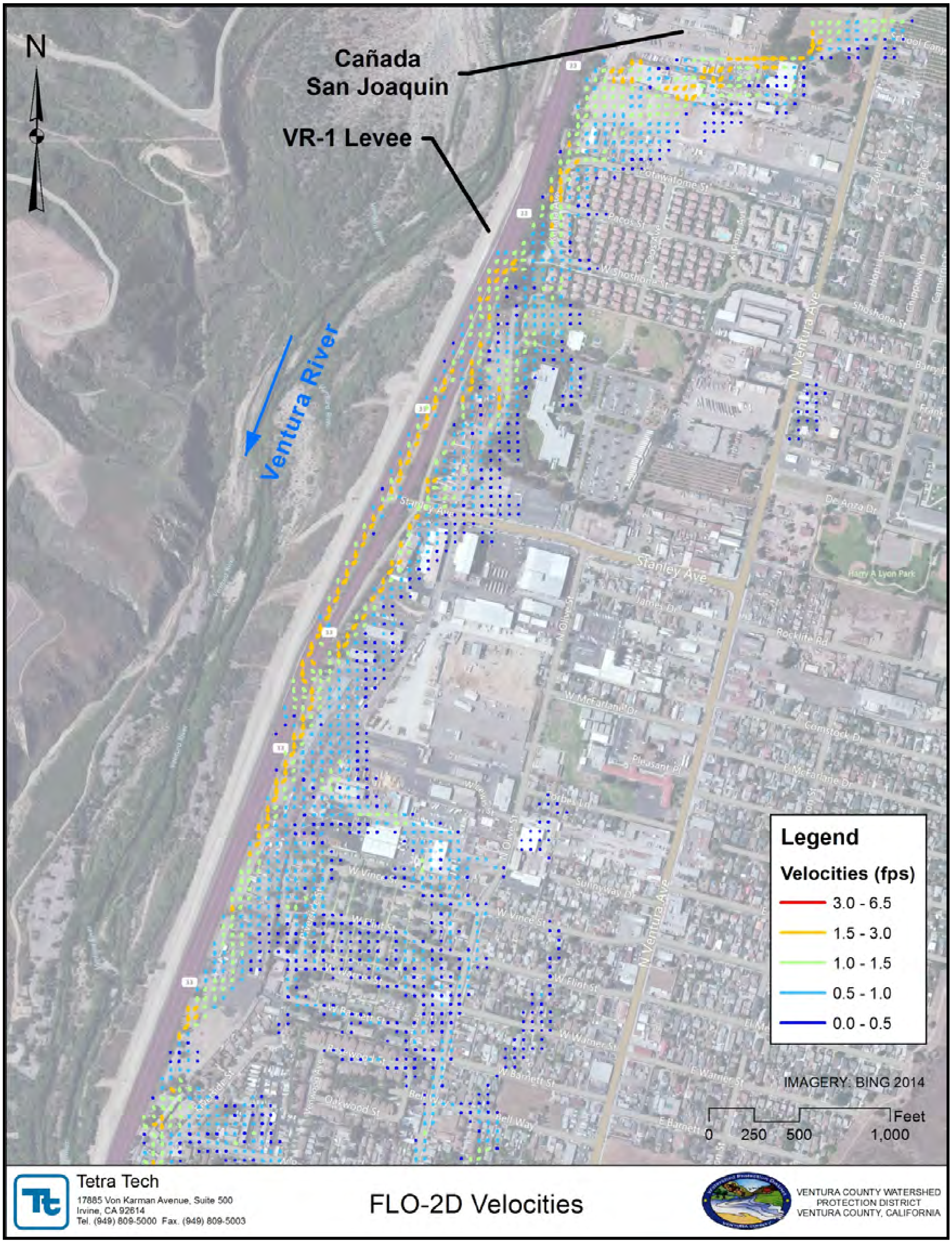

Figure 18: Cañada de San Joaquin Overbank Velocities

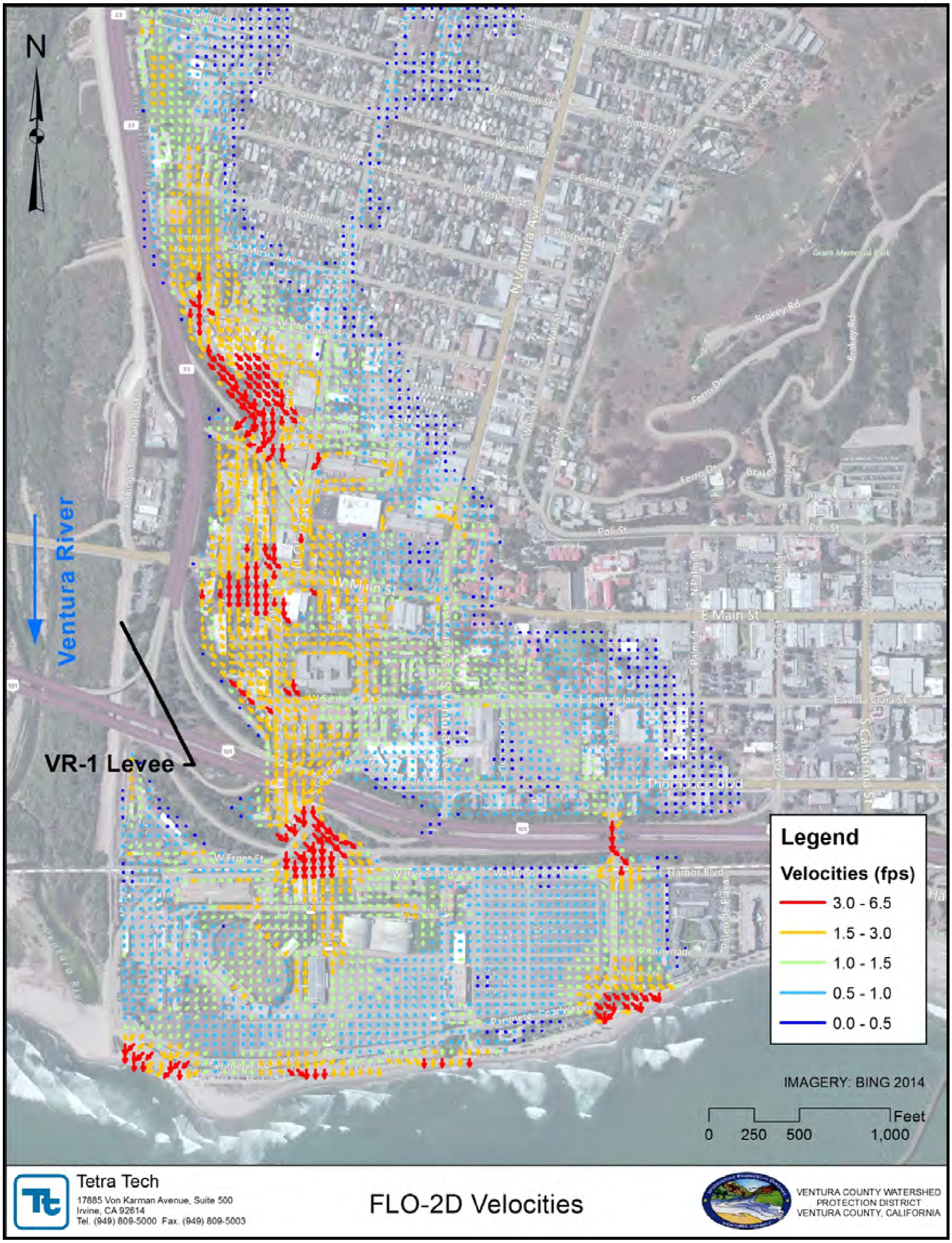

Figure 19: Ventura River Overbank Velocities

3.4 FLO-2D Pro Version Verification

The latest FLO-2D Pro Version (FLO-2D, 2011) was used in this study and verified against the results obtained with FLO-2D 2009 Version. The same geometry (grid, roughness, streets) was used in both versions of the software, utilizing the same inflow hydrographs. Results from the two versions were compared cell by cell, including maximum WSEs and velocities. The differences can be found in Table 7 below.

Table 7: FLO-2D Pro and 2009 Versions Comparison

Results Difference (FLO-2D Pro Minus FLO-2D 2009)		
	WSE (ft)	**Velocity (fps)**
Minimum	-0.381	-0.607
Maximum	0.290	1.606
Mean	-0.043	0.007
Median	-0.001	0.000

The statistical results in Table 7 highlight a lack of significant differences in maximum water surface elevations and velocities. The spatial distribution of these differences can be found in Appendix B.

3.5 HEC-RAS/FLO-2D Integration

In order to map conservative but realistic flood extents, the exchange of flows between the HEC-RAS and FLO-2D models was optimized through a series of iterations to get the WSEs of both models to reasonably match at the interface. The HEC-RAS weir coefficient controls the rate of flow over the lateral structures. In general, lateral structure weir coefficients should be lower than typical values used for inline weirs. Additionally, when a lateral structure (i.e. weir equation) is being used to transfer flow from the river (1-D region) to the floodplain (2-D flow area), the weir coefficients that are used need to be very low, or too much flow will be transferred. Therefore, the weir coefficients were varied between 0.1 and 0.5 (HEC, 2013) to determine inflow hydrographs to the FLO-2D model.

Initial weir coefficients for the Ventura River were set to 0.5. This initial run produced FLO-2D WSEs that consistently exceeded the HEC-RAS WSEs by several feet in most locations along the interface. The second run used a weir coefficient of 0.1. This resulted in HEC-RAS WSEs that were consistently higher (about 2 feet) along the length of the weirs except around the SR-33 onramp where the FLO-2D results peaked 2-ft higher than HEC-RAS (due to ponding and topographic constriction), and at the exit to the ocean.

A third run used a weir coefficient of 0.3. In this case, the HEC-RAS WSEs begin approximately 2-ft higher than the FLO-2D WSEs, but then alternate from a couple feet lower (SR-33 onramp), then approximately equal from Main Street to the railroad bridge, then lower near the ocean. Figure 20, Figure 21, Figure 22, and Figure 23 highlight the differences in floodplain extents and base flood elevations (BFE) between the weir coefficients of 0.1, 0.3, and 0.5. Based on the sensitivity analysis, the weir coefficient of 0.3 was selected to produce the most reasonable energy head between the river and the overbank, and was used for floodplain mapping upstream of weir 1500. For weirs 1500, 500, 300, and 100 (south of US-101) no lateral overtopping from the Ventura River was allowed (weir coefficient = 0) since the FLO-2D WSEs south of US-101 were consistently higher (2-4 feet) than the HEC-RAS WSEs (flow concentration landward of the levee in this area would create an adverse hydraulic gradient that would effectively prevent lateral overtopping from the Ventura River).

For overbank flooding of CSJ, a more conservative weir coefficient of 0.5 was used to introduce flows to the floodplain (CSJ is a complex hydraulic system with more uncertainty in determination of laterally overtopping flows). The CSJ overbank flooding is the only source of inflow to the most upstream reach until the Ventura River lateral weirs contribute flows starting around Ramona Street (HEC-RAS weir 6500).

3.6 Floodplain Mapping

This section details the floodplain mapping delineation process for determining FEMA flood zones and BFEs. The FEMA workmaps are provided in Appendix B along with the HEC-RAS and FLO-2D results. Two workmaps were created: 1) Workmap_Exhibit 1 with effective FEMA discharges based on the FIS study (HDR, 2010); and 2) Workmap_Exhibit 2 with revised CSJ discharges as explained in Section 2.3.1.1 of this report.

3.6.1 Floodzone Mapping

For floodplain mapping on the landward side of the VR-1 Levee, FLO-2D output shapefiles based on flow depth at cell were output from FLO-2D Mapper (tool for exporting the model results to spatial data formats). Zone AE was designated as any cell with a depth of 0.5 feet or greater. These cells were dissolved together, then the edges smoothed with a smooth polygon tool in ET Geowizards, a GIS tool. The smooth method utilized was a B-Spline curve using the maximum smoothness value of 20, and maximum freedom of 10. The resulting floodplain polygon was included in the FEMA Digital Flood Insurance Rate Map (DFIRM) layer database. Where the overbank floodplain was separated from the Ventura River floodplain by structures that were assumed to have failed in the Natural Valley scenario (such as the VR-1 Levee and elevated SR-33 highway and ramps), the zone was extended to the Ventura River.

For the Ventura River floodplain mapping, the results of the unsteady HEC-RAS (MAX WS profile) were output through HEC-GeoRAS. The polygon output for the 100-yr floodplain was used to amend the existing southern edge of Zone AE, as well as to tie into the existing DFIRM upstream of Shell Road. The unsteady model floodplain was tied into the FIS (HDR, 2010) study results at RS 19998.42 within 0.2-ft of the water surface difference.

For inundation around CSJ, the results of the unsteady HEC-RAS (MAX WS profile) for that tributary were output through HEC-GeoRAS. The polygon output for the 100-yr floodplain was tied into the upstream end of the FLO-2D model at the closure structure (at the downstream end of CSJ near SR-33) and along the CSJ break out at Ventura Avenue across the field to the west where CSJ transitions into an underground culvert.

The floodway results from section 3.2.3 were also included in the floodzone mapping with some adjustments to account for different mapping and modeling techniques. As the floodway analysis was conducted with a steady-state model, WSEs were generally higher than unsteady ones, resulting in the floodway encroaching on small areas already mapped as 500-yr inundation zone. These areas were excluded from the floodway. The floodway was generally shaped to follow the 100-yr inundation mapping and was smoothed as needed. This can be seen in the workmap exhibit in Appendix B.

Figure 20: Floodplain Zone AE Comparison for Different Weir Coefficients

Figure 21: BFE Comparison for Weir Coefficient 0.3

Figure 22: BFE Comparison for Weir Coefficient 0.1

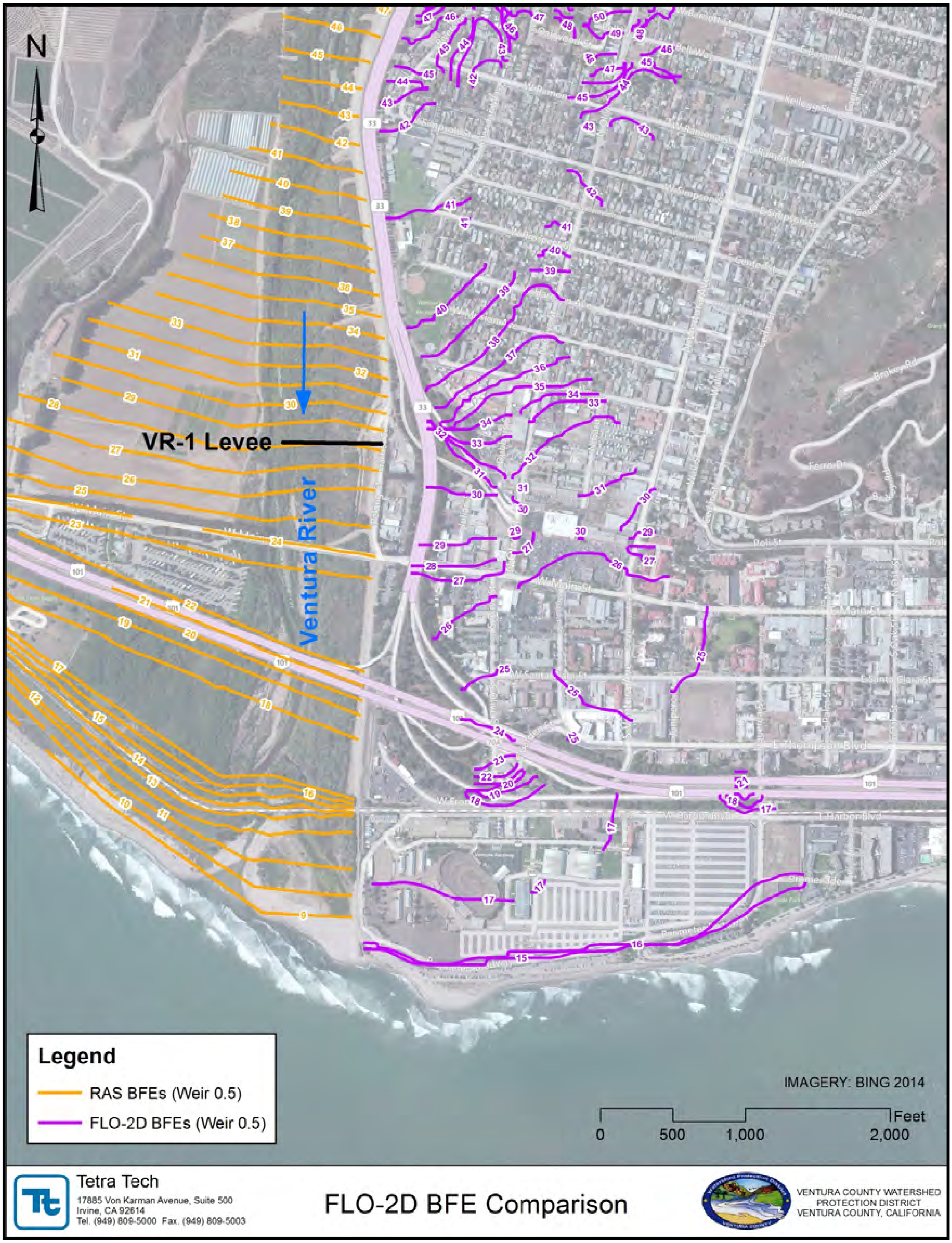

Figure 23: BFE Comparison for Weir Coefficient 0.5

3.6.2 Base Flood Elevation Mapping

For BFE mapping on the landward side of the VR-1 Levee, FLO-2D output shapefiles based on the maximum WSE at cell were output from FLO-2D Mapper. The grid was converted to a raster surface in ArcGIS, followed by a contour tool to generate one foot contours across the surface. Those contours were smoothed with a smooth polylines tool in ET Geowizards. The smooth method utilized was a Bezier curve using the maximum smoothness value of 2. This allowed the greatest freedom to remove the zig-zag nature of the grid lines from the output and create more gentle curves. Because the flood zone was expanded to cover areas where obstacles were present in the model (such as buildings), as well as where certain elevated structures were assumed to have failed (VR-1 Levee and SR-33 roadway), BFEs were extended across these areas.

For the Ventura River BFE mapping, the results of the unsteady HEC-RAS modeling were output through HEC-GeoRAS. The water surface grid created by the output had contours interpolated from it and these contours were trimmed to match the floodplain extent of the river. The BFE lines were trimmed and extended where needed to cover the flood zone. Due to the large number of BFEs (with one foot rise), some had to be removed based on the number of BFEs per inch of map space. The following criteria were used (per FEMA guidance):

- Gentle Gradient – If BFEs rise less than 1 foot per 1 inch of map distance, the BFEs shall be plotted at every whole foot of elevation rise.
- Moderate Gradient – If BFEs rise more than 1 foot, but less than 5 feet per 1 inch of map distance, the BFEs shall be plotted at approximately 1-inch intervals.
- Steep Gradient – If BFEs rise 5 feet or more per 1 inch of map distance, the BFEs shall be plotted at 0.5-inch intervals of map distance or at 5-foot intervals, whichever is greater (i.e., whichever results in a wider BFE spacing).

Gradients for this system's BFEs were moderate to steep, resulting in three out of four, or four out of five, BFE contours being removed from the map.

3.6.3 Ventura River Profiles

The maximum water surface profiles for the 100-yr and 500-yr flood events were prepared in accordance with FEMA guidelines and included in Appendix B. The profiles include lettered cross section identifiers from Table 6. Note that the WSEs plotted were the higher of the maximum WSE (from unsteady HEC-RAS model) or the critical depth, in order to eliminate supercritical regime depths (that are lower than critical depth) at some locations during unsteady flood routing.

4 REFERENCES

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APPENDIX A

TSDN Inventory Form and General Documentation

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Appendix A: TSDN Inventory Form

TSDN CATEGORY	DATA TYPE	DATA SUBMITTED
General Documentation	Special Problem Reports Index	n/a
	Special Problem Reports	n/a
	Contact Reports Index	n/a
	Contact Reports	n/a
	Meeting Minutes/Reports Index	n/a
	Meeting Minutes/Reports	n/a
	Correspondence with/from FEMA	n/a
	Correspondence with/from Contractor	n/a
	Other General Correspondence	n/a
Engineering Analyses	Hydrologic Analyses Index	n/a
	Summary Report of Hydrologic Analyses	n/a
	Computer Models, Calculations, and Execution	n/a
	Summary Report for Independent QA/QC	n/a
	Hydraulic Analyses Index	✓
	Cross Section Information	✓
	Floodway Analyses	✓
	Key To Cross-Section Labeling	✓
	Cross-Section Plots	✓
	Computer Models, Calculations, and Execution	✓
	Summary Report for Independent QA/QC	✓
	Key To Transect Labeling	n/a
	Transect and Surge Data	n/a
	Wave Height Information	n/a

TSDN CATEGORY	DATA TYPE	DATA SUBMITTED
Engineering Analyses (Cont'd)	Computer Models, Calculations, and Execution	n/a
	Summary Report for Independent QA/QC	n/a
	Shallow Flooding Models, Calculations, and	n/a
	Summary Report for Independent QA/QC	n/a
	Ice-Jam Flooding Models, Calculations, and	n/a
	Summary Report for Independent QA/QC	n/a
	Alluvial Fan Flooding Models, Calculations,	n/a
	Summary Report for Independent QA/QC	n/a
Draft FIS Report	FIS Report Narrative (Complete)	✓
	FIS Report Narrative (Revisions Summary)	n/a
	Summary of Discharges Table	✓
	Floodway Data Table	✓
	Summary of Elevations Table	n/a
	Transect Locations Table	n/a
	Surge Elevations Table	n/a
	Flood Profiles	✓
	Certification of Compliance for Work	✓
	Other Relevant Data	n/a
Mapping Information	Mapping Information Index	✓
	Topographic Mapping (Hardcopy Version)	n/a
	Topographic Mapping (Digital Version)	n/a
	Summary Report for Independent QA/QC	n/a
	Work Maps (Hardcopy Version)	✓
	Work Maps (Digital Version)	✓

TSDN CATEGORY	DATA TYPE	DATA SUBMITTED
Mapping Information (Cont'd)	Work Map Delineation Summary	✓
	Preliminary DFIRM (Hardcopy Version)	n/a
	CD-ROM with DFIRM Data	✓
	USGS Digital Orthophoto Quadrangle(s)	n/a
	Soil and Vegetation Maps	n/a
	USGS Topographic Quadrangle Maps	n/a
	Flood Hazard Boundary Map	n/a
	Community Maps	n/a
	All Other Maps	n/a
	DFIRM Database Data (Basic)	✓
	DFIRM Database Data (Enhanced)	n/a
	Digital Data Submission Checklist	n/a
	Narrative	n/a
	Photogrammetric Survey Documentation	n/a
	GPS Survey Documentation	n/a
Miscellaneous Reference Materials	Field Survey Notes/Notebook	✓
	SCS/NRCS Flood Hazard Analyses Report(s)	n/a
	USGS Floodplain Information Report(s)	n/a
	USACE Feasibility Study Reports	n/a
	Watershed Studies	n/a
	Site Visit Photographs	✓
	Community Population and Demographic	n/a
	Tax Base Reports	n/a
	Legal References	n/a
	(Other Relevant Materials)	n/a

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APPENDIX B

Engineering Analysis Supporting Data

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HYDRAULIC ANALYSES INDEX

Community Name:	City of Ventura		**State:** California	
Community ID No.	060419			
Compiled By:	Tetra Tech			
Date TSDN Submitted:	September 25, 2014			
Flooding Source/ Stream Name	**Hydraulic Method/Model Used**	**Method/ Model Analysis Date**	**Exhibit No.**	
			Paper Copy	**Electronic Media**
Ventura River	HEC-RAS 4.1	9/25/2014	Appendix B	Appendix D-Digital
Ventura River	FLO-2D PRO	9/25/2014	Appendix B	Appendix D-Digital
Cañada de San Joaquin	HEC-RAS 4.1	9/25/2014	Appendix B	Appendix D-Digital

KEY TO CROSS-SECTION LABELING		
Community Name:	City of Ventura	State: California
Community ID No.	60419	
Compiled By:	Tetra Tech	
Date TSDN Submitted:	September 25, 2014	
Prepared By:	Tetra Tech	
Flooding Source:	Ventura River	
Run Date:	8/29/2014	
Field Survey Section No.	**Cross-Section Letter in FIS Report**	**Computer Stationing**
		20502.94
		19998.42
	J	19537.86
		18984.83
		18442.92
	I	17925.92
		17163.03
		16678.11
		16613.95
	H	16529.73
		16399.76
		15865.15
		15392.48
		14901.35
		14398.78
		13923.17
		13675.08
		13489.16
		13363.41
	G	13191.51
		13021.47
	F	12877.79
	E	12597.31
	D	12340.06
		11727.16
		11251.45
		10731.75
		10156.63
		9636.13
		9188.07
		8686.77

Field Survey Section No.		Computer Stationing
		8175.15
		7671.02
		7178.09
		6672.70
		6169.65
		5654.25
		5144.70
		4636.19
		4135.26
		3621.49
		3112.68
	C	2869.57
		2796.00
		2733.19
		2496.20
		2056.05
		1975.00
		1651.52
		1071.01
		800.00
	B	694.09
		356.51
		162.99
	A	43.85
		43.00

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RIVERINE HYDRAULIC ANALYSIS
COMPUTER MODELS, CALCULATIONS, EXECUTION

(See Appendix D: Digital Data CD)

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HEC-RAS MODEL RESULTS

(Also see Appendix D: Digital Data CD)

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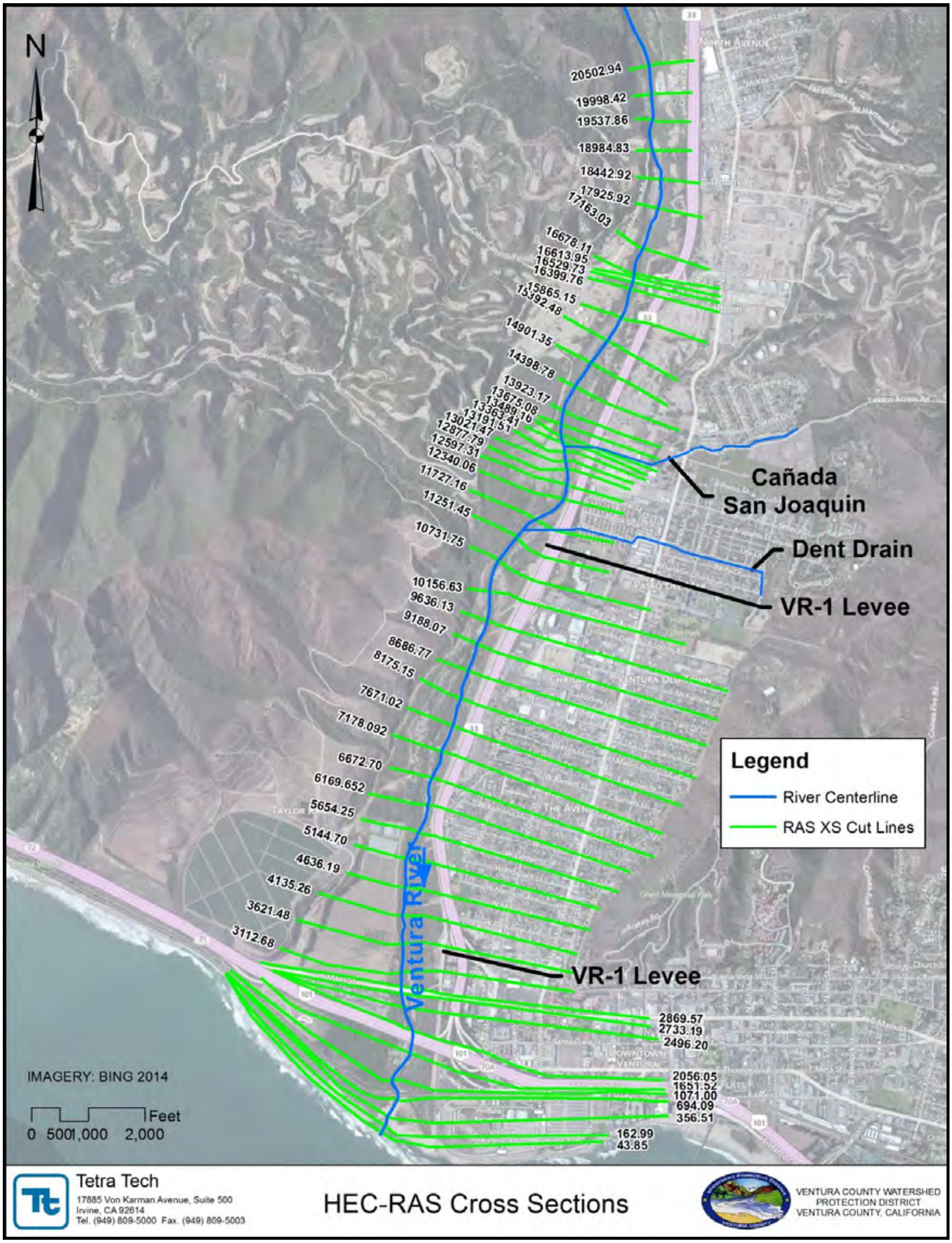


Figure B1: Ventura River HEC-RAS Model Cross Sections

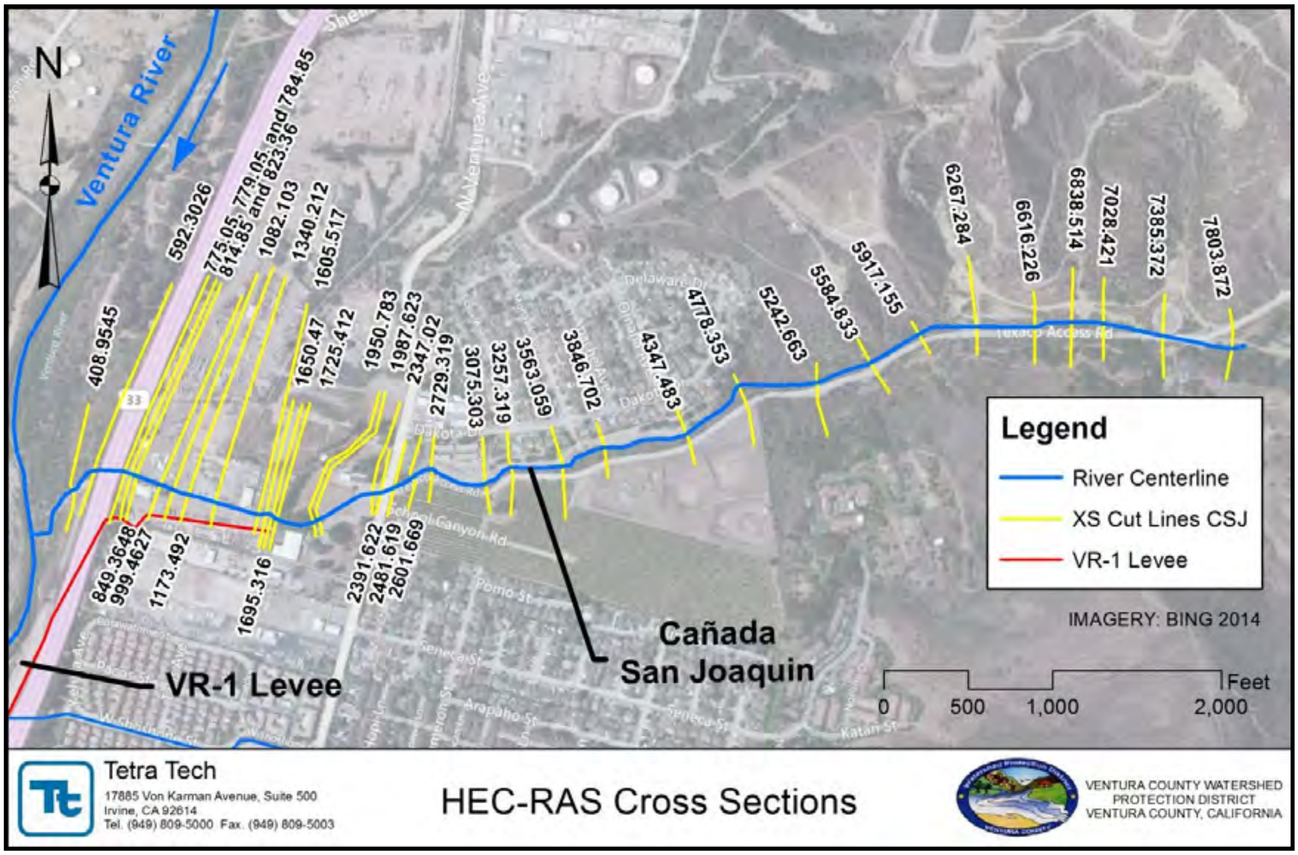
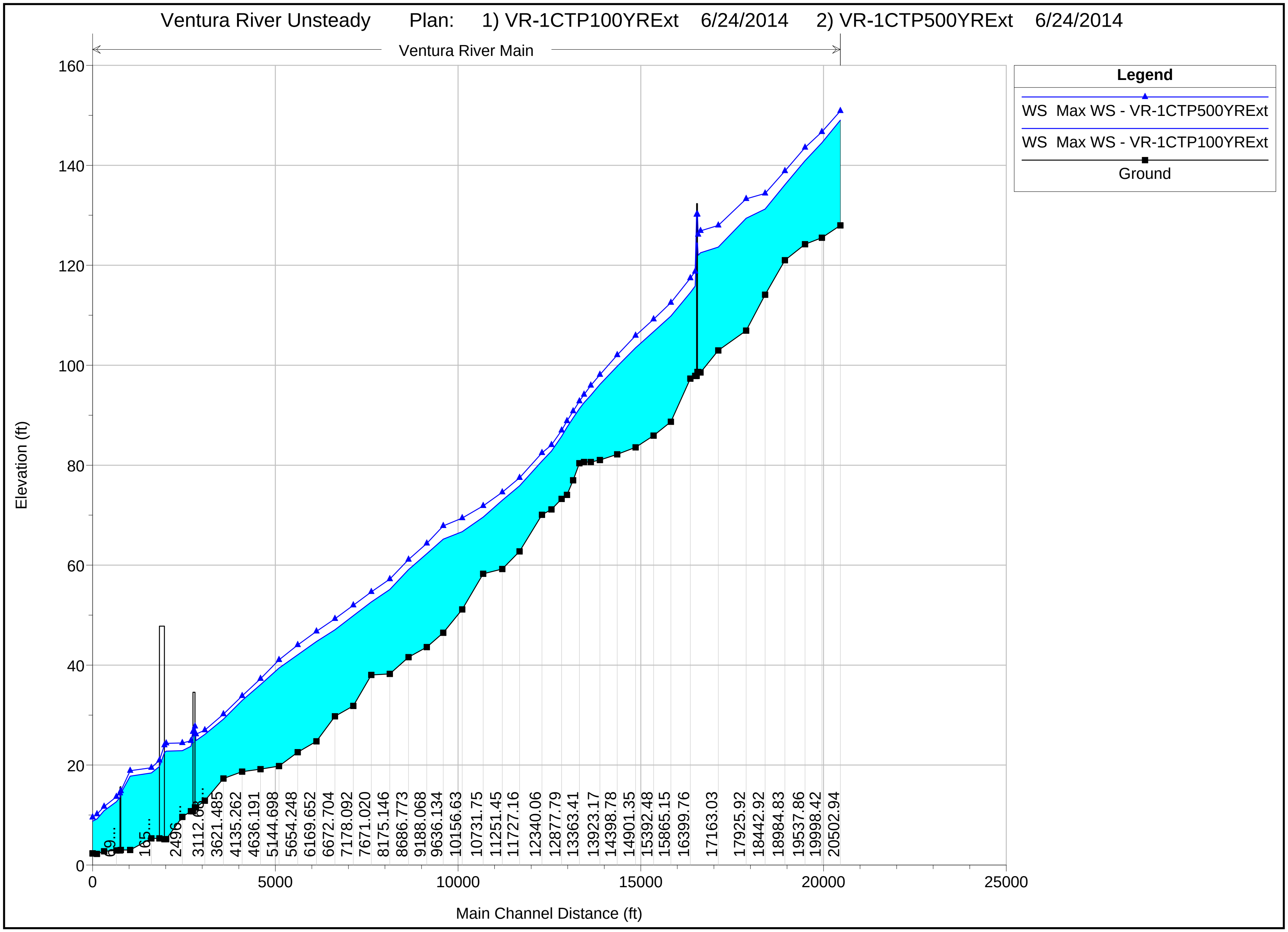


Figure B2: CSJ HEC-RAS Model Cross Sections

Ventura River MAX Water Surface Profile



Ventura River Hydraulics Table

HEC-RAS River: Ventura River Reach: Main Profile: Max WS

Reach	River Sta	Profile	Plan	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)	
Main	20502.94	Max WS	VR-1CTP100YRExt	78900.00	127.96	149.02	148.77	156.80	0.007331	27.09	5058.31	439.76	1.10
Main	20502.94	Max WS	VR-1CTP500YRExt	105500.00	127.96	150.88	154.00	161.82	0.009283	32.44	5911.46	470.09	1.25
Main	19998.42	Max WS	VR-1CTP100YRExt	78898.84	125.51	144.49	144.51	152.12	0.009533	23.39	4031.57	291.55	0.97
Main	19998.42	Max WS	VR-1CTP500YRExt	105499.40	125.51	146.68	147.91	157.87	0.007367	28.26	4691.91	311.24	1.11
Main	19537.86	Max WS	VR-1CTP100YRExt	78897.83	124.21	140.92	140.85	147.98	0.005988	21.47	3896.97	304.15	0.96
Main	19537.86	Max WS	VR-1CTP500YRExt	105498.40	124.21	143.55	144.05	152.52	0.006246	24.31	4709.19	380.39	1.00
Main	18984.83	Max WS	VR-1CTP100YRExt	78895.16	121.00	136.11	138.72	146.96	0.011499	27.45	3395.83	295.40	1.31
Main	18984.83	Max WS	VR-1CTP500YRExt	105495.60	121.00	138.85	141.93	151.75	0.010837	30.12	4217.04	304.27	1.31
Main	18442.92	Max WS	VR-1CTP100YRExt	78888.03	114.10	131.23	130.96	137.43	0.006767	20.68	4299.59	350.75	1.00
Main	18442.92	Max WS	VR-1CTP500YRExt	105471.20	114.10	134.37	133.82	141.54	0.005929	22.29	5433.34	371.41	0.97
Main	17925.92	Max WS	VR-1CTP100YRExt	78868.19	106.92	129.40		133.88	0.003470	17.35	5183.16	458.53	0.74
Main	17925.92	Max WS	VR-1CTP500YRExt	105457.80	106.92	133.28	128.71	138.32	0.003020	18.57	7402.10	745.79	0.72
Main	17163.03	Max WS	VR-1CTP100YRExt	78836.70	102.97	123.62	124.87	132.94	0.006502	26.28	4089.22	297.55	1.05
Main	17163.03	Max WS	VR-1CTP500YRExt	105436.50	102.97	127.96	130.30	137.88	0.005501	27.62	5501.32	635.48	0.99
Main	16678.11	Max WS	VR-1CTP100YRExt	78822.91	98.54	122.50		128.63	0.003420	20.33	4399.62	242.40	0.77
Main	16678.11	Max WS	VR-1CTP500YRExt	105416.70	98.54	126.88		134.21	0.003240	22.36	5509.16	274.08	0.77
Main	16613.95	Max WS	VR-1CTP100YRExt	78822.87	98.64	122.00	119.26	128.56	0.003753	21.43	4407.24	238.78	0.81
Main	16613.95	Max WS	VR-1CTP500YRExt	105437.60	98.64	126.14	123.01	134.25	0.003702	23.91	5451.21	266.29	0.83
Main	16563			Bridge									
Main	16529.73	Max WS	VR-1CTP100YRExt	78822.87	97.87	115.83	118.23	127.78	0.009406	28.30	3074.28	205.24	1.22
Main	16529.73	Max WS	VR-1CTP500YRExt	105437.40	97.87	118.74	122.16	134.00	0.009730	32.05	3686.83	215.57	1.28
Main	16399.76	Max WS	VR-1CTP100YRExt	78822.39	97.32	114.53	117.47	127.38	0.010550	29.04	2881.98	199.46	1.28
Main	16399.76	Max WS	VR-1CTP500YRExt	105437.20	97.32	117.41	121.60	133.70	0.010750	32.76	3469.39	210.41	1.33
Main	15865.15	Max WS	VR-1CTP100YRExt	78818.97	88.69	109.84	110.90	119.14	0.007016	24.97	3564.75	256.60	1.06
Main	15865.15	Max WS	VR-1CTP500YRExt	105435.70	88.69	112.52	114.57	124.52	0.007567	28.54	4264.64	266.71	1.13
Main	15392.48	Max WS	VR-1CTP100YRExt	78813.45	85.92	106.69	106.80	113.33	0.006332	20.90	4096.05	351.71	0.96
Main	15392.48	Max WS	VR-1CTP500YRExt	105433.40	85.92	109.20	109.74	117.51	0.006509	23.54	4986.84	362.73	1.00
Main	14901.35	Max WS	VR-1CTP100YRExt	78805.17	83.57	103.48	103.30	109.59	0.006848	19.99	4086.75	330.11	0.98
Main	14901.35	Max WS	VR-1CTP500YRExt	105430.10	83.57	105.92	106.04	113.61	0.006832	22.43	4909.11	339.16	1.01
Main	14398.78	Max WS	VR-1CTP100YRExt	78787.34	82.18	99.78	101.37	108.75	0.007855	24.90	3855.39	339.31	1.10
Main	14398.78	Max WS	VR-1CTP500YRExt	105426.20	82.18	102.05	104.95	113.55	0.008611	28.49	4633.35	350.15	1.18
Main	13923.17	Max WS	VR-1CTP100YRExt	78785.64	81.02	96.15	96.85	102.50	0.007454	21.46	4689.25	462.33	1.04
Main	13923.17	Max WS	VR-1CTP500YRExt	105425.30	81.02	98.10	99.51	106.14	0.008026	24.40	5603.78	499.09	1.10
Main	13675.08	Max WS	VR-1CTP100YRExt	78783.98	80.64	93.97	95.38	101.01	0.009332	23.41	4695.56	495.42	1.16
Main	13675.08	Max WS	VR-1CTP500YRExt	105424.60	80.64	95.94	97.80	104.57	0.009664	26.24	5689.19	520.52	1.21
Main	13489.16	Max WS	VR-1CTP100YRExt	78782.41	80.63	92.52	93.38	98.49	0.009395	21.58	4960.75	552.60	1.14
Main	13489.16	Max WS	VR-1CTP500YRExt	105424.00	80.63	94.12	95.48	101.82	0.010276	24.69	5850.35	566.18	1.22
Main	13363.41	Max WS	VR-1CTP100YRExt	79026.98	80.39	91.29	92.48	97.47	0.010935	21.52	4724.29	571.71	1.21
Main	13363.41	Max WS	VR-1CTP500YRExt	105886.90	80.39	92.78	94.68	100.75	0.011829	24.59	5582.59	578.49	1.29
Main	13191.51	Max WS	VR-1CTP100YRExt	79024.63	76.98	89.44	90.16	94.33	0.010263	18.71	5121.80	749.64	1.12
Main	13191.51	Max WS	VR-1CTP500YRExt	105886.00	76.98	90.79	91.95	97.07	0.011001	21.34	6064.42	765.58	1.19
Main	13021.47	Max WS	VR-1CTP100YRExt	79021.18	74.05	87.58	88.75	92.79	0.012647	19.64	5186.69	1169.64	1.24
Main	13021.47	Max WS	VR-1CTP500YRExt	105883.80	74.05	88.83	90.37	95.31	0.013127	22.11	6232.16	1177.89	1.30
Main	12877.79	Max WS	VR-1CTP100YRExt	79015.62	73.25	85.78	86.06	89.28	0.010070	16.51	6315.28	1371.05	1.08
Main	12877.79	Max WS	VR-1CTP500YRExt	105877.40	73.25	86.95	87.46	91.37	0.010567	18.69	7521.32	1392.76	1.14
Main	12597.31	Max WS	VR-1CTP100YRExt	78946.63	71.15	82.81	83.48	86.57	0.012600	17.05	6140.25	1405.89	1.18
Main	12597.31	Max WS	VR-1CTP500YRExt	105828.70	71.15	84.04	84.76	88.47	0.012012	18.69	7545.50	1409.96	1.19
Main	12340.06	Max WS	VR-1CTP100YRExt	79002.89	70.09	80.83		82.59	0.005046	12.23	9188.23	1456.28	0.78
Main	12340.06	Max WS	VR-1CTP500YRExt	105984.80	70.09	82.46		84.47	0.004523	13.16	11462.93	1471.12	0.76
Main	11727.16	Max WS	VR-1CTP100YRExt	78957.16	62.75	75.86	76.69	80.28	0.007643	19.21	6815.02	1091.06	1.03
Main	11727.16	Max WS	VR-1CTP500YRExt	105911.40	62.75	77.48	78.17	82.47	0.007568	20.98	8626.07	1176.74	1.05
Main	11251.45	Max WS	VR-1CTP100YRExt	79010.36	59.23	72.97	73.04	76.51	0.006500	17.10	7093.96	1058.20	0.94
Main	11251.45	Max WS	VR-1CTP500YRExt	105968.40	59.23	74.58	74.67	78.71	0.006493	18.84	8852.16	1107.54	0.96
Main	10731.75	Max WS	VR-1CTP100YRExt	78979.84	58.28	69.60	69.64	73.13	0.006293	15.95	6498.58	1054.10	0.91
Main	10731.75	Max WS	VR-1CTP500YRExt	105933.50	58.28	71.85	71.06	75.48	0.005087	16.52	8924.65	1122.65	0.85
Main	10156.63	Max WS	VR-1CTP100YRExt	78940.57	51.14	66.69		69.75	0.004556	14.19	5909.55	648.85	0.78
Main	10156.63	Max WS	VR-1CTP500YRExt	105883.10	51.14	69.43		72.74	0.003632	14.85	7786.31	713.13	0.73

Ventura River Hydraulics Table

HEC-RAS River: Ventura River Reach: Main Profile: Max WS (Continued)

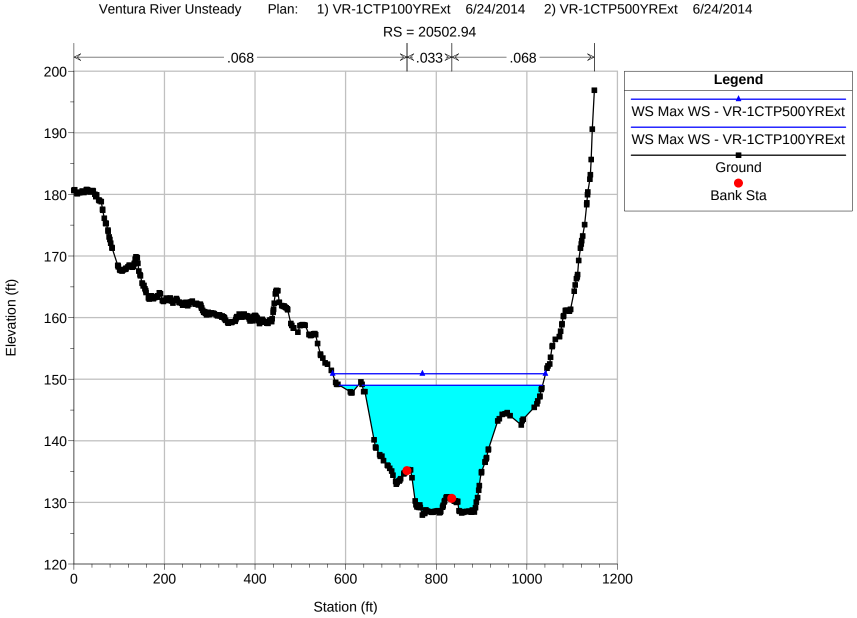
Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	9636.134	Max WS	VR-1CTP100YRExt	78931.80	46.46	65.20		67.83	0.002558	13.10	6253.26	528.74	0.62
Main	9636.134	Max WS	VR-1CTP500YRExt	105877.30	46.46	67.86		71.12	0.002533	14.63	7876.04	671.49	0.63
Main	9500			Lat Struct									
Main	9188.068	Max WS	VR-1CTP100YRExt	78924.99	43.60	62.28	62.09	67.67	0.006582	19.69	5163.06	631.09	0.85
Main	9188.068	Max WS	VR-1CTP500YRExt	105886.00	43.60	64.34	65.34	71.12	0.007394	22.54	6555.50	1159.73	0.91
Main	9000			Lat Struct									
Main	8686.773	Max WS	VR-1CTP100YRExt	78906.28	41.59	59.11		62.42	0.008940	18.04	6746.09	712.55	0.79
Main	8686.773	Max WS	VR-1CTP500YRExt	105848.40	41.59	61.11		65.23	0.009822	20.42	8232.36	1337.99	0.84
Main	8500			Lat Struct									
Main	8175.146	Max WS	VR-1CTP100YRExt	78807.84	38.25	55.13		58.24	0.006690	15.14	6489.87	1632.83	0.80
Main	8175.146	Max WS	VR-1CTP500YRExt	105786.20	38.25	57.20		60.78	0.006336	16.50	8314.57	2353.55	0.80
Main	8000			Lat Struct									
Main	7671.020	Max WS	VR-1CTP100YRExt	78738.95	38.02	52.63		55.41	0.004173	14.03	6852.49	1648.67	0.75
Main	7671.020	Max WS	VR-1CTP500YRExt	105702.60	38.02	54.64		58.07	0.004160	15.70	8654.69	2652.10	0.77
Main	7500			Lat Struct									
Main	7178.092	Max WS	VR-1CTP100YRExt	78620.00	31.85	49.88	49.33	53.57	0.004437	15.98	6285.29	1940.97	0.80
Main	7178.092	Max WS	VR-1CTP500YRExt	105658.00	31.85	51.96	51.32	56.23	0.004358	17.55	8260.10	2825.88	0.81
Main	7000			Lat Struct									
Main	6672.704	Max WS	VR-1CTP100YRExt	78606.30	29.76	47.05	47.43	52.71	0.006430	19.55	4750.02	2310.43	0.96
Main	6672.704	Max WS	VR-1CTP500YRExt	105202.90	29.76	49.25	50.08	56.01	0.006383	21.65	6029.50	2893.33	0.99
Main	6500			Lat Struct									
Main	6169.652	Max WS	VR-1CTP100YRExt	78270.46	24.75	44.72		48.18	0.003204	15.33	5859.22	2285.67	0.69
Main	6169.652	Max WS	VR-1CTP500YRExt	104083.10	24.75	46.75	44.47	51.25	0.003582	17.63	7234.71	2997.59	0.75
Main	6000			Lat Struct									
Main	5654.248	Max WS	VR-1CTP100YRExt	77790.34	22.57	42.05	41.32	46.87	0.004360	19.45	5929.45	1667.90	0.83
Main	5654.248	Max WS	VR-1CTP500YRExt	102861.30	22.57	44.02	44.57	50.10	0.004898	22.19	7408.43	2646.14	0.90
Main	5500			Lat Struct									
Main	5144.698	Max WS	VR-1CTP100YRExt	76193.53	19.79	39.41	41.75	46.58	0.006137	23.66	5392.55	1715.31	0.99
Main	5144.698	Max WS	VR-1CTP500YRExt	100311.20	19.79	41.03	44.29	49.71	0.007007	26.79	7146.47	2590.44	1.07
Main	5000			Lat Struct									
Main	4636.191	Max WS	VR-1CTP100YRExt	74054.13	19.19	36.08	37.92	41.84	0.006986	21.87	6456.31	1843.49	1.02
Main	4636.191	Max WS	VR-1CTP500YRExt	97354.31	19.19	37.26	39.38	43.98	0.007907	24.51	8041.75	2736.98	1.10
Main	4500			Lat Struct									
Main	4135.262	Max WS	VR-1CTP100YRExt	72784.91	18.68	32.93	34.52	37.87	0.007138	20.51	7448.98	2915.03	1.02
Main	4135.262	Max WS	VR-1CTP500YRExt	95599.45	18.68	33.83	35.59	39.45	0.008071	22.84	9278.82	3329.56	1.09
Main	4000			Lat Struct									
Main	3621.485	Max WS	VR-1CTP100YRExt	72069.84	17.30	29.19	30.52	33.44	0.008661	20.01	8119.92	3462.59	1.09
Main	3621.485	Max WS	VR-1CTP500YRExt	94489.54	17.30	30.17	31.60	34.47	0.008653	21.22	10483.51	3764.20	1.10
Main	3500			Lat Struct									
Main	3112.680	Max WS	VR-1CTP100YRExt	71117.59	12.87	26.13	26.61	28.63	0.006302	15.14	9508.77	3431.57	0.90
Main	3112.680	Max WS	VR-1CTP500YRExt	93209.02	12.87	26.97	27.45	29.73	0.006669	16.54	11688.30	3915.31	0.93
Main	3000			Lat Struct									
Main	2869.572	Max WS	VR-1CTP100YRExt	70409.33	11.51	24.88		27.18	0.004369	13.54	9597.26	4185.03	0.76
Main	2869.572	Max WS	VR-1CTP500YRExt	92221.71	11.51	26.16		28.09	0.003606	13.35	15078.11	4670.14	0.71
Main	2796			Mult Open									
Main	2733.189	Max WS	VR-1CTP100YRExt	70384.16	10.77	23.74	23.81	26.20	0.007957	14.33	8202.69	3765.63	0.83
Main	2733.189	Max WS	VR-1CTP500YRExt	92160.68	10.77	24.84	25.03	26.85	0.006505	13.97	12880.66	4351.90	0.77
Main	2500			Lat Struct									
Main	2496.198	Max WS	VR-1CTP100YRExt	69856.91	9.62	22.89		24.06	0.002455	10.95	14863.59	5242.26	0.58
Main	2496.198	Max WS	VR-1CTP500YRExt	91400.21	9.62	24.41		25.38	0.001964	10.68	20523.04	5617.30	0.53
Main	2200			Lat Struct									
Main	2056.048	Max WS	VR-1CTP100YRExt	68276.32	5.17	22.78		22.90	0.000406	5.07	35319.43	5752.77	0.24

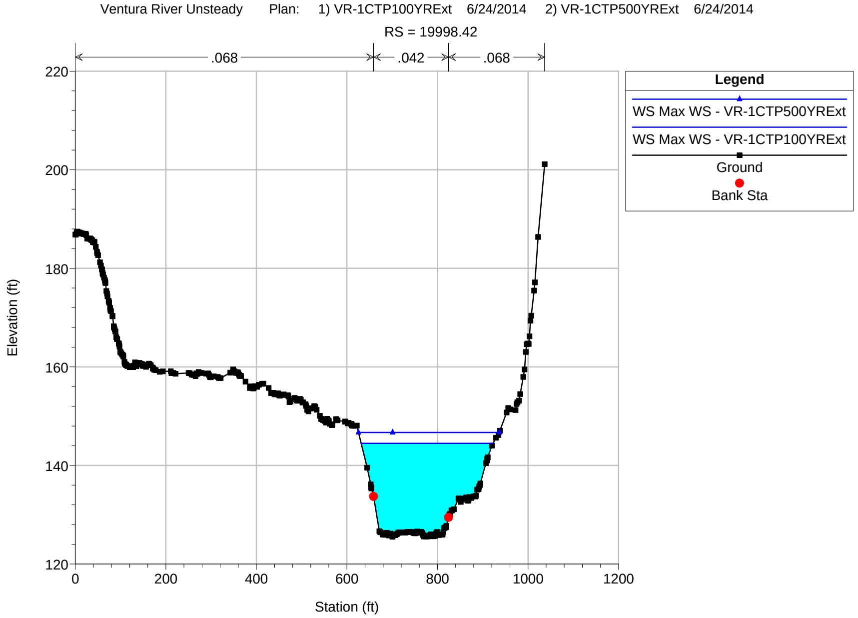
Ventura River Hydraulics Table

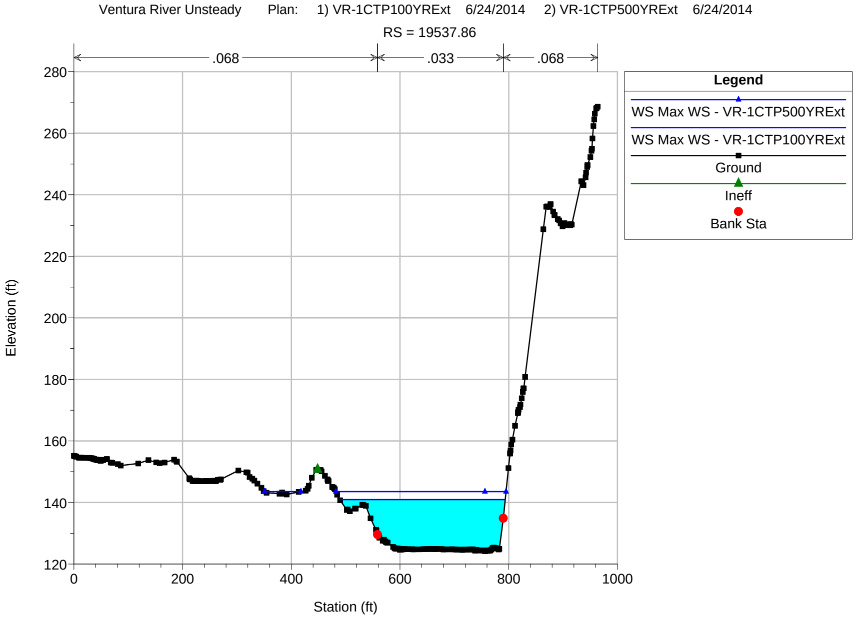
HEC-RAS River: Ventura River Reach: Main Profile: Max WS (Continued)

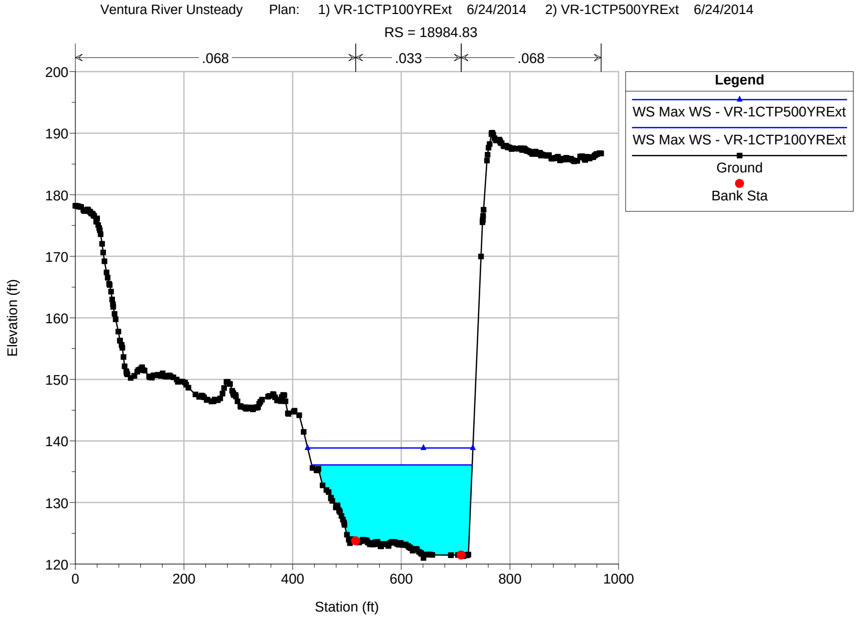
Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	2056.048	Max WS	VR-1CTP500YRExt	89072.94	5.17	24.34		24.45	0.000376	5.25	43725.44	5845.55	0.24
Main	1975			Mult Open									
Main	1651.518	Max WS	VR-1CTP100YRExt	68235.01	5.34	18.43		19.72	0.003103	11.23	12435.17	4443.56	0.64
Main	1651.518	Max WS	VR-1CTP500YRExt	89056.05	5.34	19.47		20.85	0.003140	12.09	15441.92	4585.94	0.65
Main	1500			Lat Struct									
Main	1071.007	Max WS	VR-1CTP100YRExt	68220.18	3.02	17.78		18.10	0.000766	7.10	29552.35	6560.44	0.34
Main	1071.007	Max WS	VR-1CTP500YRExt	89048.91	3.02	18.86		19.17	0.000749	7.38	37243.89	6925.56	0.34
Main	800			Mult Open									
Main	694.0917	Max WS	VR-1CTP100YRExt	68206.36	2.92	12.67	11.93	14.01	0.003985	11.68	13411.87	4971.27	0.71
Main	694.0917	Max WS	VR-1CTP500YRExt	89034.57	2.92	13.65		14.89	0.003588	11.93	18703.56	5939.56	0.69
Main	500			Lat Struct									
Main	356.5126	Max WS	VR-1CTP100YRExt	68201.38	2.74	10.86	10.38	12.50	0.005209	11.05	8832.76	3758.12	0.78
Main	356.5126	Max WS	VR-1CTP500YRExt	89032.47	2.74	11.68	11.65	13.58	0.005373	12.18	11575.74	4829.64	0.81
Main	300			Lat Struct									
Main	162.9877	Max WS	VR-1CTP100YRExt	68198.92	2.22	9.22	8.96	11.02	0.010093	11.23	7107.88	2416.36	0.87
Main	162.9877	Max WS	VR-1CTP500YRExt	89030.55	2.22	10.18	10.08	12.20	0.009338	12.08	9506.30	3821.26	0.86
Main	100			Lat Struct									
Main	43.84752	Max WS	VR-1CTP100YRExt	68197.56	2.33	8.78		9.81	0.004987	9.21	10592.36	3872.79	0.73
Main	43.84752	Max WS	VR-1CTP500YRExt	89029.33	2.33	9.53		10.75	0.004980	10.11	13107.62	4486.81	0.75
Main	43	Max WS	VR-1CTP100YRExt	68197.55	2.33	8.77	7.67	9.80	0.004982	9.19	10571.36	3867.44	0.73
Main	43	Max WS	VR-1CTP500YRExt	89029.32	2.33	9.53	8.18	10.74	0.005004	10.13	13081.07	4481.90	0.75

Ventura River Cross Sections

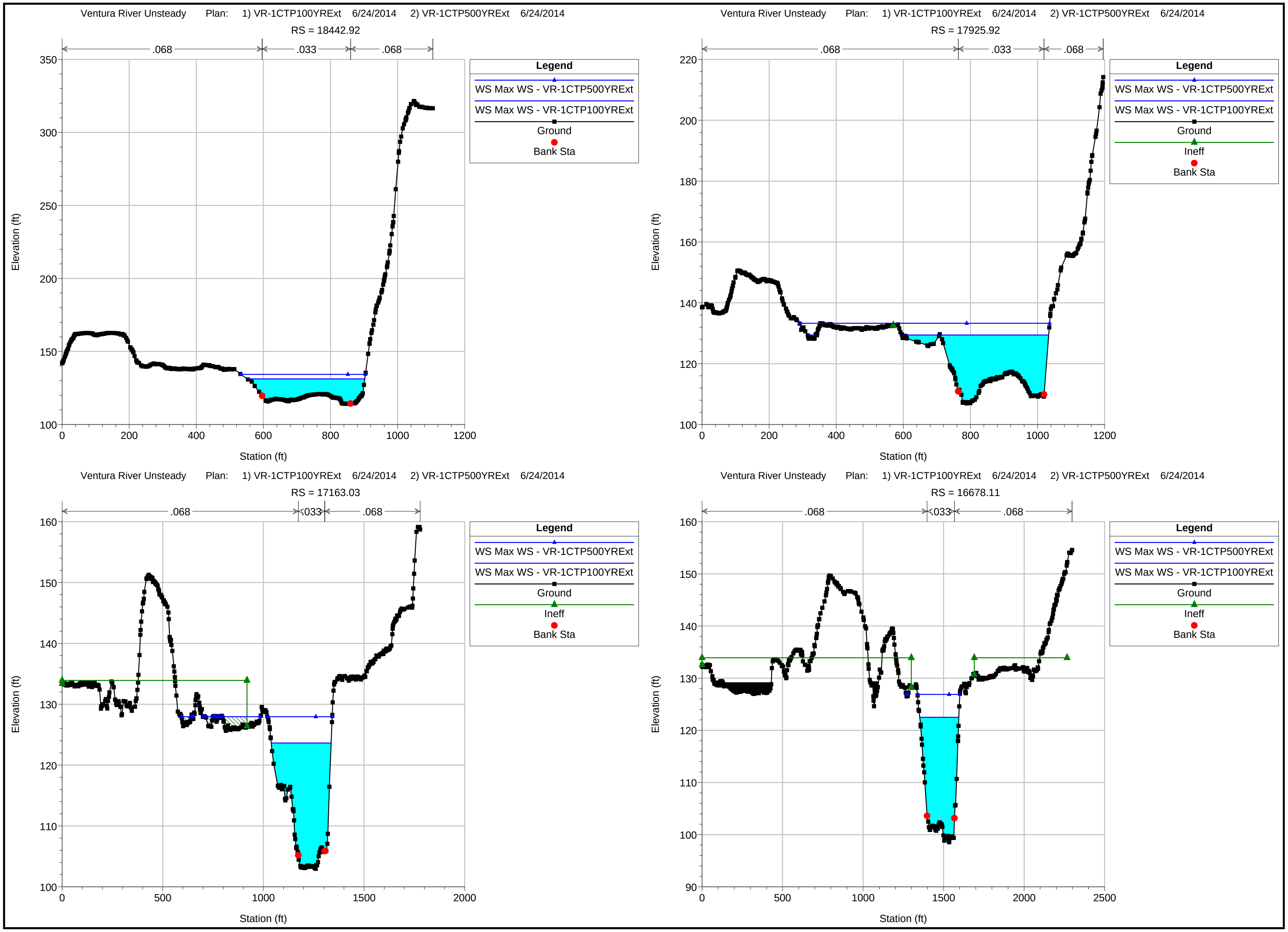




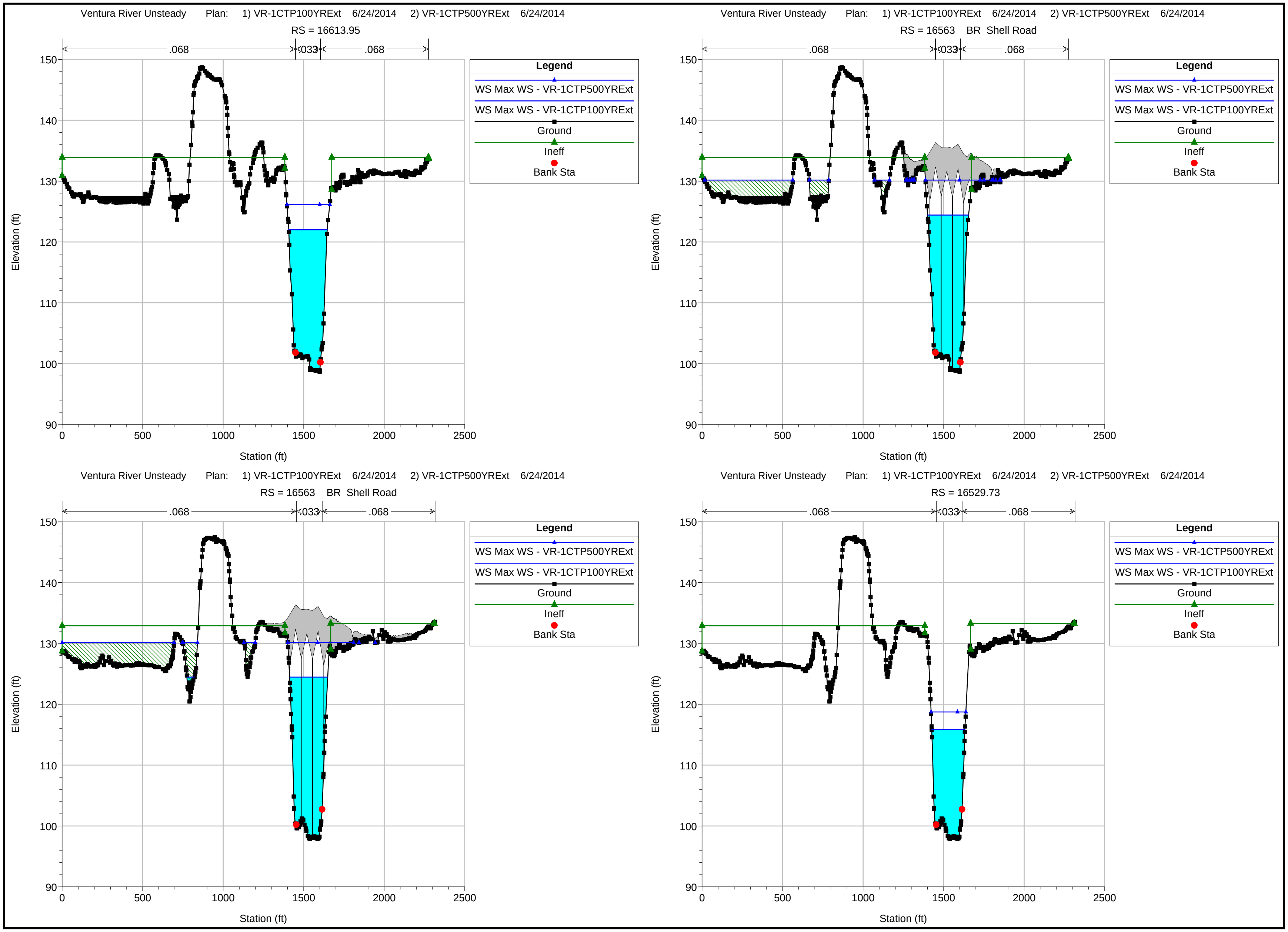




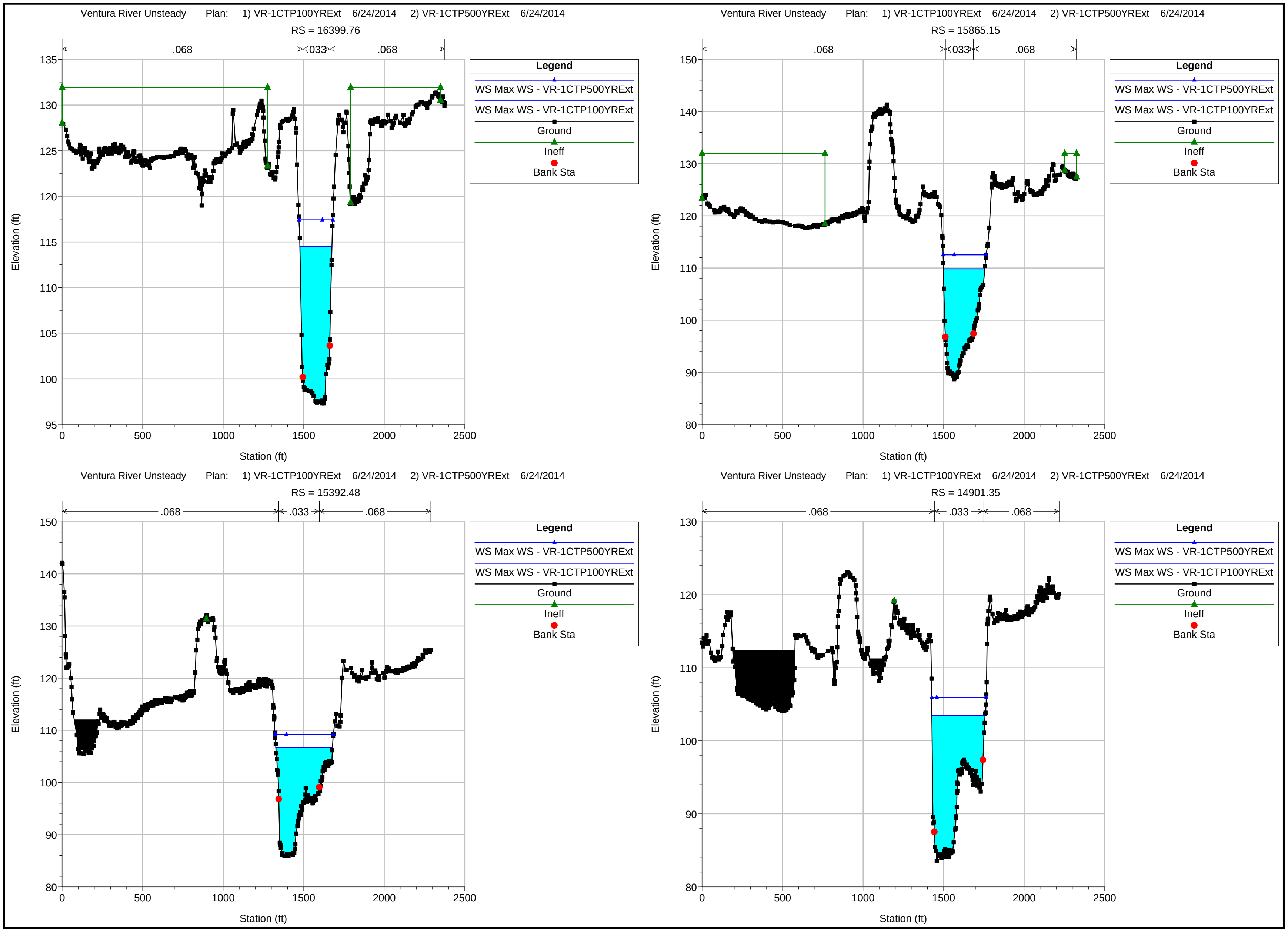
Ventura River Cross Sections



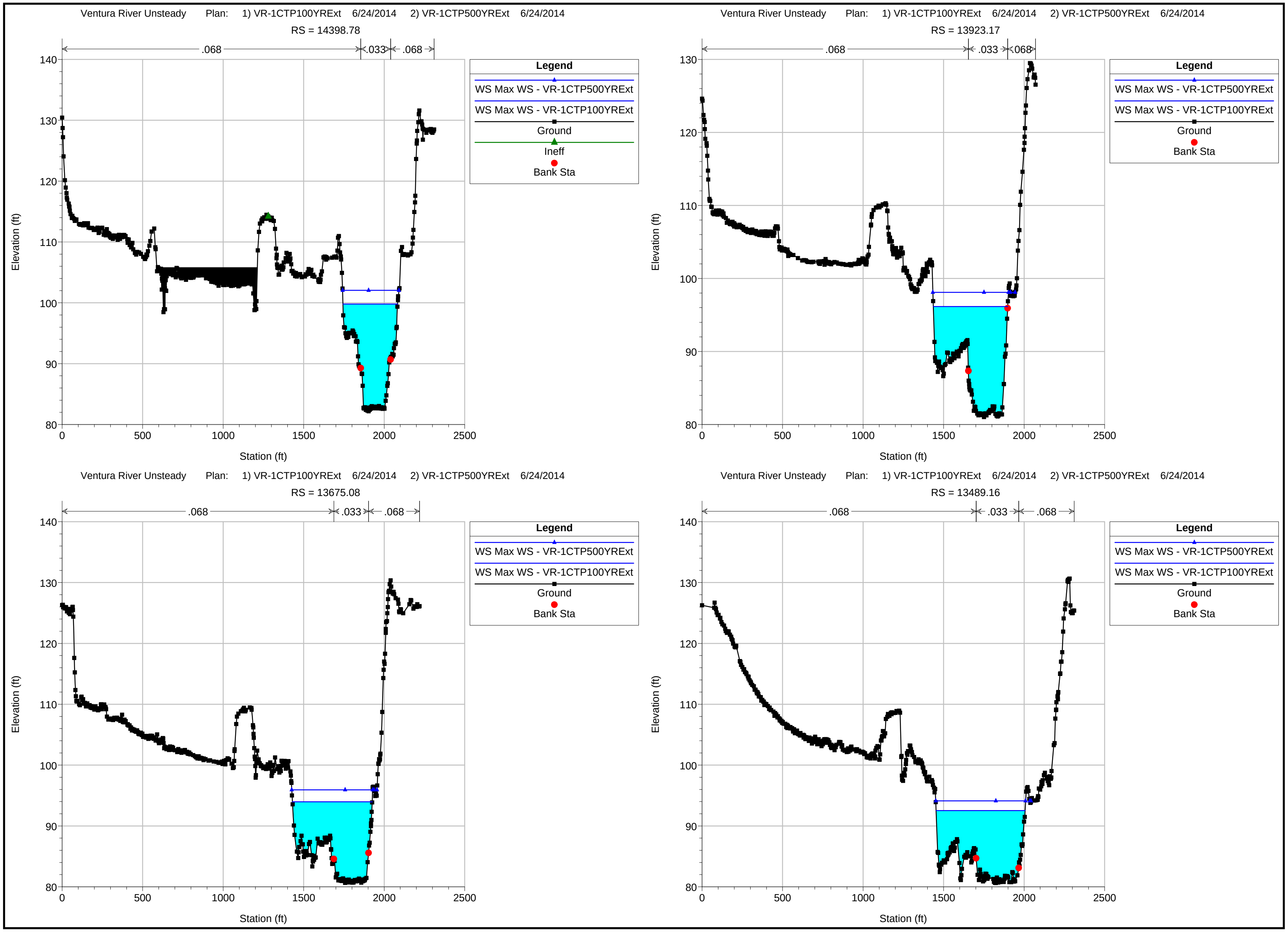
Ventura River Cross Sections



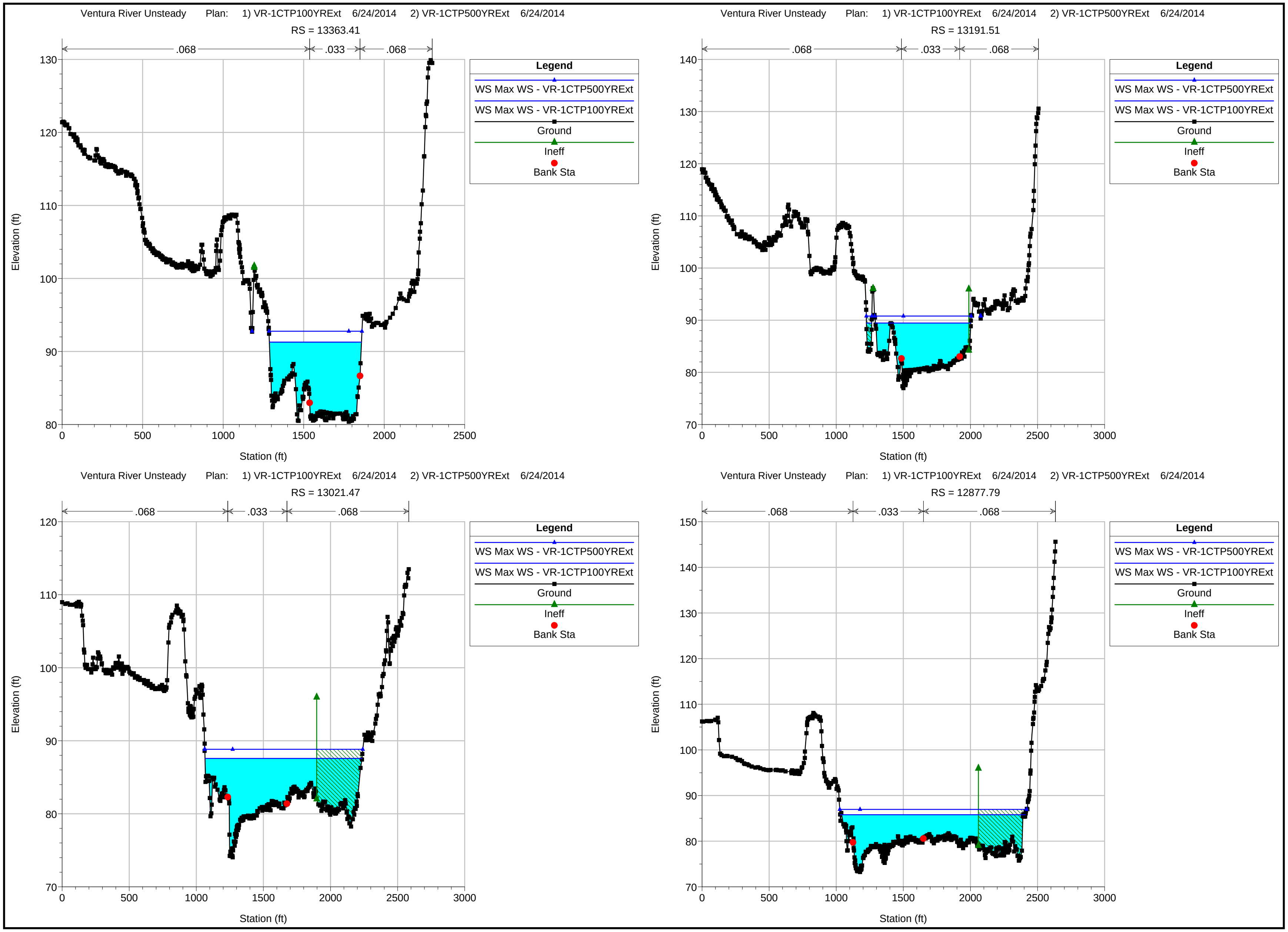
Ventura River Cross Sections



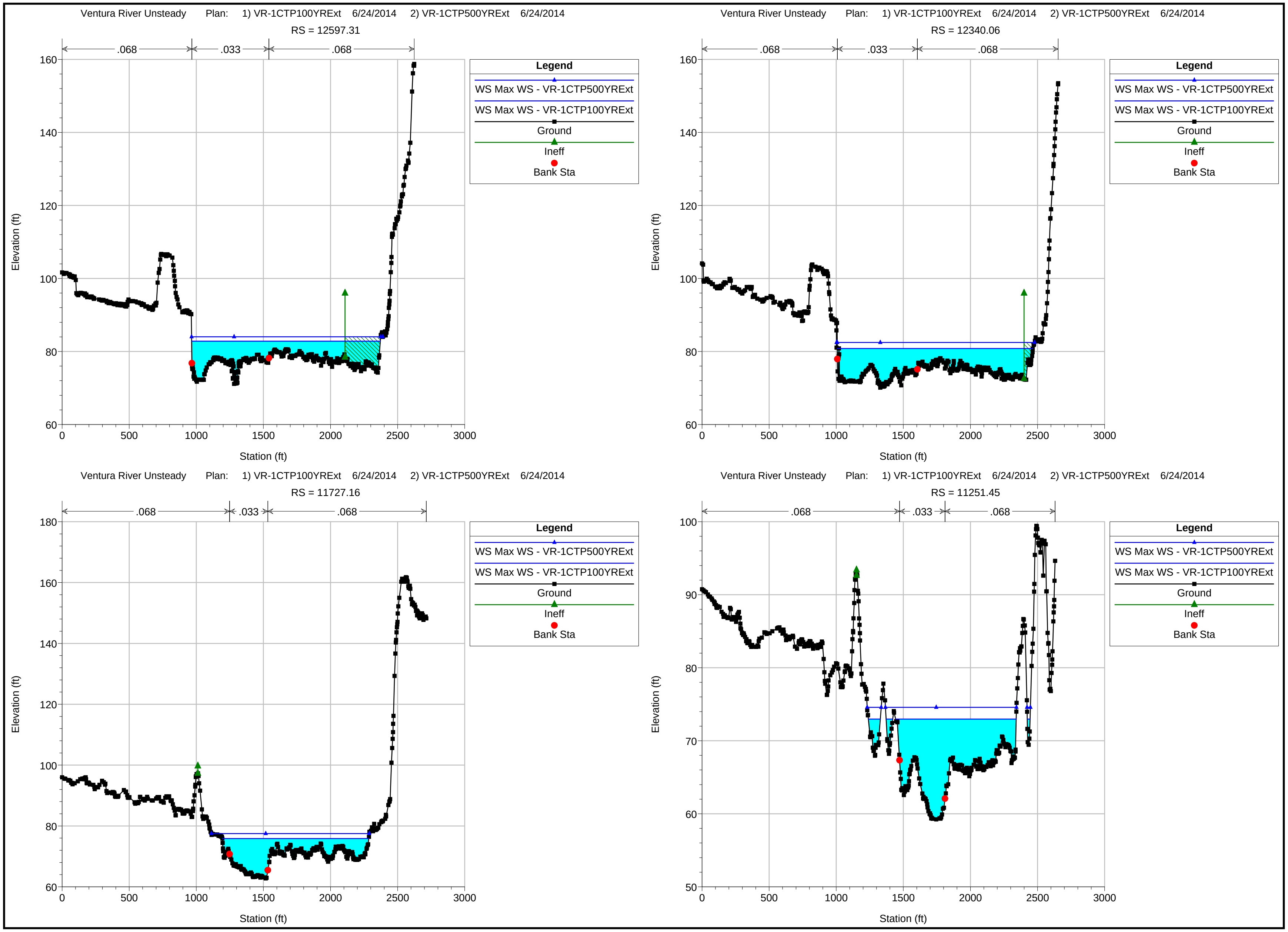
Ventura River Cross Sections



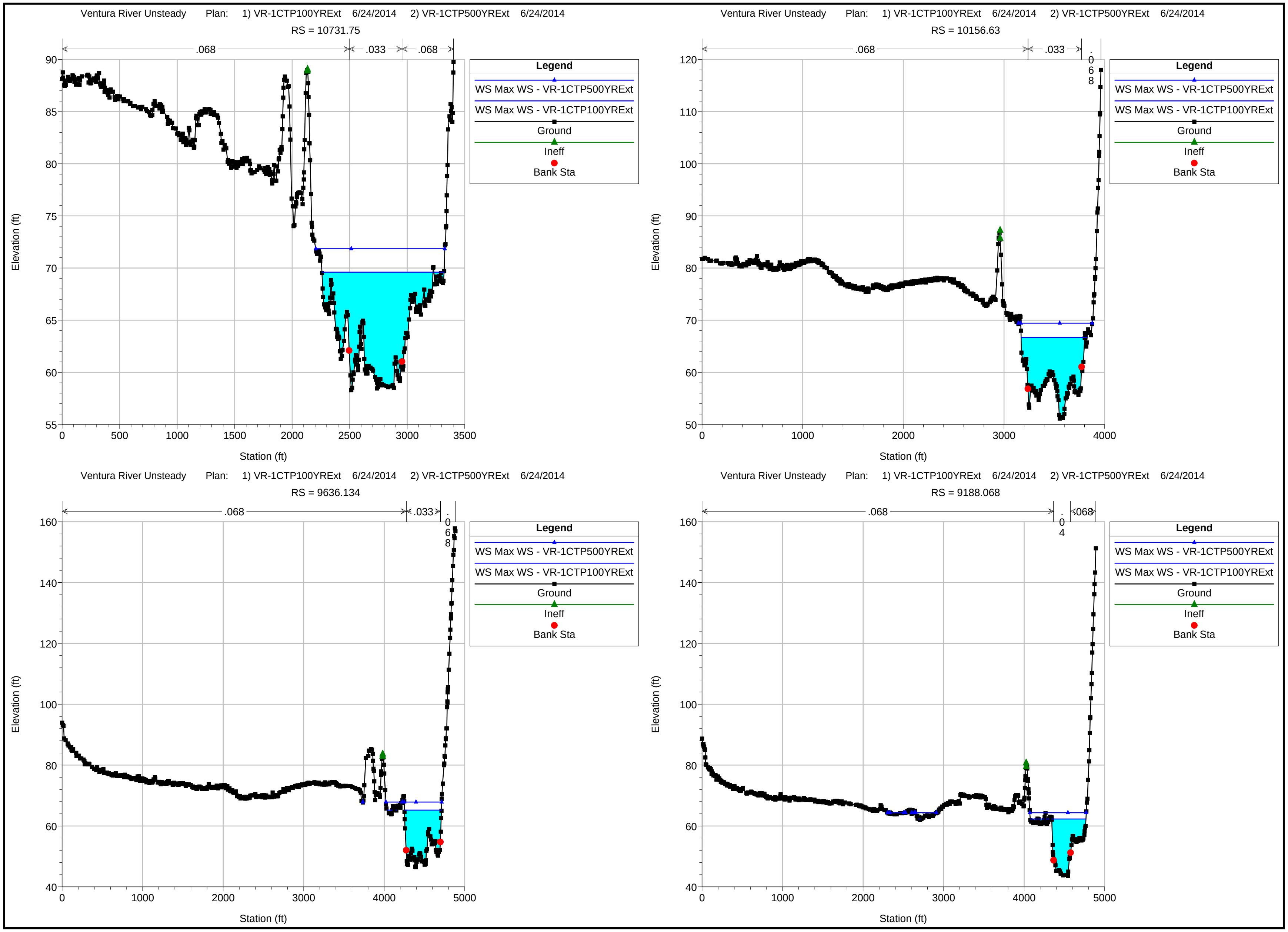
Ventura River Cross Sections



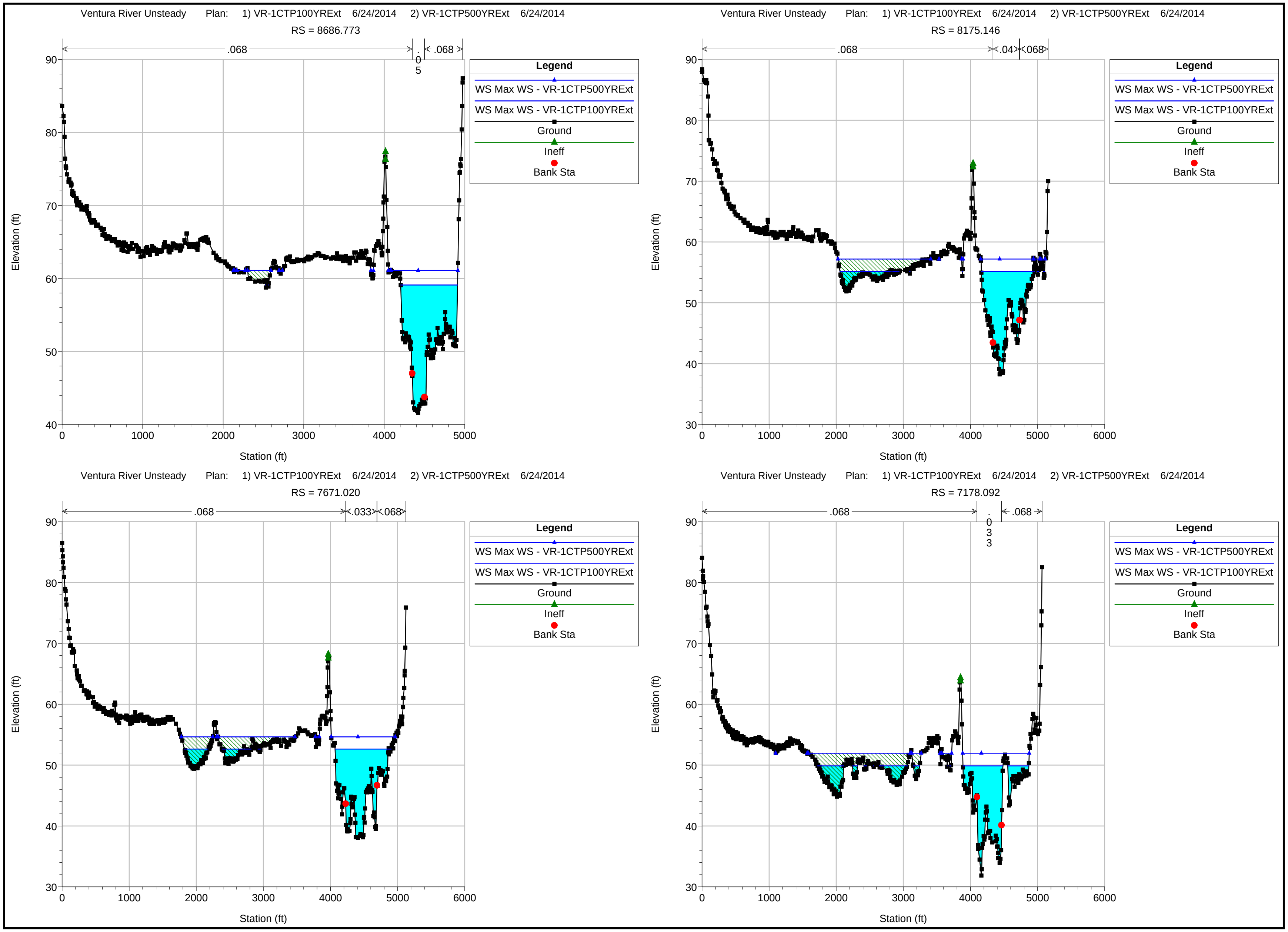
Ventura River Cross Sections



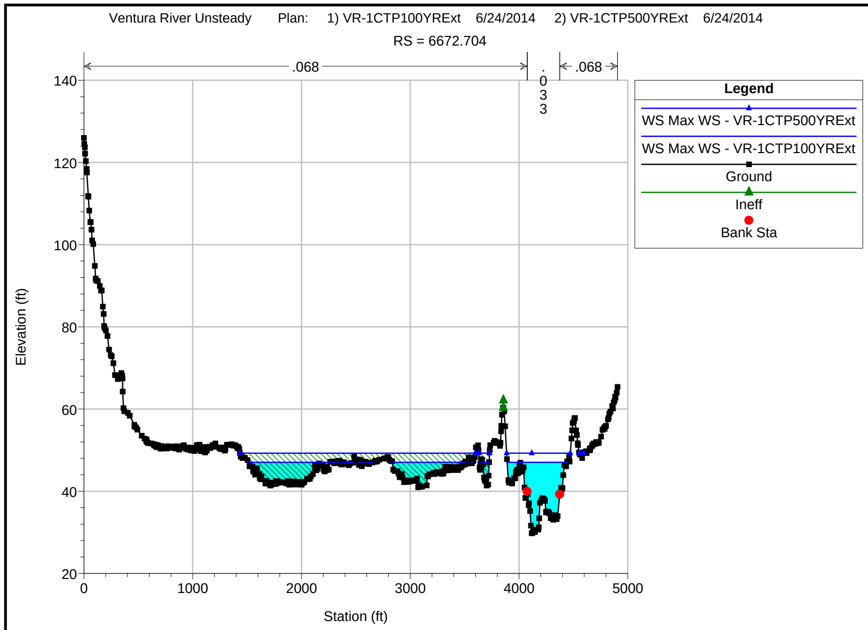
Ventura River Cross Sections

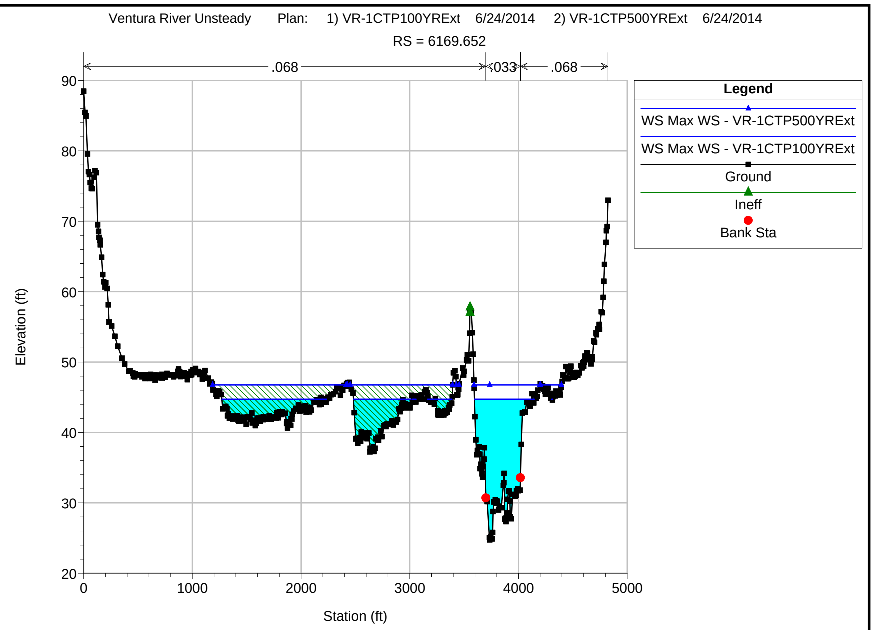


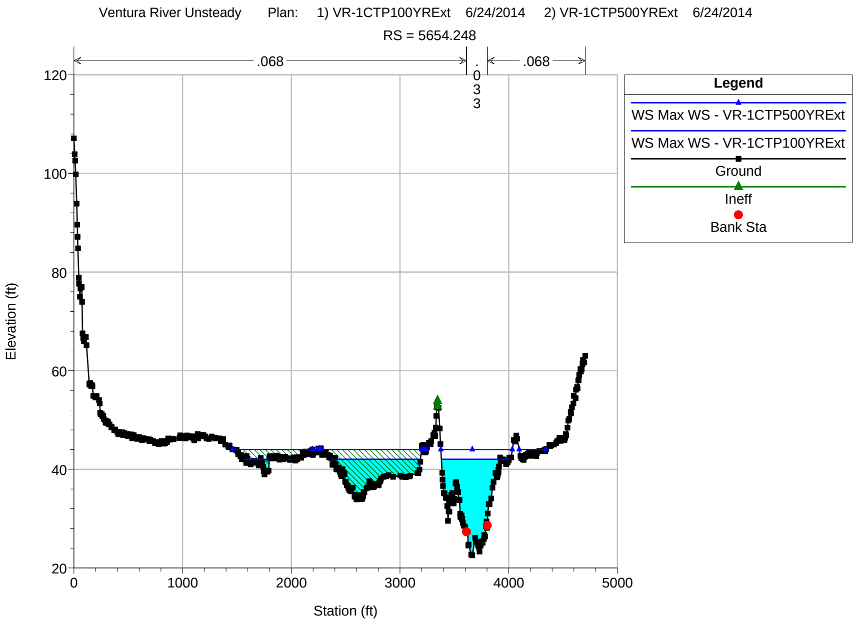
Ventura River Cross Sections

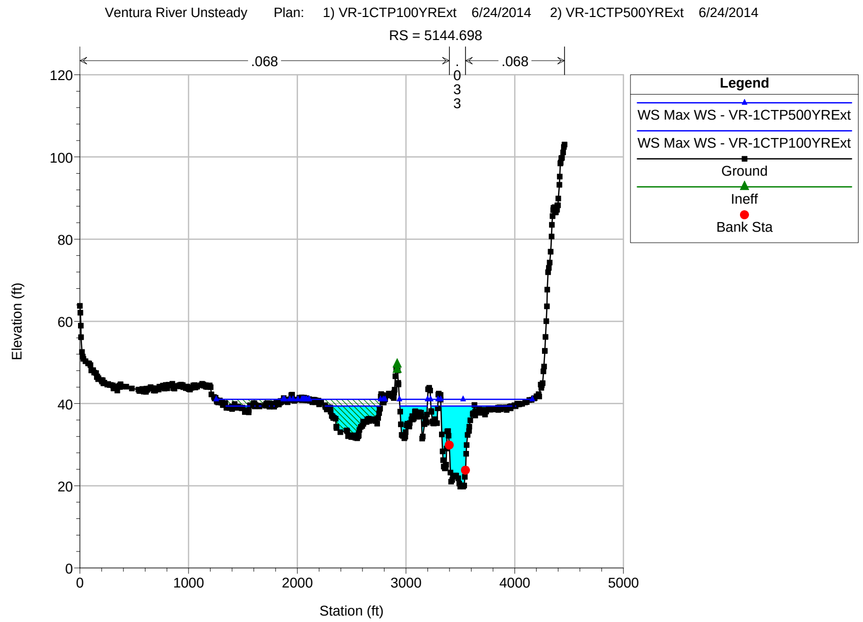


Ventura River Cross Sections

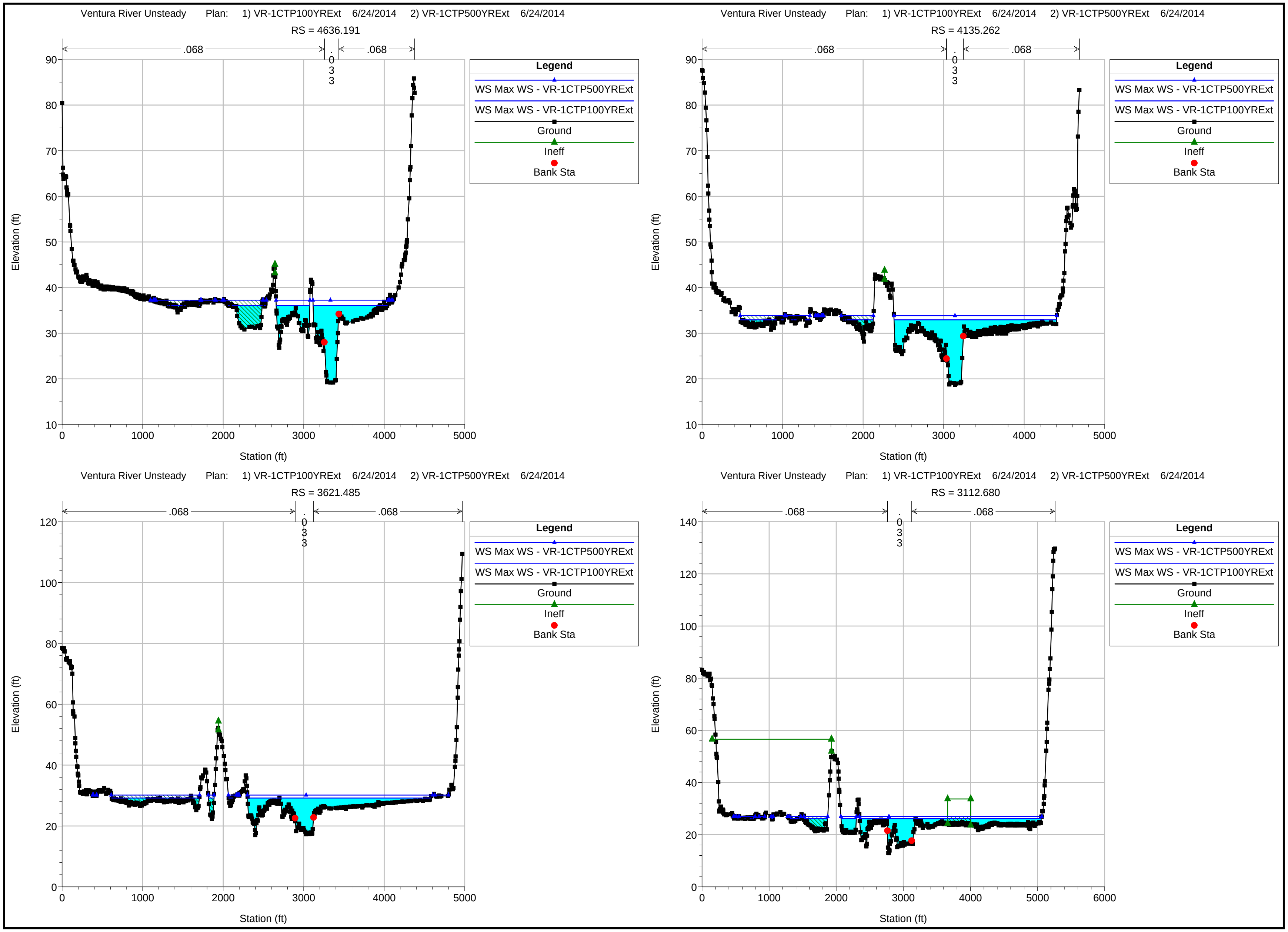




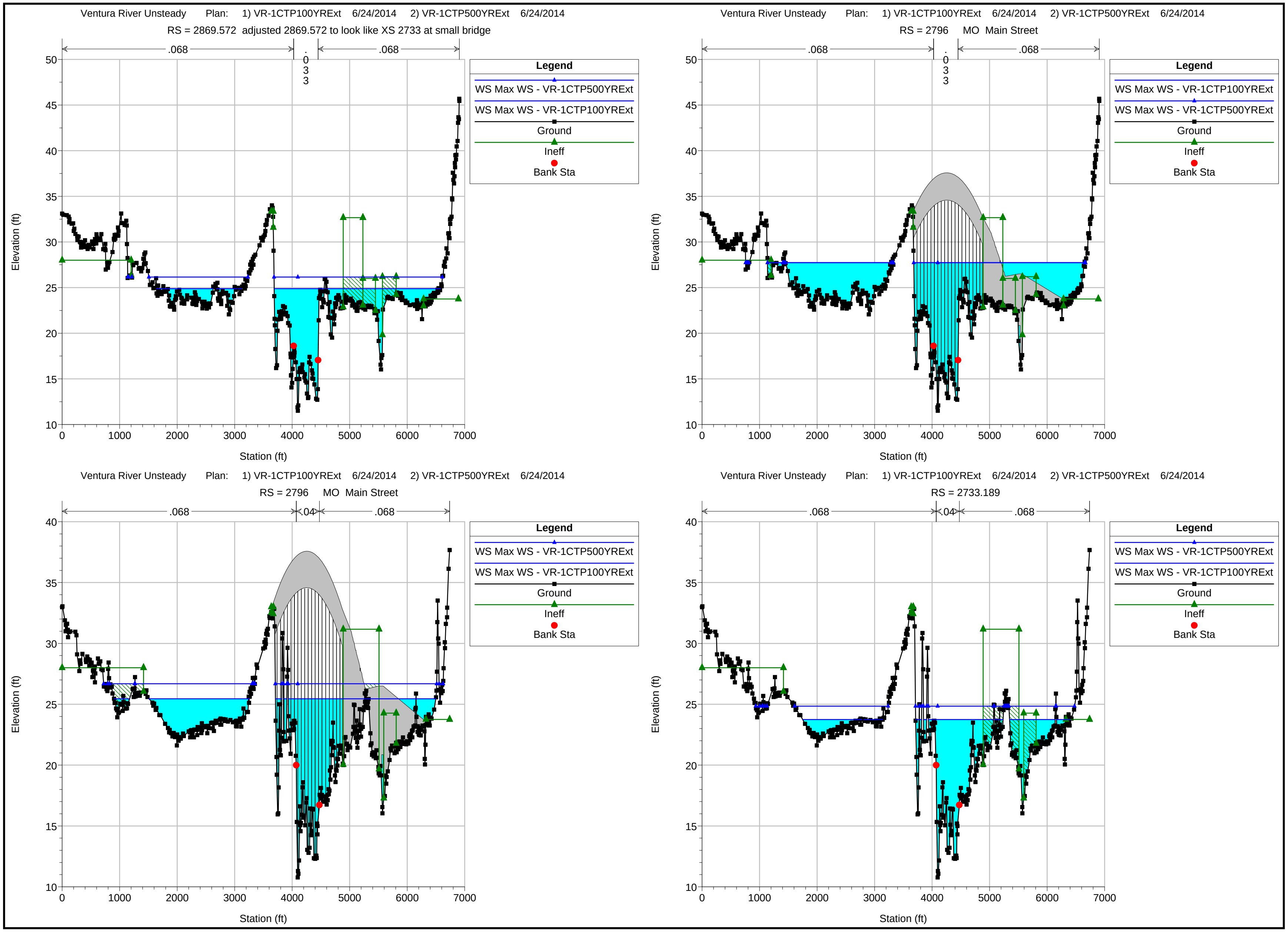




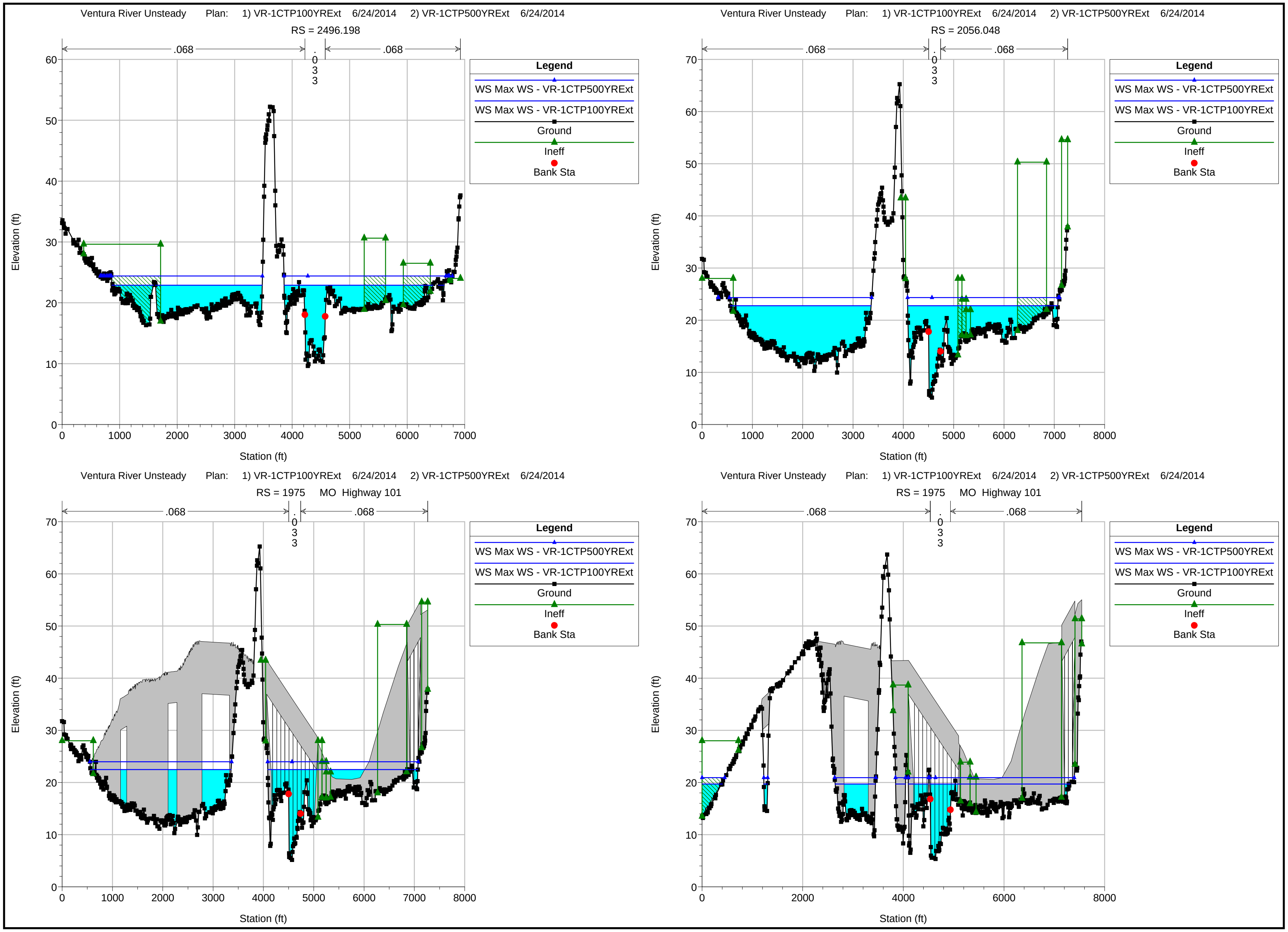
Ventura River Cross Sections



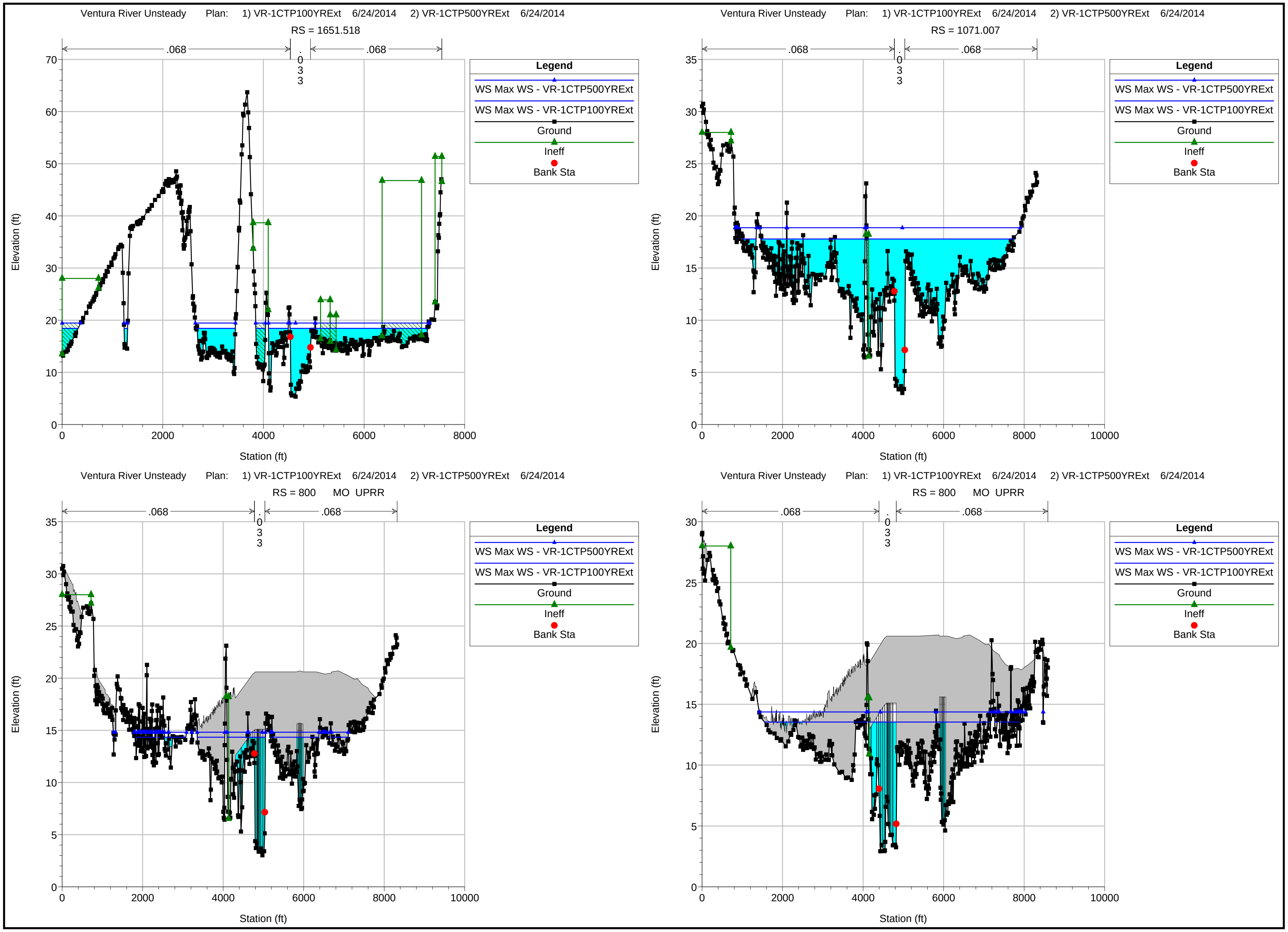
Ventura River Cross Sections



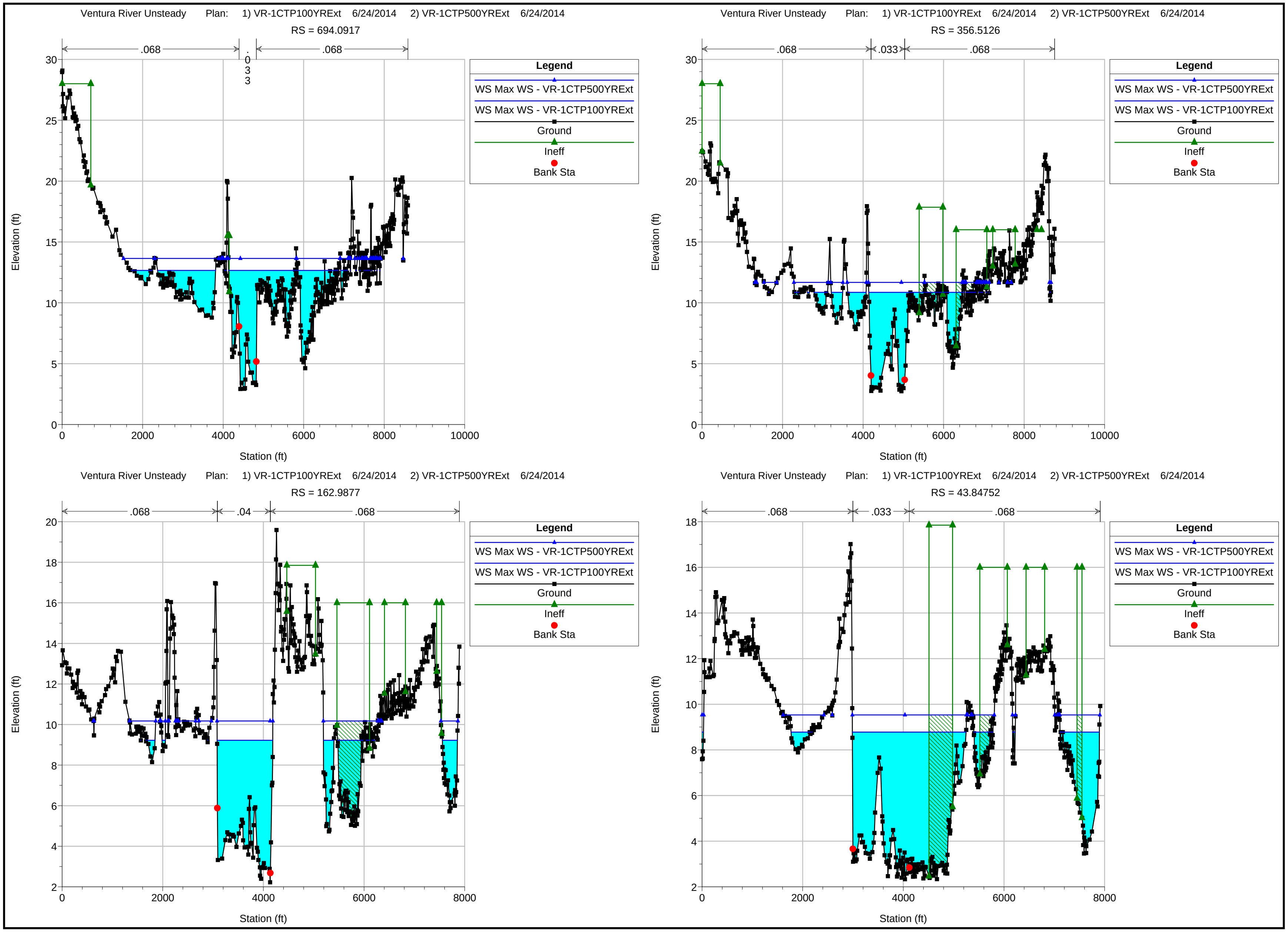
Ventura River Cross Sections



Ventura River Cross Sections



Ventura River Cross Sections



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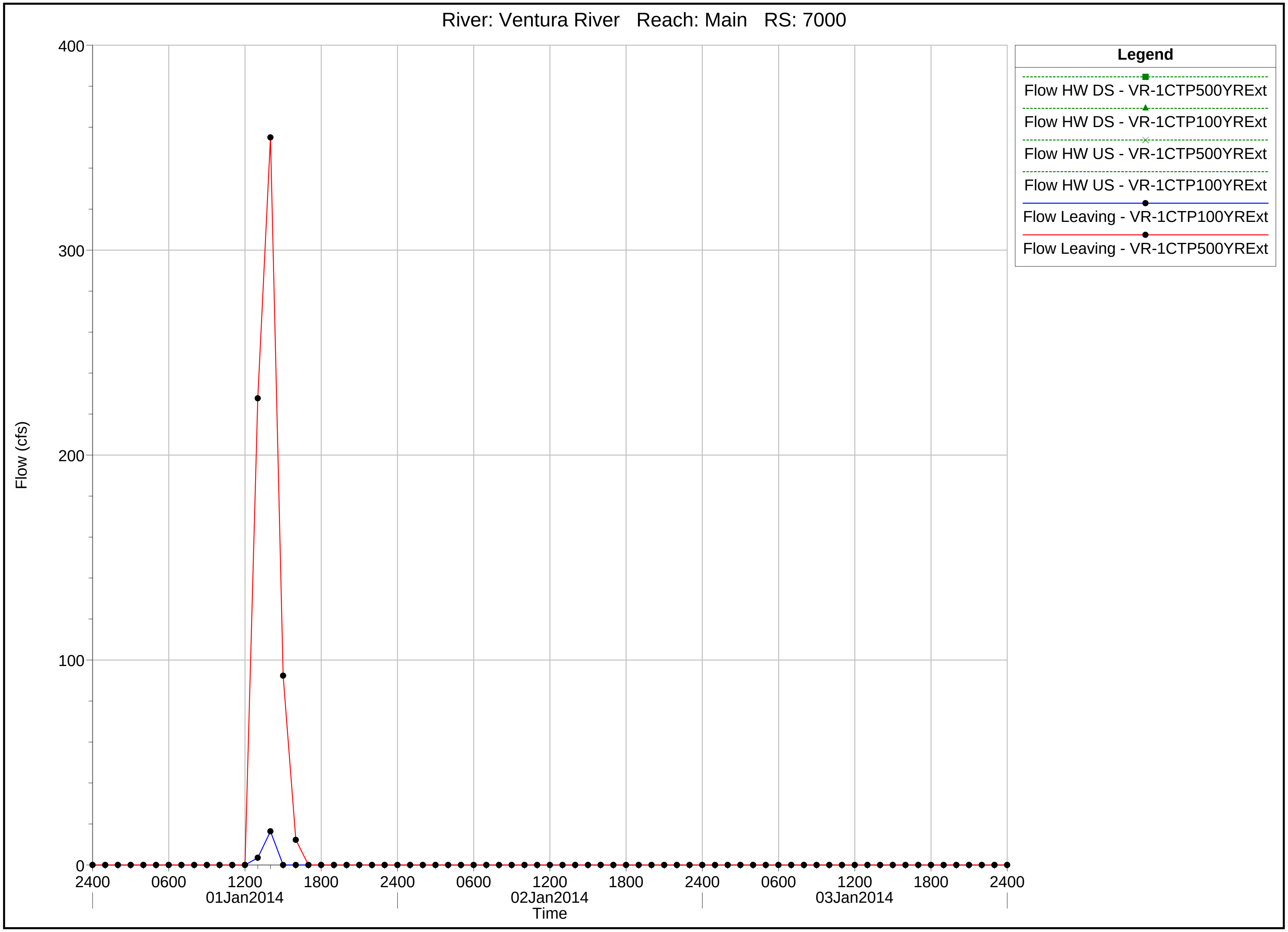
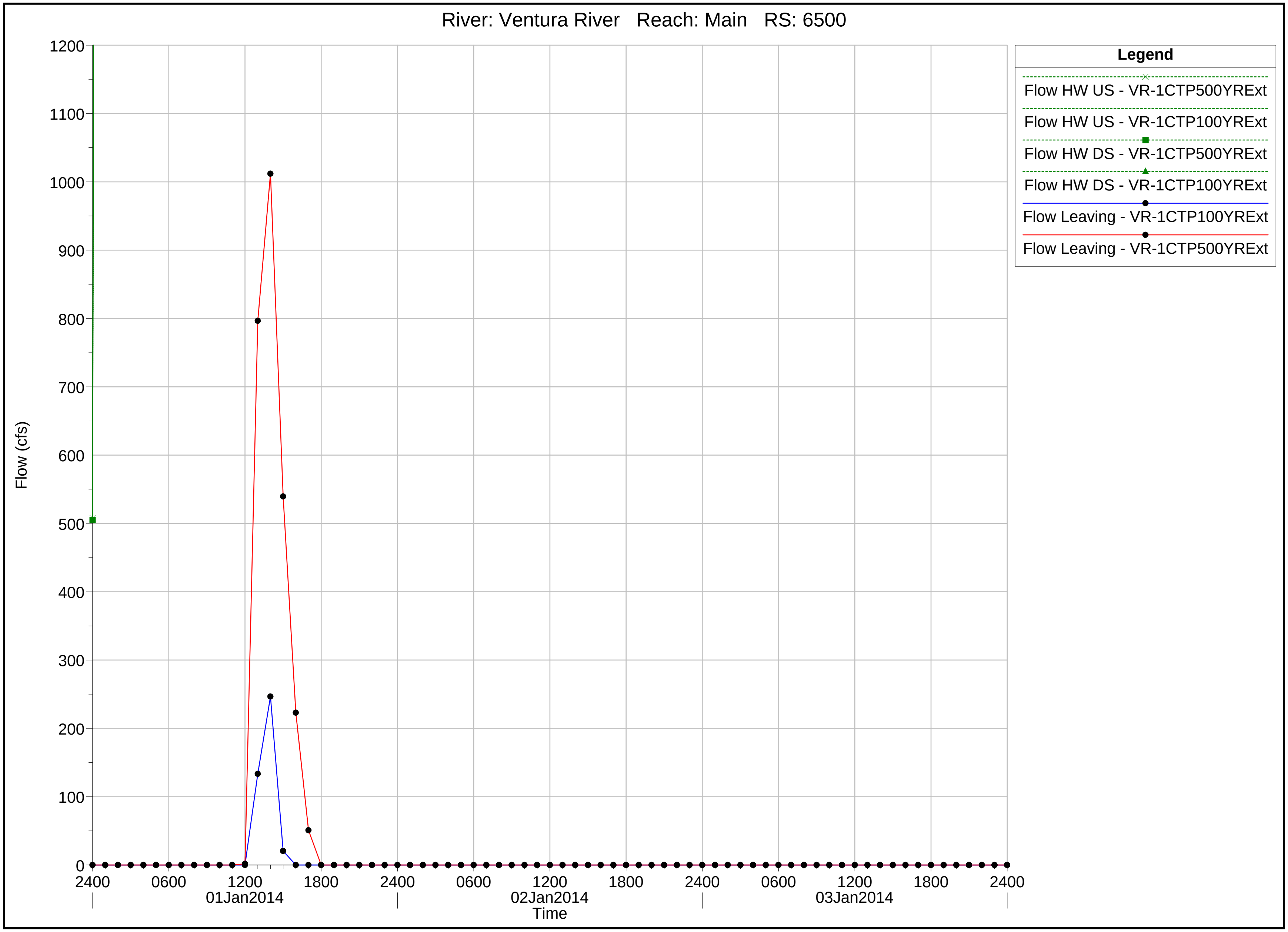
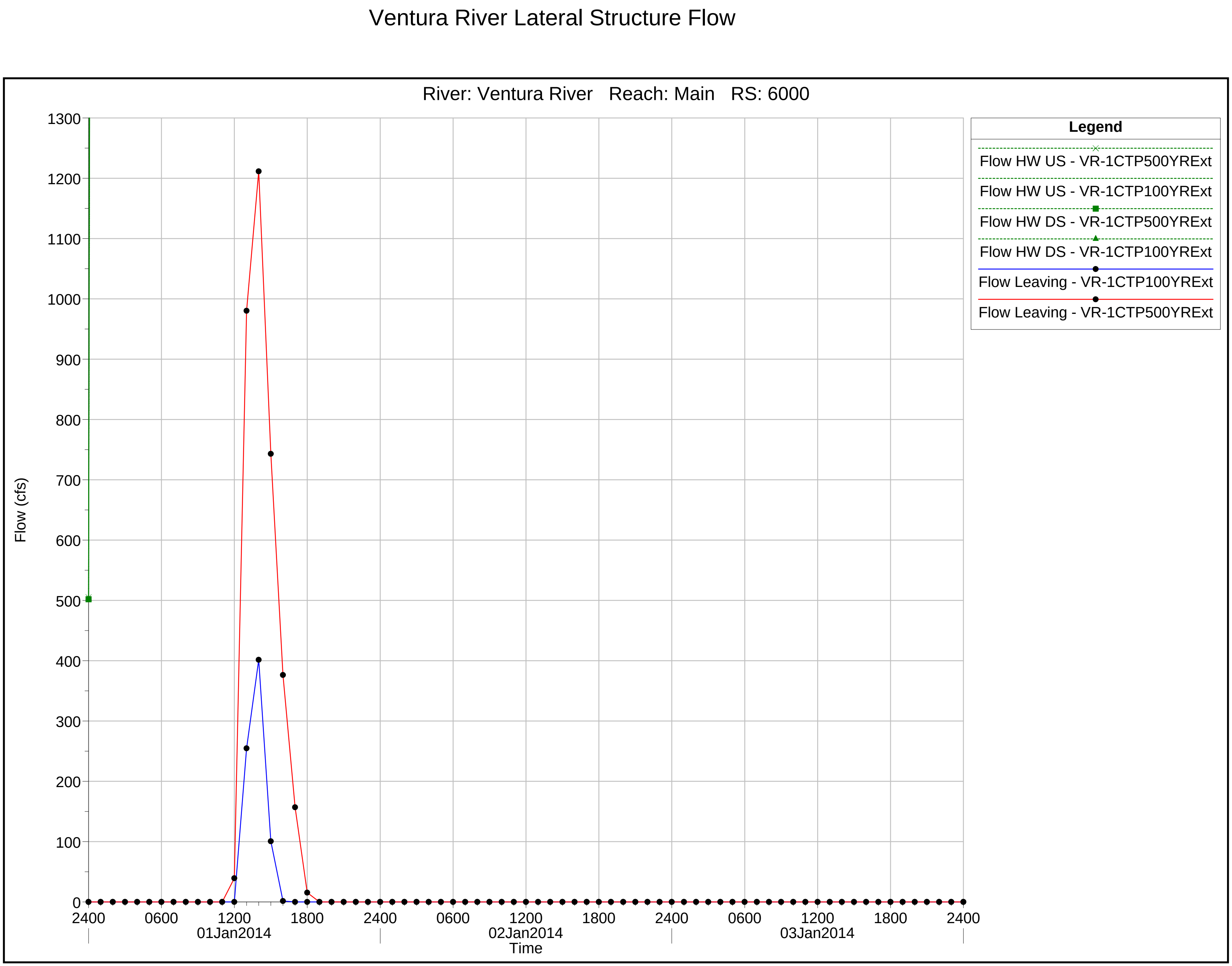
Ventura River Lateral Structure Flow

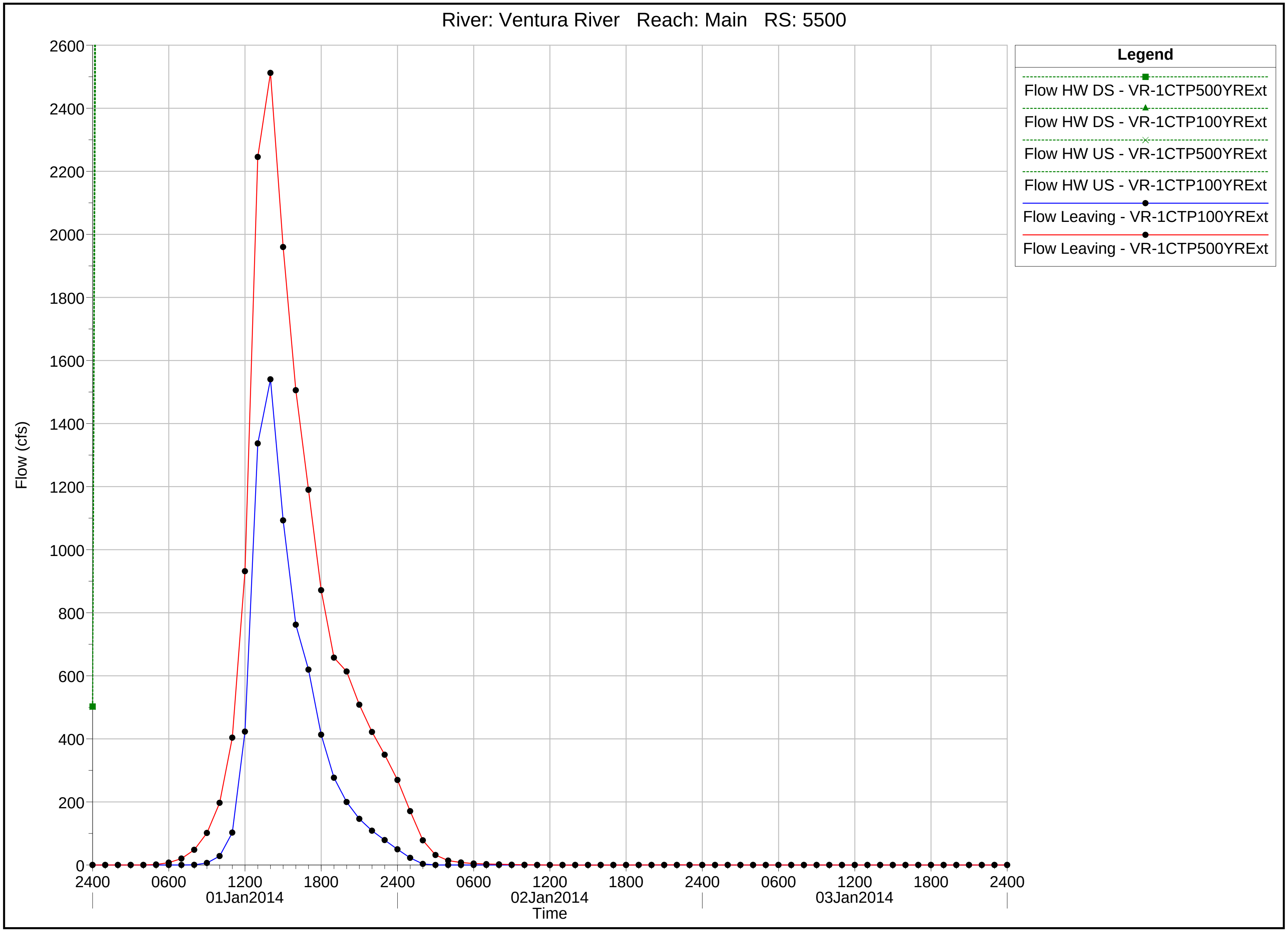


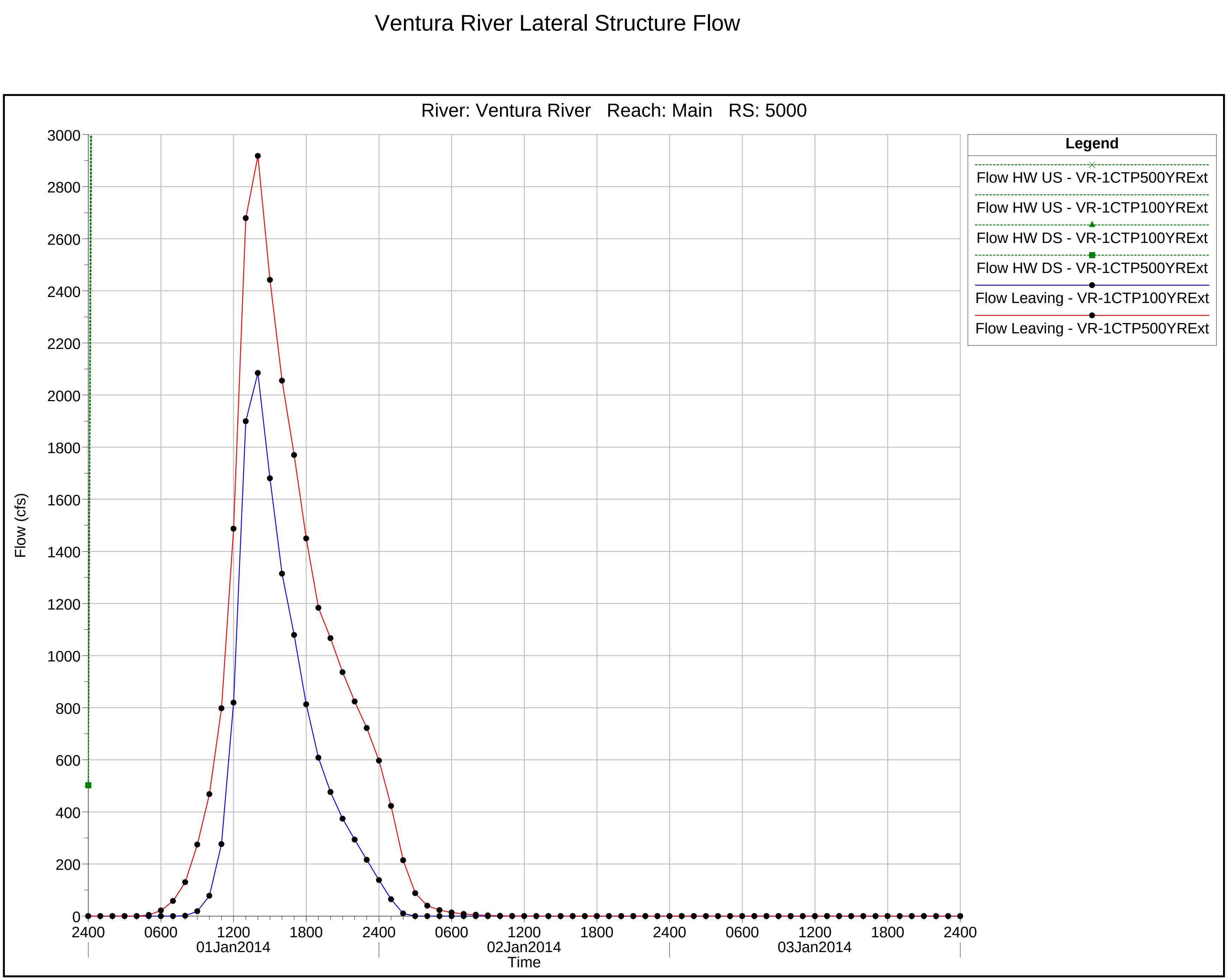
Ventura River Lateral Structure Flow



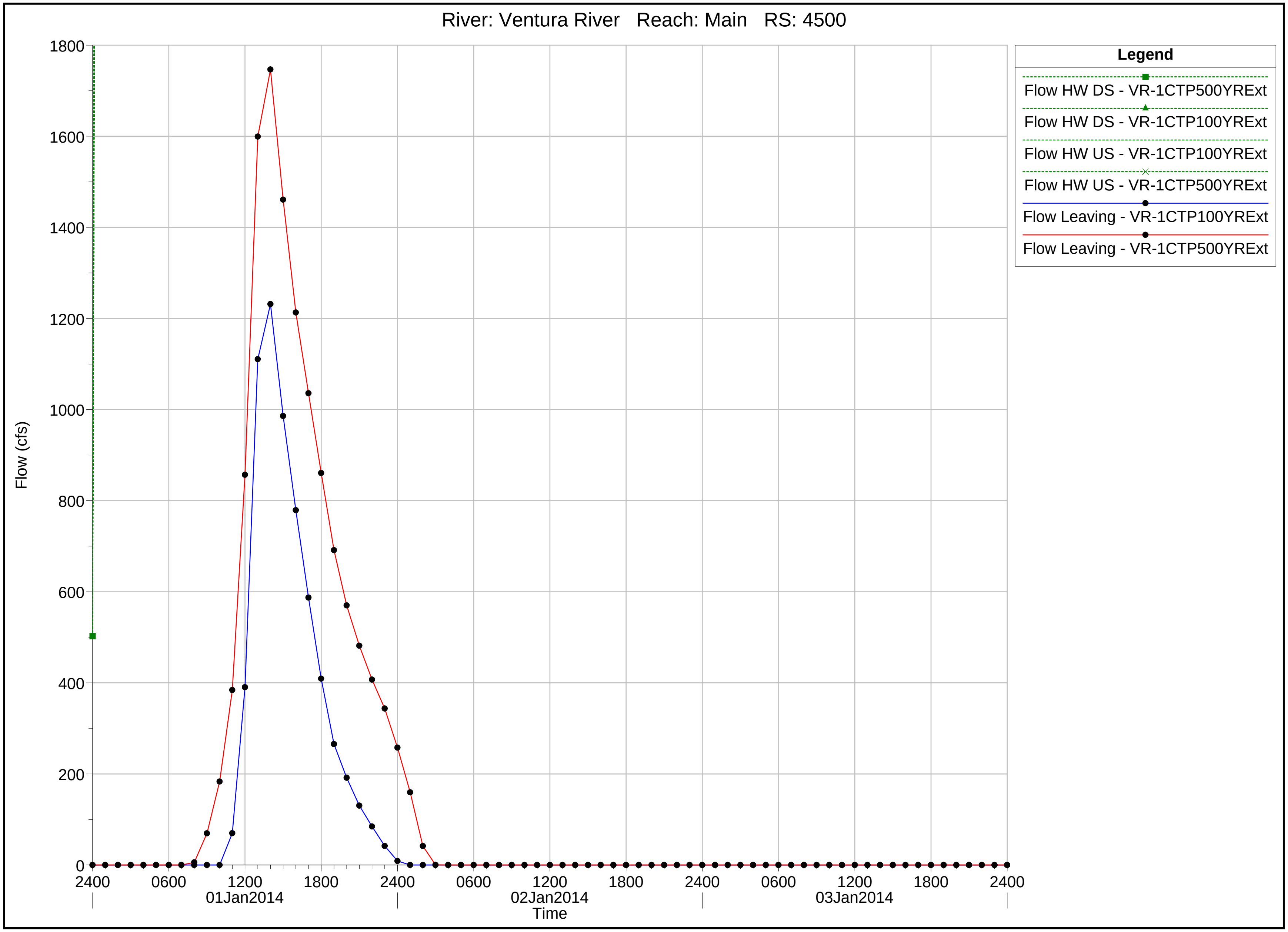

Ventura River Lateral Structure Flow
River: Ventura River Reach: Main RS: 6000
Legend
Flow HW US - VR-1CTP500YRExt
Flow HW US - VR-1CTP100YRExt
Flow HW DS - VR-1CTP500YRExt
Flow HW DS - VR-1CTP100YRExt
Flow Leaving - VR-1CTP100YRExt
Flow Leaving - VR-1CTP500YRExt
Flow (cfs)
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
2400
0600
1200
1800
2400
0600
1200
1800
2400
0600
1200
1800
2400
01Jan2014
02Jan2014
03Jan2014
Time

Ventura River Lateral Structure Flow

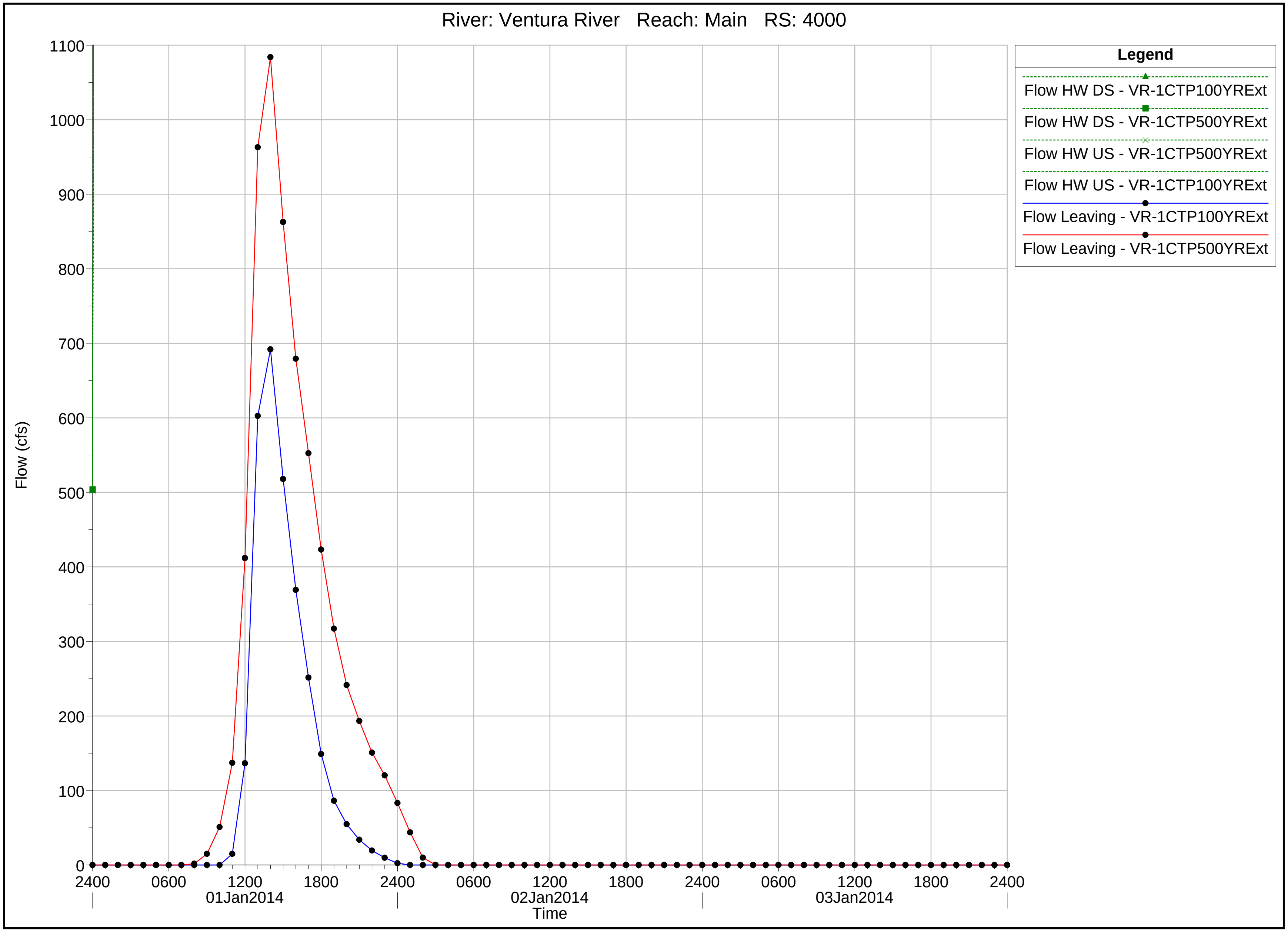



Ventura River Lateral Structure Flow
River: Ventura River   Reach: Main   RS: 5000
Legend
Flow HW US - VR-1CTP500YRExt
Flow HW US - VR-1CTP100YRExt
Flow HW DS - VR-1CTP100YRExt
Flow HW DS - VR-1CTP500YRExt
Flow Leaving - VR-1CTP100YRExt
Flow Leaving - VR-1CTP500YRExt
Flow (cfs)
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
2400
0600
1200
1800
2400
0600
1200
1800
2400
0600
1200
1800
2400
01Jan2014
02Jan2014
03Jan2014
Time

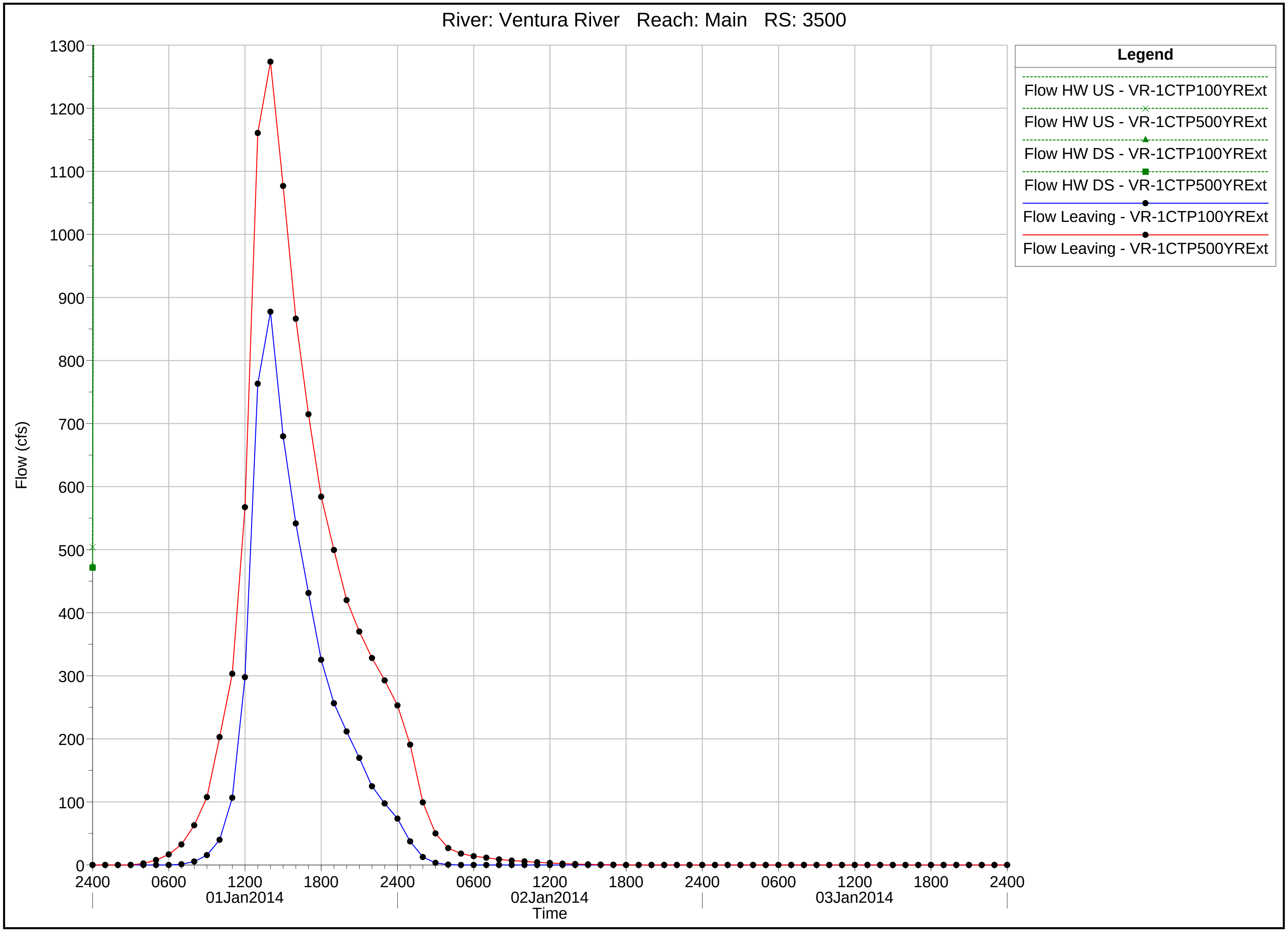
Ventura River Lateral Structure Flow



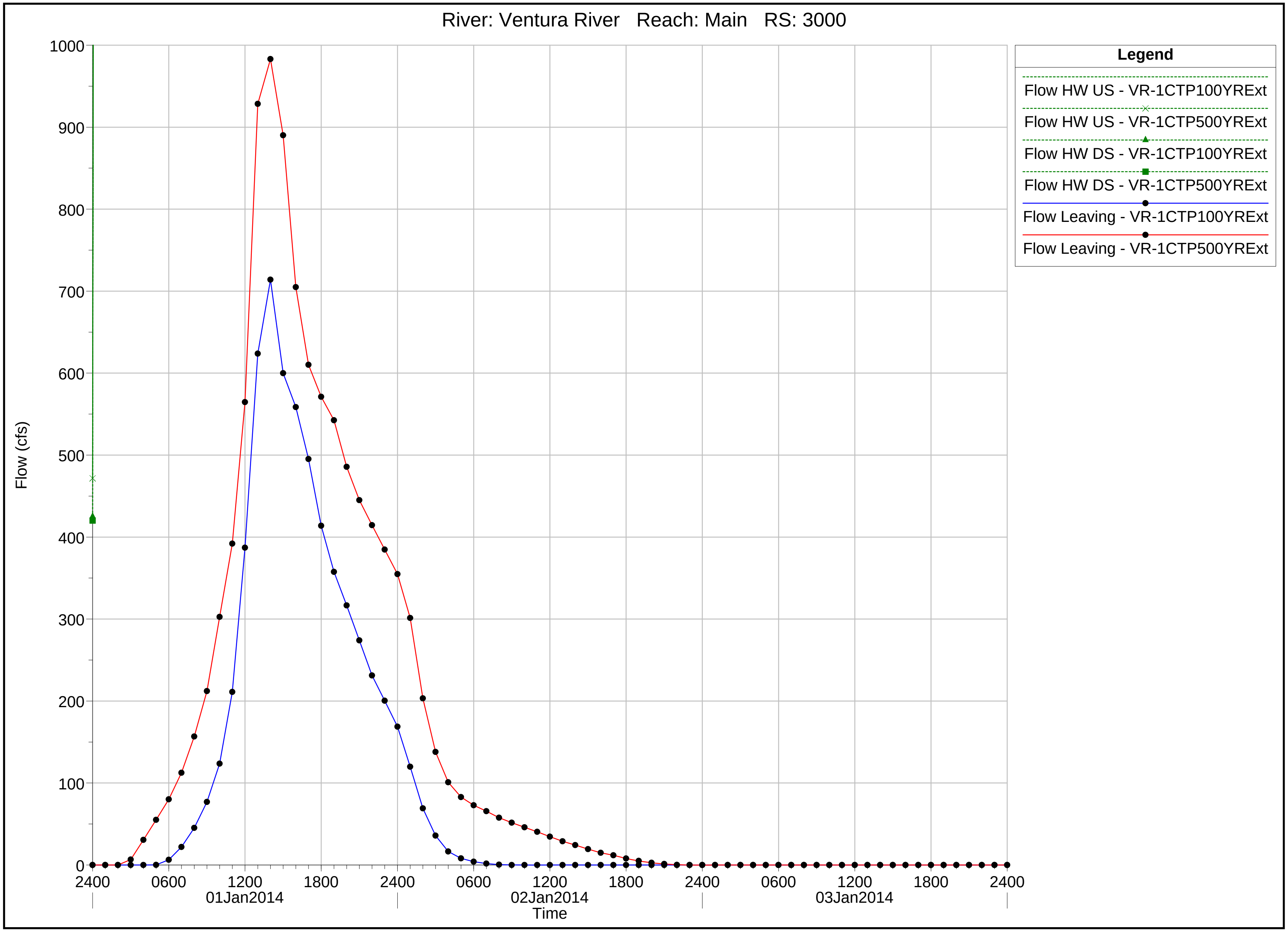
Ventura River Lateral Structure Flow



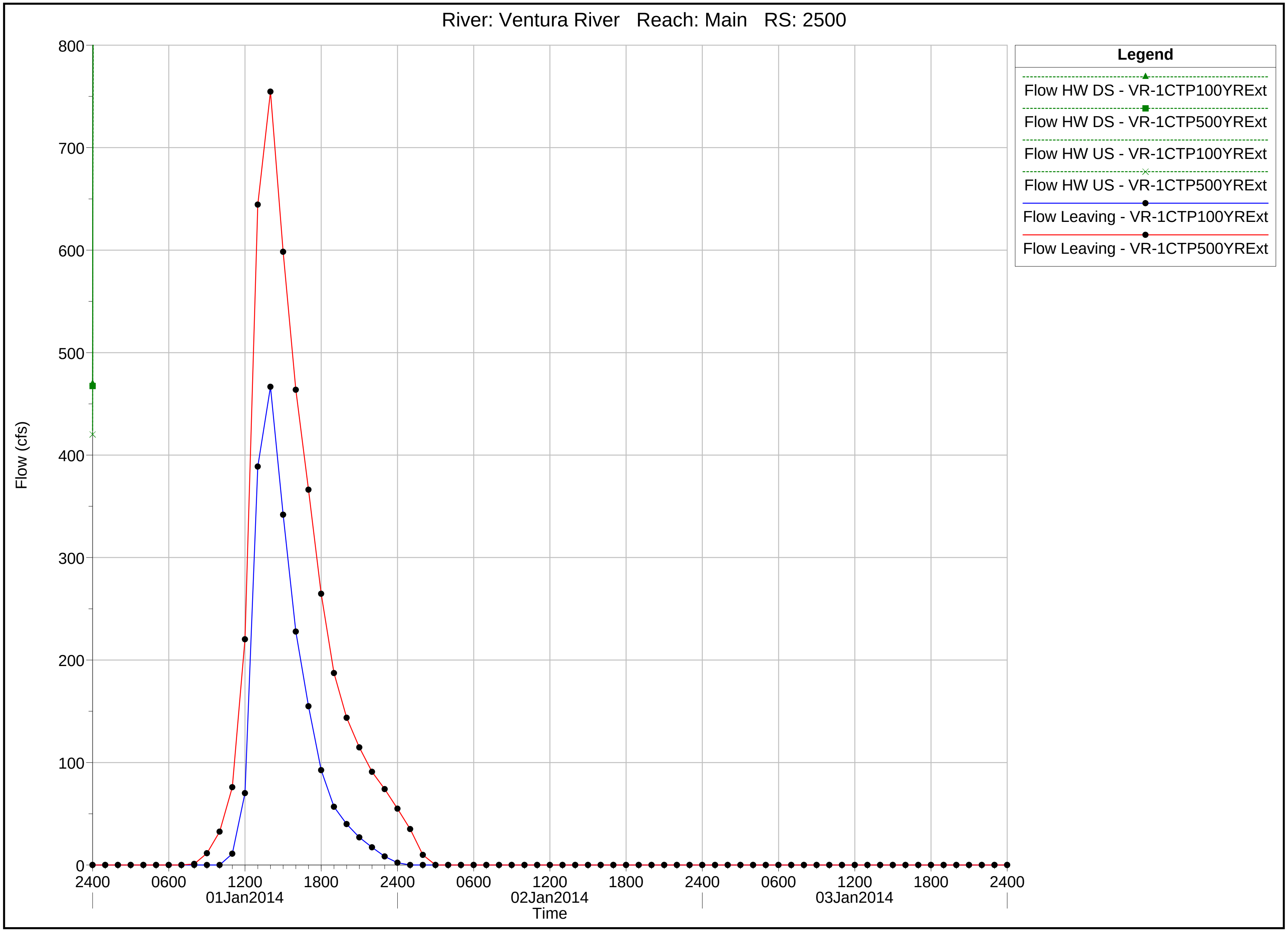
Ventura River Lateral Structure Flow



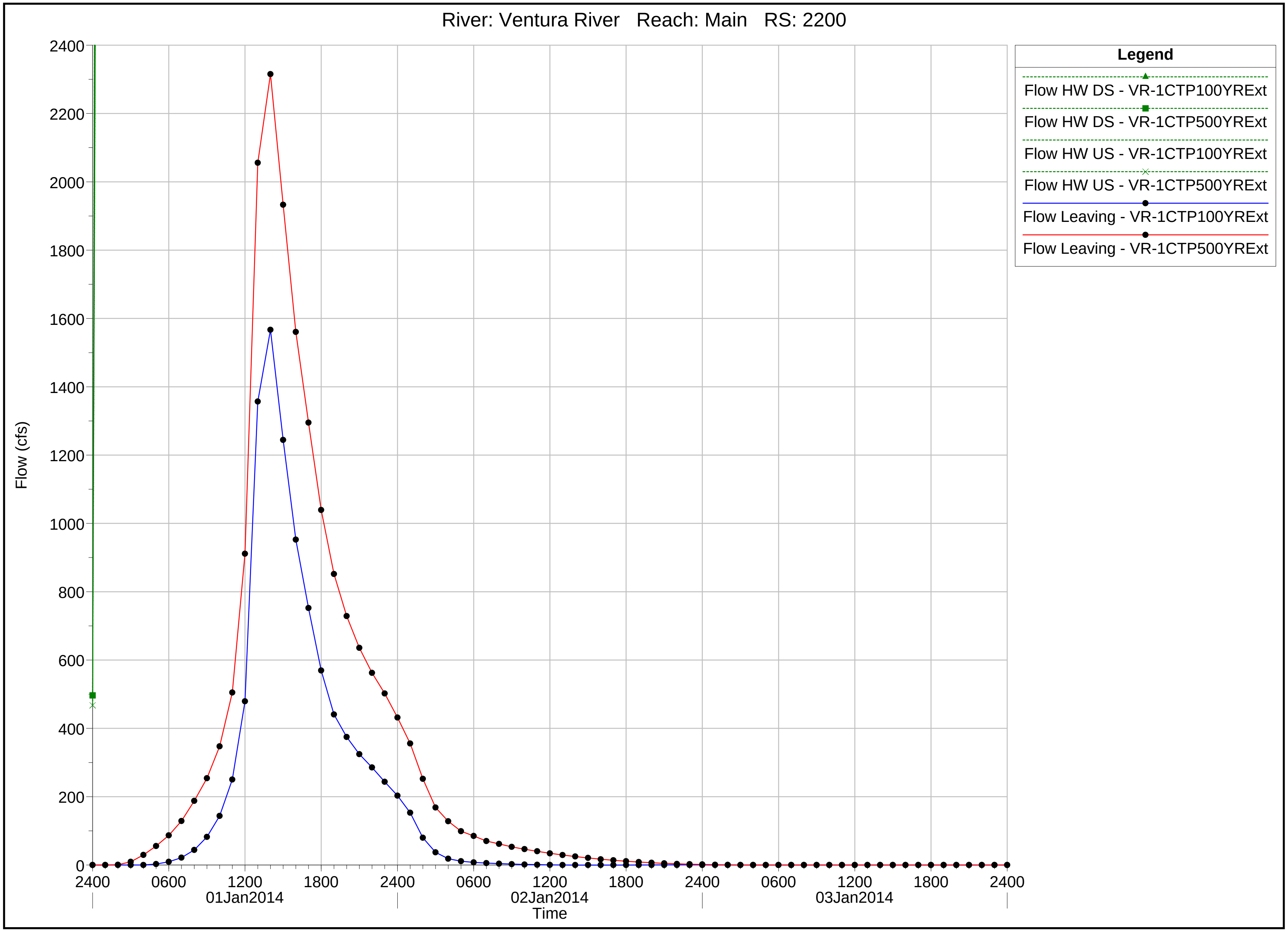
Ventura River Lateral Structure Flow



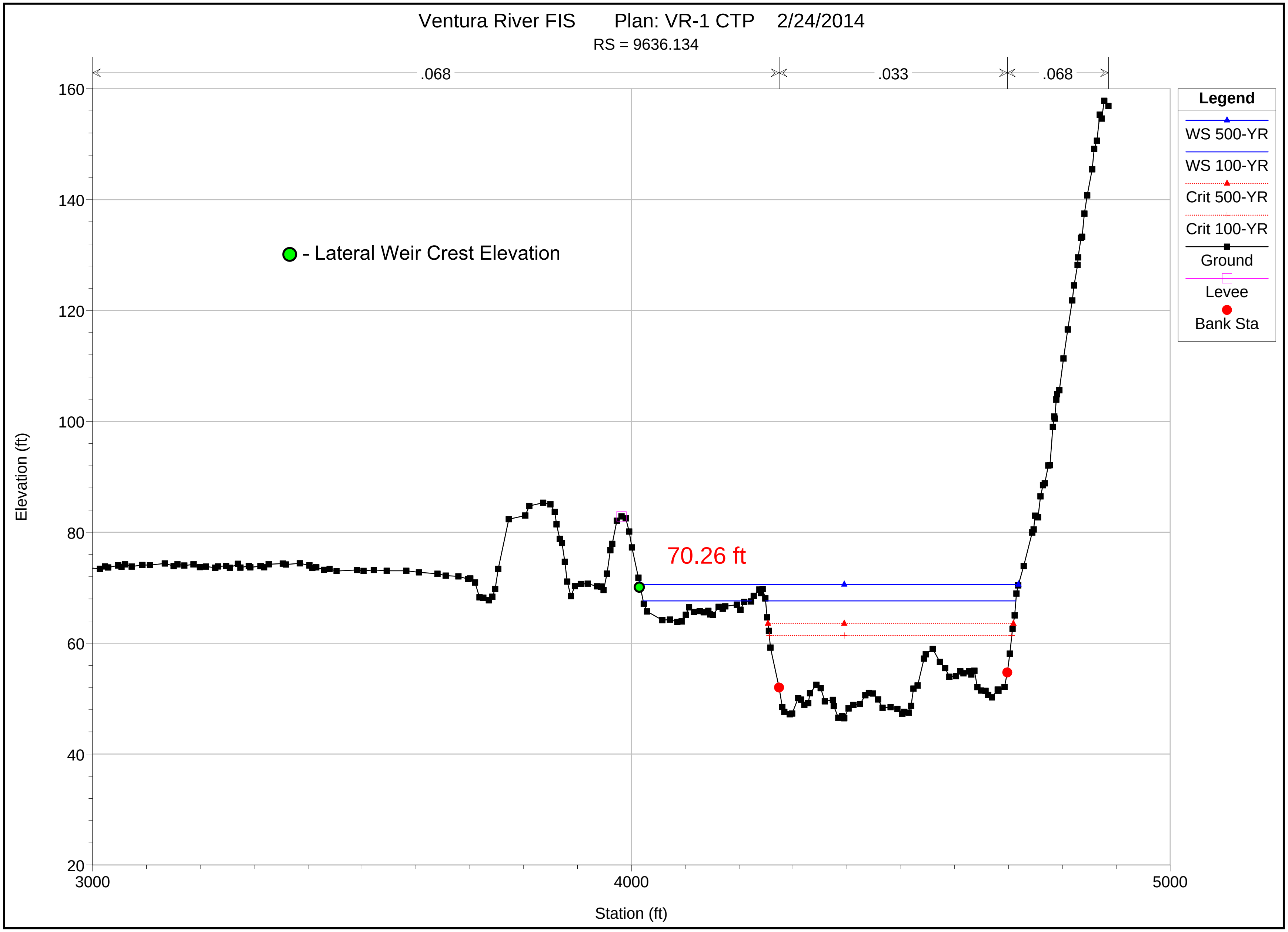
Ventura River Lateral Structure Flow



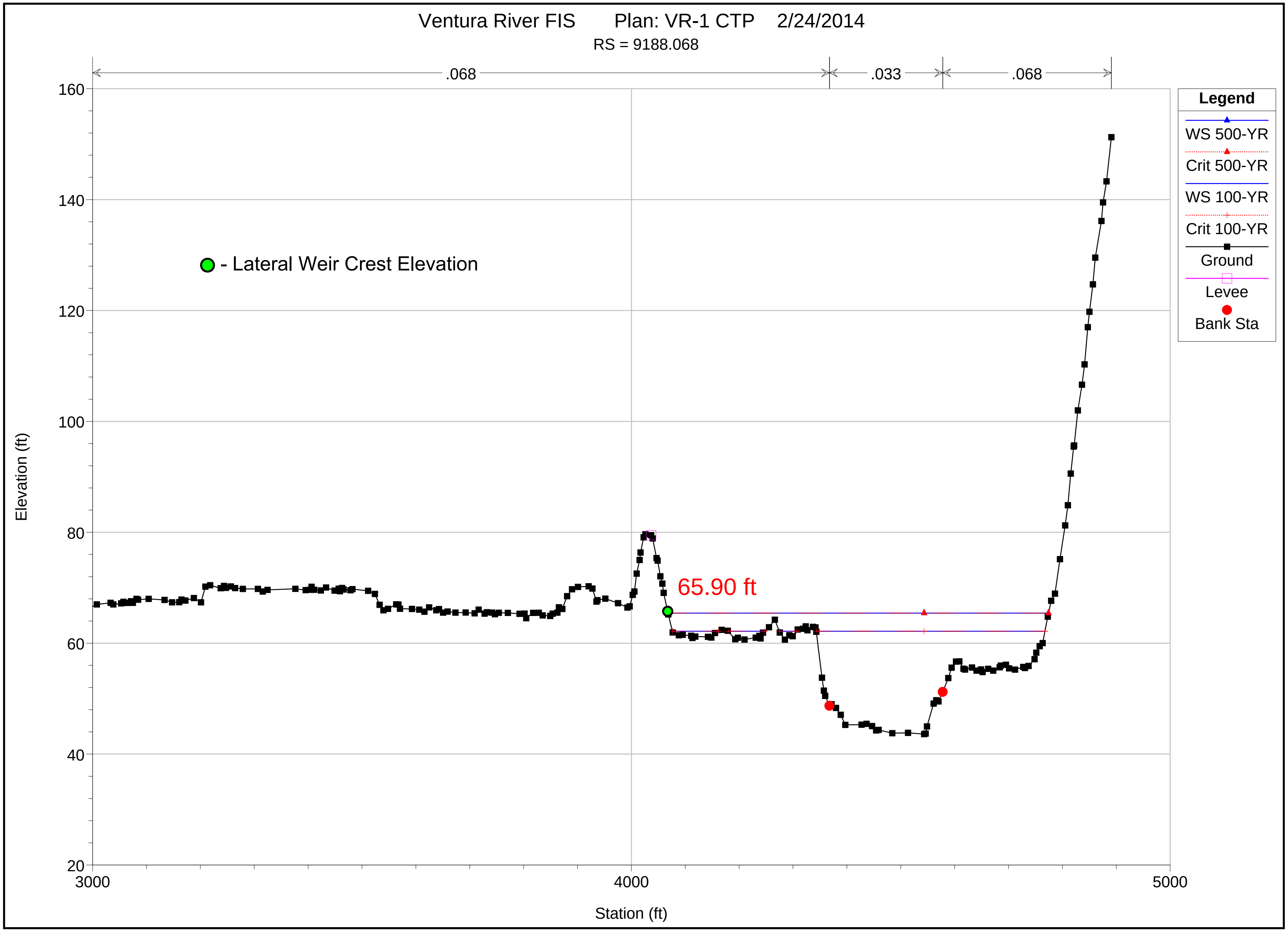
Ventura River Lateral Structure Flow



Ventura River Lateral Weirs

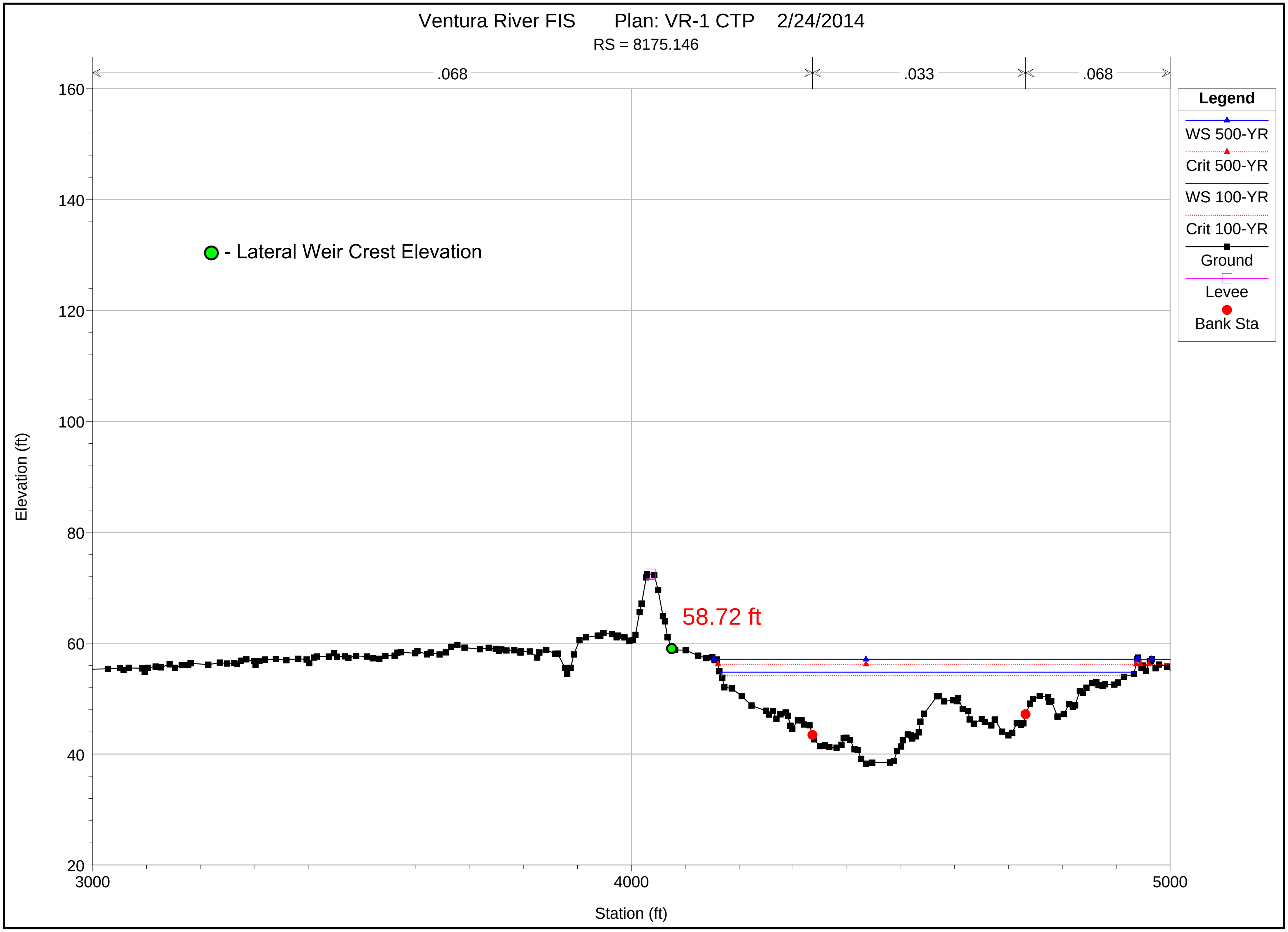


Ventura River Lateral Weirs

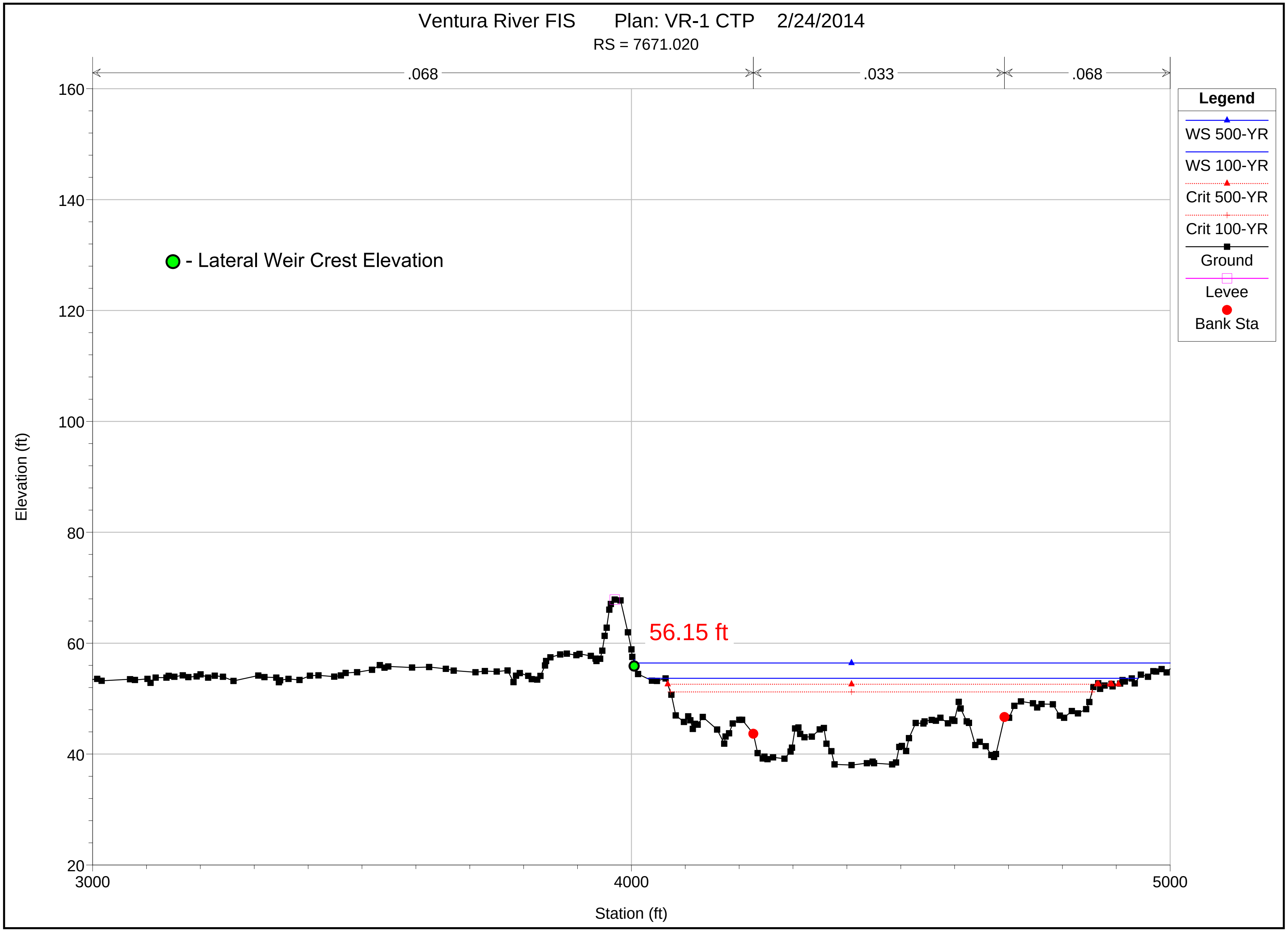


Ventura River Lateral Weirs

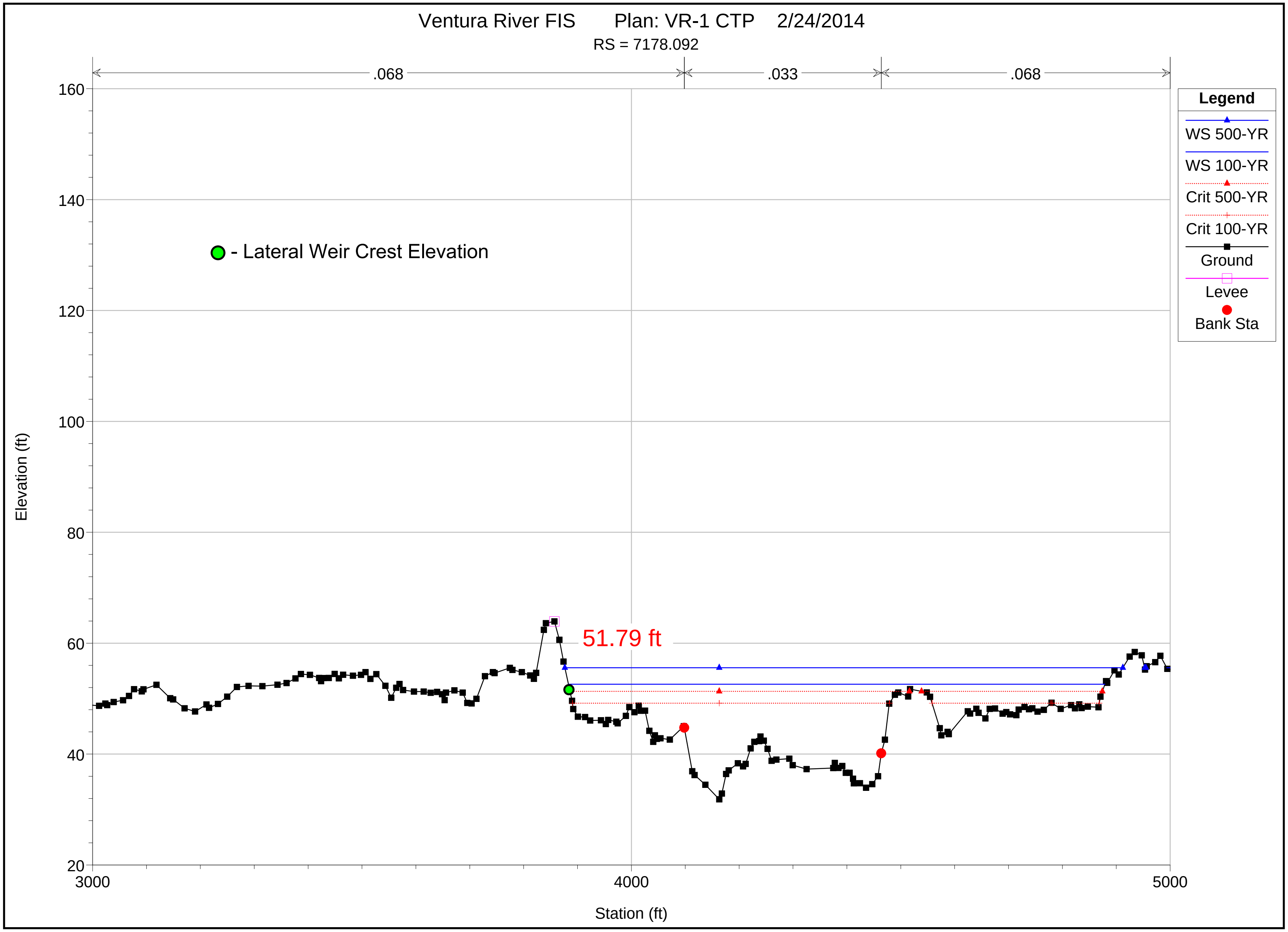
Ventura River Lateral Weirs



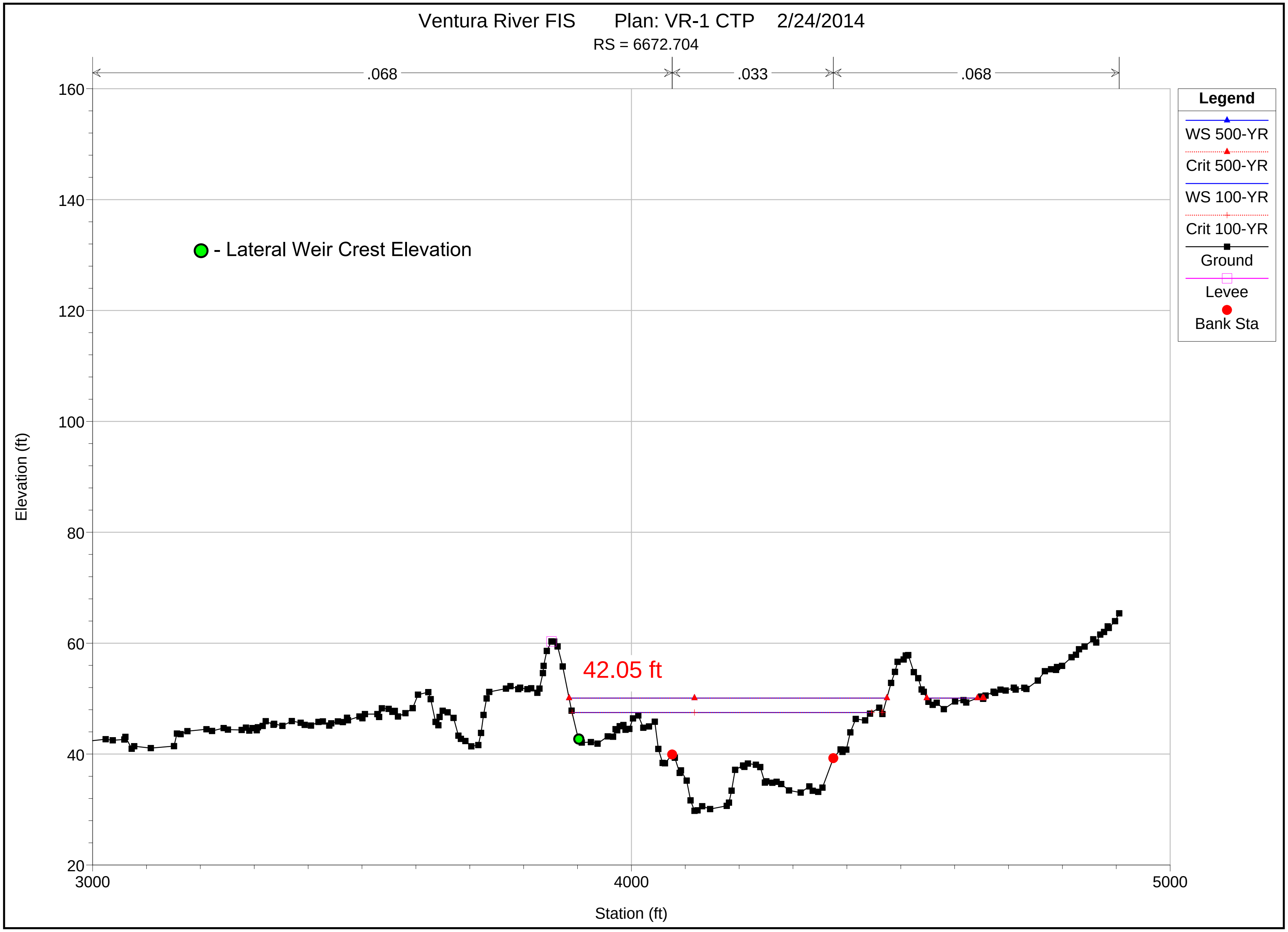
Ventura River Lateral Weirs



Ventura River Lateral Weirs



Ventura River Lateral Weirs



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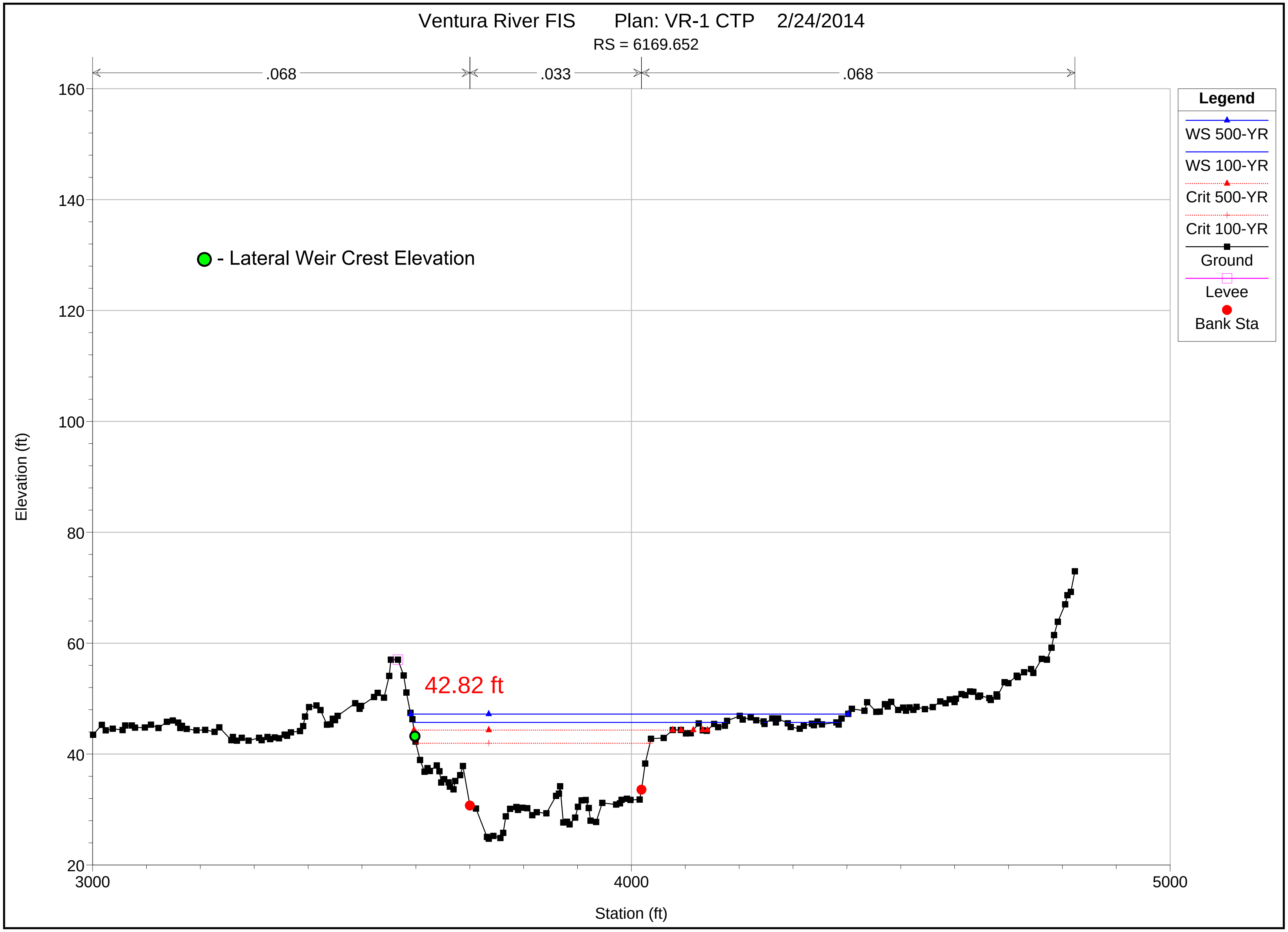
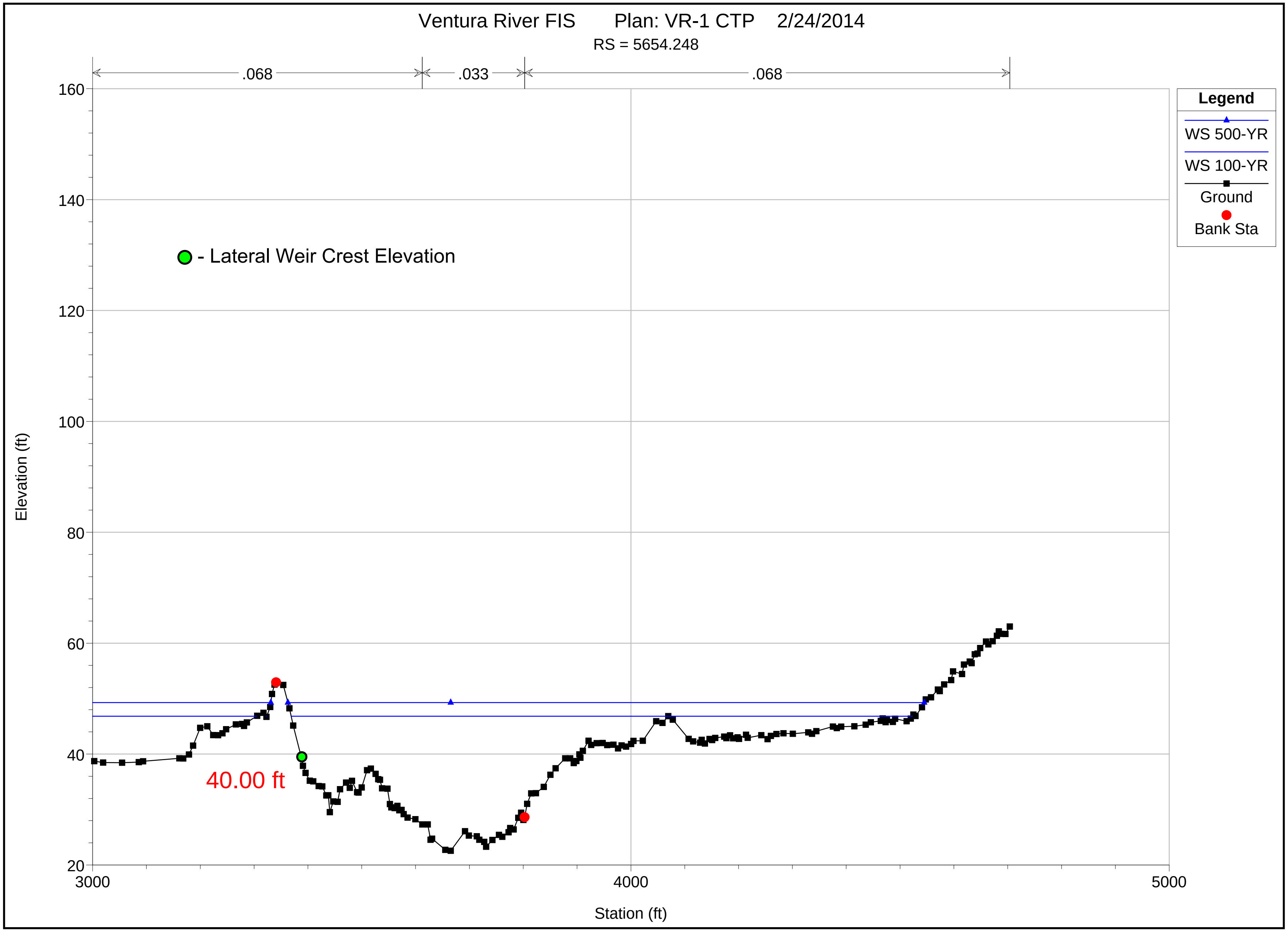


Ventura River Lateral Weirs



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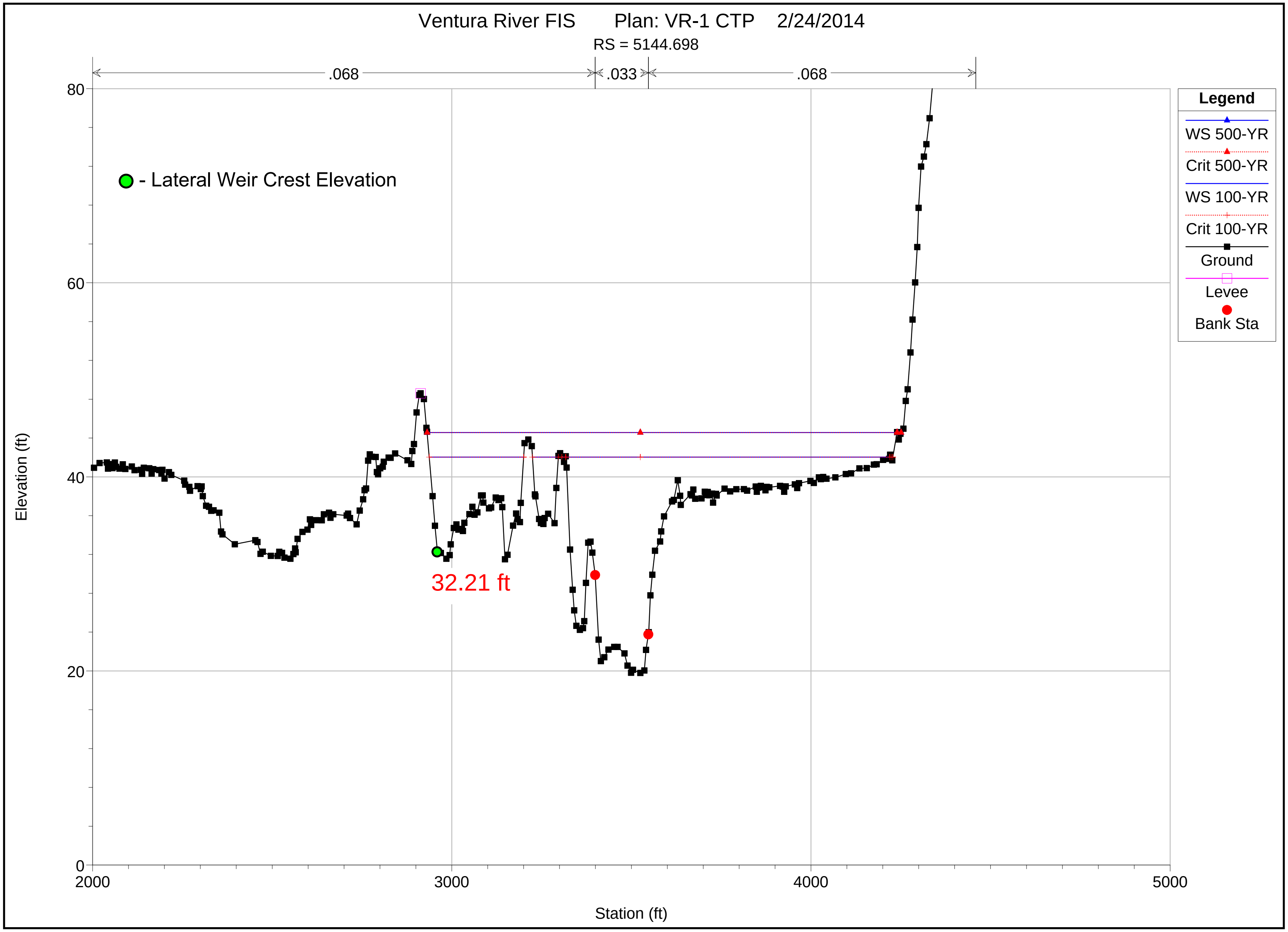
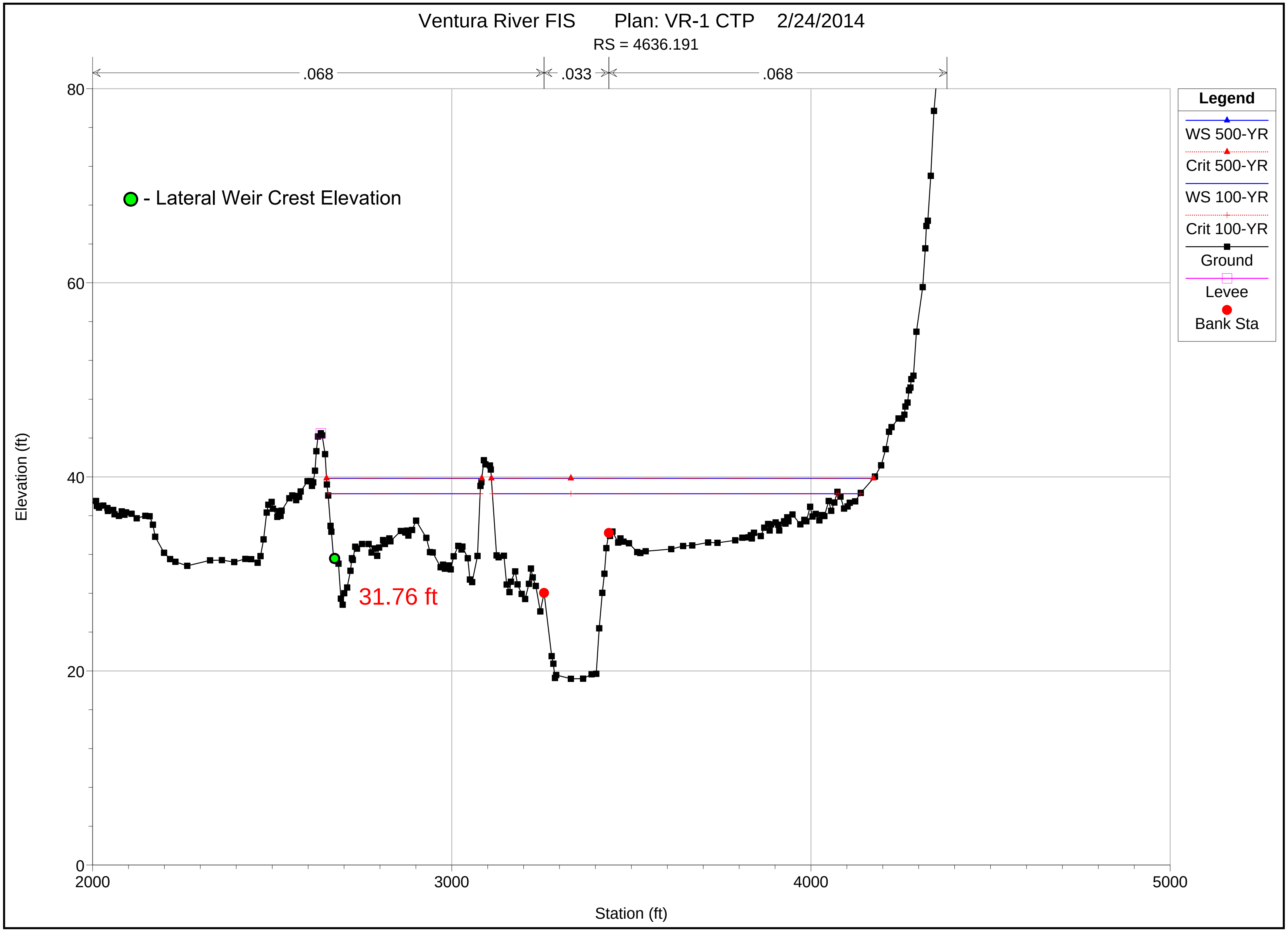


Ventura River Lateral Weirs



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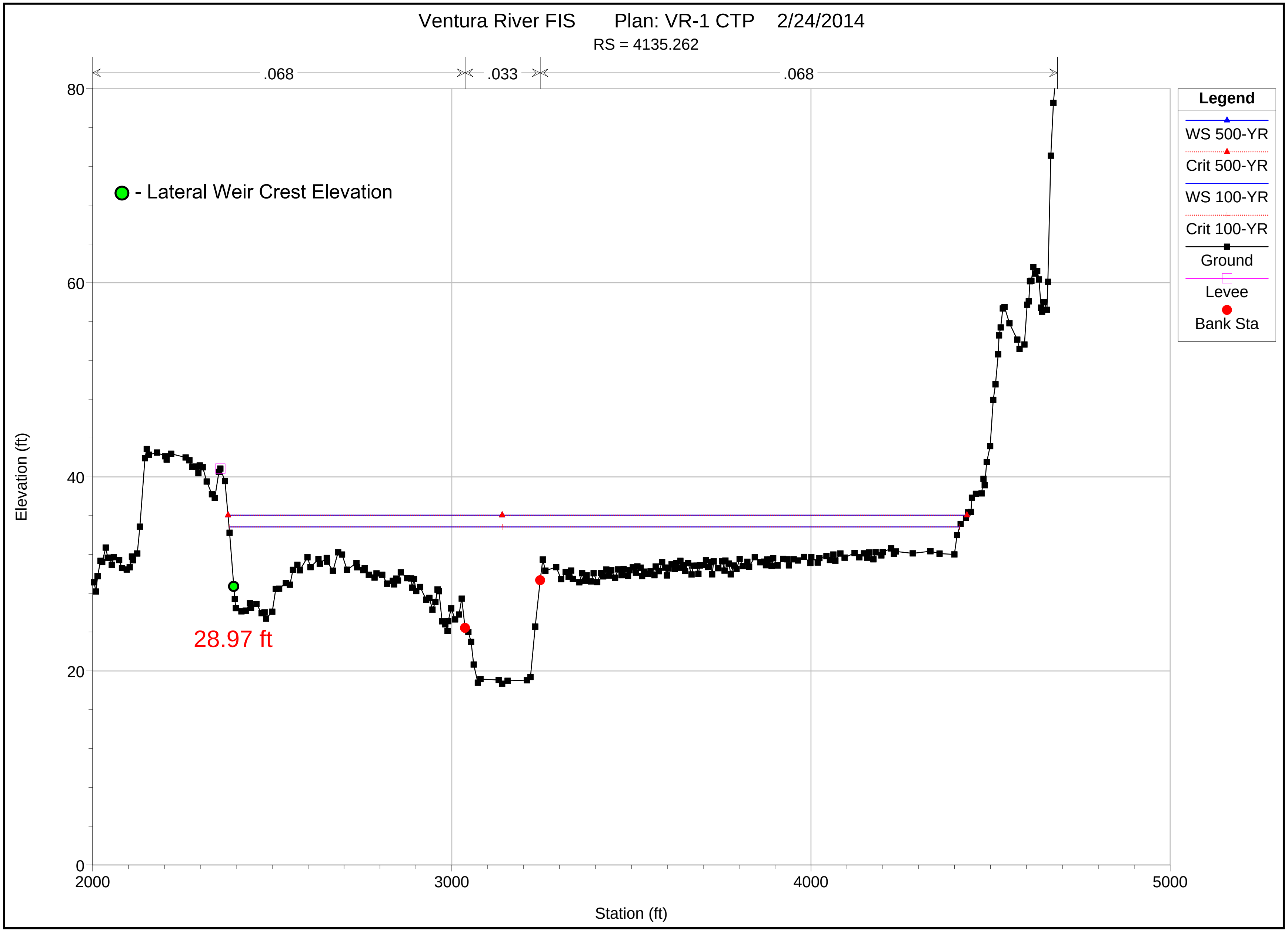
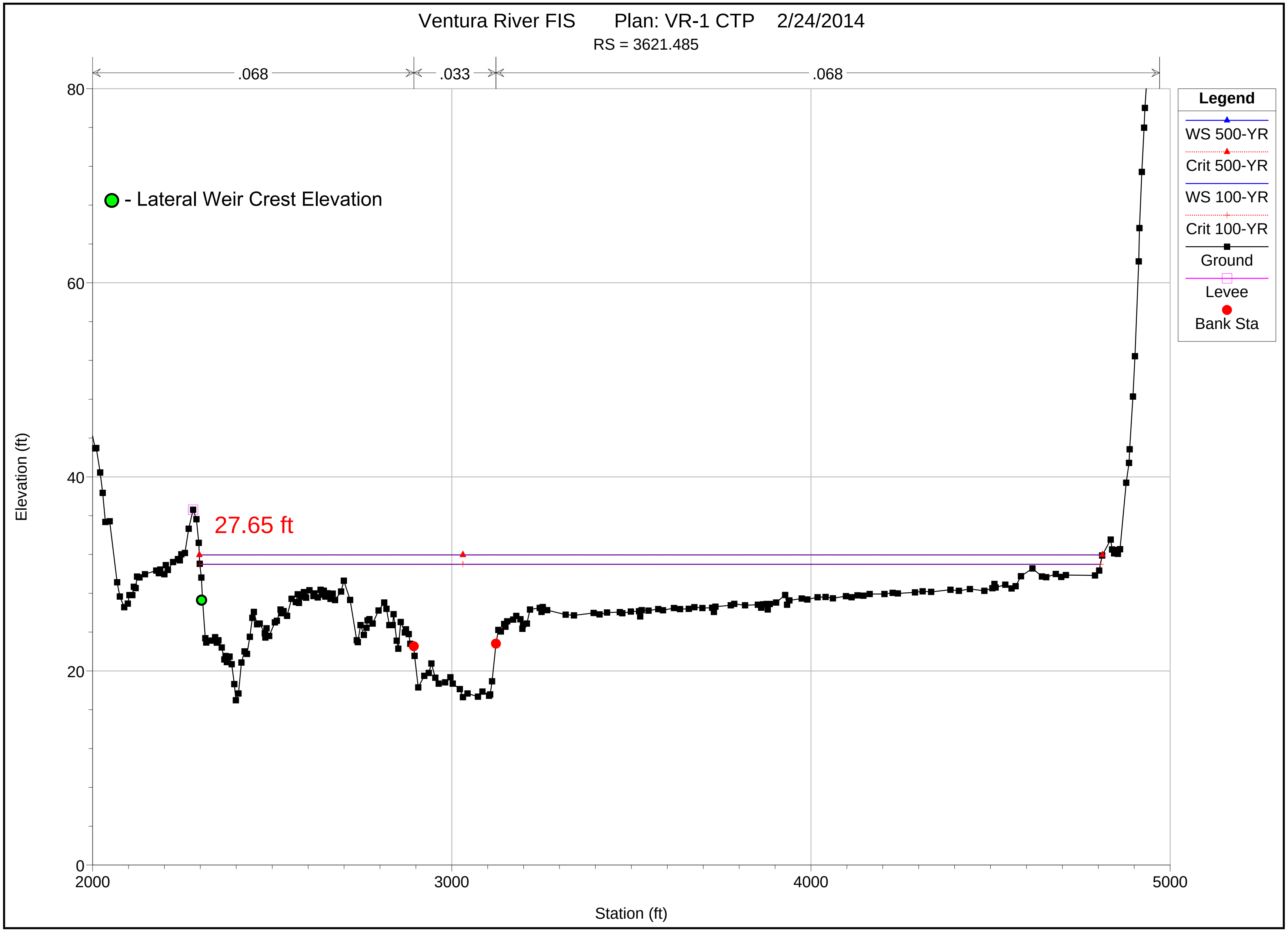


Ventura River Lateral Weirs



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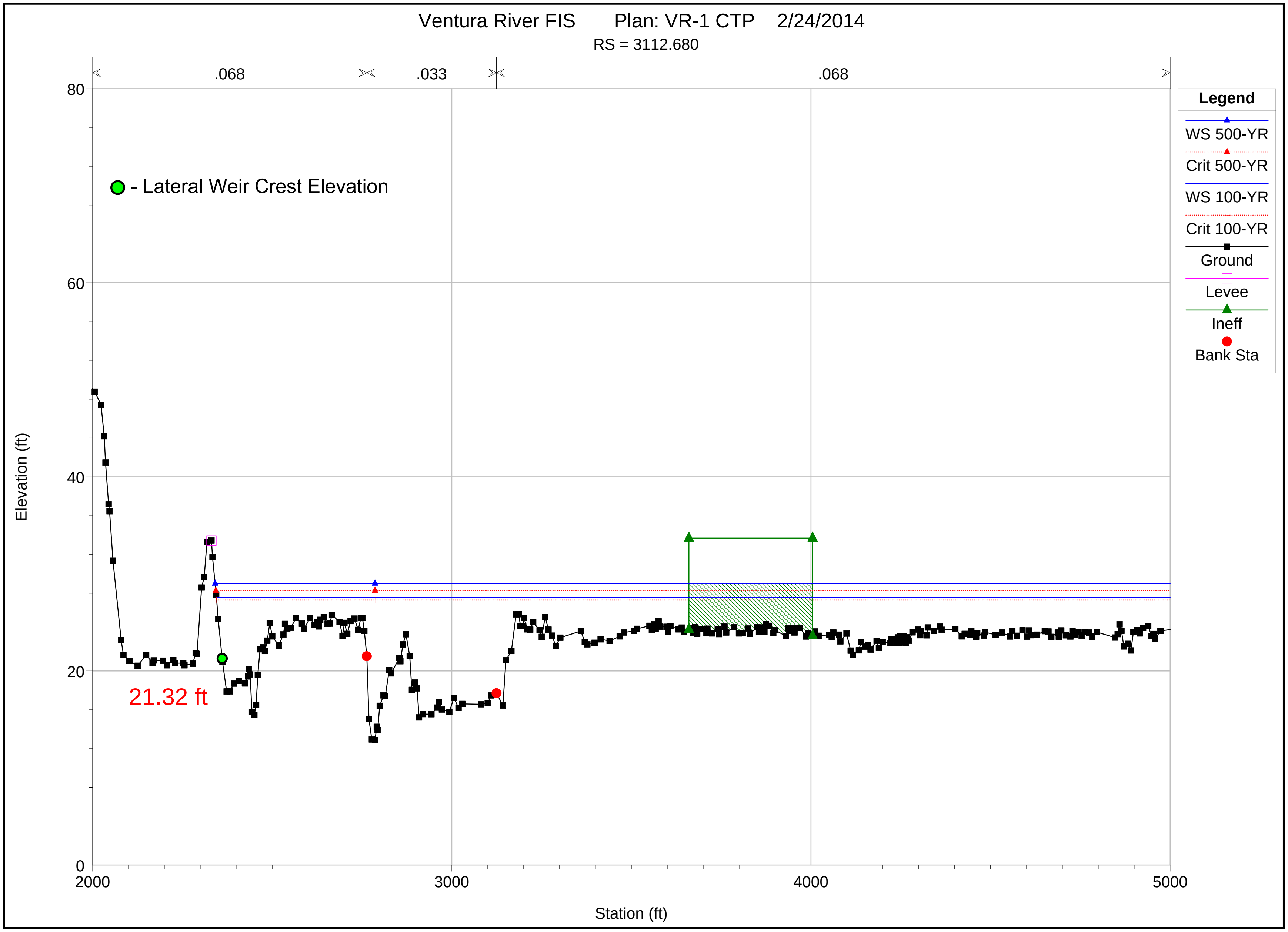
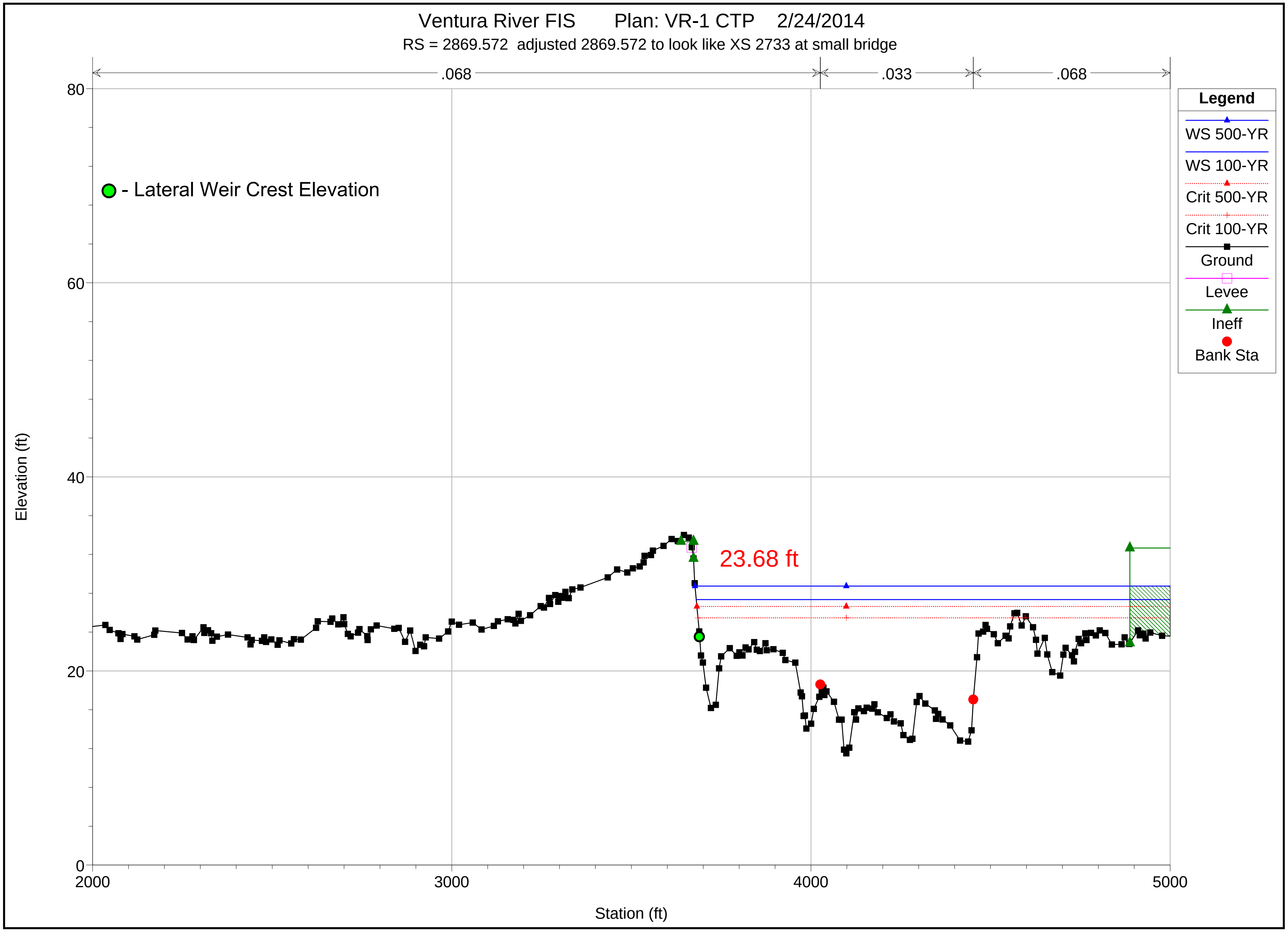


Ventura River Lateral Weirs



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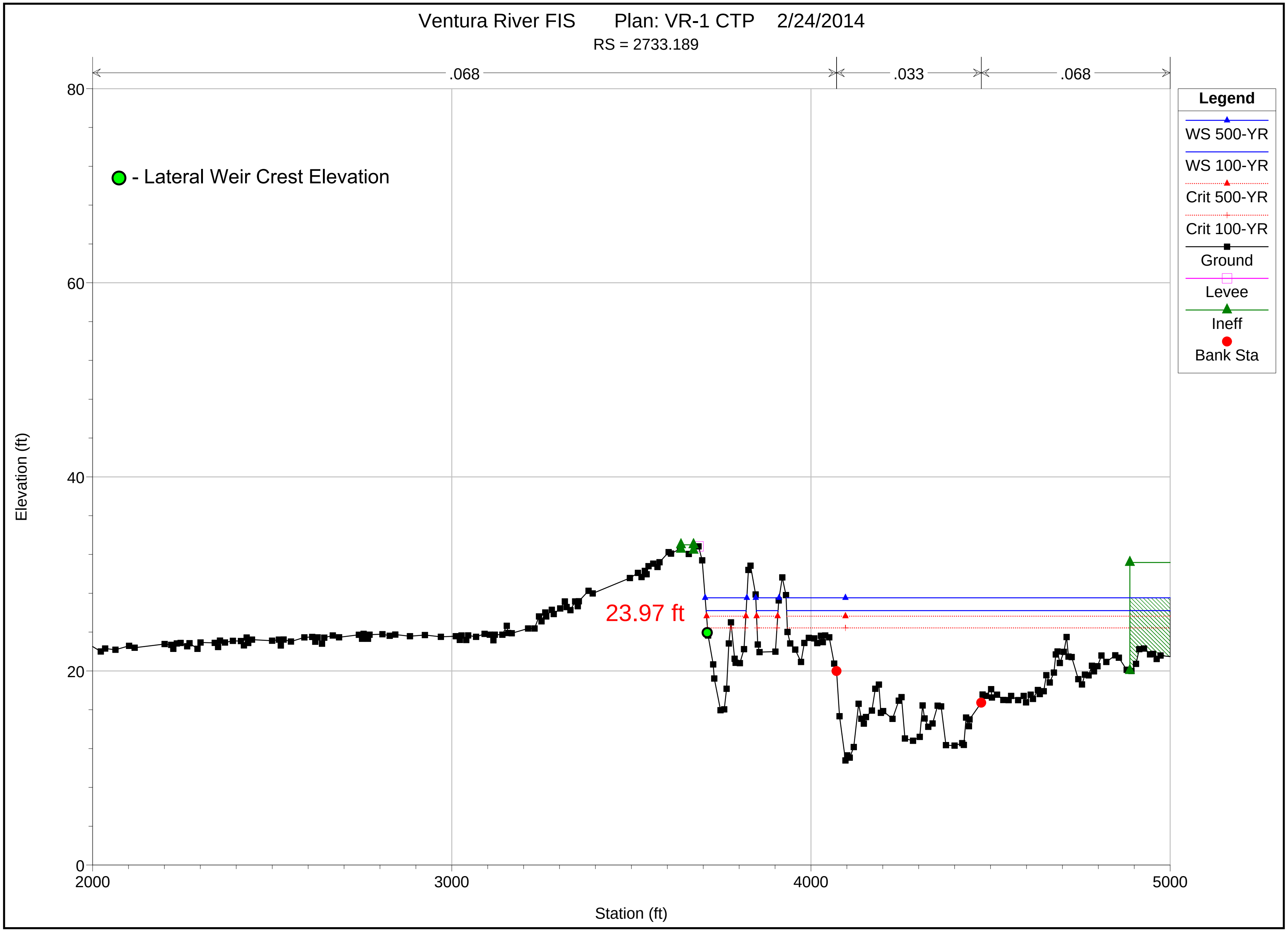
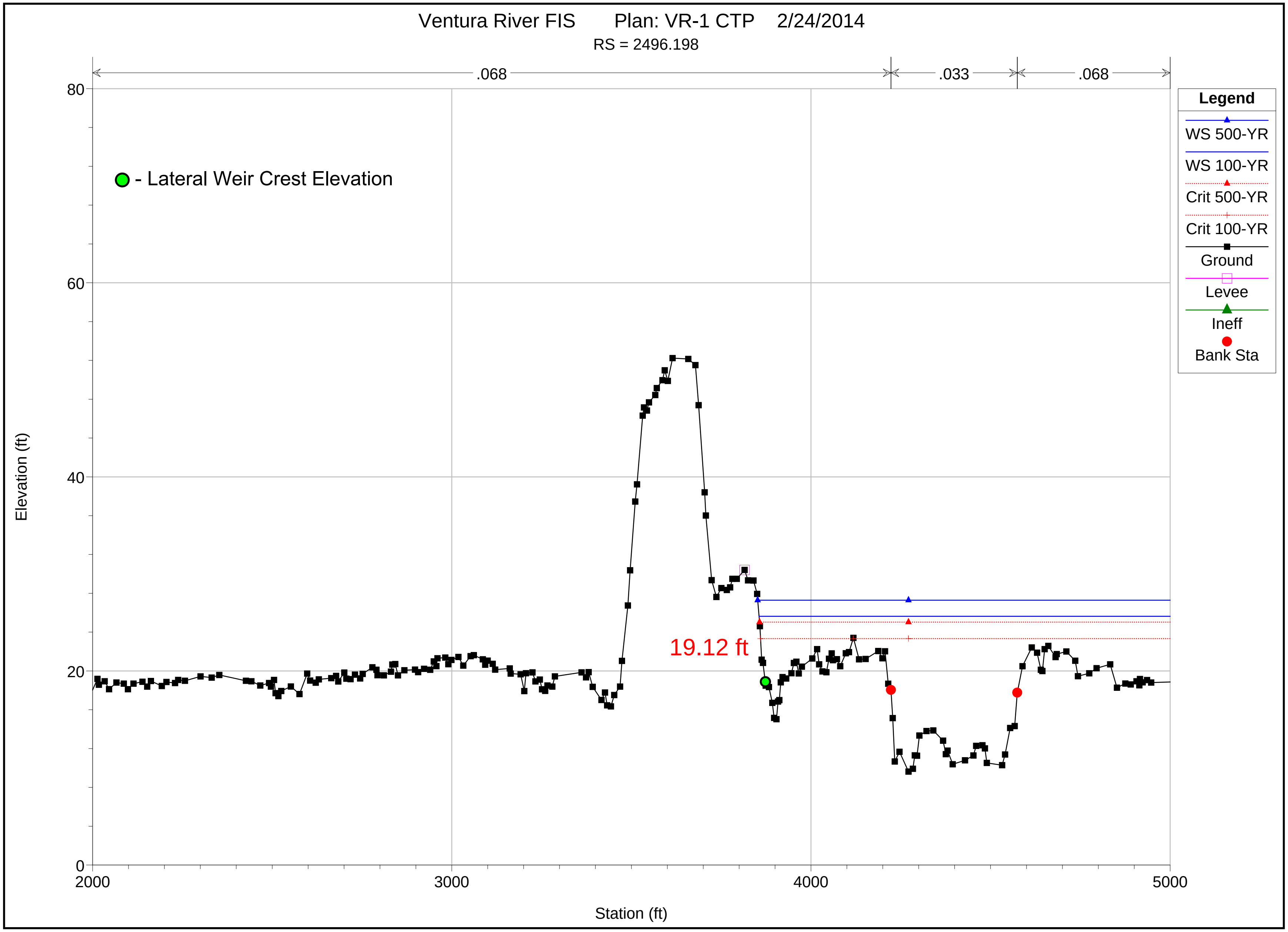
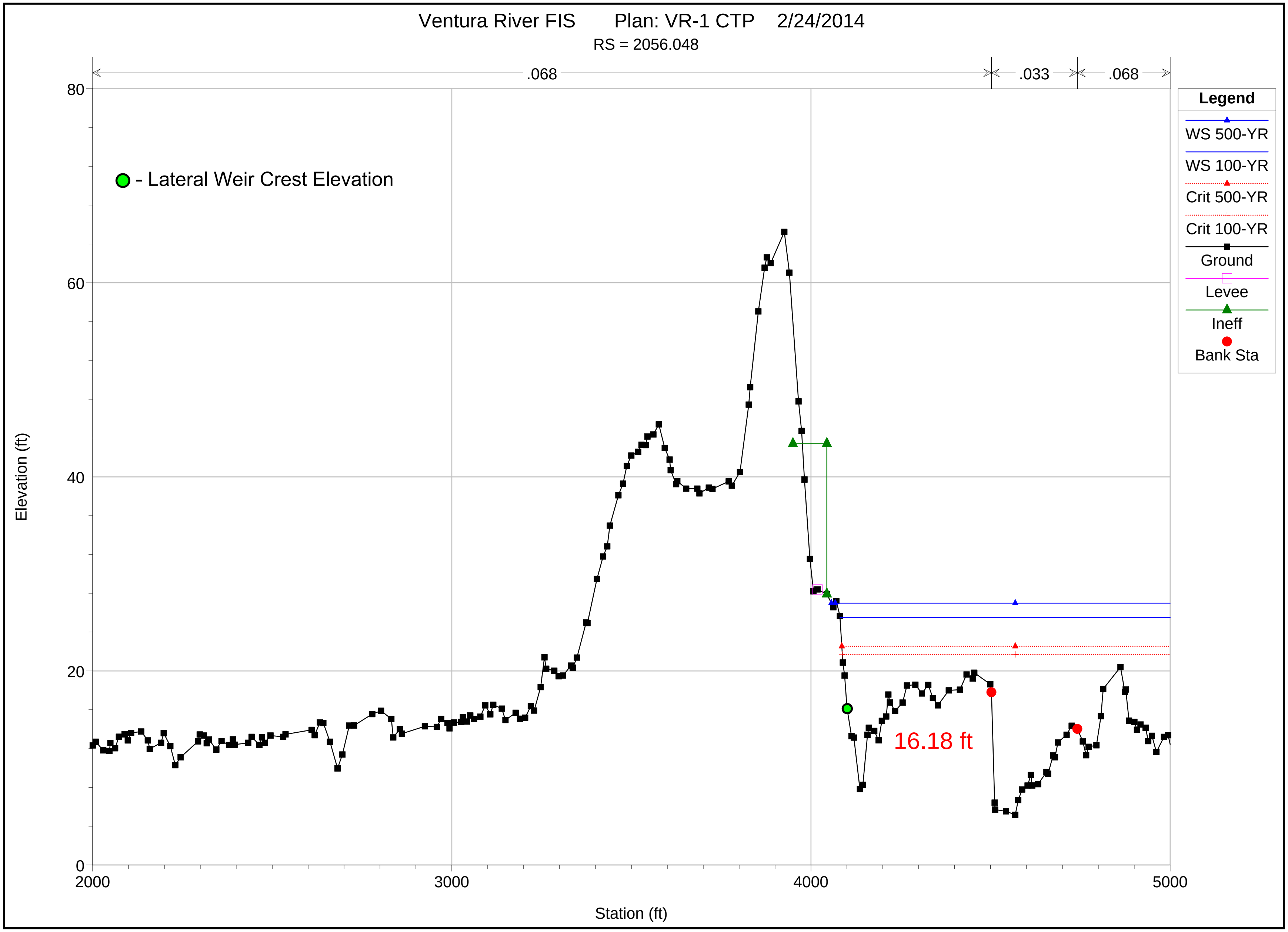


Ventura River Lateral Weirs



Ventura River Lateral Weirs



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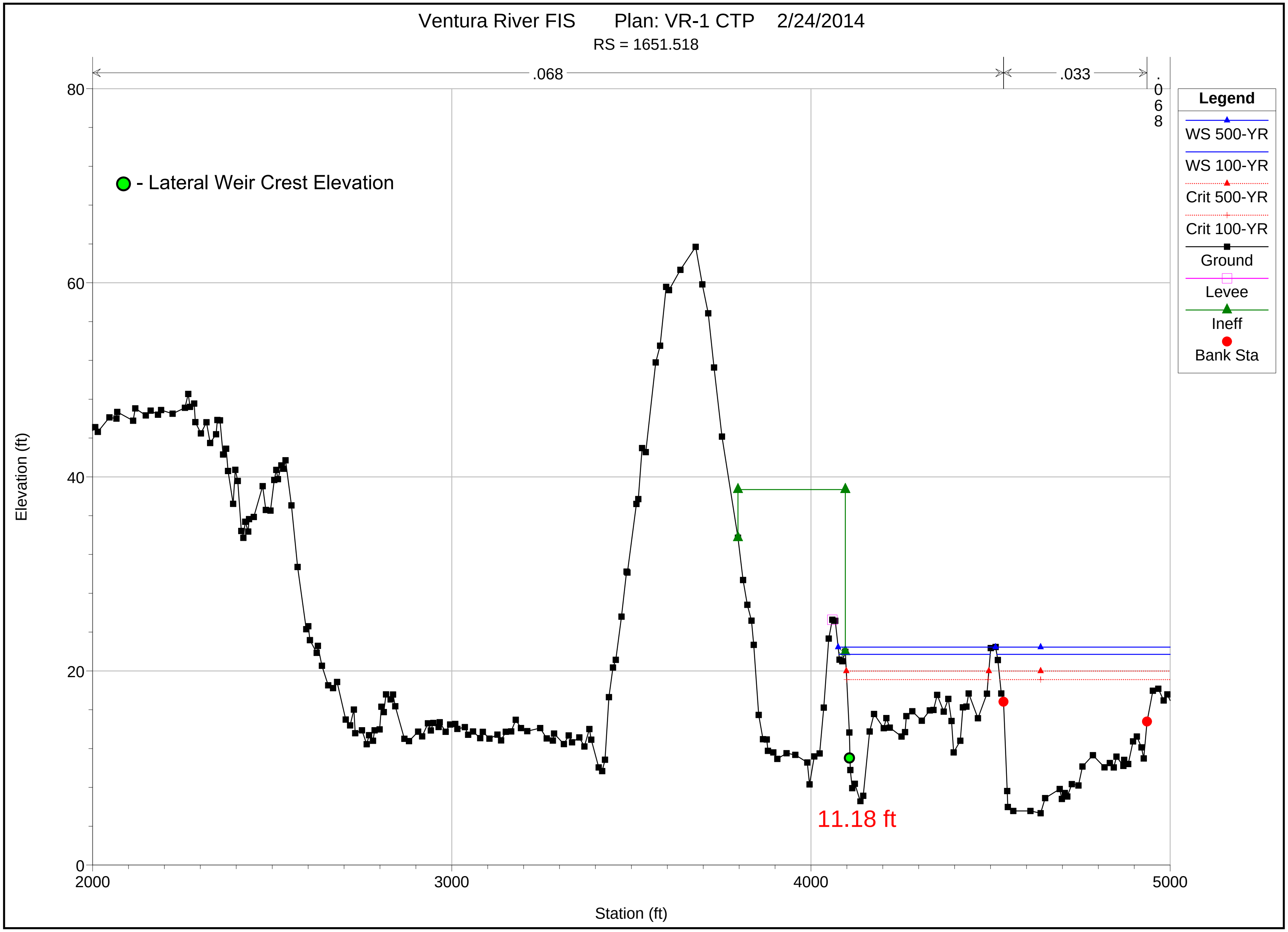

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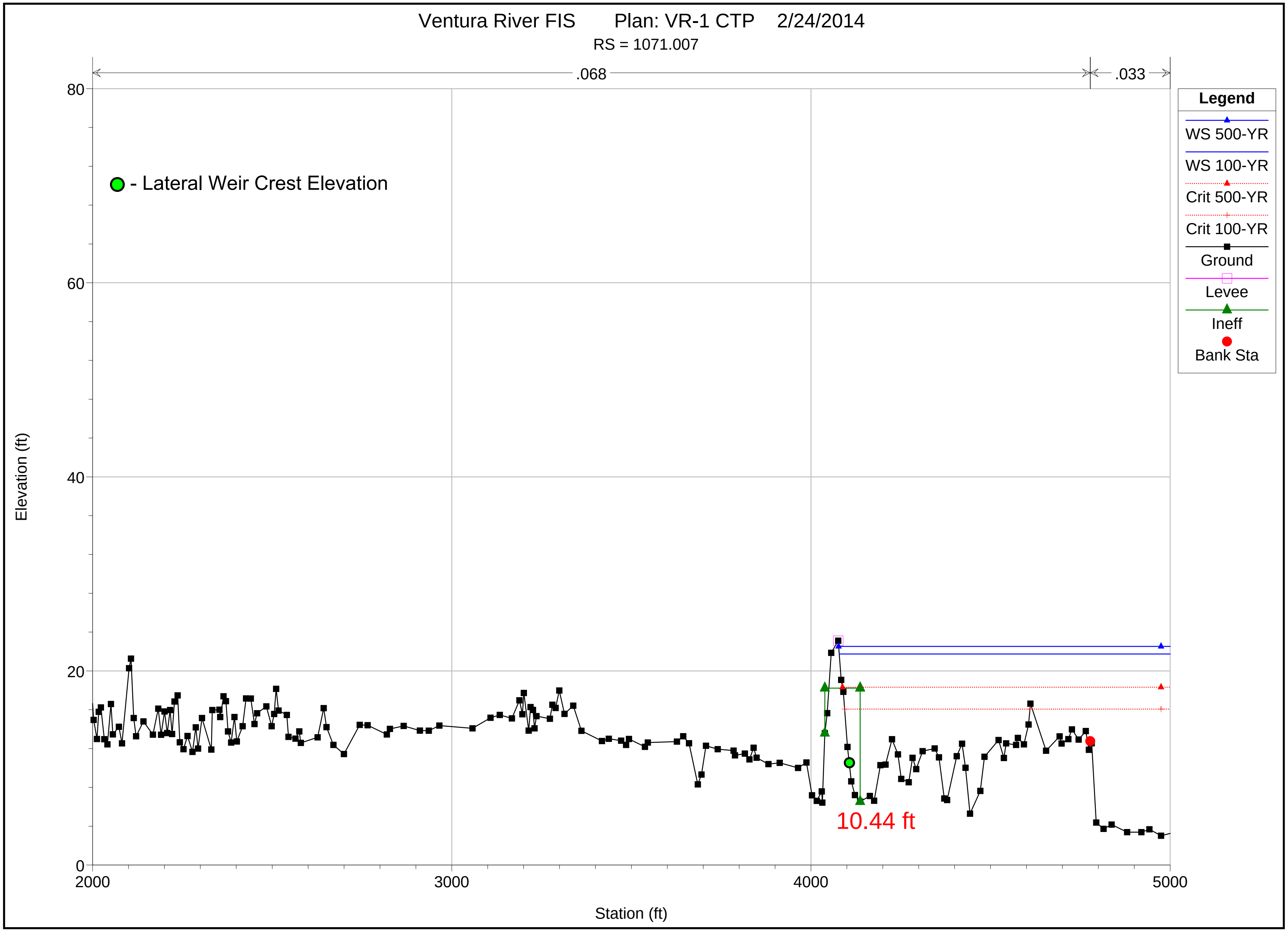

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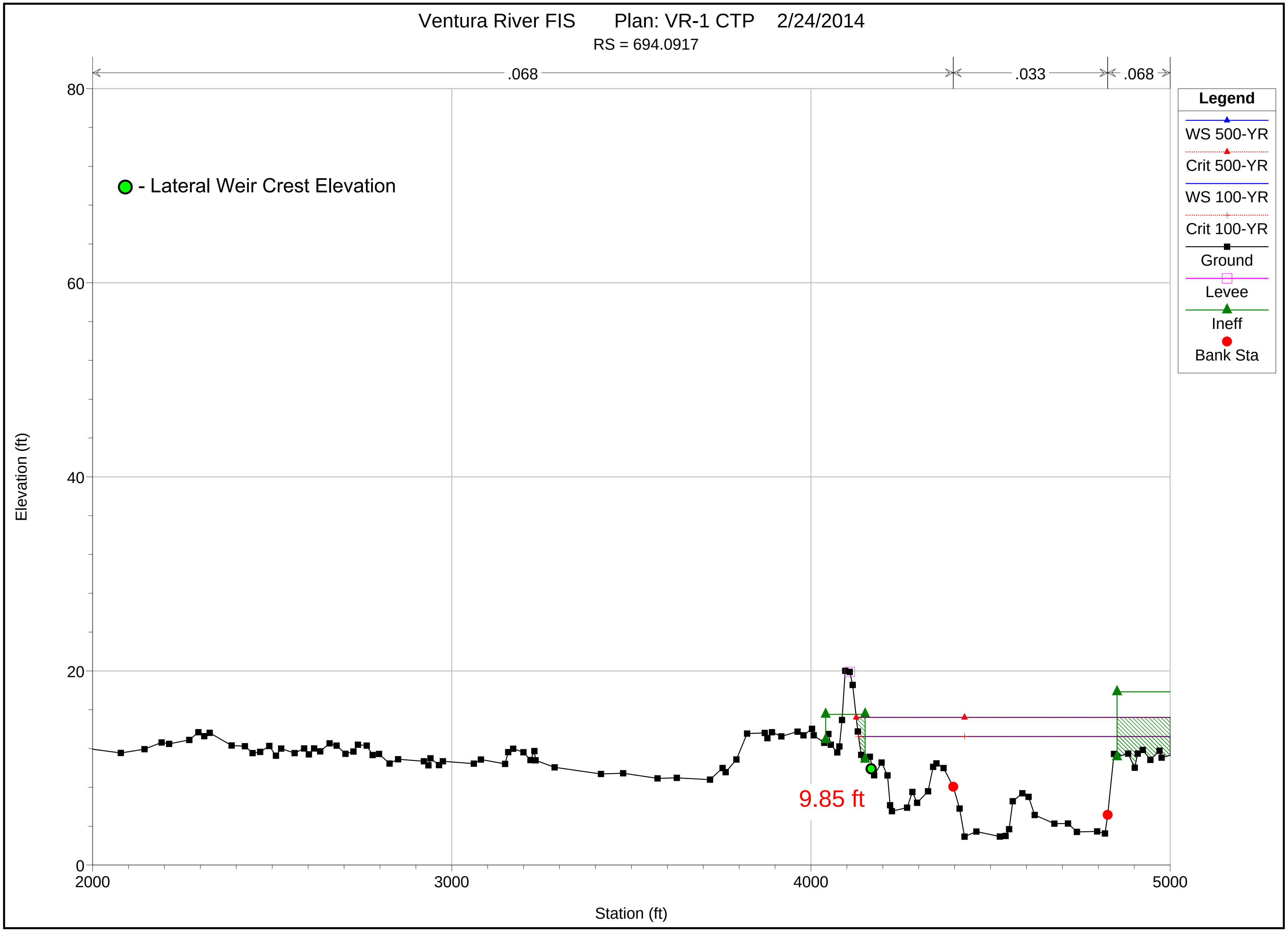

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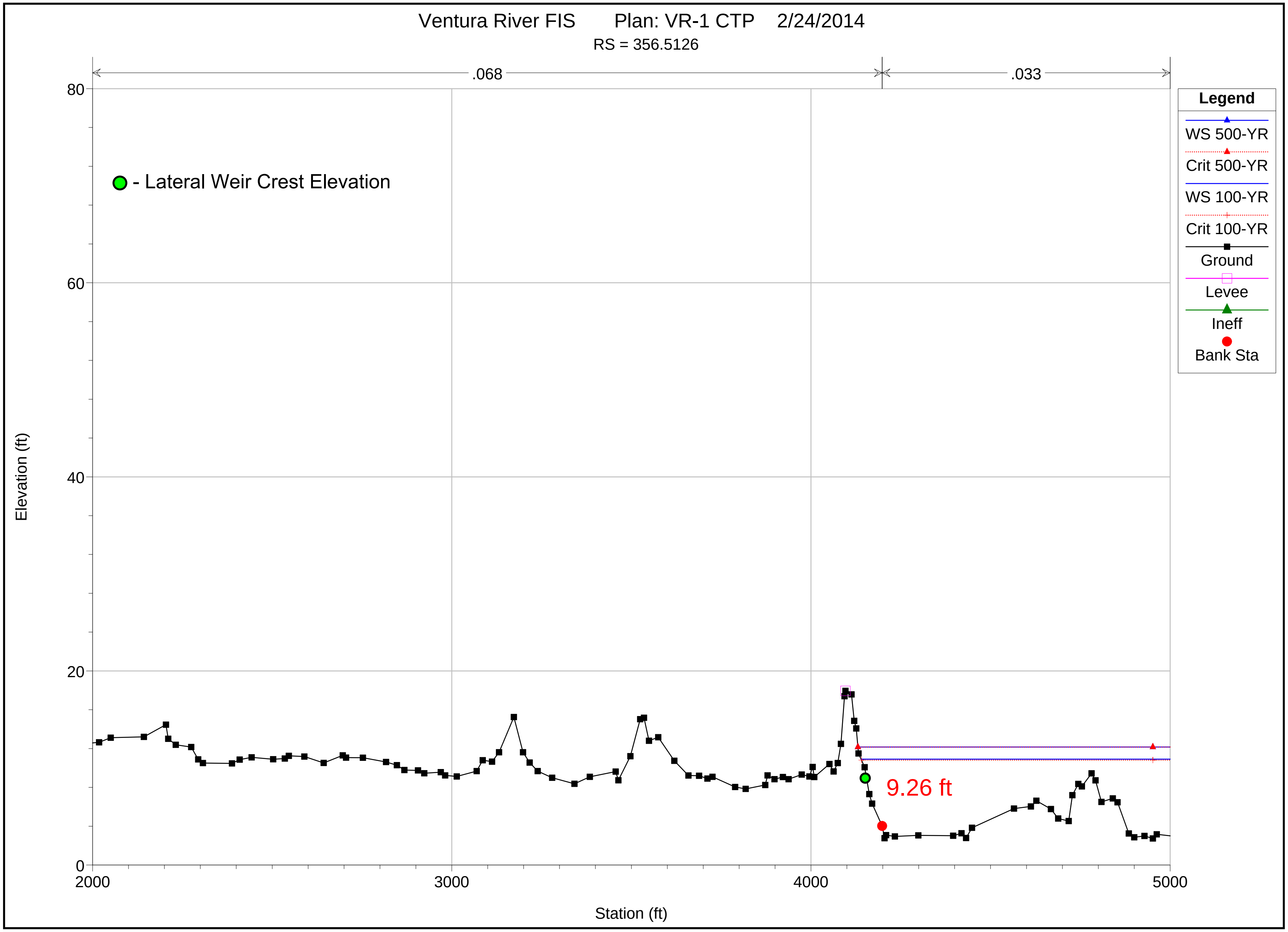

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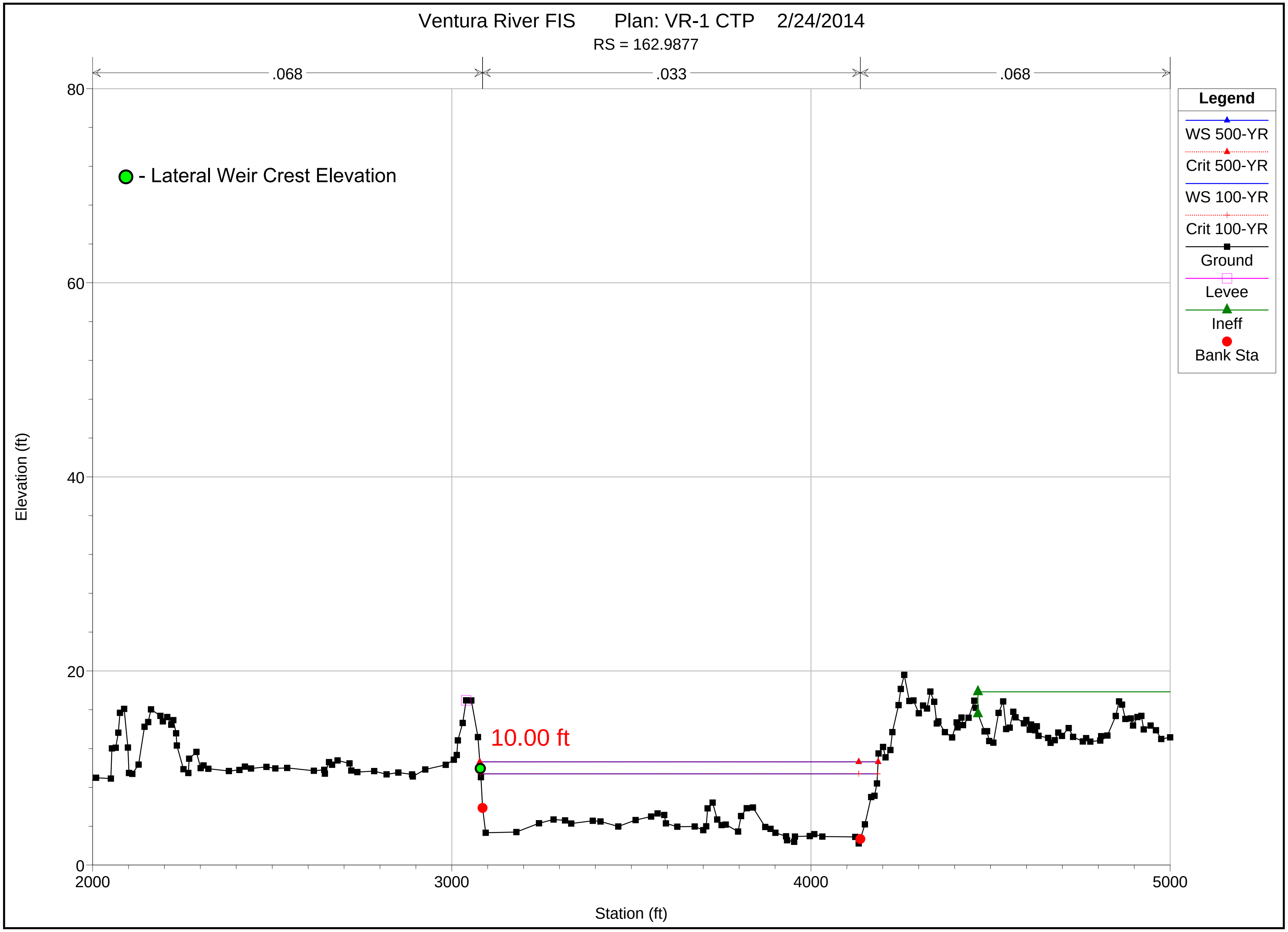
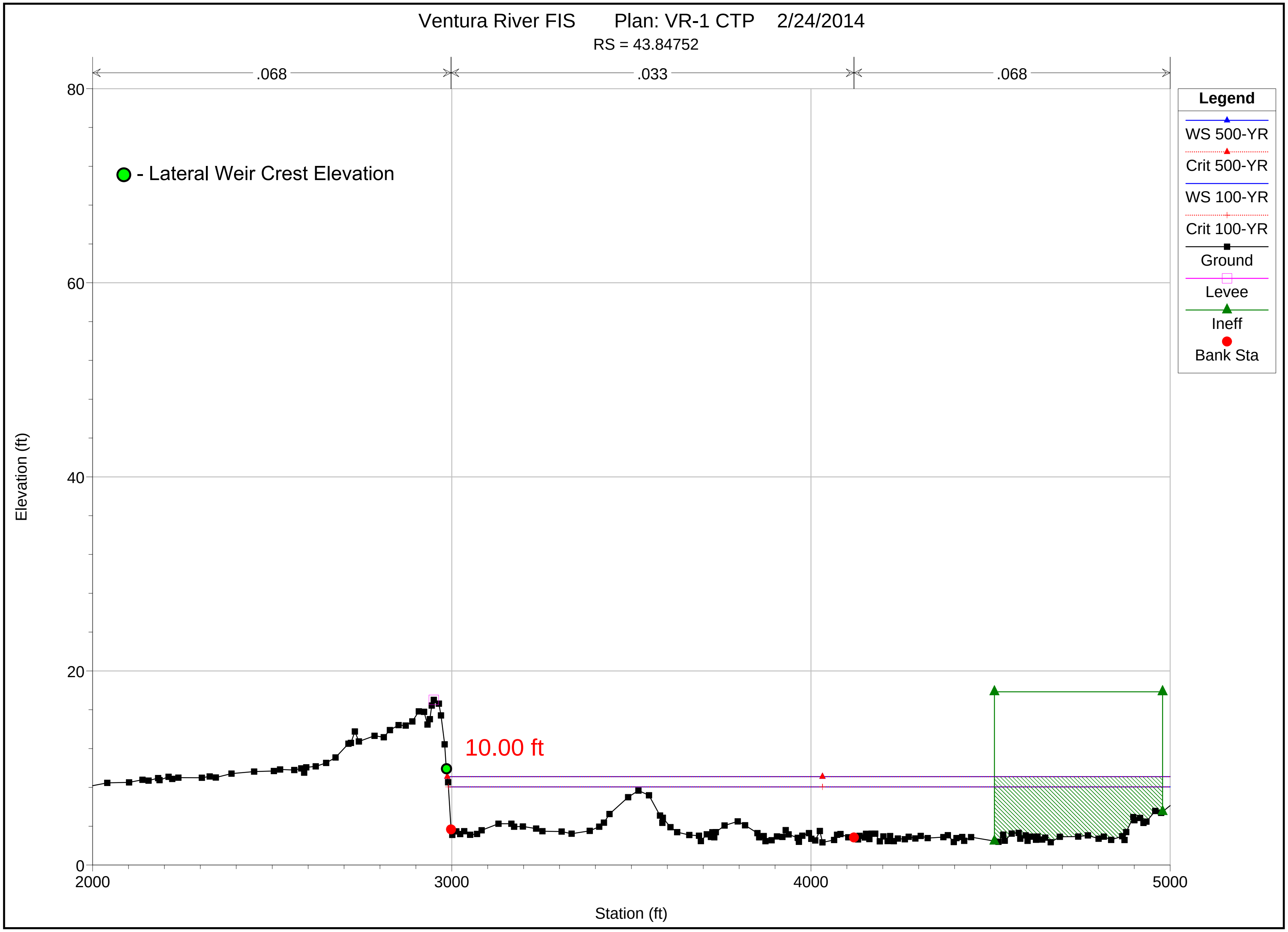


Ventura River Lateral Weirs



VENTURA RIVER WATER SURFACE PROFILES AND FLOODWAY DATA TABLE

(Also see Appendix D: Digital Data CD)

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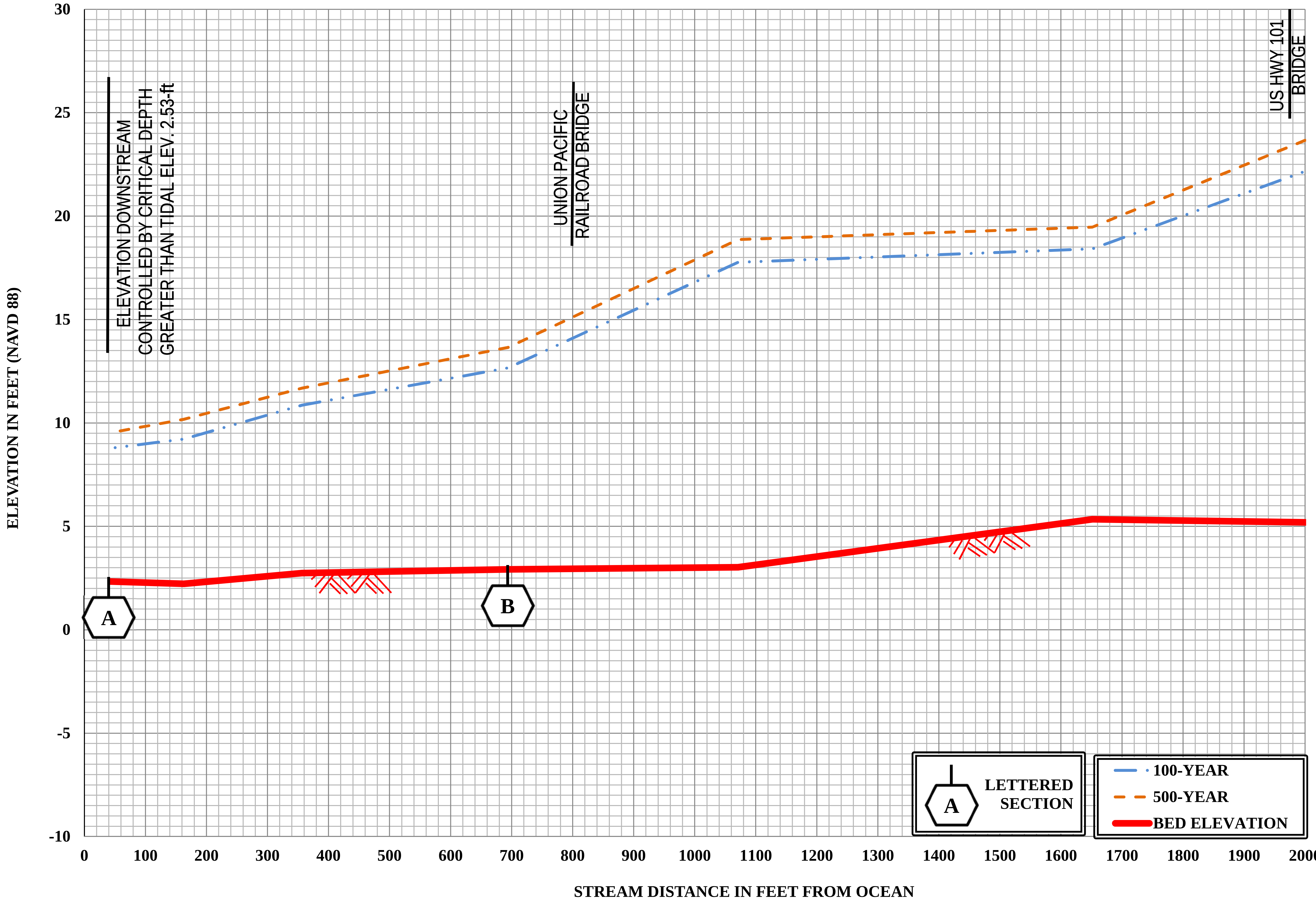
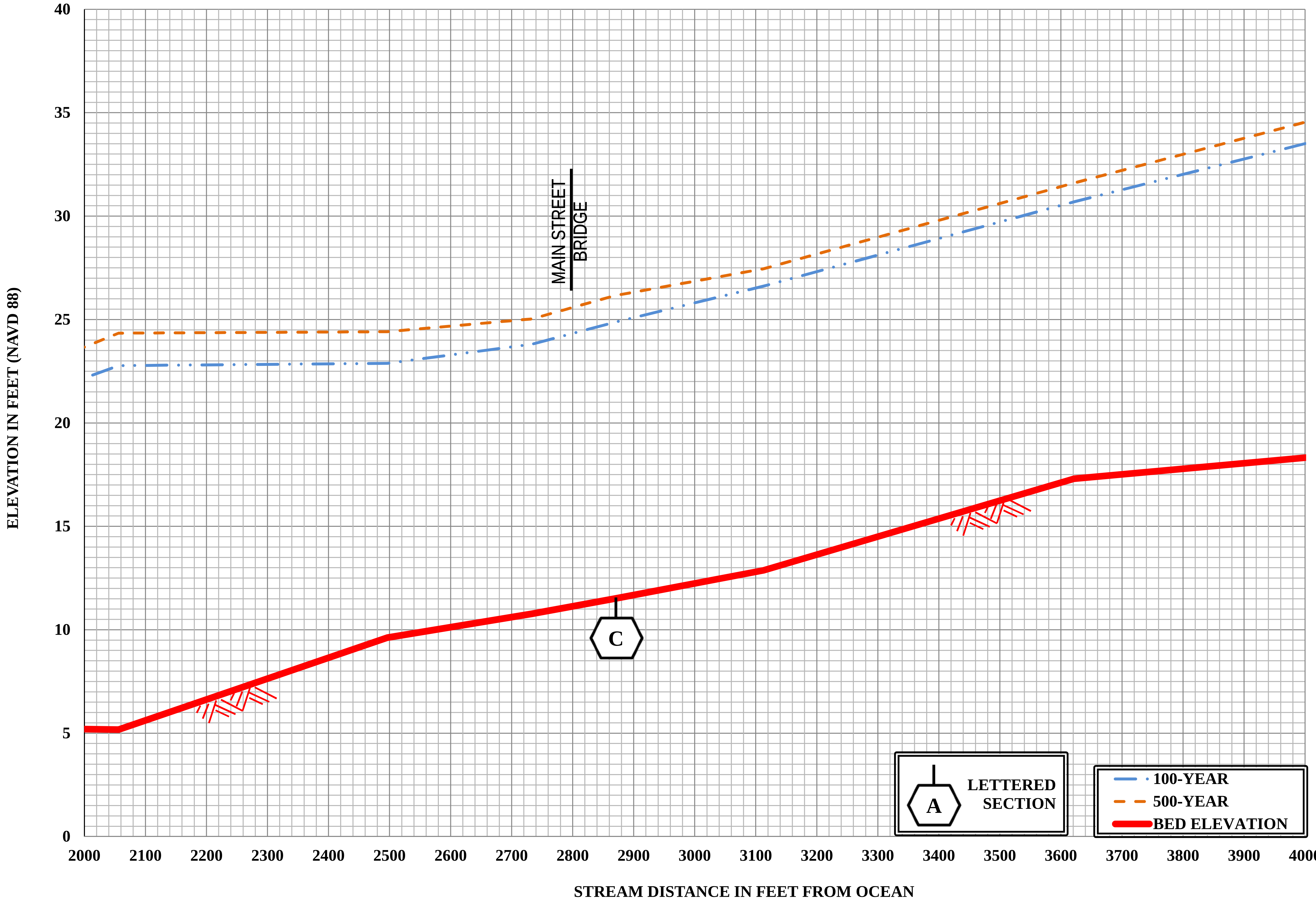


FLOOD PROFILES

VENTURA RIVER NO-LEVEE CONDITION

VENTURA COUNTY, CA
CITY OF VENTURA
VR-1 LEVEE CTP

P1

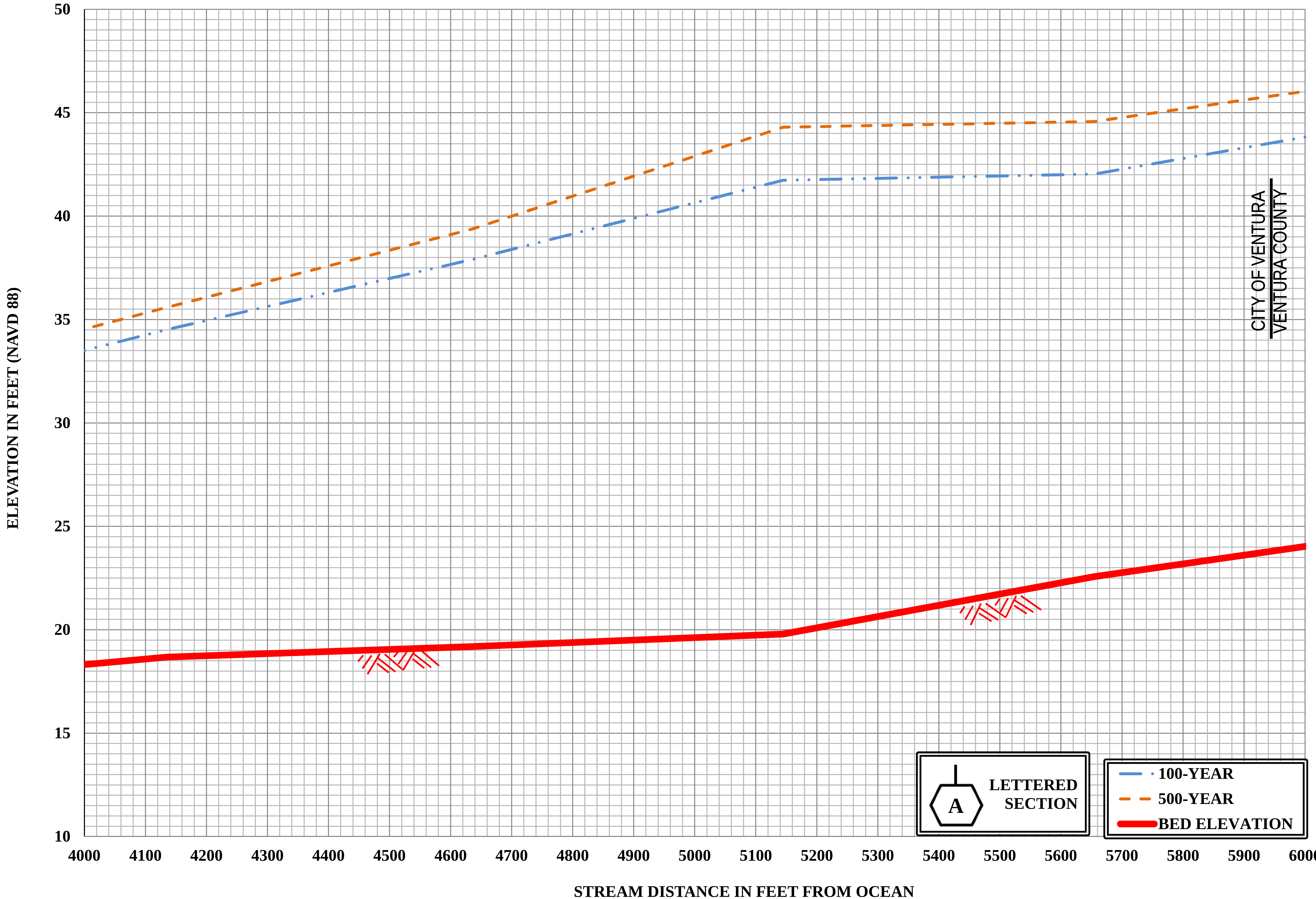


FLOOD PROFILES

VENTURA RIVER NO-LEVEE CONDITION

VENTURA COUNTY, CA
CITY OF VENTURA
VR-1 LEVEE CTP

P2

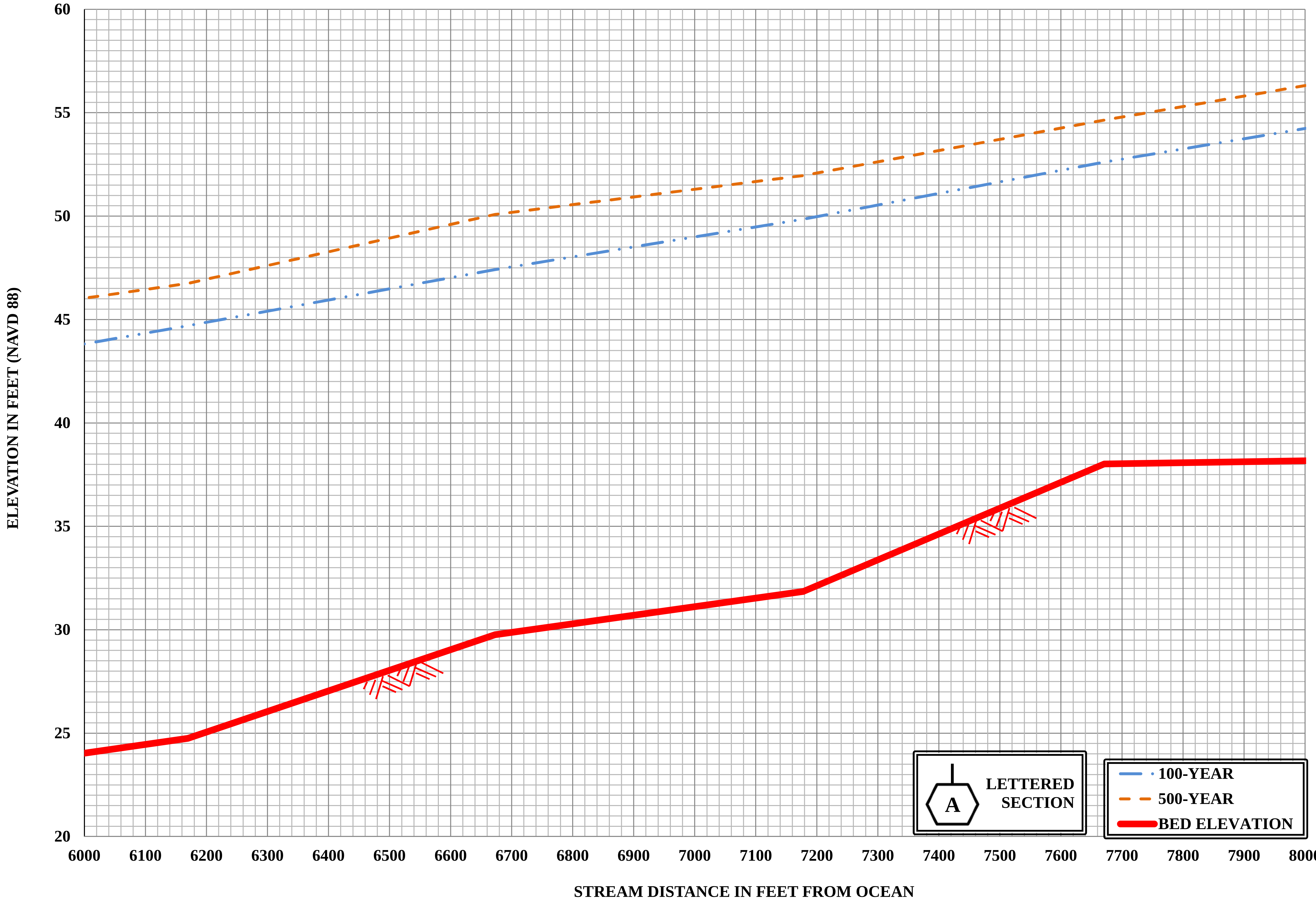


FLOOD PROFILES

VENTURA RIVER NO-LEVEE CONDITION

VENTURA COUNTY, CA
CITY OF VENTURA
VR-1 LEVEE CTP

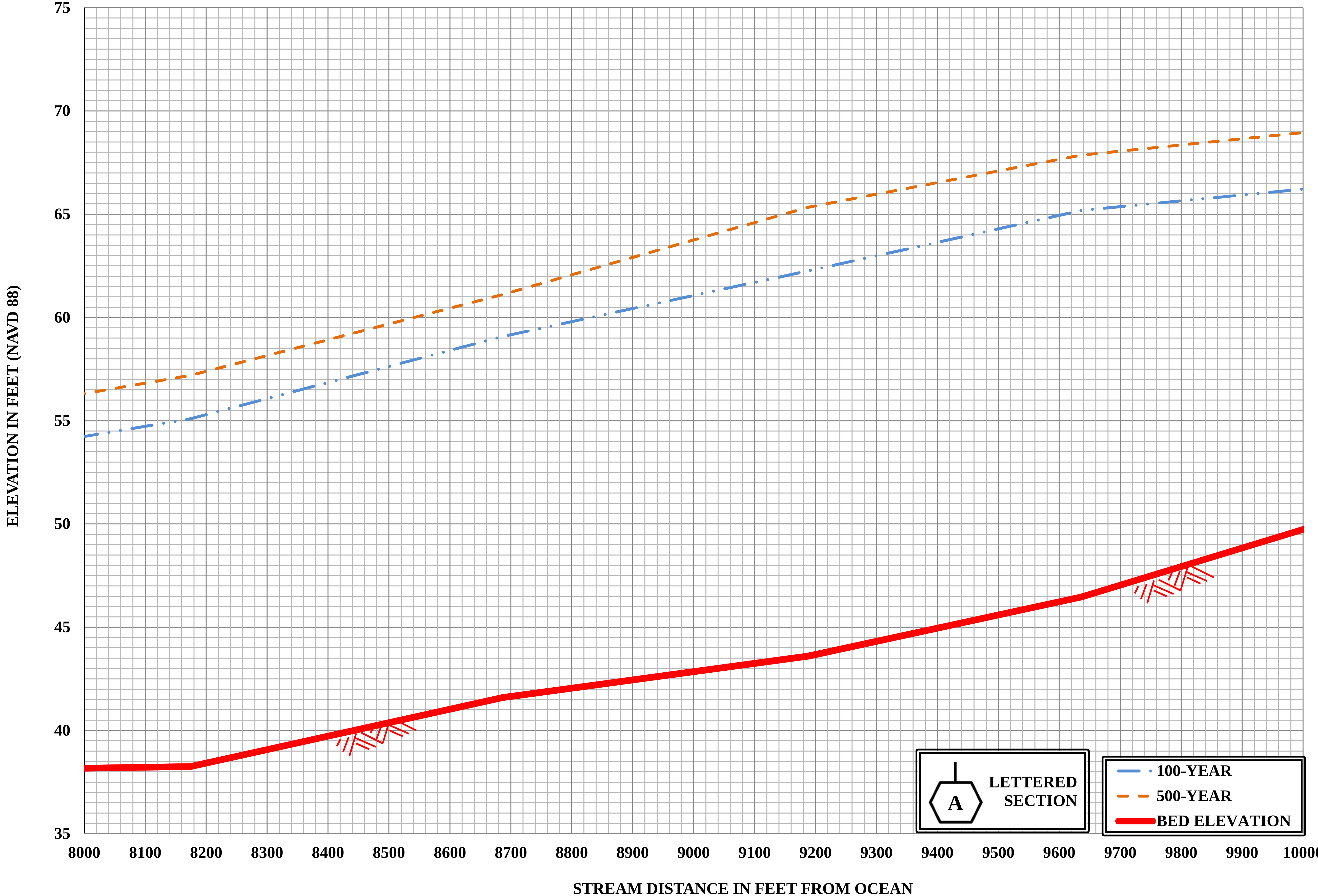
P3



FLOOD PROFILES

VENTURA RIVER NO-LEVEE CONDITION

VENTURA COUNTY, CA
CITY OF VENTURA
VR-1 LEVEE CTP

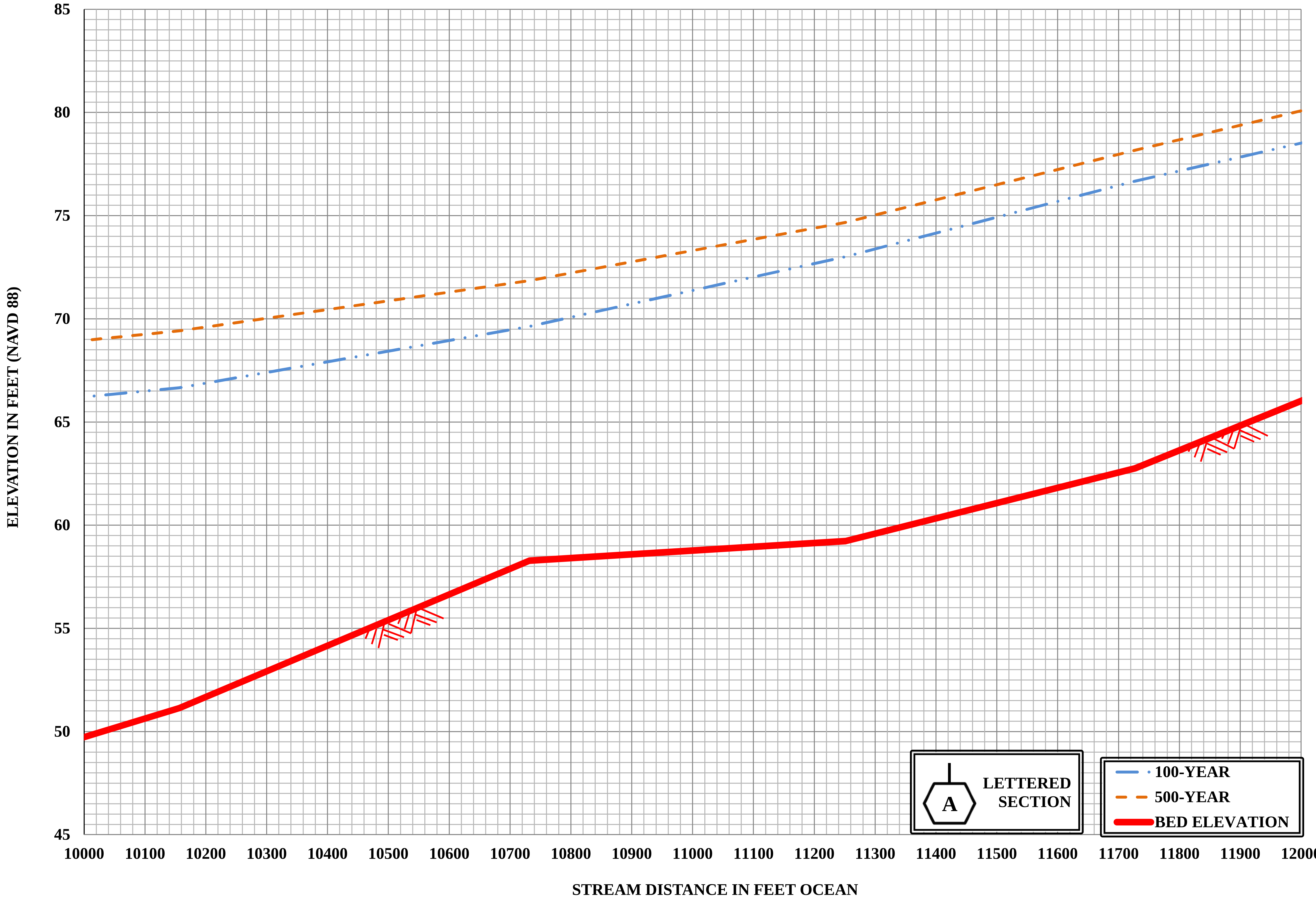


FLOOD PROFILES

VENTURA RIVER NO-LEVEE CONDITION

VENTURA COUNTY, CA
CITY OF VENTURA
VR-1 LEVEE CTP

P5

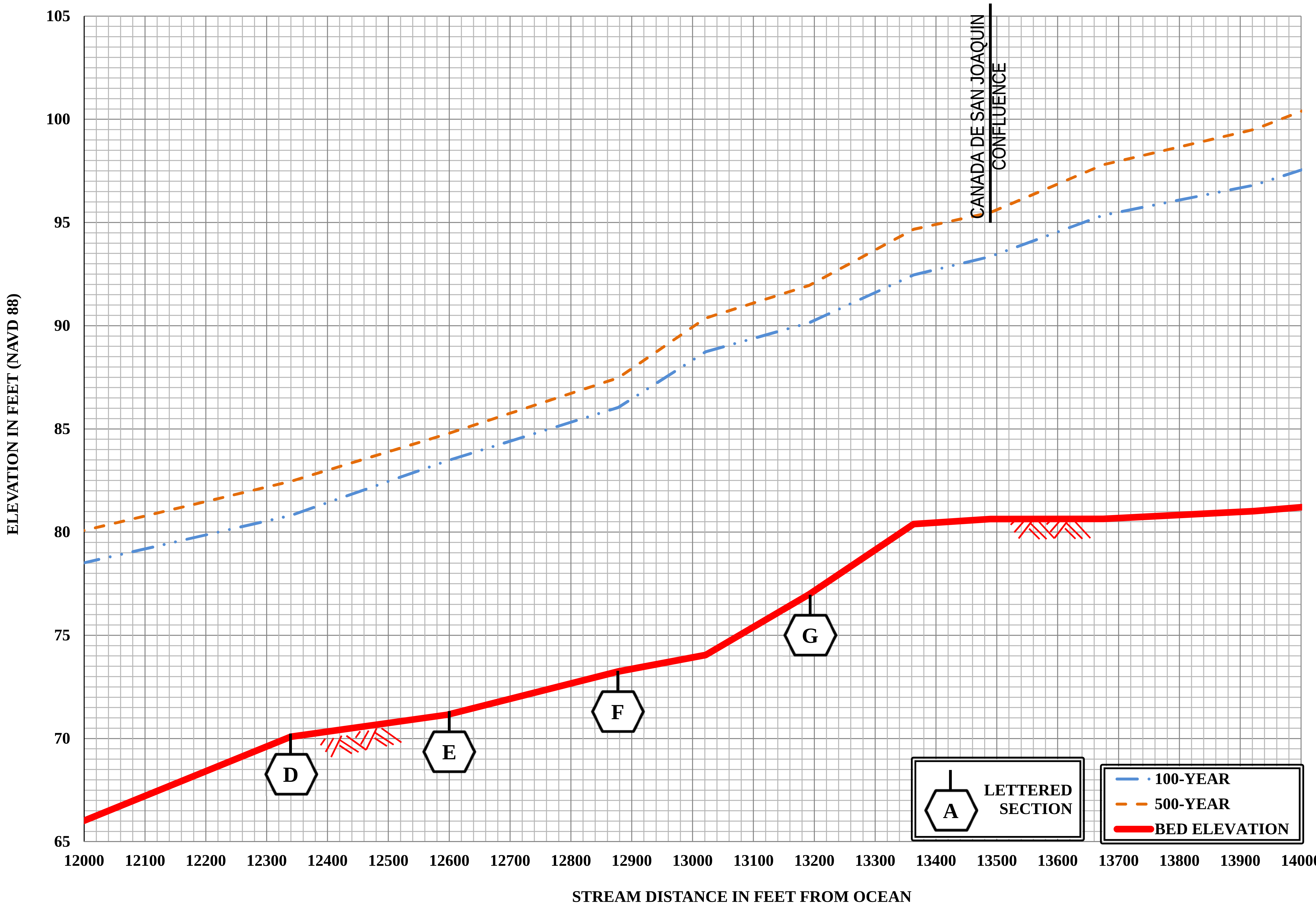


FLOOD PROFILES

VENTURA RIVER NO-LEVEE CONDITION

VENTURA COUNTY, CA
CITY OF VENTURA
VR-1 LEVEE CTP

P6

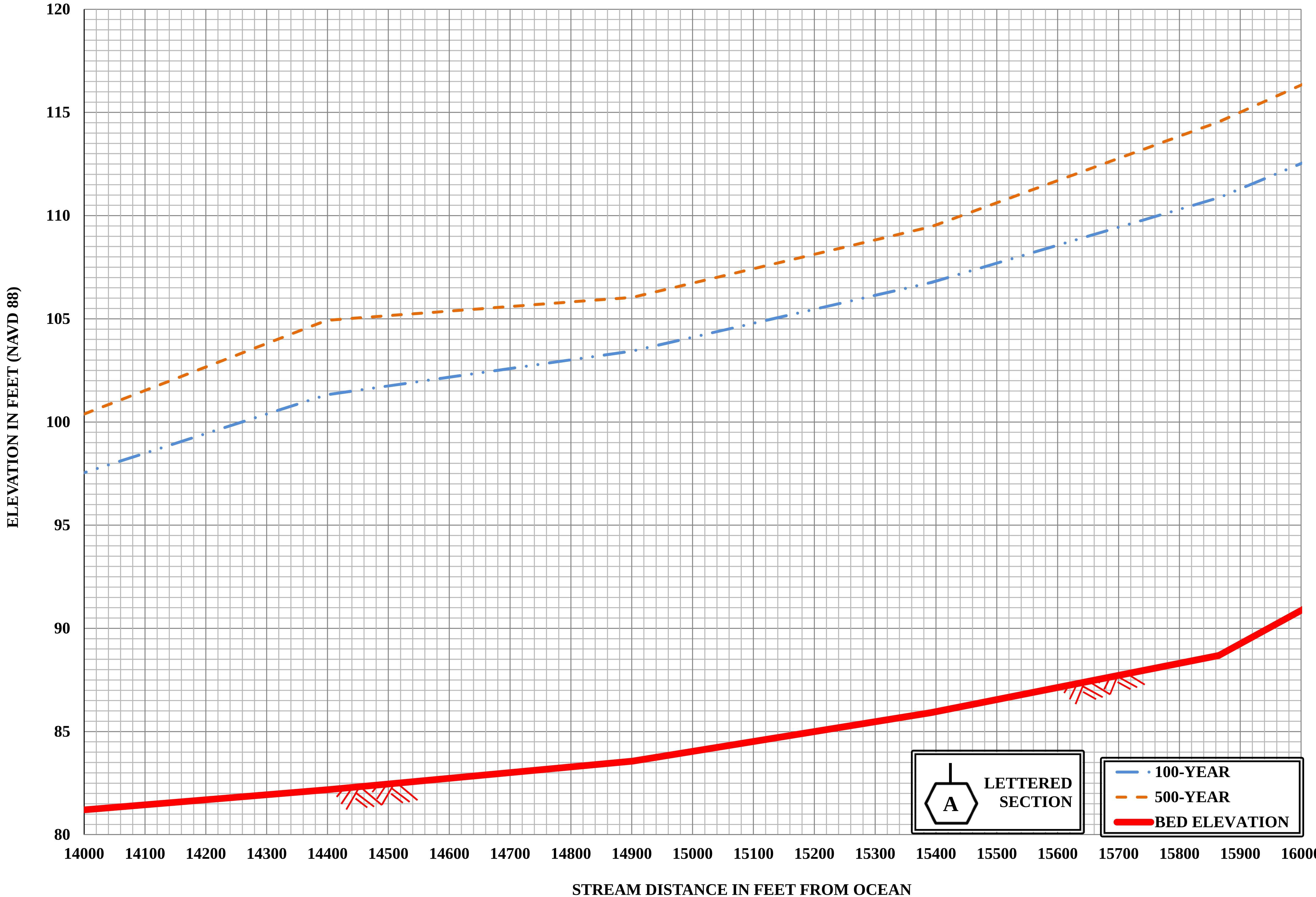


FLOOD PROFILES

VENTURA RIVER NO-LEVEE CONDITION

VENTURA COUNTY, CA
CITY OF VENTURA
VR-1 LEVEE CTP

P7

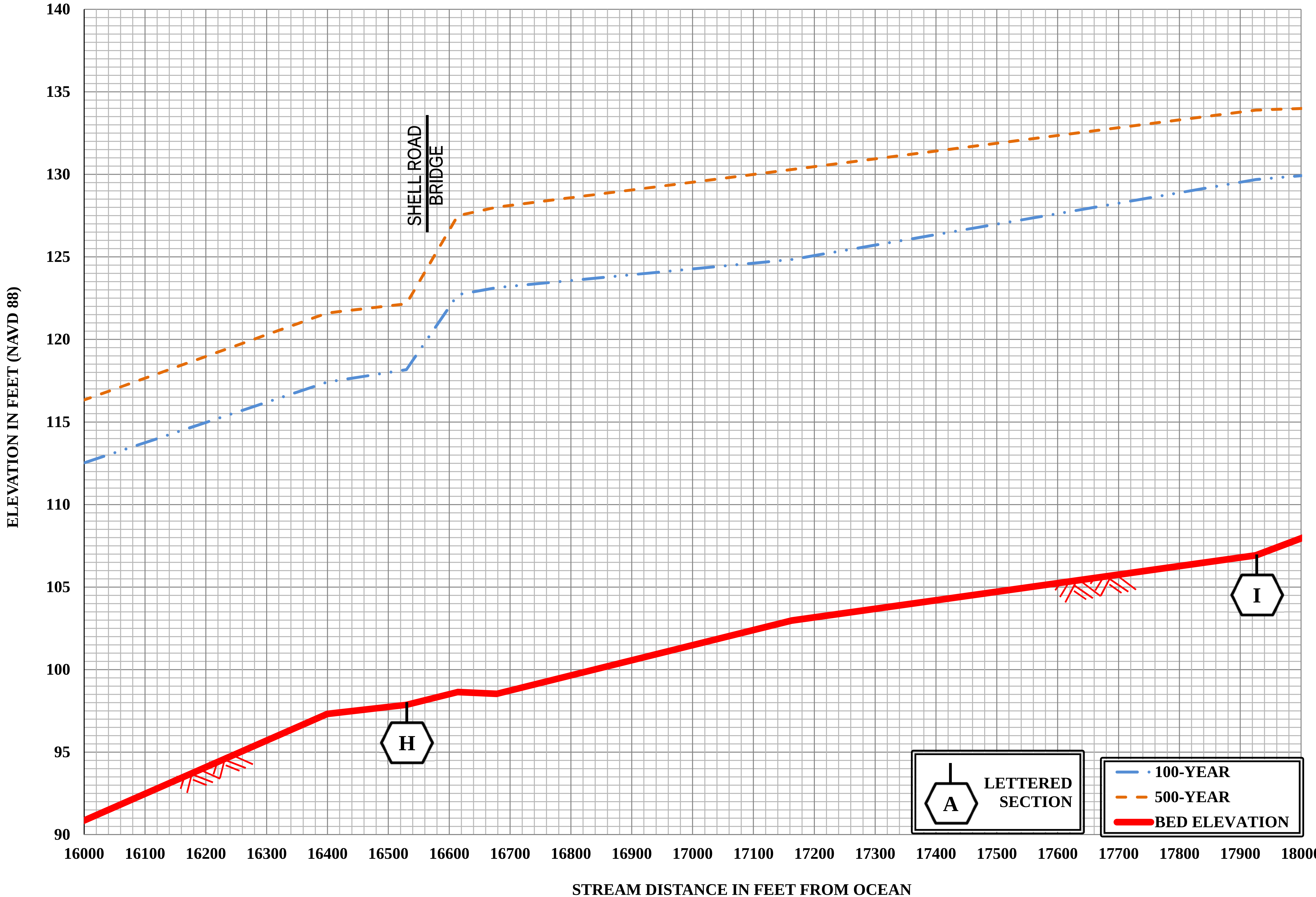


FLOOD PROFILES

VENTURA RIVER NO-LEVEE CONDITION

VENTURA COUNTY, CA
CITY OF VENTURA
VR-1 LEVEE CTP

P8

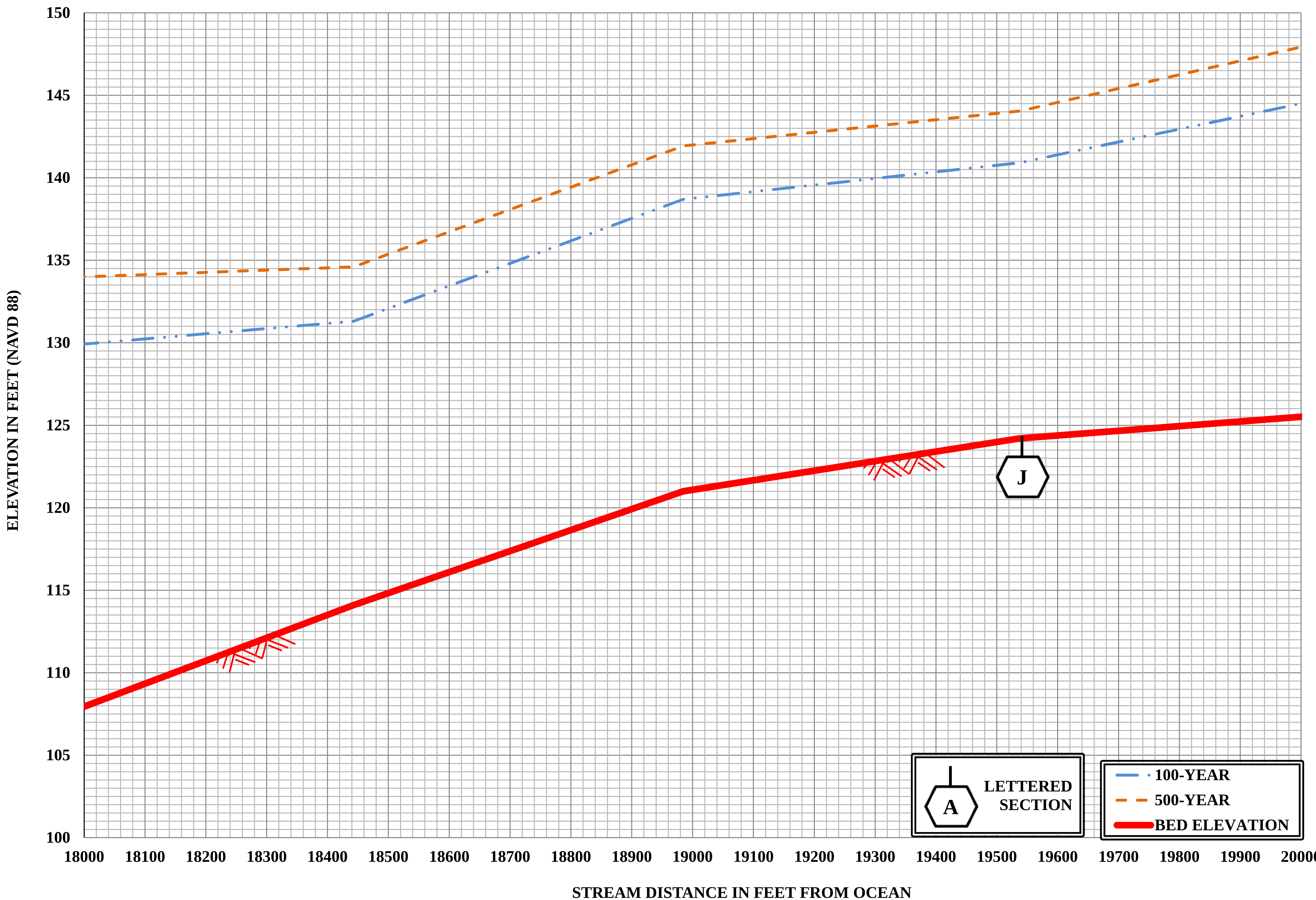


FLOOD PROFILES

VENTURA RIVER NO-LEVEE CONDITION

VENTURA COUNTY, CA
CITY OF VENTURA
VR-1 LEVEE CTP

P9

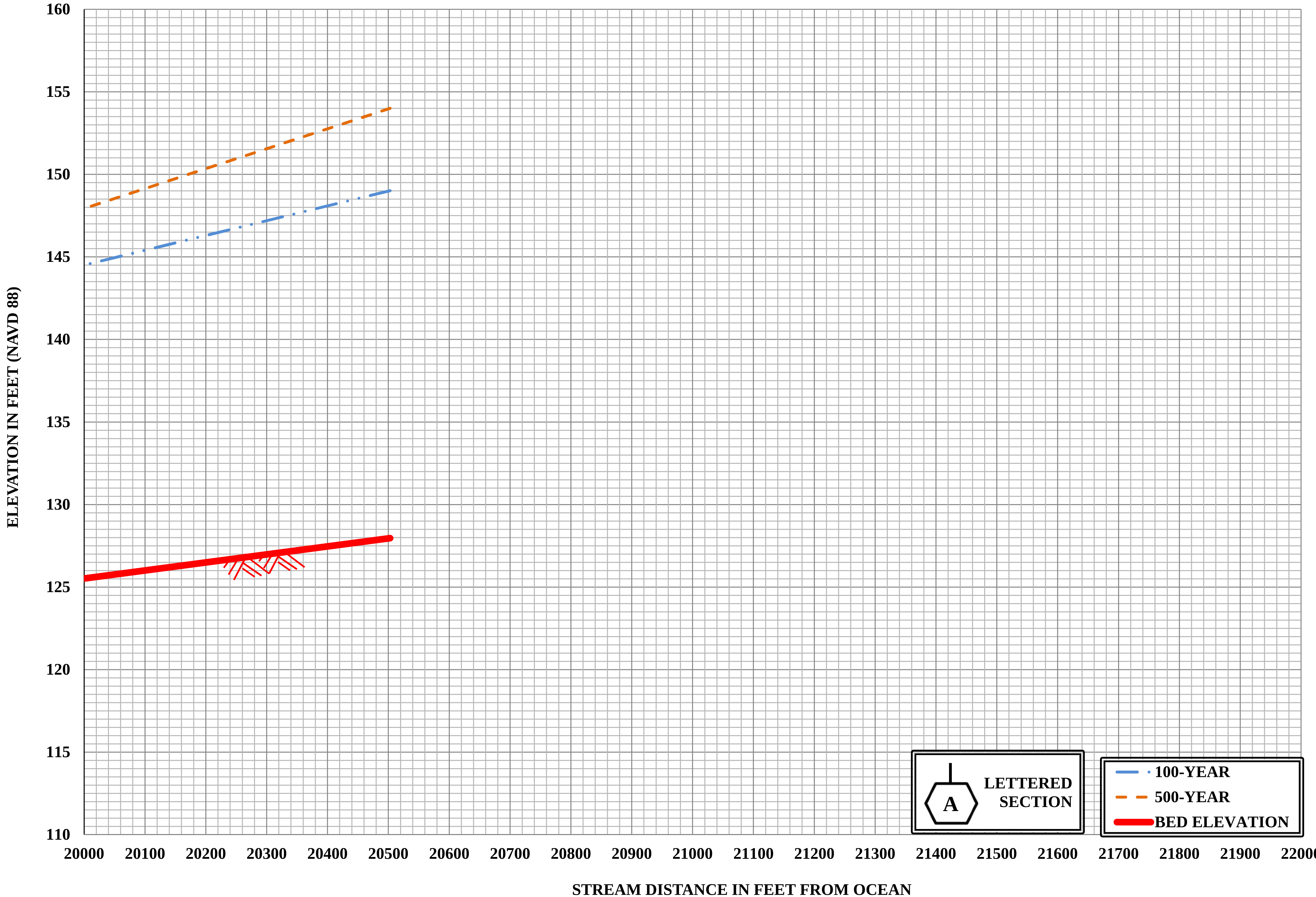


FLOOD PROFILES

VENTURA RIVER NO-LEVEE CONDITION

VENTURA COUNTY, CA
CITY OF VENTURA
VR-1 LEVEE CTP

P10



FLOOD PROFILES

VENTURA RIVER NO-LEVEE CONDITION

VENTURA COUNTY, CA
CITY OF VENTURA
VR-1 LEVEE CTP

P11

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Ventura River								
A	43	1514	9632	8.22	9.97	9.43	9.97	0.54
B	694	3168	16439	4.82	14.75	13.96	14.75	0.79
C	2870	2610	20066	4.33	27.70	27.70	28.49	0.79
D	12340	953	7524	10.52	81.39	81.39	82.19	0.80
E	12597	768	5608	14.12	83.49	83.49	84.42	0.93
F	12878	752	5639	14.04	86.07	86.07	86.93	0.86
G	13192	630	5709	13.87	90.16	90.16	90.99	0.83
H	16530	224	4459	17.70	121.23	121.23	122.23	1.00
I	17926	435	6818	11.57	132.52	132.52	133.46	0.94
J	19538	274	4918	16.04	143.95	143.95	144.93	0.98

[1] Feet Above Pacific Ocean at the Mouth of Ventura River

TABLE

FEDERAL EMERGENCY MANAGEMENT AGENCY

VENTURA COUNTY, CA
AND INCORPORATED AREAS

FLOODWAY DATA

VENTURA RIVER

HEC-RAS Plan: 100-yr Floodway River: Ventura River Reach: Main Profile: Encroachment 4

Reach	River Sta	Profile	Top Wdth Act	Area	Vel Total	W.S. Elev	Base WS	Prof Delta WS
			(ft)	(sq ft)	(ft/s)	(ft)	(ft)	(ft)
Main	20502.94	Encroachment 4	383.76	4983.73	15.83	149.06	148.77	0.29
Main	19998.42	Encroachment 4	230.20	3770.62	20.92	144.67	144.70	-0.04
Main	19537.86	Encroachment 4	274.12	4917.81	16.04	144.93	143.95	0.98
Main	18984.83	Encroachment 4	257.50	3878.83	20.34	139.00	138.72	0.27
Main	18442.92	Encroachment 4	306.35	4891.01	16.13	134.31	133.61	0.71
Main	17925.92	Encroachment 4	435.35	6817.51	11.57	133.46	132.52	0.94
Main	17163.03	Encroachment 4	253.23	4161.68	18.96	125.06	124.88	0.18
Main	16678.11	Encroachment 4	218.24	4576.35	17.24	123.74	123.70	0.04
Main	16613.95	Encroachment 4	225.36	4606.12	17.13	123.01	122.31	0.69
Main	16563 BR U	Encroachment 4	217.36	4344.15	18.16	122.42	121.45	0.97
Main	16563 BR D	Encroachment 4	218.37	4395.14	17.95	122.47	121.49	0.98
Main	16529.73	Encroachment 4	224.37	4458.85	17.70	122.23	121.23	1.00
Main	16399.76	Encroachment 4	185.77	3372.20	23.40	117.40	117.48	-0.08
Main	15865.15	Encroachment 4	237.72	3738.07	21.18	110.99	110.96	0.03
Main	15392.48	Encroachment 4	334.32	4346.67	18.21	107.55	107.47	0.08
Main	14901.35	Encroachment 4	320.71	5164.88	15.33	107.06	107.11	-0.05
Main	14398.78	Encroachment 4	326.05	4362.99	18.14	101.43	101.40	0.03
Main	13923.17	Encroachment 4	464.90	5054.22	15.66	96.94	96.88	0.05
Main	13675.08	Encroachment 4	476.91	5257.68	15.06	95.38	95.42	-0.04
Main	13489.16	Encroachment 4	514.32	5287.27	14.97	93.57	93.43	0.13
Main	13363.41	Encroachment 4	564.69	5387.03	14.70	92.50	92.48	0.02
Main	13191.51	Encroachment 4	629.79	5708.96	13.87	90.99	90.16	0.82
Main	13021.47	Encroachment 4	637.60	5356.60	14.78	89.23	88.77	0.46
Main	12877.79	Encroachment 4	752.33	5638.55	14.04	86.93	86.07	0.86
Main	12597.31	Encroachment 4	768.17	5607.88	14.12	84.42	83.49	0.93
Main	12340.06	Encroachment 4	953.12	7523.93	10.52	82.19	81.39	0.80
Main	11727.16	Encroachment 4	818.88	6632.02	11.94	77.37	76.70	0.67
Main	11251.45	Encroachment 4	716.53	5734.40	13.81	73.66	73.04	0.63
Main	10731.75	Encroachment 4	696.31	5467.45	14.48	69.64	69.72	-0.08
Main	10156.63	Encroachment 4	603.57	6684.52	11.84	68.23	68.23	-0.01
Main	9636.134	Encroachment 4	635.21	7448.70	10.63	67.37	67.40	-0.04
Main	9188.068	Encroachment 4	635.78	5249.67	15.08	62.42	62.11	0.31
Main	8686.773	Encroachment 4	584.12	5761.86	13.74	58.80	58.88	-0.08
Main	8175.146	Encroachment 4	717.53	6527.13	12.13	55.33	55.37	-0.04
Main	7671.020	Encroachment 4	850.96	7704.52	10.28	53.67	53.68	0.00
Main	7178.092	Encroachment 4	966.71	8745.11	9.05	52.54	52.60	-0.06
Main	6672.704	Encroachment 4	551.58	5046.76	15.69	47.59	47.49	0.10
Main	6169.652	Encroachment 4	549.25	6710.63	11.80	46.28	46.32	-0.04
Main	5654.248	Encroachment 4	905.31	7758.31	10.20	44.41	44.48	-0.08
Main	5144.698	Encroachment 4	1130.17	8338.73	9.49	42.12	42.11	0.00
Main	4636.191	Encroachment 4	910.36	7581.04	10.44	38.27	38.26	0.01
Main	4135.262	Encroachment 4	1401.10	9376.11	8.44	34.83	34.84	-0.01
Main	3621.485	Encroachment 4	1301.44	8879.83	8.92	31.05	30.99	0.06
Main	3112.680	Encroachment 4	1654.65	9985.55	7.93	28.21	28.00	0.22
Main	2869.572	Encroachment 4	2610.05	20065.57	4.33	28.49	27.70	0.80
Main	2796 BR U #1	Encroachment 4	1153.14	8689.13	8.19	27.36	26.90	0.46
Main	2796 BR U #2	Encroachment 4	530.28	1586.36	0.07	29.07	28.54	0.53
Main	2796 BR D #1	Encroachment 4	1040.73	9205.24	7.73	27.31	26.86	0.46
Main	2796 BR D #2	Encroachment 4	295.59	1139.39	0.16	28.18	27.67	0.51
Main	2733.189	Encroachment 4	1626.76	16964.76	5.72	27.52	26.99	0.53
Main	2496.198	Encroachment 4	2403.84	23039.71	3.94	27.34	26.69	0.65
Main	2056.048	Encroachment 4	2387.12	30325.34	3.16	27.18	26.50	0.68
Main	1975 BR U #1	Encroachment 4						
Main	1975 BR U #2	Encroachment 4	1572.22	8498.15	8.95	22.80	22.47	0.33
Main	1975 BR U #3	Encroachment 4						
Main	1975 BR D #1	Encroachment 4						
Main	1975 BR D #2	Encroachment 4	1021.04	8185.48	9.29	22.30	21.92	0.38
Main	1975 BR D #3	Encroachment 4						
Main	1651.518	Encroachment 4	1194.14	11430.51	7.74	21.74	21.74	0.00
Main	1071.007	Encroachment 4	3563.12	34580.05	2.29	22.08	21.66	0.41
Main	800 BR U #1	Encroachment 4		3403.58	12.88	21.82	21.44	0.37

HEC-RAS Plan: 100-yr Floodway River: Ventura River Reach: Main Profile: Encroachment 4 (Continued)

Reach	River Sta	Profile	Top Wdth Act	Area	Vel Total	W.S. Elev	Base WS	Prof Delta WS
			(ft)	(sq ft)	(ft/s)	(ft)	(ft)	(ft)
Main	800 BR U #2	Encroachment 4		945.13	12.68	22.20	21.86	0.34
Main	800 BR D #1	Encroachment 4		5192.97	8.44	21.74	21.44	0.29
Main	800 BR D #2	Encroachment 4		1234.16	9.71	21.56	21.35	0.21
Main	694.0917	Encroachment 4	3167.97	16438.55	4.82	14.75	13.96	0.78
Main	356.5126	Encroachment 4	1038.83	6732.63	11.76	11.70	11.28	0.41
Main	162.9877	Encroachment 4	1107.58	7046.39	11.23	10.47	9.99	0.48
Main	43.84752	Encroachment 4	1513.68	9631.66	8.22	9.97	9.43	0.54
Main	43	Encroachment 4	1509.48	6937.00	11.41	8.19	8.04	0.14

CHECK-RAS
OUTPUT AND RESOLUTIONS

(Also see Appendix D: Digital Data CD)

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	HEC-RAS Project: venturraiverunste.prj						
	Plan File:	venturariverunste.p01					
	Geometry File:	venturariverunste.g04					
	Flow File:	venturariverunste.f03					
	Repor Date:	6/25/2014					
River	**Reach**	**RS**	**Structure**	**Check Type**	**Message ID**	**Message**	**Comments**
Ventura River	Main	18442.92		NT CHECK	NT TL 02	Contraction and expansion loss coefficients are 0.6 and 0.8, respectively. However, this cross section is not at a hydraulic structure. They should be equal to 0.1 and 0.3 according to page 5-8 of the HEC-RAS Hydraulic Reference Manual (HEC, 2010).	The contraction and expansion loss coefficients were inherited from the FIS RAS model to simulate multiple openings.
Ventura River	Main	2056.048		NT CHECK	NT TL 01S3	This is Section3 of a hydraulic structure. The contraction and expansion loss coefficients are 0.6 and 0.8. They should be equal to 0.3 and 0.5, respectively, for typical structure sections according to page 5-8 of the HEC-RAS Hydraulic Reference Manual (HEC, 2010).	The contraction and expansion loss coefficients were inherited from the FIS RAS model to simulate multiple openings.
Ventura River	Main	162.9877		NT CHECK	NT TL 02	Contraction and expansion loss coefficients are 0.6 and 0.8, respectively. However, this cross section is not at a hydraulic structure. They should be equal to 0.1 and 0.3 according to page 5-8 of the HEC-RAS Hydraulic Reference Manual (HEC, 2010).	The contraction and expansion loss coefficients were inherited from the FIS RAS model to simulate outlet at Ocean (first 3 cross-sections).

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	43.84752		NT CHECK	NT TL 02	Contraction and expansion loss coefficients are 0.6 and 0.8, respectively. However, this cross section is not at a hydraulic structure. They should be equal to 0.1 and 0.3 according to page 5-8 of the HEC-RAS Hydraulic Reference Manual (HEC, 2010).	The contraction and expansion loss coefficients were inherited from the FIS RAS model to simulate outlet at Ocean (first 3 cross-sections).
Ventura River	Main	43		NT CHECK	NT TL 02	Contraction and expansion loss coefficients are 0.6 and 0.8, respectively. However, this cross section is not at a hydraulic structure. They should be equal to 0.1 and 0.3 according to page 5-8 of the HEC-RAS Hydraulic Reference Manual (HEC, 2010).	The contraction and expansion loss coefficients were inherited from the FIS RAS model to simulate outlet at Ocean (first 3 cross-sections).

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	16563	Bridge-UP	NT CHECK	NT RS 02BUC	This is the Upstream Bridge Section (BRU). The channel n value of 0.033 for the upstream internal bridge opening section is equal to or larger than the channel n value of 0.033 at Section 3. Usually, the channel "n" value of the bridge opening section represents the area below the bridge deck and is less than the channel "n" value of Section 3. The "n" value for Section 3 represents the natural valley channel section roughness for the reach between Section 3 and Section 4. Please change the "n" value of the internal bridge opening section or provide supporting information for the use of a higher "n" value.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	16563	Bridge-DN	NT CHECK	NT RS 02BDC	This is the Downstream Bridge Section (BRD). The channel n value of 0.033 for the downstream internal bridge opening section is equal to or larger than the channel n value of 0.033 at Section 2. Usually, the channel "n" value of the bridge opening section represents the area below the bridge deck and is less than the channel "n" value of Section 2. The "n" value for Section 2 represents the natural valley channel section roughness for the reach between Section 3 and Section 4. Please change the "n" value of the internal bridge opening section or provide supporting information for the use of the higher "n" value.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	43		XS CHECK	XS IF 01R	Flow code will be IR. The area to the right of the ineffective flow station may be considered effective. The 1%-annual-chance WSEL of 8.04 is higher than the ground elevation 2.460124 of the Right Ineffective Flow Station. However, it is equal to or lower than the right ineffective flow elevation of 17.85. The lateral structure was not modeled downstream of this River Station. Lower the ineffective flow elevation to the ground elevation to consider the area right of the ineffective flow station as effective, or model a lateral structure if the overflow will take a different flow path. The ineffective flow elevation could be accepted if the area right of the ineffective flow station is non conveyance.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	43.84752		XS CHECK	XS IF 01R	Flow code will be IR. The area to the right of the ineffective flow station may be considered effective. The 1%-annual-chance WSEL of 9.43 is higher than the ground elevation 2.460124 of the Right Ineffective Flow Station. However, it is equal to or lower than the right ineffective flow elevation of 17.85. The lateral structure was not modeled downstream of this River Station. Lower the ineffective flow elevation to the ground elevation to consider the area right of the ineffective flow station as effective, or model a lateral structure if the overflow will take a different flow path. The ineffective flow elevation could be accepted if the area right of the ineffective flow station is non conveyance.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	356.5126		XS CHECK	XS IF 01R	Flow code will be IR. The area to the right of the ineffective flow station may be considered effective. The 1%-annual-chance WSEL of 11.28 is higher than the ground elevation 9.169923 of the Right Ineffective Flow Station. However, it is equal to or lower than the right ineffective flow elevation of 17.85. The lateral structure was not modeled downstream of this River Station. Lower the ineffective flow elevation to the ground elevation to consider the area right of the ineffective flow station as effective, or model a lateral structure if the overflow will take a different flow path. The ineffective flow elevation could be accepted if the area right of the ineffective flow station is non conveyance.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	2496.198		XS CHECK	XS IF 01R	Flow code will be IR. The area to the right of the ineffective flow station may be considered effective. The 1%-annual-chance WSEL of 26.69 is higher than the ground elevation 18.88681 of the Right Ineffective Flow Station. However, it is equal to or lower than the right ineffective flow elevation of 30.63. The lateral structure was not modeled downstream of this River Station. Lower the ineffective flow elevation to the ground elevation to consider the area right of the ineffective flow station as effective, or model a lateral structure if the overflow will take a different flow path. The ineffective flow elevation could be accepted if the area right of the ineffective flow station is non conveyance.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	12340.06		XS CHECK	XS IF 01R	Flow code will be IR. The area to the right of the ineffective flow station may be considered effective. The 1%-annual-chance WSEL of 81.39 is higher than the ground elevation 72.52089 of the Right Ineffective Flow Station. However, it is equal to or lower than the right ineffective flow elevation of 95.952. The lateral structure was not modeled downstream of this River Station. Lower the ineffective flow elevation to the ground elevation to consider the area right of the ineffective flow station as effective, or model a lateral structure if the overflow will take a different flow path. The ineffective flow elevation could be accepted if the area right of the ineffective flow station is non conveyance.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	12597.31		XS CHECK	XS IF 01R	Flow code will be IR. The area to the right of the ineffective flow station may be considered effective. The 1%-annual-chance WSEL of 83.49 is higher than the ground elevation 78.40571 of the Right Ineffective Flow Station. However, it is equal to or lower than the right ineffective flow elevation of 95.952. The lateral structure was not modeled downstream of this River Station. Lower the ineffective flow elevation to the ground elevation to consider the area right of the ineffective flow station as effective, or model a lateral structure if the overflow will take a different flow path. The ineffective flow elevation could be accepted if the area right of the ineffective flow station is non conveyance.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	12877.79		XS CHECK	XS IF 01R	Flow code will be IR. The area to the right of the ineffective flow station may be considered effective. The 1%-annual-chance WSEL of 86.07 is higher than the ground elevation 79.0192 of the Right Ineffective Flow Station. However, it is equal to or lower than the right ineffective flow elevation of 95.952. The lateral structure was not modeled downstream of this River Station. Lower the ineffective flow elevation to the ground elevation to consider the area right of the ineffective flow station as effective, or model a lateral structure if the overflow will take a different flow path. The ineffective flow elevation could be accepted if the area right of the ineffective flow station is non conveyance.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	13021.47		XS CHECK	XS IF 01R	Flow code will be IR. The area to the right of the ineffective flow station may be considered effective. The 1%-annual-chance WSEL of 88.77 is higher than the ground elevation 82.01353 of the Right Ineffective Flow Station. However, it is equal to or lower than the right ineffective flow elevation of 95.952. The lateral structure was not modeled downstream of this River Station. Lower the ineffective flow elevation to the ground elevation to consider the area right of the ineffective flow station as effective, or model a lateral structure if the overflow will take a different flow path. The ineffective flow elevation could be accepted if the area right of the ineffective flow station is non conveyance.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	13191.51		XS CHECK	XS IF 01R	Flow code will be IR. The area to the right of the ineffective flow station may be considered effective. The 1%-annual-chance WSEL of 90.16 is higher than the ground elevation 84.22066 of the Right Ineffective Flow Station. However, it is equal to or lower than the right ineffective flow elevation of 95.952. The lateral structure was not modeled downstream of this River Station. Lower the ineffective flow elevation to the ground elevation to consider the area right of the ineffective flow station as effective, or model a lateral structure if the overflow will take a different flow path. The ineffective flow elevation could be accepted if the area right of the ineffective flow station is non conveyance.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	17925.92		XS CHECK	XS IF 01L	Flow code will be IL. The area left of the ineffective flow station may be considered effective. The 1%-annual-chance WSEL of 132.52 is higher than the ground elevation 132.4759 of the Left Ineffective Flow Station. However, it is equal to or lower than the left ineffective flow elevation of 132.67. The lateral structure was not modeled downstream of this River Station. Lower the ineffective flow elevation to the ground elevation to consider the area left of the ineffective flow station as effective, or model a lateral structure if the overflow will take a different flow path. The ineffective flow elevation could be accepted if the area left of the ineffective flow station is non conveyance.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	17163.03		XS CHECK	XS CD 01	Critical Depth occurs at 1%-annual-chance flood. Flow Code will be "C". The Ineffective flow option is used. The Ineffective Flow elevation is equal to or higher than the Critical WSEL. Please investigate whether this selection is appropriate.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	16399.76		XS CHECK	XS CD 01	Critical Depth occurs at 1%-annual-chance flood. Flow Code will be "C". The Ineffective flow option is used. The Ineffective Flow elevation is equal to or higher than the Critical WSEL. Please investigate whether this selection is appropriate.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	15865.15		XS CHECK	XS CD 01	Critical Depth occurs at 1%-annual-chance flood. Flow Code will be "C". The Ineffective flow option is used. The Ineffective Flow elevation is equal to or higher than the Critical WSEL. Please investigate whether this selection is appropriate.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	14398.78		XS CHECK	XS CD 01	Critical Depth occurs at 1%-annual-chance flood. Flow Code will be "C". The Ineffective flow option is used. The Ineffective Flow elevation is equal to or higher than the Critical WSEL. Please investigate whether this selection is appropriate.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	13363.41		XS CHECK	XS CD 01	Critical Depth occurs at 1%-annual-chance flood. Flow Code will be "C". The Ineffective flow option is used. The Ineffective Flow elevation is equal to or higher than the Critical WSEL. Please investigate whether this selection is appropriate.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	13191.51		XS CHECK	XS CD 01	Critical Depth occurs at 1%-annual-chance flood. Flow Code will be "C". The Ineffective flow option is used. The Ineffective Flow elevation is equal to or higher than the Critical WSEL. Please investigate whether this selection is appropriate.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	13021.47		XS CHECK	XS CD 01	Critical Depth occurs at 1%-annual-chance flood. Flow Code will be "C". The Ineffective flow option is used. The Ineffective Flow elevation is equal to or higher than the Critical WSEL. Please investigate whether this selection is appropriate.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	12877.79		XS CHECK	XS CD 01	Critical Depth occurs at 1%-annual-chance flood. Flow Code will be "C". The Ineffective flow option is used. The Ineffective Flow elevation is equal to or higher than the Critical WSEL. Please investigate whether this selection is appropriate.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	12597.31		XS CHECK	XS CD 01	Critical Depth occurs at 1%-annual-chance flood. Flow Code will be "C". The Ineffective flow option is used. The Ineffective Flow elevation is equal to or higher than the Critical WSEL. Please investigate whether this selection is appropriate.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	11727.16		XS CHECK	XS CD 01	Critical Depth occurs at 1%-annual-chance flood. Flow Code will be "C". The Ineffective flow option is used. The Ineffective Flow elevation is equal to or higher than the Critical WSEL. Please investigate whether this selection is appropriate.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	11251.45		XS CHECK	XS DF 01L	Divided flow. Flow code will be DL. The 1%-annual-chance flood discharge has a divided flow. The starting and ending stations of the cross section should not extend beyond the watershed boundary of the studied stream. Please review the extent of the cross section. If the cross section extends beyond the watershed boundary then the cross sections need to be trimmed and the HEC-RAS geometry file may need to be recreated using a GIS program. Or use the ineffective flow option, if it has not been considered, to limit the extent of the cross section or to block the divided flow area if it is a local depression.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	11251.45		XS CHECK	XS DF 01R	Divided flow. Flow code will be DR. The 1%-annual-chance flood discharge has a divided flow. The starting and ending stations of the cross section should not extend beyond the watershed boundary of the studied stream. Please review the extent of the cross section. If the cross section extends beyond the watershed boundary then the cross section needs to be trimmed and the HEC-RAS geometry file may need to be recreated using a GIS program. Or use the ineffective flow option, if it has not been considered, to limit the extent of the cross section or to block the divided flow area if it is a local depression.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	11251.45		XS CHECK	XS CD 01	Critical Depth occurs at 1%-annual-chance flood. Flow Code will be "C". The Ineffective flow option is used. The Ineffective Flow elevation is equal to or higher than the Critical WSEL. Please investigate whether this selection is appropriate.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	9636.134		XS CHECK	XS DF 01L	Divided flow. Flow code will be DL. The 1%-annual-chance flood discharge has a divided flow. The starting and ending stations of the cross section should not extend beyond the watershed boundary of the studied stream. Please review the extent of the cross section. If the cross section extends beyond the watershed boundary then the cross sections need to be trimmed and the HEC-RAS geometry file may need to be recreated using a GIS program. Or use the ineffective flow option, if it has not been considered, to limit the extent of the cross section or to block the divided flow area if it is a local depression.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	9188.068		XS CHECK	XS CD 01	Critical Depth occurs at 1%-annual-chance flood. Flow Code will be "C". The Ineffective flow option is used. The Ineffective Flow elevation is equal to or higher than the Critical WSEL. Please investigate whether this selection is appropriate.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	8175.146		XS CHECK	XS DF 01R	Divided flow. Flow code will be DR. The 1%-annual-chance flood discharge has a divided flow. The starting and ending stations of the cross section should not extend beyond the watershed boundary of the studied stream. Please review the extent of the cross section. If the cross section extends beyond the watershed boundary then the cross section needs to be trimmed and the HEC-RAS geometry file may need to be recreated using a GIS program. Or use the ineffective flow option, if it has not been considered, to limit the extent of the cross section or to block the divided flow area if it is a local depression.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	6672.704		XS CHECK	XS CD 01	Critical Depth occurs at 1%-annual-chance flood. Flow Code will be "C". The Ineffective flow option is used. The Ineffective Flow elevation is equal to or higher than the Critical WSEL. Please investigate whether this selection is appropriate.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	6169.652		XS CHECK	XS DF 01R	Divided flow. Flow code will be DR. The 1%-annual-chance flood discharge has a divided flow. The starting and ending stations of the cross section should not extend beyond the watershed boundary of the studied stream. Please review the extent of the cross section. If the cross section extends beyond the watershed boundary then the cross section needs to be trimmed and the HEC-RAS geometry file may need to be recreated using a GIS program. Or use the ineffective flow option, if it has not been considered, to limit the extent of the cross section or to block the divided flow area if it is a local depression.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	5654.248		XS CHECK	XS DF 01R	Divided flow. Flow code will be DR. The 1%-annual-chance flood discharge has a divided flow. The starting and ending stations of the cross section should not extend beyond the watershed boundary of the studied stream. Please review the extent of the cross section. If the cross section extends beyond the watershed boundary then the cross section needs to be trimmed and the HEC-RAS geometry file may need to be recreated using a GIS program. Or use the ineffective flow option, if it has not been considered, to limit the extent of the cross section or to block the divided flow area if it is a local depression.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	5144.698		XS CHECK	XS CD 01	Critical Depth occurs at 1%-annual-chance flood. Flow Code will be "C". The Ineffective flow option is used. The Ineffective Flow elevation is equal to or higher than the Critical WSEL. Please investigate whether this selection is appropriate.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	4636.191		XS CHECK	XS CD 01	Critical Depth occurs at 1%-annual-chance flood. Flow Code will be "C". The Ineffective flow option is used. The Ineffective Flow elevation is equal to or higher than the Critical WSEL. Please investigate whether this selection is appropriate.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	4135.262		XS CHECK	XS CD 01	Critical Depth occurs at 1%-annual-chance flood. Flow Code will be "C". The Ineffective flow option is used. The Ineffective Flow elevation is equal to or higher than the Critical WSEL. Please investigate whether this selection is appropriate.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	3621.485		XS CHECK	XS CD 01	Critical Depth occurs at 1%-annual-chance flood. Flow Code will be "C". The Ineffective flow option is used. The Ineffective Flow elevation is equal to or higher than the Critical WSEL. Please investigate whether this selection is appropriate.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	2869.572		XS CHECK	XS IF 02L	Flow code will be MIL. Multiple (block) Ineffective Stations are selected for the left overbank at this River Station. This is not Section 2 or Section 3 of Multiple Openings or Multiple Culverts. Please explain why the multiple blocks ineffective flow option was used. Consider using the normal ineffective flow option.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	2869.572		XS CHECK	XS IF 02R	Flow code will be MIR. Multiple (block) Ineffective Stations are selected for the right overbank at this River Station. This is not Section 2 or Section 3 of Multiple Openings or Multiple Culverts. Please justify why the Multiple Blocks Ineffective Flow option was used. Consider using the normal Ineffective Flow option.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	2733.189		XS CHECK	XS IF 02L	Flow code will be MIL. Multiple (block) Ineffective Stations are selected for the left overbank at this River Station. This is not Section 2 or Section 3 of Multiple Openings or Multiple Culverts. Please explain why the multiple blocks ineffective flow option was used. Consider using the normal ineffective flow option.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	2733.189		XS CHECK	XS IF 02R	Flow code will be MIR. Multiple (block) Ineffective Stations are selected for the right overbank at this River Station. This is not Section 2 or Section 3 of Multiple Openings or Multiple Culverts. Please justify why the Multiple Blocks Ineffective Flow option was used. Consider using the normal Ineffective Flow option.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	2496.198		XS CHECK	XS IF 02R	Flow code will be MIR. Multiple (block) Ineffective Stations are selected for the right overbank at this River Station. This is not Section 2 or Section 3 of Multiple Openings or Multiple Culverts. Please justify why the Multiple Blocks Ineffective Flow option was used. Consider using the normal Ineffective Flow option.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	2056.048		XS CHECK	XS IF 02L	Flow code will be MIL. Multiple (block) Ineffective Stations are selected for the left overbank at this River Station. This is not Section 2 or Section 3 of Multiple Openings or Multiple Culverts. Please explain why the multiple blocks ineffective flow option was used. Consider using the normal ineffective flow option.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	2056.048		XS CHECK	XS IF 02R	Flow code will be MIR. Multiple (block) Ineffective Stations are selected for the right overbank at this River Station. This is not Section 2 or Section 3 of Multiple Openings or Multiple Culverts. Please justify why the Multiple Blocks Ineffective Flow option was used. Consider using the normal Ineffective Flow option.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	1651.518		XS CHECK	XS IF 02L	Flow code will be MIL. Multiple (block) Ineffective Stations are selected for the left overbank at this River Station. This is not Section 2 or Section 3 of Multiple Openings or Multiple Culverts. Please explain why the multiple blocks ineffective flow option was used. Consider using the normal ineffective flow option.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	1651.518		XS CHECK	XS IF 02R	Flow code will be MIR. Multiple (block) Ineffective Stations are selected for the right overbank at this River Station. This is not Section 2 or Section 3 of Multiple Openings or Multiple Culverts. Please justify why the Multiple Blocks Ineffective Flow option was used. Consider using the normal Ineffective Flow option.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	1071.007		XS CHECK	XS IF 02L	Flow code will be MIL. Multiple (block) Ineffective Stations are selected for the left overbank at this River Station. This is not Section 2 or Section 3 of Multiple Openings or Multiple Culverts. Please explain why the multiple blocks ineffective flow option was used. Consider using the normal ineffective flow option.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	694.0917		XS CHECK	XS DF 01R	Divided flow. Flow code will be DR. The 1%-annual-chance flood discharge has a divided flow. The starting and ending stations of the cross section should not extend beyond the watershed boundary of the studied stream. Please review the extent of the cross section. If the cross section extends beyond the watershed boundary then the cross section needs to be trimmed and the HEC-RAS geometry file may need to be recreated using a GIS program. Or use the ineffective flow option, if it has not been considered, to limit the extent of the cross section or to block the divided flow area if it is a local depression.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	694.0917		XS CHECK	XS IF 02L	Flow code will be MIL. Multiple (block) Ineffective Stations are selected for the left overbank at this River Station. This is not Section 2 or Section 3 of Multiple Openings or Multiple Culverts. Please explain why the multiple blocks ineffective flow option was used. Consider using the normal ineffective flow option.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	356.5126		XS CHECK	XS IF 02R	Flow code will be MIR. Multiple (block) Ineffective Stations are selected for the right overbank at this River Station. This is not Section 2 or Section 3 of Multiple Openings or Multiple Culverts. Please justify why the Multiple Blocks Ineffective Flow option was used. Consider using the normal Ineffective Flow option.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	162.9877		XS CHECK	XS IF 02R	Flow code will be MIR. Multiple (block) Ineffective Stations are selected for the right overbank at this River Station. This is not Section 2 or Section 3 of Multiple Openings or Multiple Culverts. Please justify why the Multiple Blocks Ineffective Flow option was used. Consider using the normal Ineffective Flow option.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	43.84752		XS CHECK	XS IF 02R	Flow code will be MIR. Multiple (block) Ineffective Stations are selected for the right overbank at this River Station. This is not Section 2 or Section 3 of Multiple Openings or Multiple Culverts. Please justify why the Multiple Blocks Ineffective Flow option was used. Consider using the normal Ineffective Flow option.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	43		XS CHECK	XS IF 02R	Flow code will be MIR. Multiple (block) Ineffective Stations are selected for the right overbank at this River Station. This is not Section 2 or Section 3 of Multiple Openings or Multiple Culverts. Please justify why the Multiple Blocks Ineffective Flow option was used. Consider using the normal Ineffective Flow option.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	43		XS CHECK	XS CD 01	Critical Depth occurs at 1%-annual-chance flood. Flow Code will be "C". The Ineffective flow option is used. The Ineffective Flow elevation is equal to or higher than the Critical WSEL. Please investigate whether this selection is appropriate.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	19537.86		XS CHECK	XS LC 01	LenChl Up/TopWdthAct Dn = 1.82. The ratio is more than 1.1. LenChlUp is more than 500 feet. This cross section is located too far upstream from the critical depth cross section 18984.83 for the 1%-annual-chance flood. The cross section should move closer to the critical depth section, or an additional cross section should be added between the two cross sections. The HEC-RAS geometry file may need to be recreated using a GIS program.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	17925.92		XS CHECK	XS LC 01	LenChl Up/TopWdthAct Dn = 2.52. The ratio is more than 1.1. LenChlUp is more than 500 feet. This cross section is located too far upstream from the critical depth cross section 17163.03 for the 1%-annual-chance flood. The cross section should move closer to the critical depth section, or an additional cross section should be added between the two cross sections. The HEC-RAS geometry file may need to be recreated using a GIS program.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	14901.35		XS CHECK	XS LC 01	LenChl Up/TopWdthAct Dn = 1.45. The ratio is more than 1.1. LenChlUp is more than 500 feet. This cross section is located too far upstream from the critical depth cross section 14398.78 for the 1%-annual-chance flood. The cross section should move closer to the critical depth section, or an additional cross section should be added between the two cross sections. The HEC-RAS geometry file may need to be recreated using a GIS program.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	2796	MultiOpen-UP	XS CHECK	XS DC 01	Discharge decreases in the downstream direction for 1%-annual-chance flood. There are no lateral structures. Documentation of hydrologic analysis is required or provide explanation.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	2733.189		XS CHECK	XS DC 03	Discharge is different between the upstream side and downstream side of the structure for 1%-annual-chance flood. They should be the same.	The ineffective flow elevation was set high to restrict the flow conveyance within the channel (i.e. right of the existing levee).
Ventura River	Main	1975	MultiOpen-UP	XS CHECK	XS DC 01	Discharge decreases in the downstream direction for 1%-annual-chance flood. There are no lateral structures. Documentation of hydrologic analysis is required or provide explanation.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	1651.518		XS CHECK	XS DC 03	Discharge is different between the upstream side and downstream side of the structure for 1%-annual-chance flood. They should be the same.	The ineffective flow elevation was set high to restrict the flow conveyance within the channel (i.e. right of the existing levee).

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	800	MultiOpen-UP	XS CHECK	XS DC 01	Discharge decreases in the downstream direction for 1%-annual-chance flood. There are no lateral structures. Documentation of hydrologic analysis is required or provide explanation.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	694.0917		XS CHECK	XS DC 03	Discharge is different between the upstream side and downstream side of the structure for 1%-annual-chance flood. They should be the same.	The ineffective flow elevation was set high to restrict the flow conveyance within the channel (i.e. right of the existing levee).
Ventura River	Main	43		XS CHECK	XS SW 01DK	The name of the stream is Ventura River, Main. The flow regime is subcritical or mixed flow. Starting WSEL is computed from Known WSEL as the downstream boundary for 1%-annual-chance flood. Provide backup information on Known WSEL or use energy slope as the downstream boundary.	Downstream water surface elevation of 2.53 feet was obtained from the FIS RAS model and used for computing the base profile and 3.53 feet was used for computing the floodway profile.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	43		FLOODWAY CHECK	FW SW 04M1	The name of the stream is (Ventura River, Main). Encroachment Method 1 is used. The total conveyance for the 1%-annual-chance flood profile is 744020.1. The total conveyance for the floodway profile is 719718.4. The difference in conveyance between the floodway profile and the 1%-annual-chance flood profile is more than 1%. The Normal Depth option with the same energy slope as the 1%-annual-chance flood profile must be used for both the 1%-annual-chance flood profile and the floodway profile and the plan should be rerun. This message may not be applicable when revising only a portion of a hydraulic model.	Downstream water surface elevation of 2.53 feet was obtained from the FIS RAS model and used for computing the base profile and 3.53 feet was used for computing the floodway profile.
Ventura River	Main			MPCHECK	MP SW 01DK	The name of the stream is (Ventura River, Main). The flow regime is subcritical or mixed flow. Starting water-surface elevations are computed from Known WSELs as the downstream boundary condition. Provide backup information on Known water-surface elevations or use same energy slope for all the profiles as the starting boundary condition and rerun the plan.	Downstream water surface elevation of 2.53 feet was obtained from the FIS RAS model and used for computing the base profile and 3.53 feet was used for computing the floodway profile.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	16563	Bridge-UP	STRUCTURE CHECK	ST DT 01B	This is (Bridge-UP). 'Upstream Dist' of 20 in "Bridge Width Table" is less than the height of the bridge opening of 33.7. This indicates that Section 3 may not be placed at the foot of the road embankment or wing walls and may not represent the natural valley cross section. Section 3 should be relocated or provide a statement that it represents the natural valley cross section. The HEC-RAS geometry file may need to be recreated using a GIS program. Lengths at Sections 4, 3 and 2 and 'Upstream Dist' should be adjusted.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	16563	Bridge-UP	STRUCTURE CHECK	BR LW 01	This is a Bridge Section. The selected profile is 1%-annual-chance. Type of flow is low and weir flow because, 1. EGEL 3 of 128.69 is greater than MinTopRd of 123.66 . 2. EGEL 3 of 128.69 is less than MxLoCdU of 132.34 .	Noted

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	16563	Bridge-UP	STRUCTURE CHECK	BR PW 06	This is Bridge-UP. The selected profile is 1%-annual-chance. EGEL of 128.69 at Section 3 is higher than the MinTopRd of 123.66. However the WSEL of 121.45 at BRU is less than MinTopRd. Please investigate the problem.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	16563	Bridge	STRUCTURE CHECK	ST GD 01US	This is (Bridge-UP) Section. The road data is outside the ground data. The starting station of 1230 from upstream Road data is less than the starting station of 0 from the upstream internal section. The 1%-annual-chance flood EGEL of 128.69 at Section 3 is higher than the ground elevation of the starting GR station and lower than the high chord elevation of the starting Road station. The road data should be included in the ground data. The HEC-RAS geometry file may need to be recreated using a GIS program.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	16563	Bridge	STRUCTURE CHECK	ST GD 03S3	This is Section 3. The highest flood frequency that has weir flow is 1%-annual-chance. All the ineffective flow elevations at Section 3 are lower than the water-surface elevation at Section 3. The velocity head at Section 3 is more than 0.5 foot and more than the velocity head at Section 4. Section 3 should be checked to make sure it represents the natural valley cross section. The HEC-RAS geometry file may need to be recreated using a GIS program.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	16563	Bridge	STRUCTURE CHECK	ST GD 02BU	This is the Upstream Bridge Section. There is only one bridge. However, the low cord line crosses the ground line at more than two locations. The ground and deck/roadway data should be checked.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	16613.95	Bridge	STRUCTURE CHECK	ST IF 03S3L	This is Section 3. The selected profile is 1%-annual-chance. Weir flow occurs at (Bridge-UP). However, the left ineffective flow elevation of 133.91 at the left ineffective flow station 1382.98 is equal to or higher than the WSEL of 122.31. The computed upstream LMnTpRd is 123.66. The ineffective flow elevation should be equal to or lower than the computed LMnTpRdU. It should also be lower than the WSEL at Section 3.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	16613.95	Bridge	STRUCTURE CHECK	ST IF 04S3R	This is Section 3. The selected profile is 1%-annual-chance. Weir flow occurs at (Bridge-UP). However, the right ineffective flow elevation of 133.91 at the right ineffective flow station 1673.95 is equal to or higher than the WSEL of 122.31. The computed upstream RMnTpRd is 131.11. The ineffective flow elevation should be equal to the computed RMnTpRdU.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	16678.11	Bridge	STRUCTURE CHECK	ST IF 07S4L	This is Section 4. Left Ineffective flow option was considered at this section. However, it should be a fully expanded cross section. Ineffective flow stations and elevations should be cleared from this section, unless the areas beyond the ineffective flow stations are not within the flow path of the stream. This message should be ignored if this section is Section 2 of the upstream structure.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	16678.11	Bridge	STRUCTURE CHECK	ST IF 07S4R	This is Section 4. Right Ineffective flow option was considered at this section. However, it should be a fully expanded cross section. Ineffective flow stations and elevations should be cleared from this section, unless the areas beyond the ineffective flow stations are not within the flow path of the stream. This message should be ignored if this section is Section 2 of the upstream structure.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	16563	Bridge	STRUCTURE CHECK	ST GD 03S3	This is Section 3. The highest flood frequency that has weir flow is 1%-annual-chance. All the ineffective flow elevations at Section 3 are lower than the water-surface elevation at Section 3. The velocity head at Section 3 is more than 0.5 foot and more than the velocity head at Section 4. Section 3 should be checked to make sure it represents the natural valley cross section. The HEC-RAS geometry file may need to be recreated using a GIS program.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	16563	Bridge	STRUCTURE CHECK	ST GD 02BD	This is the Downstream Bridge Section. There is only one bridge. However, the low cord line crosses the ground line at more than two locations. The ground and deck/roadway data should be checked.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	16529.73	Bridge	STRUCTURE CHECK	ST IF 03S2L	This is Section 2. The selected profile is 1%-annual-chance. Weir flow occurs at (Bridge-DN). However, the left ineffective flow elevation of 131.91 at the left ineffective flow station 1383.62 is equal to or higher than the WSEL of 121.23. The ineffective flow elevation should be lower than the WSEL at Section 2.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	16529.73	Bridge	STRUCTURE CHECK	ST IF 04S2R	This is Section 2. The selected profile is 100-yr. Weir flow occurs at (Bridge-DN). However, the right ineffective flow elevation of 131.91 at the right ineffective flow station 1671.76 is equal to or higher than the WSEL of 121.23. The upstream RMnTpRu is 131.11. The ineffective flow elevation should be lower than the WSEL at Section 2.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	16399.76	Bridge	STRUCTURE CHECK	ST IF 07S1L	This is Section 1. Left Ineffective flow option was considered at this section. However, it should be a fully expanded cross section. Ineffective flow stations and elevations should be cleared from this section, unless the areas beyond the ineffective flow stations are not within the flow path of the stream. This message should be ignored if this section is Section 3 of the downstream structure.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	16399.76	Bridge	STRUCTURE CHECK	ST IF 07S1R	This is Section 1. Right Ineffective flow option was considered at this section. However, it should be a fully expanded cross section. Ineffective flow stations and elevations should be cleared from this section, unless the areas beyond the ineffective flow stations are not within the flow path of the stream. This message should be ignored if this section is Section 3 of the downstream structure.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	2796	MultiOpen-UP	STRUCTURE CHECK	BR LF 01	This is (Bridge #1). The selected profile is 1%-annual-chance. Type of flow is low flow because, 1. EGEL 3 of 28.66 is less than or equal to MinTopRd of 32.83. 2. EGEL 3 of 28.66 is less than MxLoCdU of 34.57.	Noted
Ventura River	Main	2796	MultiOpen-UP	STRUCTURE CHECK	BR PW 02	This is a Bridge Section. The selected profile is 1%-annual-chance. Type of flow is submerged pressure and weir flow because, 1. EGEL 3 of 28.66 is greater than MinTopRd of 26.24 . 2. EGEL 3 of 28.66 is equal to or greater than MxLoCdU of 20.86. 3. WSEL 2 of 26.99 is equal to or greater than MxLoCdD of 20.86 .	Noted

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	2796	MultiOpen	STRUCTURE CHECK	ST GD 03S2	This is Section 2. The highest flood frequency that has weir flow is 1%-annual-chance. All the ineffective flow elevations at Section 2 are lower than the water-surface elevation at Section 2. The velocity head at Section 2 is more than 0.5 foot and more than the velocity head at Section 1. Section 2 should be checked to make sure it represents the natural valley cross section. The HEC-RAS geometry file may need to be recreated using a GIS program.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	2796	MultiOpen	STRUCTURE CHECK	ST GD 03S2	This is Section 2. The highest flood frequency that has weir flow is 1%-annual-chance. All the ineffective flow elevations at Section 2 are lower than the water-surface elevation at Section 2. The velocity head at Section 2 is more than 0.5 foot and more than the velocity head at Section 1. Section 2 should be checked to make sure it represents the natural valley cross section. The HEC-RAS geometry file may need to be recreated using a GIS program.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	2796	MultiOpen	STRUCTURE CHECK	ST GD 03S2	This is Section 2. The highest flood frequency that has weir flow is 1%-annual-chance. All the ineffective flow elevations at Section 2 are lower than the water-surface elevation at Section 2. The velocity head at Section 2 is more than 0.5 foot and more than the velocity head at Section 1. Section 2 should be checked to make sure it represents the natural valley cross section. The HEC-RAS geometry file may need to be recreated using a GIS program.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	2796	MultiOpen	STRUCTURE CHECK	ST GD 03S2	This is Section 2. The highest flood frequency that has weir flow is 1%-annual-chance. All the ineffective flow elevations at Section 2 are lower than the water-surface elevation at Section 2. The velocity head at Section 2 is more than 0.5 foot and more than the velocity head at Section 1. Section 2 should be checked to make sure it represents the natural valley cross section. The HEC-RAS geometry file may need to be recreated using a GIS program.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	1975	MultiOpen-UP	STRUCTURE CHECK	BR LW 01	This is a Bridge Section. The selected profile is 1%-annual-chance. Type of flow is low and weir flow because, 1. EGEL 3 of 26.93 is greater than MinTopRd of 23.82997 . 2. EGEL 3 of 26.93 is less than MxLoCdU of 37.03 .	Noted
Ventura River	Main	1975	MultiOpen-UP	STRUCTURE CHECK	BR LF 01	This is (Bridge #2). The selected profile is 1%-annual-chance. Type of flow is low flow because, 1. EGEL 3 of 26.93 is less than or equal to MinTopRd of 28.93. 2. EGEL 3 of 26.93 is less than MxLoCdU of 36.92.	Noted

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	1975	MultiOpen-UP	STRUCTURE CHECK	BR LW 01	This is a Bridge Section. The selected profile is 1%-annual-chance. Type of flow is low and weir flow because, 1. EGEL 3 of 26.93 is greater than MinTopRd of 22.70266 . 2. EGEL 3 of 26.93 is less than MxLoCdU of 47.8 .	Noted
Ventura River	Main	1975	MultiOpen	STRUCTURE CHECK	ST GD 03S2	This is Section 2. The highest flood frequency that has weir flow is 1%-annual-chance. All the ineffective flow elevations at Section 2 are lower than the water-surface elevation at Section 2. The velocity head at Section 2 is more than 0.5 foot and more than the velocity head at Section 1. Section 2 should be checked to make sure it represents the natural valley cross section. The HEC-RAS geometry file may need to be recreated using a GIS program.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	1975	MultiOpen	STRUCTURE CHECK	ST GD 03S2	This is Section 2. The highest flood frequency that has weir flow is 1%-annual-chance. All the ineffective flow elevations at Section 2 are lower than the water-surface elevation at Section 2. The velocity head at Section 2 is more than 0.5 foot and more than the velocity head at Section 1. Section 2 should be checked to make sure it represents the natural valley cross section. The HEC-RAS geometry file may need to be recreated using a GIS program.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	1975	MultiOpen	STRUCTURE CHECK	ST GD 03S2	This is Section 2. The highest flood frequency that has weir flow is 1%-annual-chance. All the ineffective flow elevations at Section 2 are lower than the water-surface elevation at Section 2. The velocity head at Section 2 is more than 0.5 foot and more than the velocity head at Section 1. Section 2 should be checked to make sure it represents the natural valley cross section. The HEC-RAS geometry file may need to be recreated using a GIS program.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	1975	MultiOpen	STRUCTURE CHECK	ST GD 03S2	This is Section 2. The highest flood frequency that has weir flow is 1%-annual-chance. All the ineffective flow elevations at Section 2 are lower than the water-surface elevation at Section 2. The velocity head at Section 2 is more than 0.5 foot and more than the velocity head at Section 1. Section 2 should be checked to make sure it represents the natural valley cross section. The HEC-RAS geometry file may need to be recreated using a GIS program.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	1975	MultiOpen	STRUCTURE CHECK	ST GD 03S2	This is Section 2. The highest flood frequency that has weir flow is 1%-annual-chance. All the ineffective flow elevations at Section 2 are lower than the water-surface elevation at Section 2. The velocity head at Section 2 is more than 0.5 foot and more than the velocity head at Section 1. Section 2 should be checked to make sure it represents the natural valley cross section. The HEC-RAS geometry file may need to be recreated using a GIS program.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	1975	MultiOpen	STRUCTURE CHECK	ST GD 03S2	This is Section 2. The highest flood frequency that has weir flow is 1%-annual-chance. All the ineffective flow elevations at Section 2 are lower than the water-surface elevation at Section 2. The velocity head at Section 2 is more than 0.5 foot and more than the velocity head at Section 1. Section 2 should be checked to make sure it represents the natural valley cross section. The HEC-RAS geometry file may need to be recreated using a GIS program.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	800	MultiOpen-UP	STRUCTURE CHECK	BR PW 01	This is a Bridge Section. The selected profile is 1%-annual-chance. Type of flow is sluice gate pressure and weir flow because, 1. EGEL 3 of 21.89 is greater than MinTopRd of 18.29947 . 2. EGEL 3 of 21.89 is equal to or greater than MxLoCdU of 15.1. 3. WSEL 2 of 13.96 is less than MxLoCdD of 15.1 .	Noted
Ventura River	Main	800	MultiOpen-UP	STRUCTURE CHECK	BR PW 01	This is a Bridge Section. The selected profile is 1%-annual-chance. Type of flow is sluice gate pressure and weir flow because, 1. EGEL 3 of 21.89 is greater than MinTopRd of 20.6 . 2. EGEL 3 of 21.89 is equal to or greater than MxLoCdU of 15.7. 3. WSEL 2 of 13.96 is less than MxLoCdD of 15.6 .	Noted

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	800	MultiOpen	STRUCTURE CHECK	ST GD 01US	This is (MultiOpen-UP) Section. The road data is outside the ground data. The starting station of 27.3 from upstream Road data is less than the starting station of 0 from the upstream internal section. The 1%-annual-chance flood EGEL of 21.89 at Section 3 is higher than the ground elevation of the starting GR station and lower than the high chord elevation of the starting Road station. The road data should be included in the ground data. The HEC-RAS geometry file may need to be recreated using a GIS program.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	800	MultiOpen	STRUCTURE CHECK	ST GD 01US	This is (MultiOpen-UP) Section. The road data is outside the ground data. The starting station of 27.3 from upstream Road data is less than the starting station of 0 from the upstream internal section. The 1%-annual-chance flood EGEL of 21.89 at Section 3 is higher than the ground elevation of the starting GR station and lower than the high chord elevation of the starting Road station. The road data should be included in the ground data. The HEC-RAS geometry file may need to be recreated using a GIS program.	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	800	MultiOpen	STRUCTURE CHECK	ST IF 02S3R	This is Section 3. The selected profile is 1%-annual-chance. Weir flow occurs at (MultiOpen). However,right ineffective flow station was not considered at Section 3. The ineffective flow station and elevation should be inserted. The right ineffective flow elevation should be equal to rmntprdu of 20.6. The placement of the right ineffective flow station is explained on page 5-7 of Hydraulic Reference Manual (HEC, 2010).	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	800	MultiOpen	STRUCTURE CHECK	ST IF 02S2R	This is Section 2. The selected profile is 1%-annual-chance. Weir flow occurs at (MultiOpen). However, right ineffective flow station was not considered at Section 2. The ineffective flow station and elevation should be inserted. The right ineffective flow elevation should be less than the wsel2 of 13.96 of the 1%-annual-chance profile. The placement of the right ineffective flow station is explained on page 5-7 of Hydraulic Reference Manual (HEC, 2010).	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	2796	MultiOpen	STRUCTURE CHECK	MS IF 01S2L	This is Section 2 of Multiple Structures. Left Ineffective Flow Station was not considered at Section 2. The Multiple Block Ineffective Flow option should be used. The left ineffective flow elevation should be higher than the highest discharge that has low flow or pressure flow or less than the WSEL of the lowest discharge that has weir flow. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	The ineffective flow elevation was set high to restrict the flow conveyance within the channel (i.e. right of the existing levee).
Ventura River	Main	2796	MultiOpen	STRUCTURE CHECK	MS IF 01S2R	This is Section 2 of Multiple Structures. Right Ineffective Flow Station was not considered at Section 2. Multiple Block Ineffective Flow option should be used. The right ineffective flow elevation should be higher than the highest discharge that has low flow or pressure flow or less than the WSEL of the lowest discharge that has weir flow. The placement of the ineffective flow stations is explained on page 5-10 the Applications Guide (HEC, 2010).	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	2796	MultiOpen	STRUCTURE CHECK	MS IF 01S3L	This is Section 3 of Multiple Structures. Left Ineffective Flow Station was not considered at Section 3. Multiple Block Ineffective Flow option should be used. The left ineffective flow elevation should be equal to -9999. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	The ineffective flow elevation was set high to restrict the flow conveyance within the channel (i.e. right of the existing levee).

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	2796	MultiOpen	STRUCTURE CHECK	MS IF 01S3R	This is Section 3 of Multiple Structures. Right Ineffective Flow Station was not considered at Section 3. Multiple Block Ineffective Flow option should be used. The right ineffective flow elevation should be equal to -9999. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	2796	MultiOpen	STRUCTURE CHECK	MS IF 01S2L	This is Section 2 of Multiple Structures. Left Ineffective Flow Station was not considered at Section 2. The Multiple Block Ineffective Flow option should be used. The left ineffective flow elevation should be higher than the highest discharge that has low flow or pressure flow or less than the WSEL of the lowest discharge that has weir flow. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	The ineffective flow elevation was set high to restrict the flow conveyance within the channel (i.e. right of the existing levee).
Ventura River	Main	2796	MultiOpen	STRUCTURE CHECK	MS IF 01S2R	This is Section 2 of Multiple Structures. Right Ineffective Flow Station was not considered at Section 2. Multiple Block Ineffective Flow option should be used. The right ineffective flow elevation should be higher than the highest discharge that has low flow or pressure flow or less than the WSEL of the lowest discharge that has weir flow. The placement of the ineffective flow stations is explained on page 5-10 the Applications Guide (HEC, 2010).	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	2796	MultiOpen	STRUCTURE CHECK	MS IF 01S3L	This is Section 3 of Multiple Structures. Left Ineffective Flow Station was not considered at Section 3. Multiple Block Ineffective Flow option should be used. The left ineffective flow elevation should be equal to -9999. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	The ineffective flow elevation was set high to restrict the flow conveyance within the channel (i.e. right of the existing levee).
Ventura River	Main	2796	MultiOpen	STRUCTURE CHECK	MS IF 01S3R	This is Section 3 of Multiple Structures. Right Ineffective Flow Station was not considered at Section 3. Multiple Block Ineffective Flow option should be used. The right ineffective flow elevation should be equal to -9999. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	2796	MultiOpen	STRUCTURE CHECK	MS IF 01S2L	This is Section 2 of Multiple Structures. Left Ineffective Flow Station was not considered at Section 2. The Multiple Block Ineffective Flow option should be used. The left ineffective flow elevation should be higher than the highest discharge that has low flow or pressure flow or less than the WSEL of the lowest discharge that has weir flow. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	The ineffective flow elevation was set high to restrict the flow conveyance within the channel (i.e. right of the existing levee).

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Ventura River	Main	2796	MultiOpen	STRUCTURE CHECK	MS IF 01S3L	This is Section 3 of Multiple Structures. Left Ineffective Flow Station was not considered at Section 3. Multiple Block Ineffective Flow option should be used. The left ineffective flow elevation should be equal to -9999. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	The ineffective flow elevation was set high to restrict the flow conveyance within the channel (i.e. right of the existing levee).

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Ventura River	Main	2796	MultiOpen	STRUCTURE CHECK	MS IF 01S3R	This is Section 3 of Multiple Structures. Right Ineffective Flow Station was not considered at Section 3. Multiple Block Ineffective Flow option should be used. The right ineffective flow elevation should be equal to -9999. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	1975	MultiOpen	STRUCTURE CHECK	MS IF 01S2L	This is Section 2 of Multiple Structures. Left Ineffective Flow Station was not considered at Section 2. The Multiple Block Ineffective Flow option should be used. The left ineffective flow elevation should be higher than the highest discharge that has low flow or pressure flow or less than the WSEL of the lowest discharge that has weir flow. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	The ineffective flow elevation was set high to restrict the flow conveyance within the channel (i.e. right of the existing levee).
Ventura River	Main	1975	MultiOpen	STRUCTURE CHECK	MS IF 01S2R	This is Section 2 of Multiple Structures. Right Ineffective Flow Station was not considered at Section 2. Multiple Block Ineffective Flow option should be used. The right ineffective flow elevation should be higher than the highest discharge that has low flow or pressure flow or less than the WSEL of the lowest discharge that has weir flow. The placement of the ineffective flow stations is explained on page 5-10 the Applications Guide (HEC, 2010).	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	1975	MultiOpen	STRUCTURE CHECK	MS IF 01S3L	This is Section 3 of Multiple Structures. Left Ineffective Flow Station was not considered at Section 3. Multiple Block Ineffective Flow option should be used. The left ineffective flow elevation should be equal to -9999. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	The ineffective flow elevation was set high to restrict the flow conveyance within the channel (i.e. right of the existing levee).
Ventura River	Main	1975	MultiOpen	STRUCTURE CHECK	MS IF 01S3R	This is Section 3 of Multiple Structures. Right Ineffective Flow Station was not considered at Section 3. Multiple Block Ineffective Flow option should be used. The right ineffective flow elevation should be equal to -9999. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	1975	MultiOpen	STRUCTURE CHECK	MS IF 01S2L	This is Section 2 of Multiple Structures. Left Ineffective Flow Station was not considered at Section 2. The Multiple Block Ineffective Flow option should be used. The left ineffective flow elevation should be higher than the highest discharge that has low flow or pressure flow or less than the WSEL of the lowest discharge that has weir flow. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	The ineffective flow elevation was set high to restrict the flow conveyance within the channel (i.e. right of the existing levee).

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Ventura River	Main	1975	MultiOpen	STRUCTURE CHECK	MS IF 01S3L	This is Section 3 of Multiple Structures. Left Ineffective Flow Station was not considered at Section 3. Multiple Block Ineffective Flow option should be used. The left ineffective flow elevation should be equal to -9999. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	The ineffective flow elevation was set high to restrict the flow conveyance within the channel (i.e. right of the existing levee).

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	1975	MultiOpen	STRUCTURE CHECK	MS IF 01S3R	This is Section 3 of Multiple Structures. Right Ineffective Flow Station was not considered at Section 3. Multiple Block Ineffective Flow option should be used. The right ineffective flow elevation should be equal to -9999. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	800	MultiOpen	STRUCTURE CHECK	MS IF 01S2L	This is Section 2 of Multiple Structures. Left Ineffective Flow Station was not considered at Section 2. The Multiple Block Ineffective Flow option should be used. The left ineffective flow elevation should be higher than the highest discharge that has low flow or pressure flow or less than the WSEL of the lowest discharge that has weir flow. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	The ineffective flow elevation was set high to restrict the flow conveyance within the channel (i.e. right of the existing levee).
Ventura River	Main	800	MultiOpen	STRUCTURE CHECK	MS IF 01S2R	This is Section 2 of Multiple Structures. Right Ineffective Flow Station was not considered at Section 2. Multiple Block Ineffective Flow option should be used. The right ineffective flow elevation should be higher than the highest discharge that has low flow or pressure flow or less than the WSEL of the lowest discharge that has weir flow. The placement of the ineffective flow stations is explained on page 5-10 the Applications Guide (HEC, 2010).	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

River	Reach	RS	Structure	Check Type	Message ID	Message	Comments
Ventura River	Main	-9999	MultiOpen	STRUCTURE CHECK	MS IF 01S3L	This is Section 3 of Multiple Structures. Left Ineffective Flow Station was not considered at Section 3. Multiple Block Ineffective Flow option should be used. The left ineffective flow elevation should be equal to -9999. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	-9999	MultiOpen	STRUCTURE CHECK	MS IF 01S3R	This is Section 3 of Multiple Structures. Right Ineffective Flow Station was not considered at Section 3. Multiple Block Ineffective Flow option should be used. The right ineffective flow elevation should be equal to -9999. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
Ventura River	Main	800	MultiOpen	STRUCTURE CHECK	MS IF 01S2L	This is Section 2 of Multiple Structures. Left Ineffective Flow Station was not considered at Section 2. The Multiple Block Ineffective Flow option should be used. The left ineffective flow elevation should be higher than the highest discharge that has low flow or pressure flow or less than the WSEL of the lowest discharge that has weir flow. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	The ineffective flow elevation was set high to restrict the flow conveyance within the channel (i.e. right of the existing levee).

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Ventura River	Main	800	MultiOpen	STRUCTURE CHECK	MS IF 01S2R	This is Section 2 of Multiple Structures. Right Ineffective Flow Station was not considered at Section 2. Multiple Block Ineffective Flow option should be used. The right ineffective flow elevation should be higher than the highest discharge that has low flow or pressure flow or less than the WSEL of the lowest discharge that has weir flow. The placement of the ineffective flow stations is explained on page 5-10 the Applications Guide (HEC, 2010).	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.
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Ventura River	Main	-9999	MultiOpen	STRUCTURE CHECK	MS IF 01S3L	This is Section 3 of Multiple Structures. Left Ineffective Flow Station was not considered at Section 3. Multiple Block Ineffective Flow option should be used. The left ineffective flow elevation should be equal to -9999. The placement of the ineffective flow stations is explained on page 5-10 of the Applications Guide (HEC, 2010).	The FIS RAS model was used in the analysis, no cross section data were modified in order for a fair comparison.

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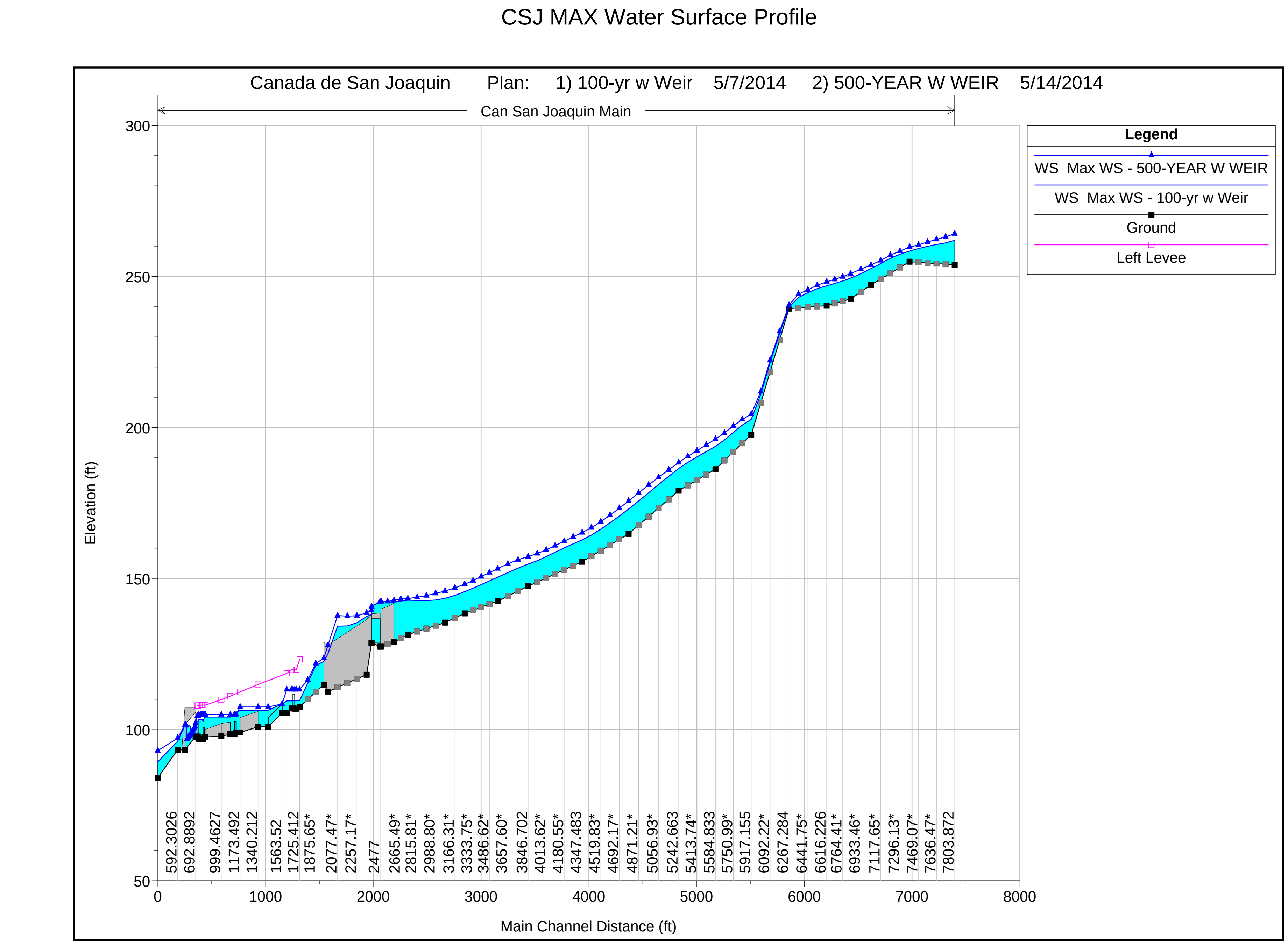
CSJ MAX Water Surface Profile
Canada de San Joaquin Plan: 1) 100-yr w Weir 5/7/2014 2) 500-YEAR W WEIR 5/14/2014
Can San Joaquin Main
Legend
WS Max WS - 500-YEAR W WEIR
WS Max WS - 100-yr w Weir
Ground
Left Levee
Elevation (ft)
Main Channel Distance (ft)
300
250
200
150
100
50
0
1000
2000
3000
4000
5000
6000
7000
8000
592.3026
692.8892
999.4627
1173.492
1340.212
1563.52
1725.412
1875.65*
2077.47*
2257.17*
2477
2665.49*
2815.81*
2988.80*
3166.31*
3333.75*
3486.62*
3657.60*
3846.702
4013.62*
4180.55*
4347.483
4519.83*
4692.17*
4871.21*
5056.93*
5242.663
5413.74*
5584.833
5750.99*
5917.155
6092.22*
6267.284
6441.75*
6616.226
6764.41*
6933.46*
7117.65*
7296.13*
7469.07*
7636.47*
7803.872

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CSJ Hydraulics Table

HEC-RAS River: Can San Joaquin Reach: Main Profile: Max WS

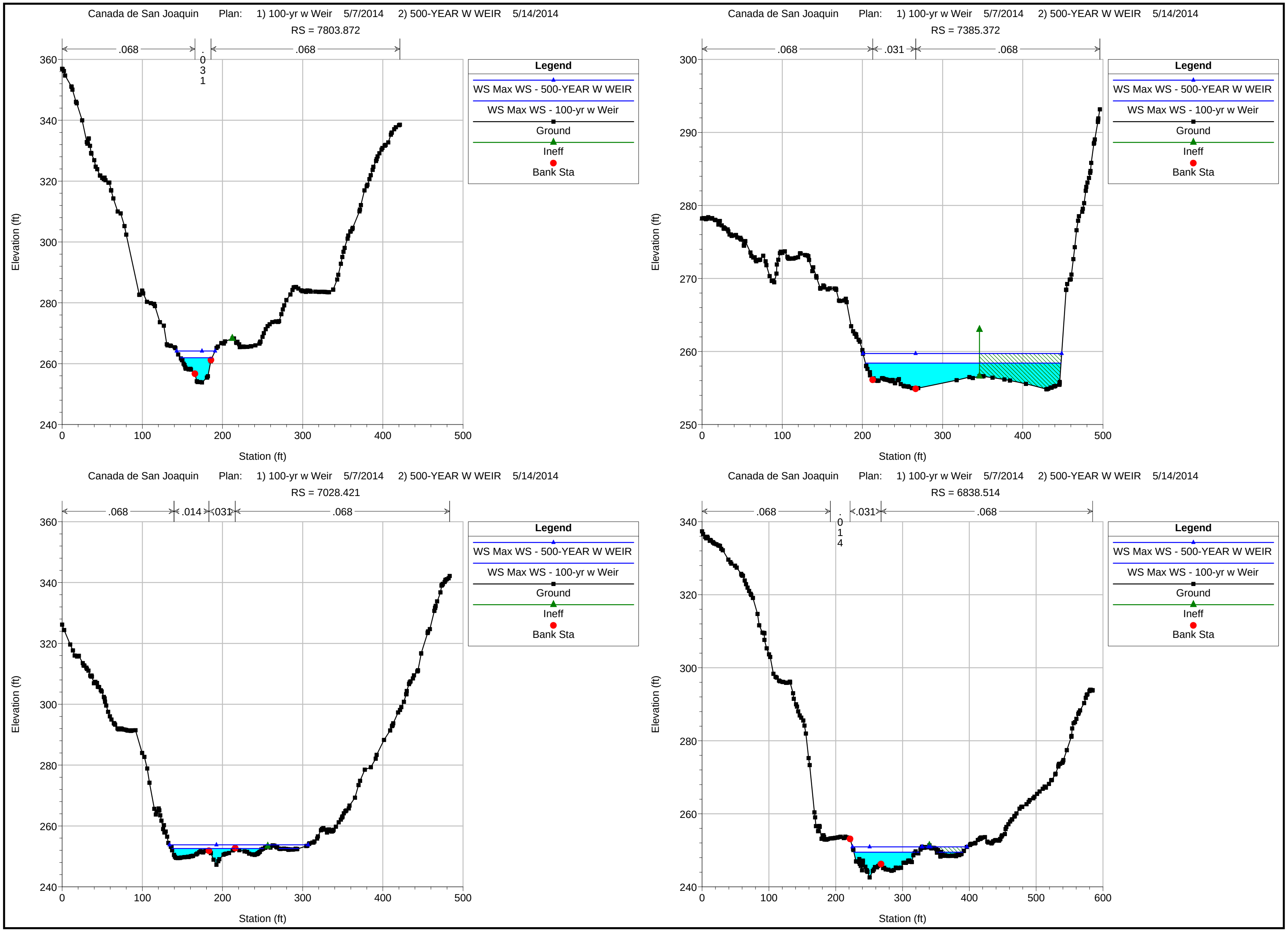
Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	7803.872	Max WS	100-yr w Weir	2383.00	253.82	261.94	262.48	265.47	0.011377	15.92	190.29	39.54	1.09
Main	7803.872	Max WS	500-YEAR W WEIR	4526.52	253.82	264.16	265.42	270.31	0.014143	21.51	287.99	47.98	1.27
Main	7385.372	Max WS	100-yr w Weir	2374.24	254.88	258.41	258.24	259.44	0.011628	9.90	361.84	244.03	1.07
Main	7385.372	Max WS	500-YEAR W WEIR	4511.45	254.88	259.72	259.51	261.34	0.010829	12.46	550.05	247.84	1.10
Main	7028.421	Max WS	100-yr w Weir	2368.27	247.23	252.57	253.56	256.13	0.010591	8.30	207.86	136.81	0.96
Main	7028.421	Max WS	500-YEAR W WEIR	4504.04	247.23	253.79	255.21	258.39	0.007947	9.46	403.91	172.88	0.89
Main	6838.514	Max WS	100-yr w Weir	2365.00	242.56	249.48		250.50	0.007608	9.54	348.24	130.97	0.84
Main	6838.514	Max WS	500-YEAR W WEIR	4394.00	242.56	250.93	250.54	252.76	0.009659	12.83	494.89	167.57	0.99
Main	6616.226	Max WS	100-yr w Weir	2362.01	240.33	246.93	247.02	248.61	0.009519	10.62	258.14	125.11	0.96
Main	6616.226	Max WS	500-YEAR W WEIR	4521.27	240.33	248.23	248.70	250.62	0.010561	13.41	479.55	148.81	1.05
Main	6267.284	Max WS	100-yr w Weir	2360.59	239.35	239.88	242.50	257.52	0.052987	4.68	71.30	49.74	1.58
Main	6267.284	Max WS	500-YEAR W WEIR	4493.51	239.35	240.48	244.02	272.16	0.069824	7.38	112.47	84.56	1.73
Main	5917.155	Max WS	100-yr w Weir	2360.45	197.63	202.74	203.83	206.50	0.019536	16.44	181.59	55.93	1.46
Main	5917.155	Max WS	500-YEAR W WEIR	4493.07	197.63	204.43	206.24	210.46	0.020074	21.15	287.44	66.69	1.57
Main	5584.833	Max WS	100-yr w Weir	2359.94	186.18	193.77	195.15	198.41	0.020565	17.29	136.52	29.71	1.42
Main	5584.833	Max WS	500-YEAR W WEIR	4491.81	186.18	196.13	198.18	202.84	0.022123	20.79	216.06	37.30	1.52
Main	5242.663	Max WS	100-yr w Weir	2359.46	179.08	186.42	187.90	191.14	0.026959	17.44	135.27	37.39	1.62
Main	5242.663	Max WS	500-YEAR W WEIR	4490.86	179.08	188.39	190.50	195.14	0.025920	20.84	215.49	43.71	1.65
Main	4778.353	Max WS	100-yr w Weir	2358.87	164.78	173.01	174.98	179.32	0.027647	20.17	116.94	22.78	1.57
Main	4778.353	Max WS	500-YEAR W WEIR	4489.52	164.78	175.70	178.74	184.90	0.029427	24.35	184.40	27.36	1.65
Main	4347.483	Max WS	100-yr w Weir	2358.15	155.57	162.79	163.60	166.44	0.015387	15.33	153.78	32.65	1.25
Main	4347.483	Max WS	500-YEAR W WEIR	4487.97	155.57	165.20	166.66	170.60	0.016451	18.64	240.72	39.51	1.33
Main	3846.702	Max WS	100-yr w Weir	2356.92	147.49	154.80	155.03	157.29	0.011276	12.68	185.93	43.14	1.08
Main	3846.702	Max WS	500-YEAR W WEIR	4485.07	147.49	157.26	157.56	160.73	0.010209	14.95	300.05	49.47	1.07
Main	3563.059	Max WS	100-yr w Weir	2356.14	142.52	150.39	151.29	154.48	0.015871	16.24	145.12	26.75	1.23
Main	3563.059	Max WS	500-YEAR W WEIR	4483.63	142.52	153.26	155.02	159.12	0.016619	19.43	230.78	32.99	1.29
Main	3257.319	Max WS	100-yr w Weir	2354.86	138.47	145.67	146.45	148.98	0.015254	14.59	161.38	37.68	1.24
Main	3257.319	Max WS	500-YEAR W WEIR	4482.55	138.47	148.14	149.59	152.53	0.014217	16.82	266.53	46.64	1.24
Main	3075.303	Max WS	100-yr w Weir	2353.67	135.42	143.45	143.19	145.57	0.008483	11.69	201.31	42.31	0.94
Main	3075.303	Max WS	500-YEAR W WEIR	4479.42	135.42	145.88	145.96	148.78	0.009467	13.66	327.97	59.51	1.03
Main	2729.319	Max WS	100-yr w Weir	2344.79	131.47	142.84		143.39	0.001936	5.95	411.10	114.94	0.46
Main	2729.319	Max WS	500-YEAR W WEIR	4475.22	131.47	143.37	142.40	144.97	0.005189	10.22	484.65	165.28	0.76
Main	2601.669	Max WS	100-yr w Weir	2343.89	128.98	142.17	139.98	143.35	0.004130	8.93	371.84	250.13	0.63
Main	2601.669	Max WS	500-YEAR W WEIR	2066.33	128.98	142.79		143.37	0.001970	6.57	531.87	269.77	0.44
Main	2572			Lat Struct									
Main	2481.619	Max WS	100-yr w Weir	2223.22	127.46	142.40		142.60	0.000439	3.94	1043.66	401.60	0.23
Main	2481.619	Max WS	500-YEAR W WEIR	2172.94	127.46	142.37		142.56	0.000425	3.87	1031.81	395.38	0.22
Main	2477			Culvert									
Main	2391.622	Max WS	100-yr w Weir	2223.20	128.73	138.06		141.39	0.079005	14.65	151.77	129.00	0.89
Main	2391.622	Max WS	500-YEAR W WEIR	5289.14	128.73	139.55	139.98	141.05	0.027372	9.76	557.18	331.61	0.66
Main	2369			Lat Struct									
Main	2347.020	Max WS	100-yr w Weir	2215.40	118.17	137.47		138.06	0.021958	6.26	361.30	199.48	0.36
Main	2347.020	Max WS	500-YEAR W WEIR	5067.49	118.17	138.62	138.65	139.59	0.017963	7.35	691.95	512.70	0.40
Main	1987.623	Max WS	100-yr w Weir	1681.90	112.58	125.05		128.87	0.188248	15.69	107.21	9.76	0.83
Main	1987.623	Max WS	500-YEAR W WEIR	2328.34	112.58	127.88	126.12	131.78	0.250954	15.90	147.55	55.64	1.53
Main	1950.783	Max WS	100-yr w Weir	1681.62	114.89	122.59		124.27	0.038699	10.39	161.91	37.61	0.67
Main	1950.783	Max WS	500-YEAR W WEIR	2479.20	114.89	123.63		126.43	0.037605	13.42	184.78	42.01	0.81
Main	1725.412	Max WS	100-yr w Weir	1644.73	107.60	109.60		109.81	0.008500	2.14	456.88	517.45	0.27
Main	1725.412	Max WS	500-YEAR W WEIR	2279.20	107.60	113.28		113.29	0.000049	0.30	2935.01	734.22	0.03
Main	1695.316	Max WS	100-yr w Weir	1645.27	106.94	109.55	108.87	109.64	0.001832	3.23	713.05	549.59	0.35
Main	1695.316	Max WS	500-YEAR W WEIR	2283.20	106.94	113.28	109.08	113.29	0.000034	0.72	3128.22	700.81	0.05
Main	1674.163			Bridge									
Main	1650.470	Max WS	100-yr w Weir	1644.81	107.00	109.52		109.58	0.000869	3.49	922.69	604.84	0.39
Main	1650.470	Max WS	500-YEAR W WEIR	2278.54	107.00	113.28		113.29	0.000026	0.91	3478.17	703.50	0.07
Main	1605.517	Max WS	100-yr w Weir	1645.21	105.44	109.51	108.27	109.54	0.000482	2.20	1127.39	722.14	0.20
Main	1605.517	Max WS	500-YEAR W WEIR	2286.72	105.44	113.28	108.40	113.29	0.000018	0.53	4654.87	1090.01	0.04
Main	1563.52			Bridge									
Main	1340.212	Max WS	100-yr w Weir	1317.28	100.92	106.40		106.40	0.000093	1.18	2145.28	1387.76	0.09

CSJ Hydraulics Table

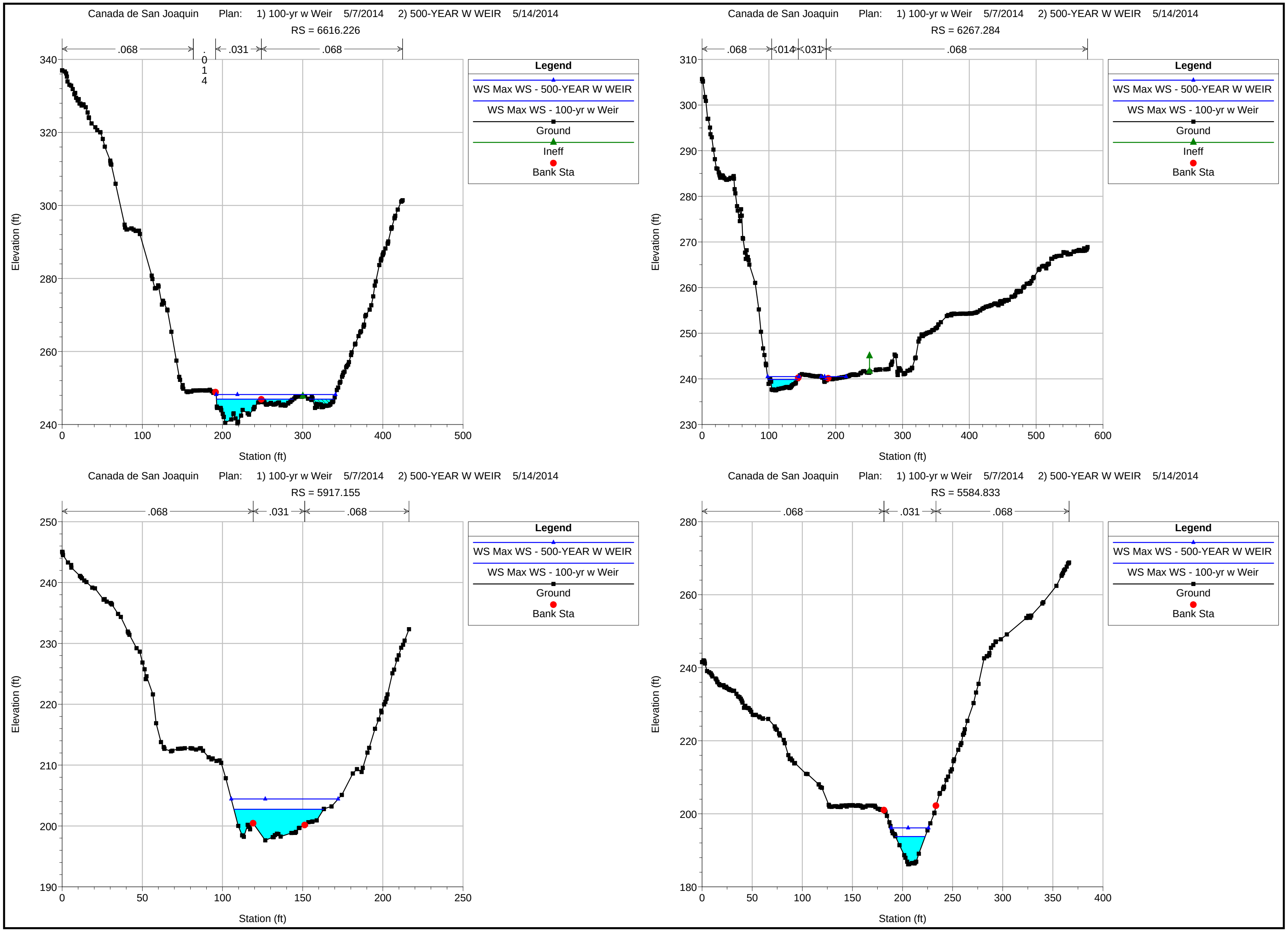
HEC-RAS River: Can San Joaquin Reach: Main Profile: Max WS (Continued)

Reach	River Sta	Profile	Plan	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)	
Main	1340.212	Max WS	500-YEAR W WEIR	2225.84	100.92	107.47		107.48	0.000050	0.85	3784.76	1493.66	0.07
Main	1300			Lat Struct									
Main	1173.492	Max WS	100-yr w Weir	1202.79	99.04	106.39	104.61	106.39	0.000012	0.46	3969.09	1484.53	0.04
Main	1173.492	Max WS	500-YEAR W WEIR	1881.44	99.04	107.47	104.80	107.48	0.000010	0.49	5610.38	1551.17	0.03
Main	1136.874			Bridge									
Main	1082.103	Max WS	100-yr w Weir	1202.79	98.44	104.15		105.29	0.005484	8.63	143.61	1201.56	0.73
Main	1082.103	Max WS	500-YEAR W WEIR	1800.31	98.44	104.98		104.99	0.000082	1.19	2706.21	1346.11	0.09
Main	1000			Lat Struct									
Main	999.4627	Max WS	100-yr w Weir	1086.03	97.81	104.15		104.16	0.000057	0.99	2224.28	1339.45	0.08
Main	999.4627	Max WS	500-YEAR W WEIR	1601.59	97.81	104.98		104.99	0.000034	0.85	3348.65	1363.07	0.06
Main	850			Lat Struct									
Main	849.3648	Max WS	100-yr w Weir	691.78	97.58	104.15	101.22	104.15	0.000009	0.37	2910.86	1300.43	0.03
Main	849.3648	Max WS	500-YEAR W WEIR	1045.04	97.58	104.99	102.05	104.99	0.000008	0.38	4006.51	1327.54	0.03
Main	826.6341			Bridge									
Main	823.36	Max WS	100-yr w Weir	689.90	96.96	103.30		103.31	0.000057	0.84	1590.90	853.37	0.07
Main	823.36	Max WS	500-YEAR W WEIR	1044.98	96.96	104.98		104.99	0.000018	0.59	3600.57	1318.82	0.04
Main	814.8544	Max WS	100-yr w Weir	688.69	96.96	103.30		103.31	0.000056	0.84	1590.55	853.23	0.07
Main	814.8544	Max WS	500-YEAR W WEIR	1044.98	96.96	104.98		104.99	0.000018	0.59	3600.44	1318.82	0.04
Main	801.0891			Culvert									
Main	784.85	Max WS	100-yr w Weir	687.79	97.68	102.71		103.18	0.003114	5.50	127.56	756.19	0.52
Main	784.85	Max WS	500-YEAR W WEIR	1044.80	97.68	104.48		104.90	0.001778	5.30	210.63	960.91	0.42
Main	779.05	Max WS	100-yr w Weir	688.36	97.68	102.68		103.16	0.003194	5.55	126.55	752.45	0.52
Main	779.05	Max WS	500-YEAR W WEIR	1044.89	97.68	104.46		104.89	0.001794	5.31	209.99	959.40	0.42
Main	775.0487	Max WS	100-yr w Weir	688.44	97.68	102.67		103.15	0.003249	5.58	125.84	749.71	0.53
Main	775.0487	Max WS	500-YEAR W WEIR	1044.90	97.68	104.45		104.88	0.001805	5.33	209.54	958.34	0.42
Main	692.8892			Culvert									
Main	592.3026	Max WS	100-yr w Weir	688.44	93.32	96.10	97.71	101.75	0.076419	19.07	36.10	55.51	2.46
Main	592.3026	Max WS	500-YEAR W WEIR	1044.90	93.32	97.16	98.77	102.14	0.044393	17.91	58.35	71.37	1.96
Main	408.9545	Max WS	100-yr w Weir	886.16	84.05	89.35	87.83	89.98	0.005000	6.34	139.68	33.92	0.55
Main	408.9545	Max WS	500-YEAR W WEIR	1044.85	84.05	93.01	88.20	93.22	0.001000	3.70	282.04	44.60	0.26

CSJ Cross Sections



CSJ Cross Sections



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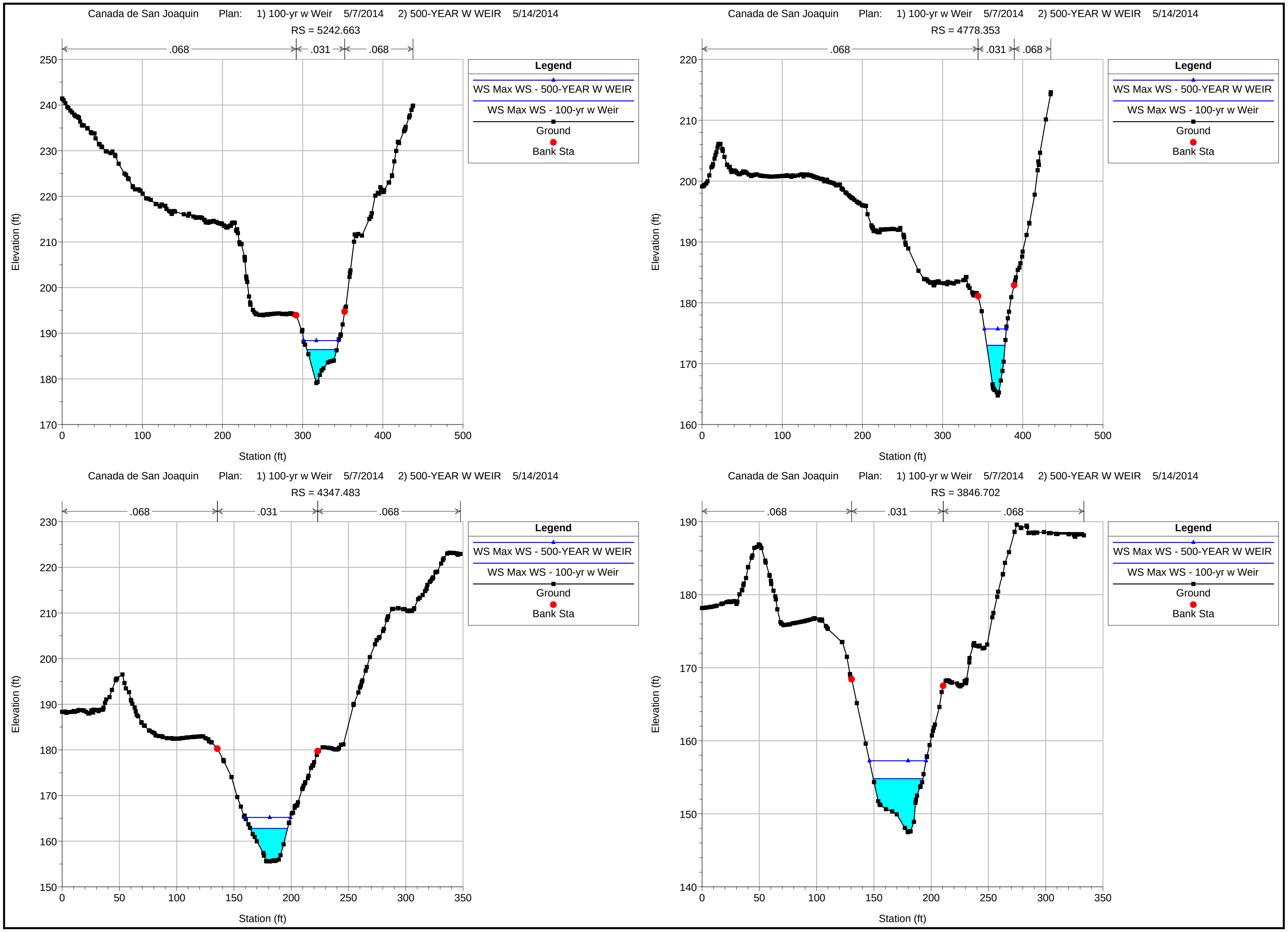

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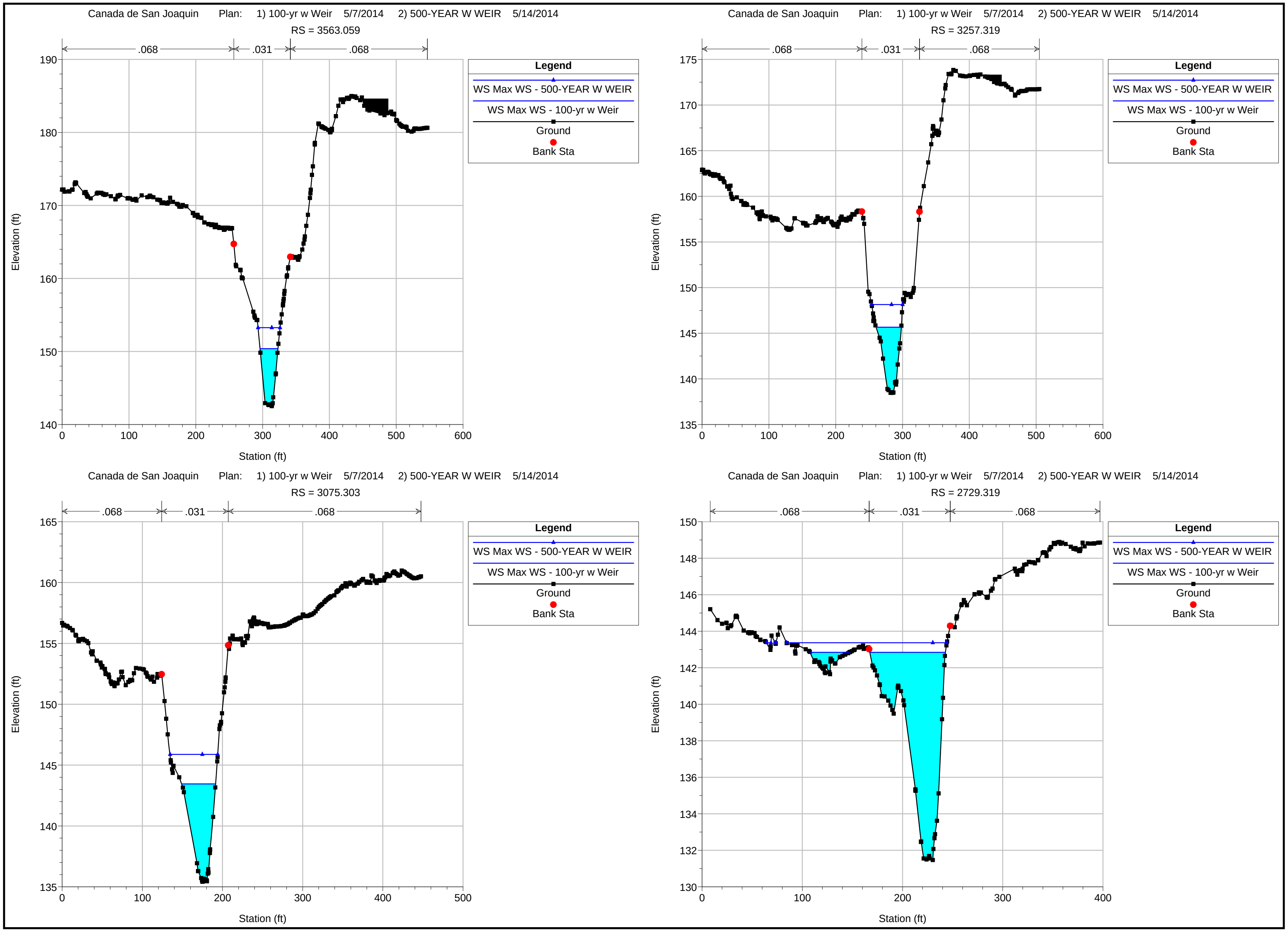

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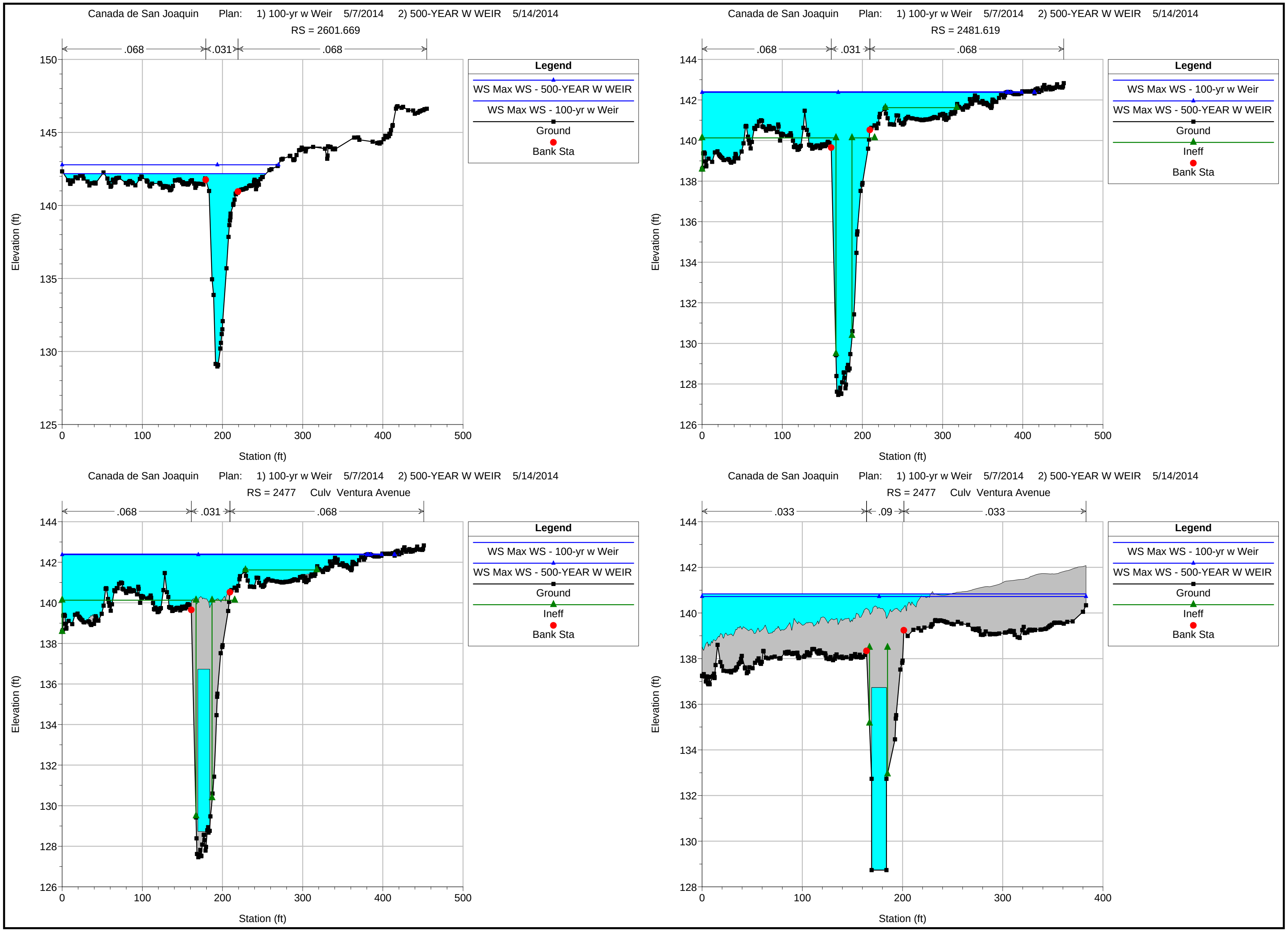

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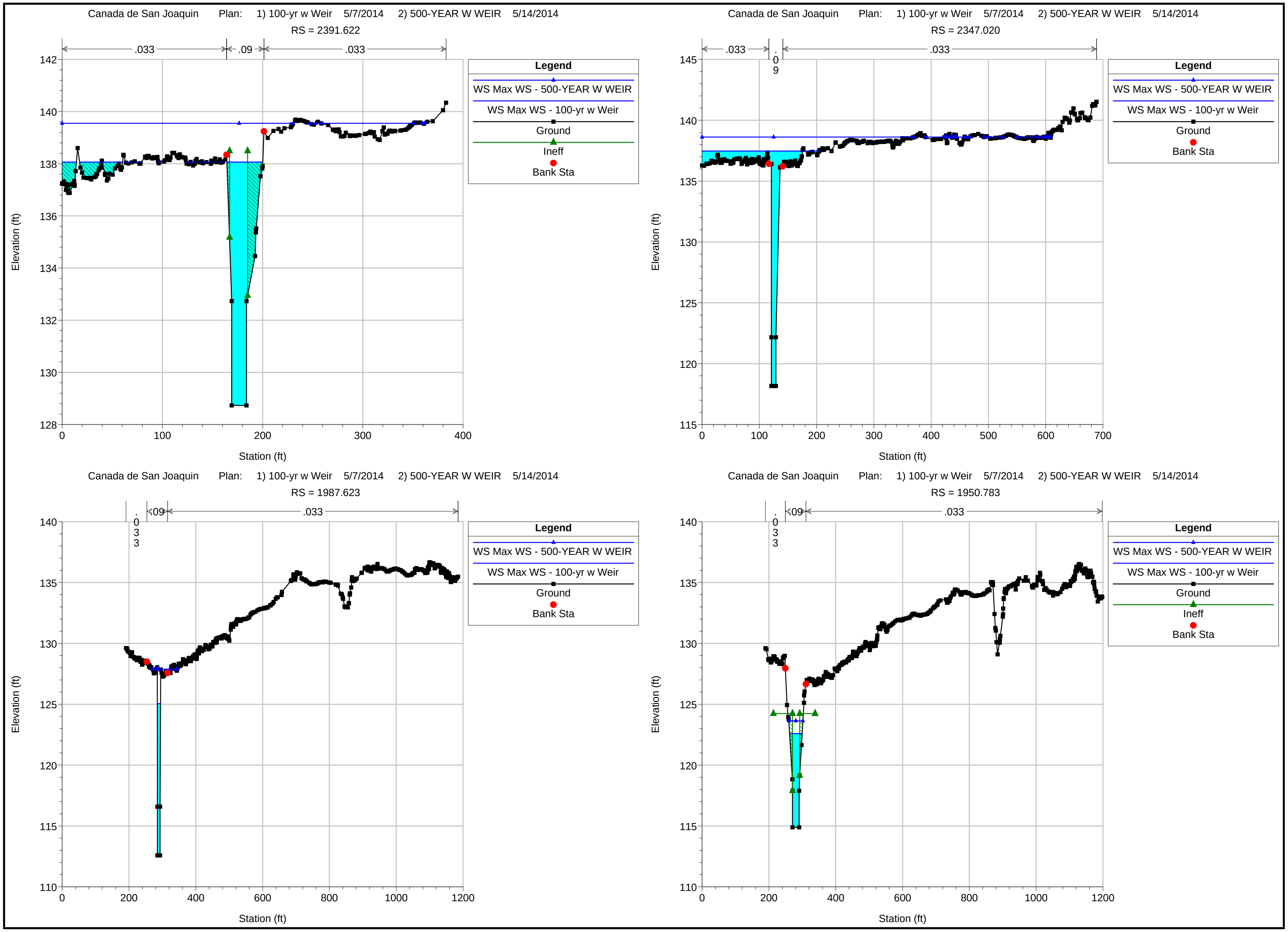

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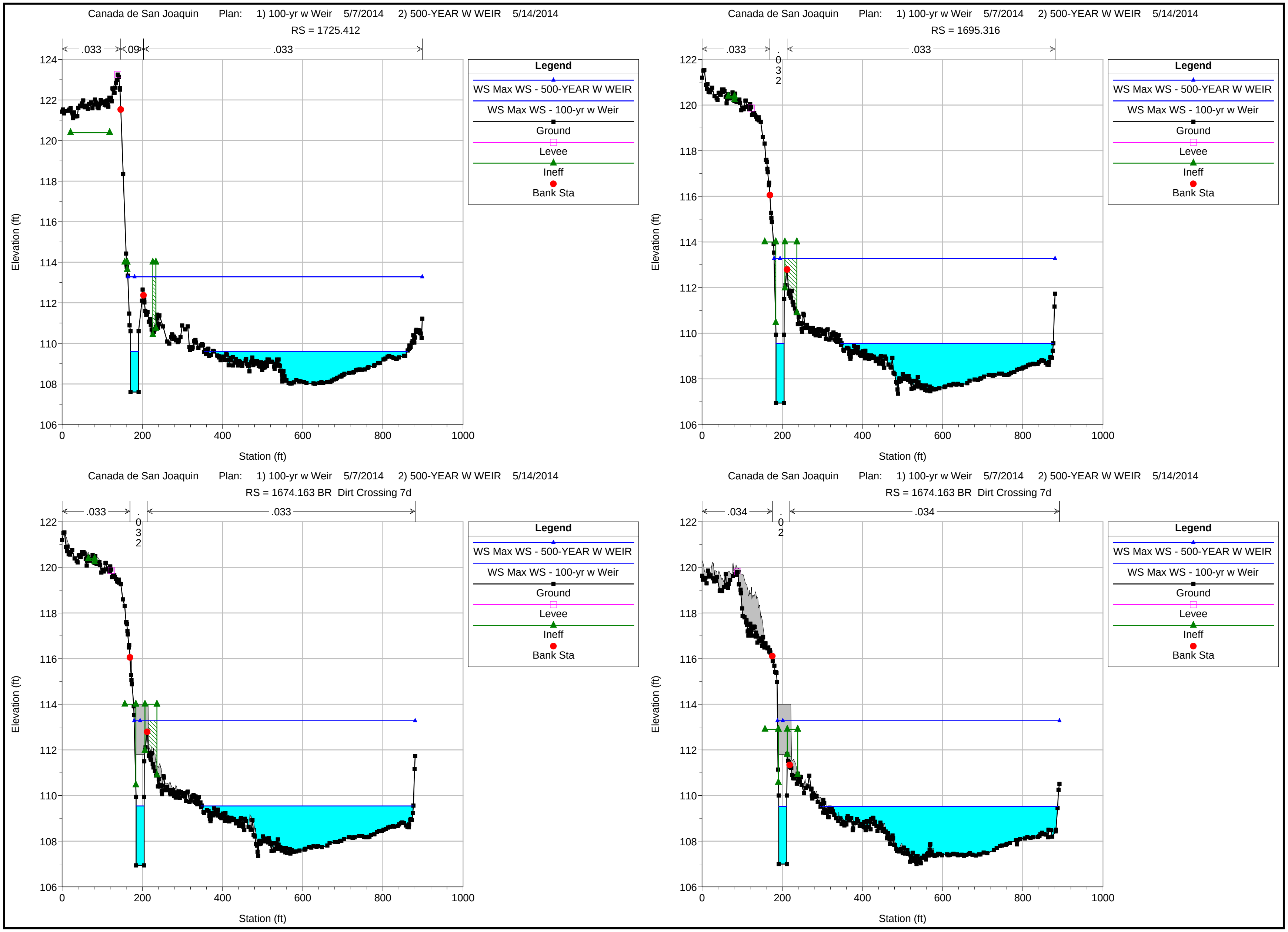

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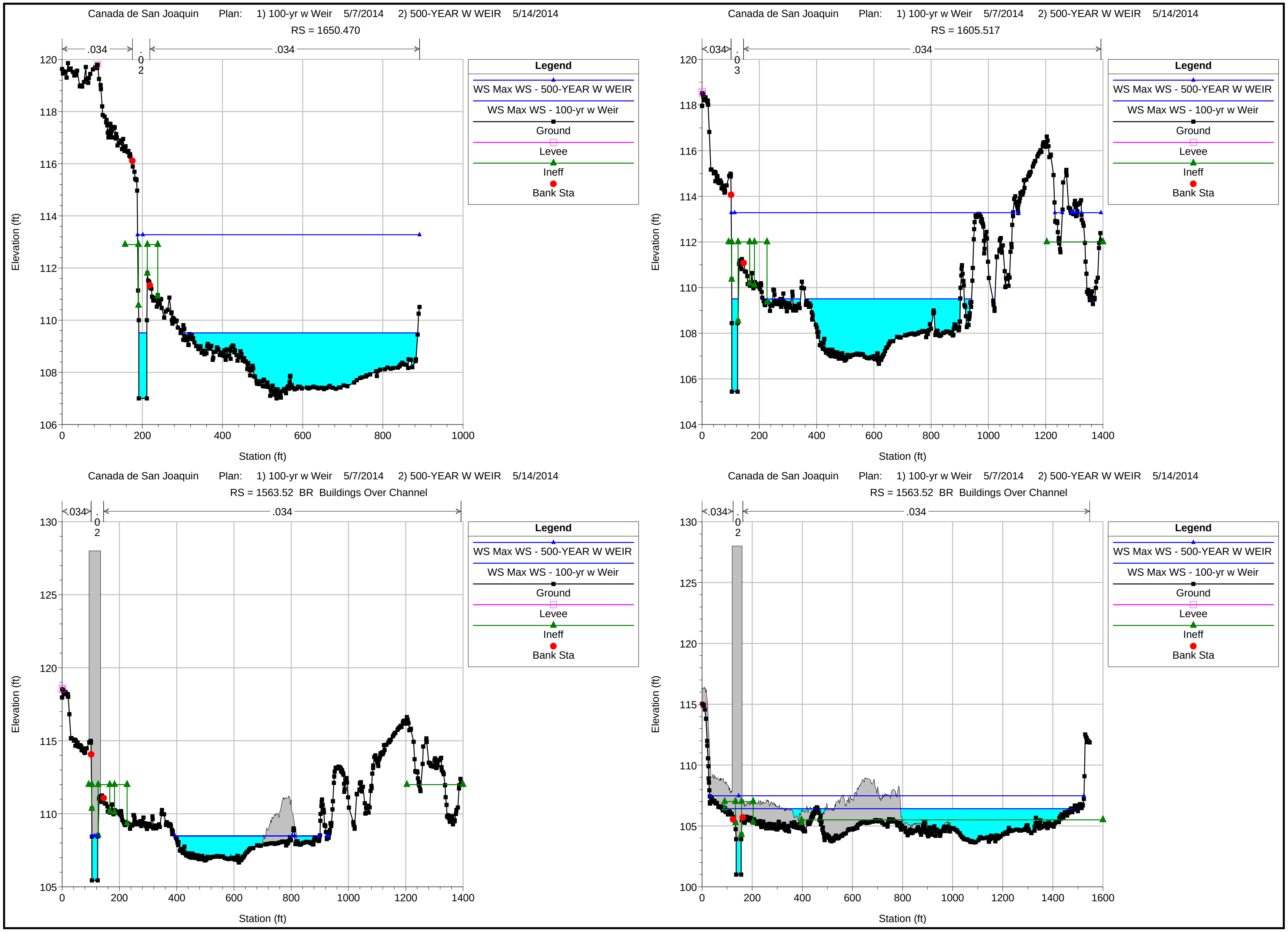

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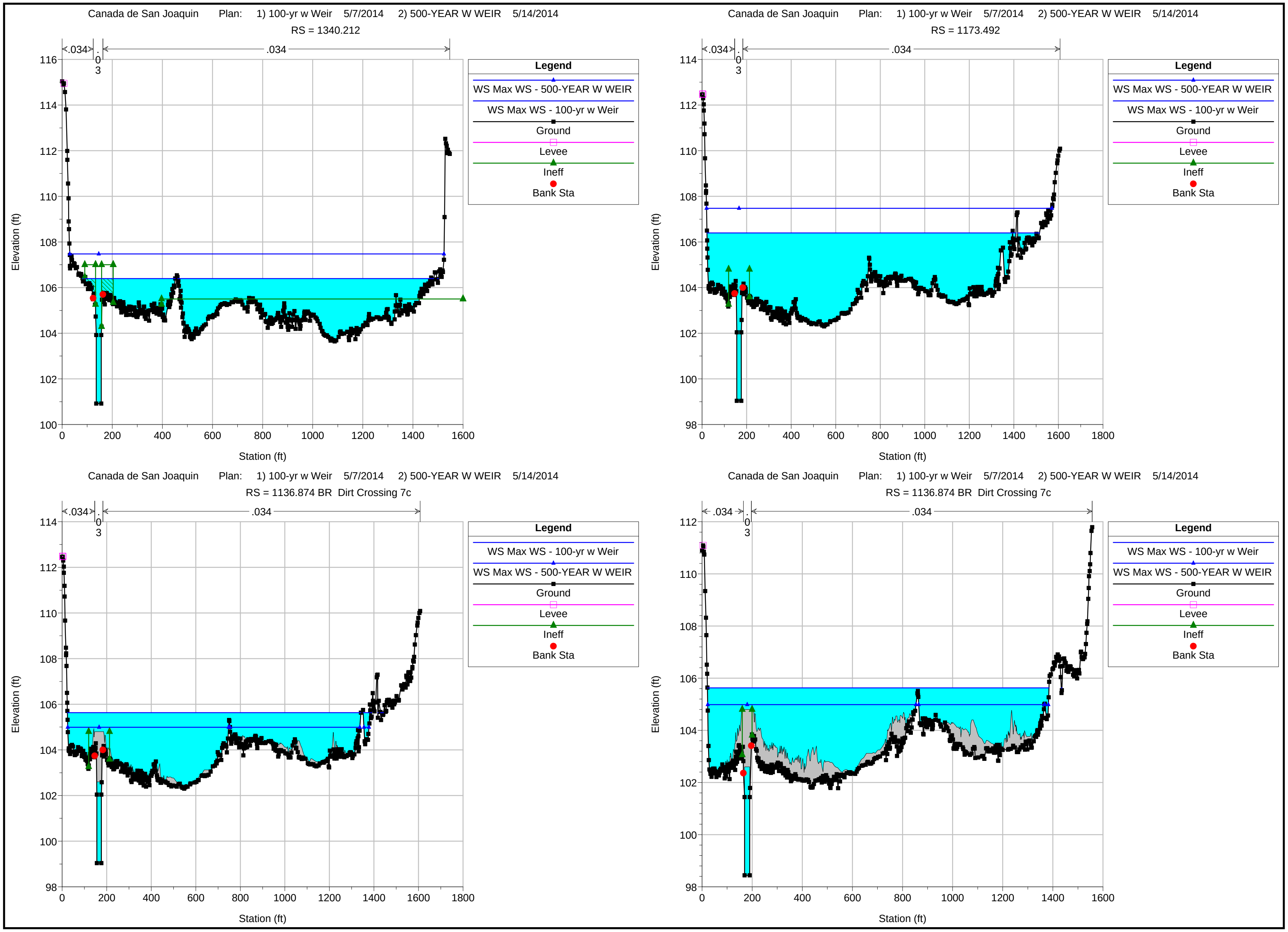

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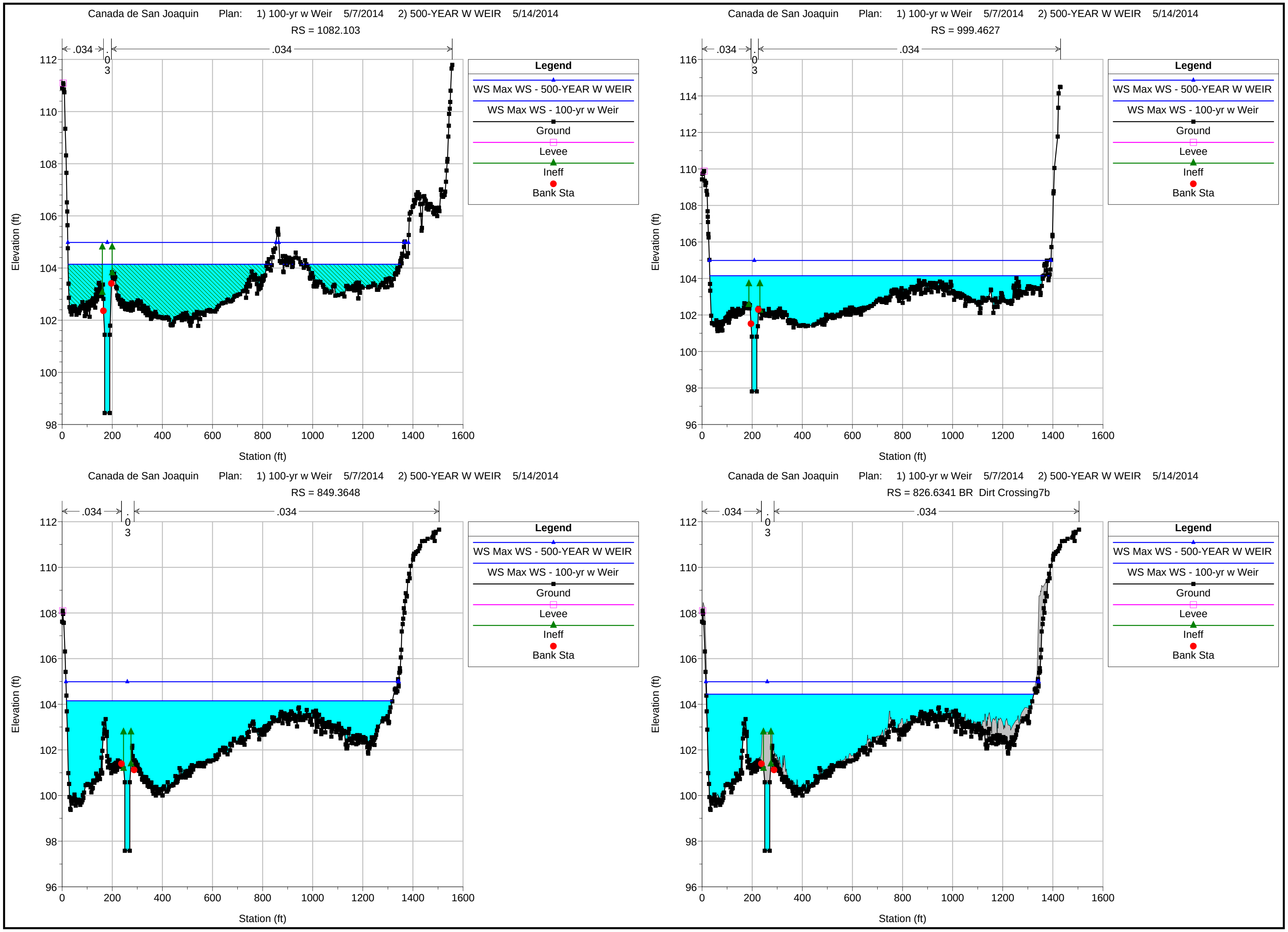

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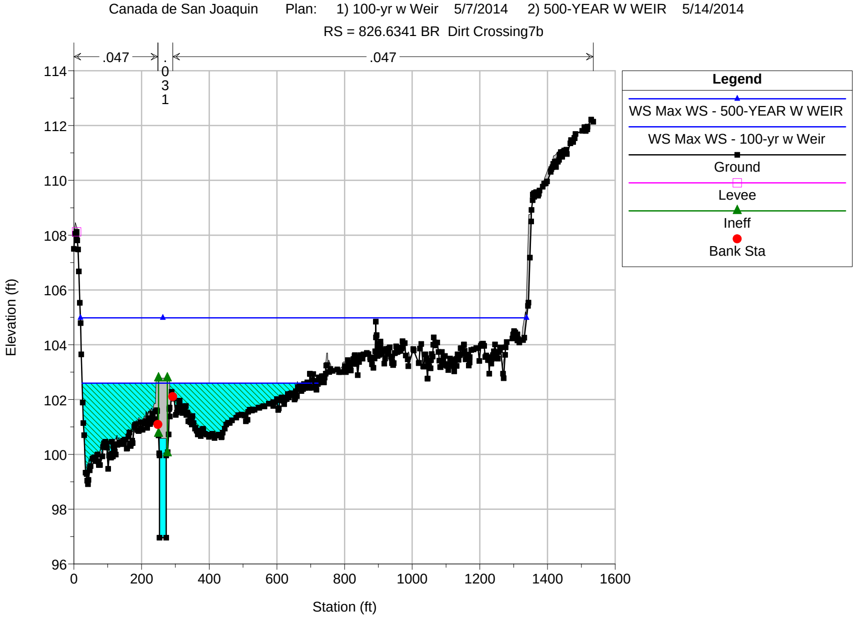

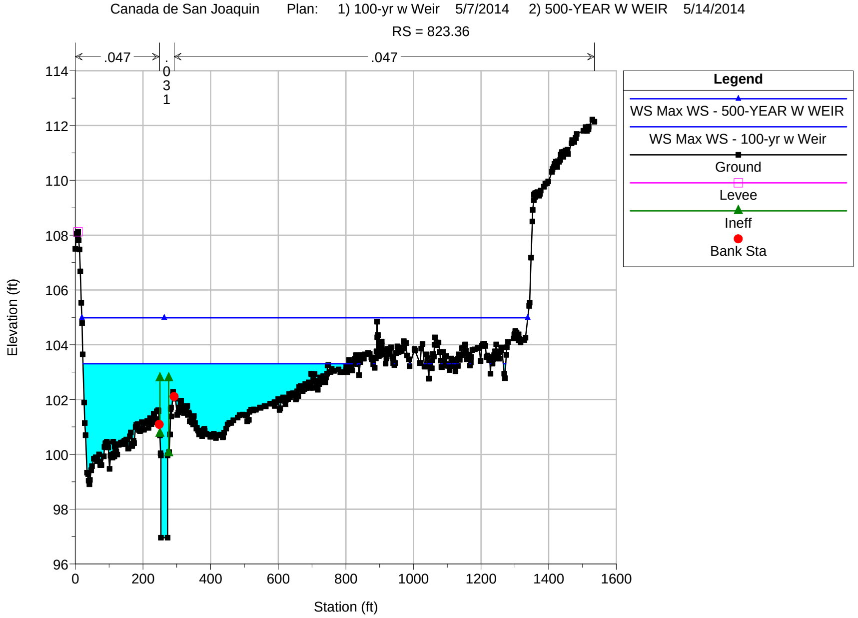

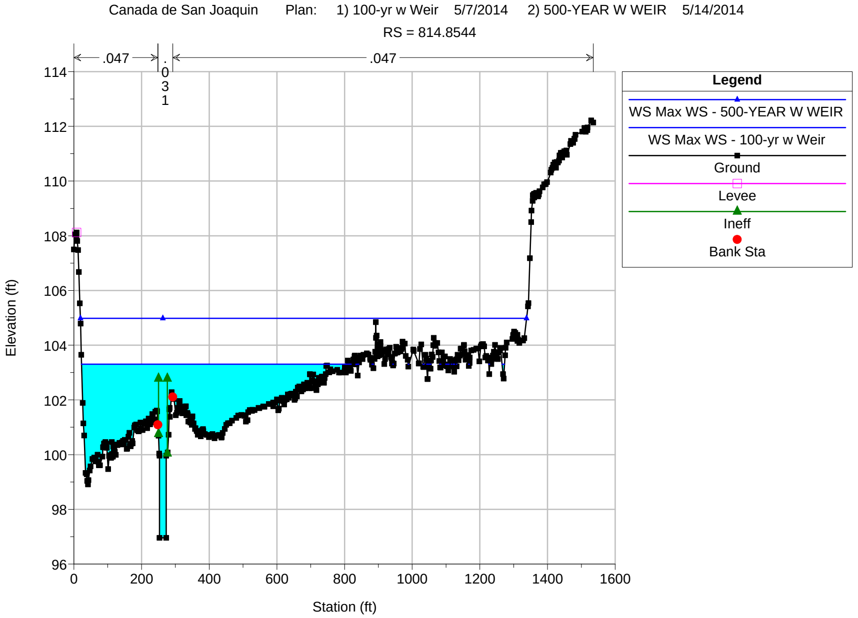

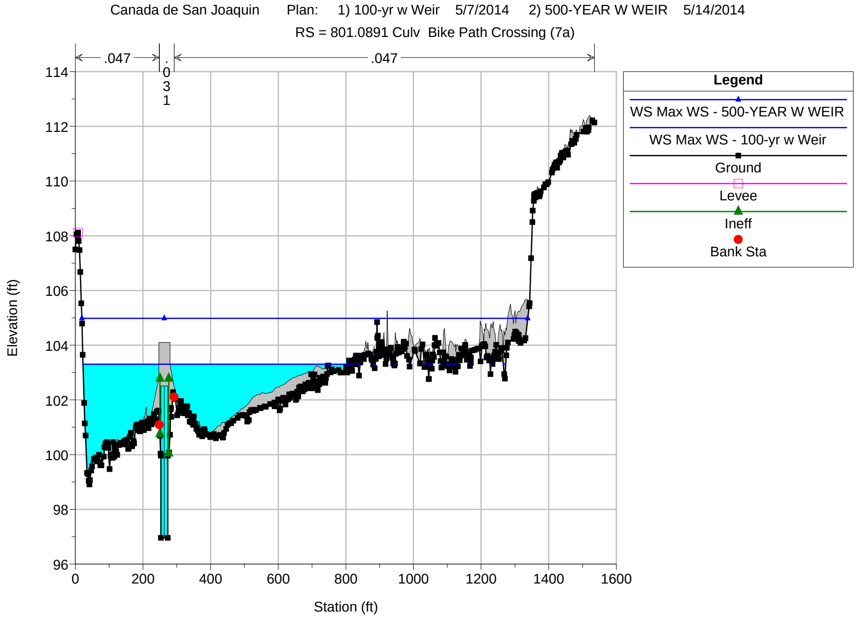

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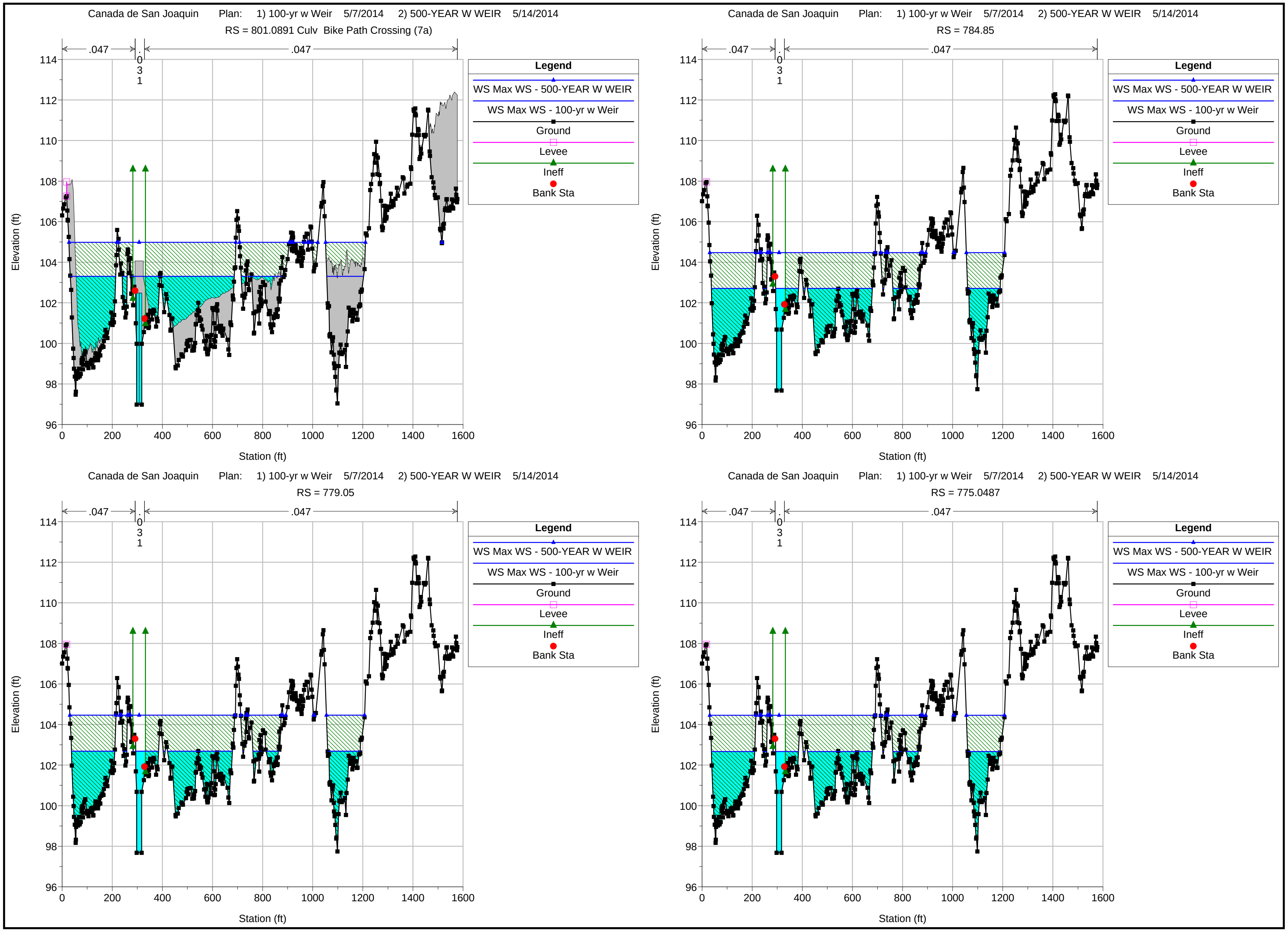

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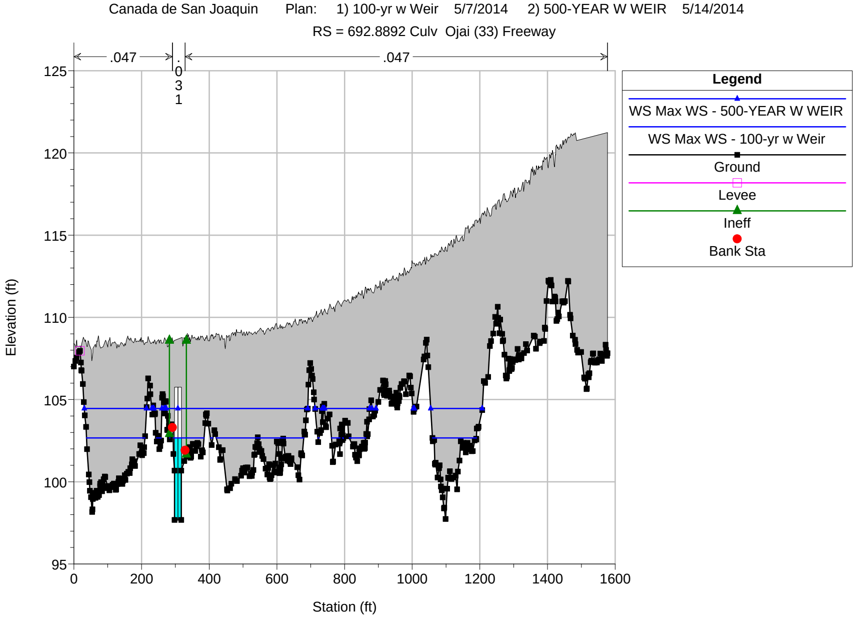

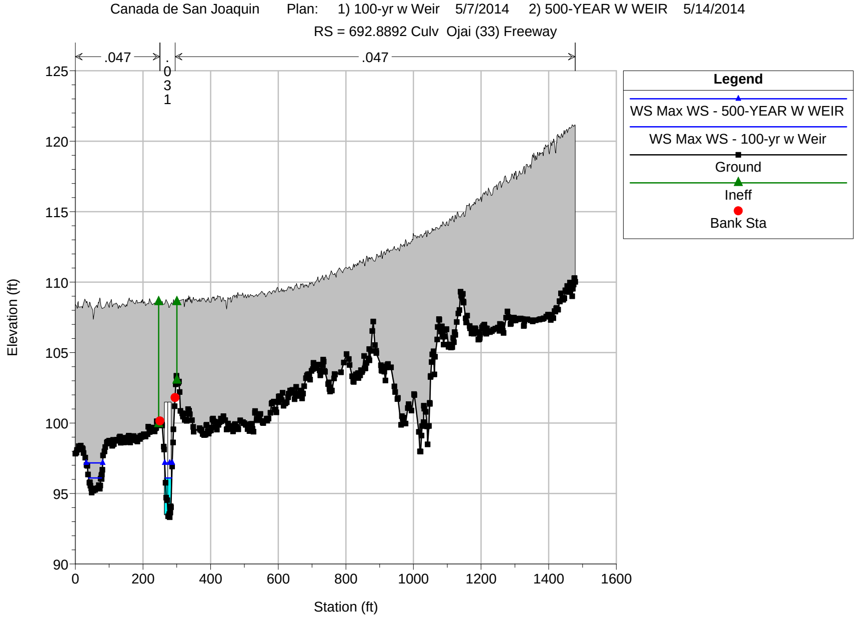

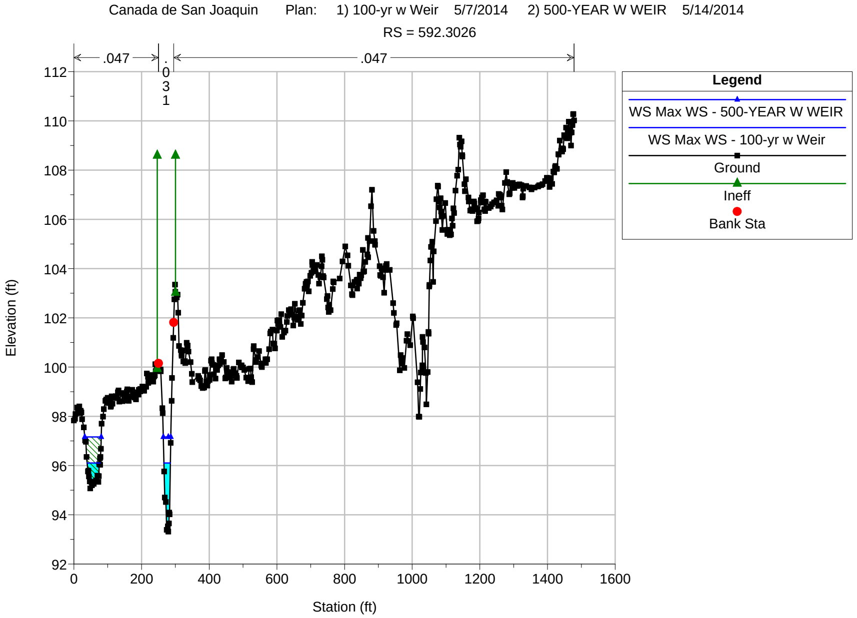

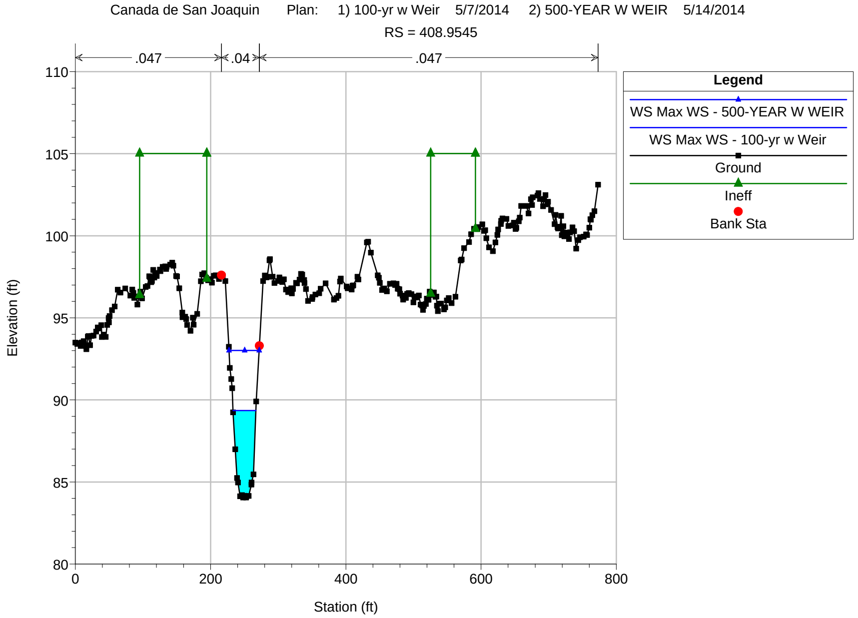

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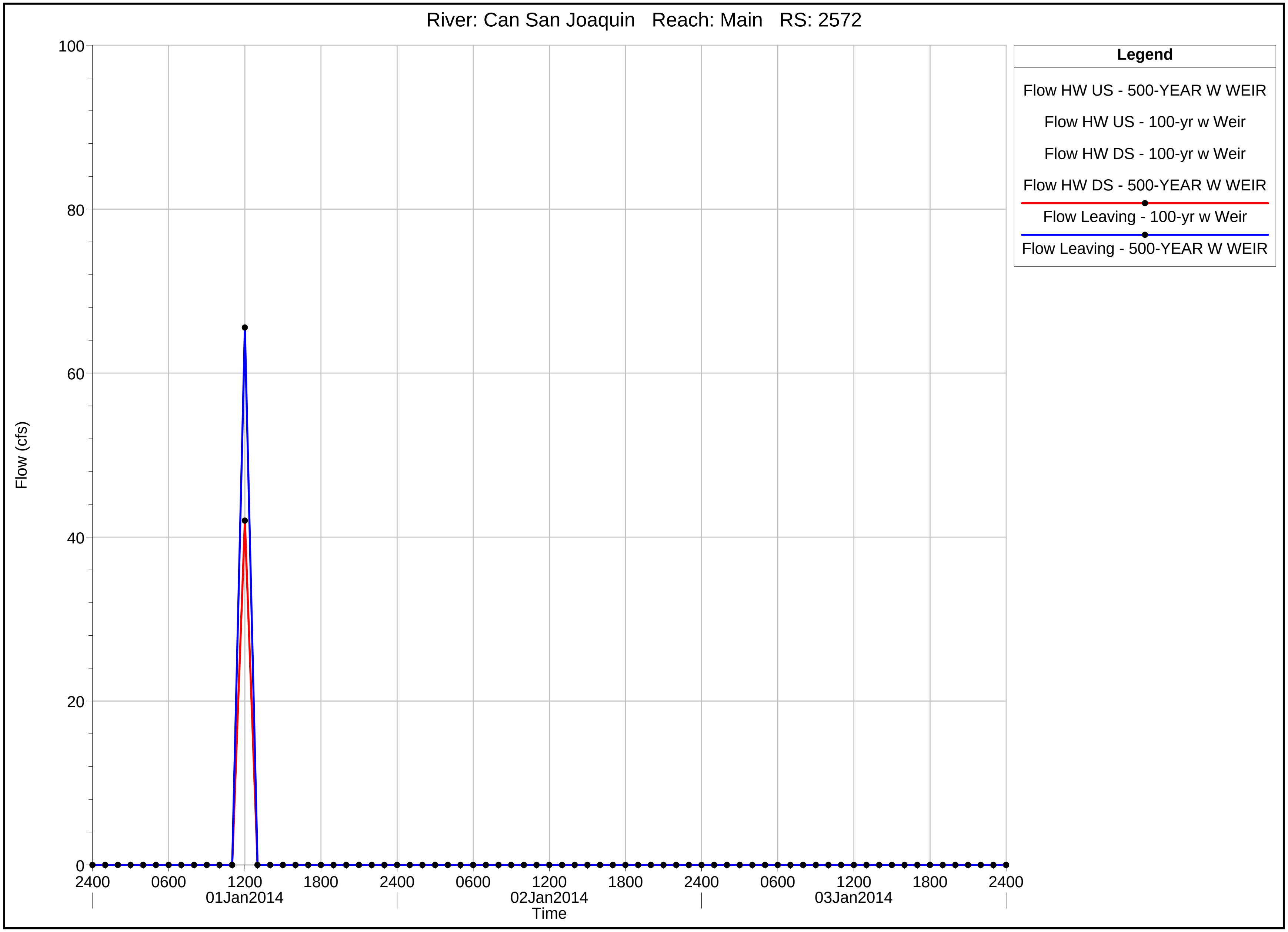
CSJ Lateral Structure Flow



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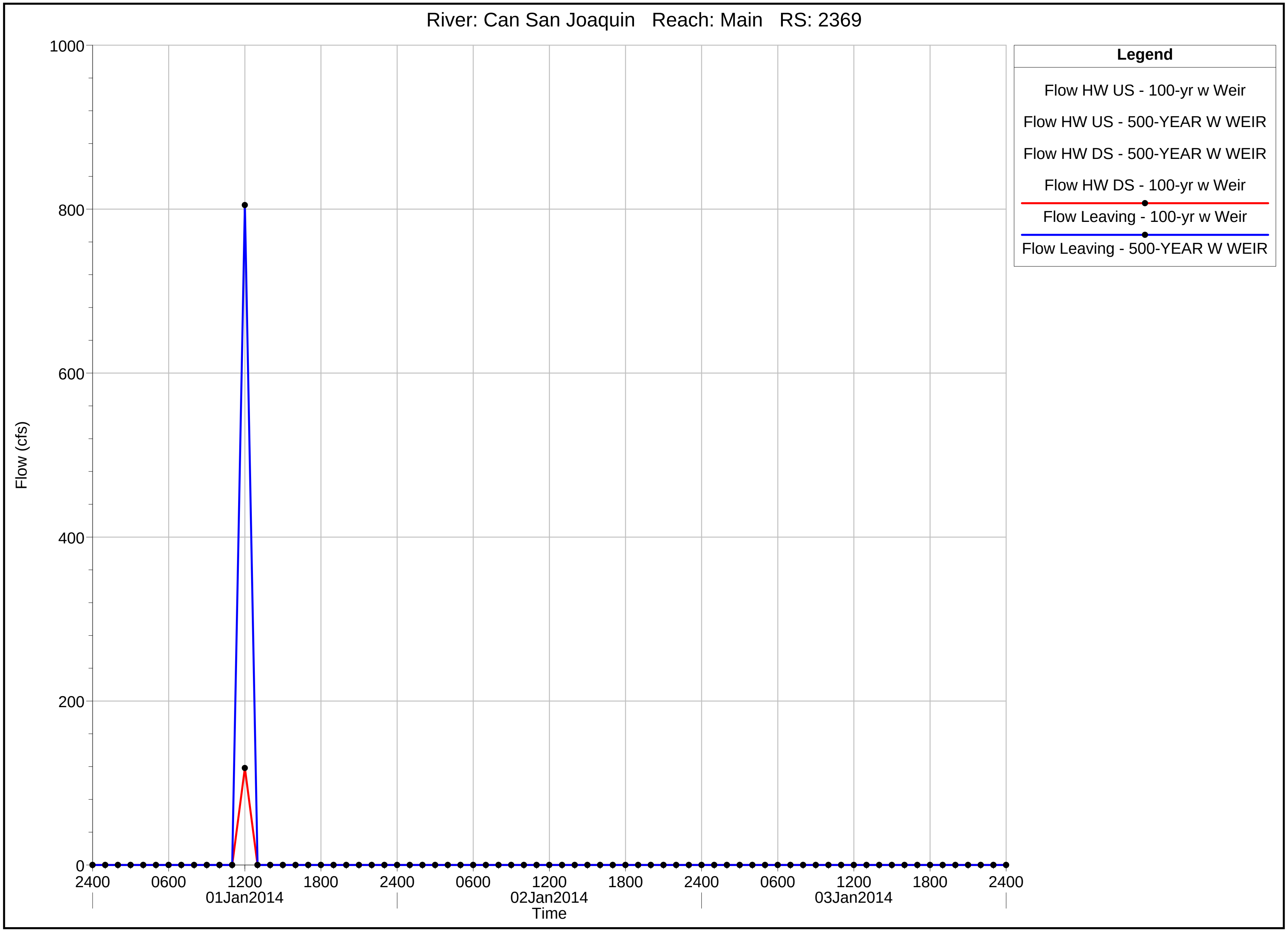
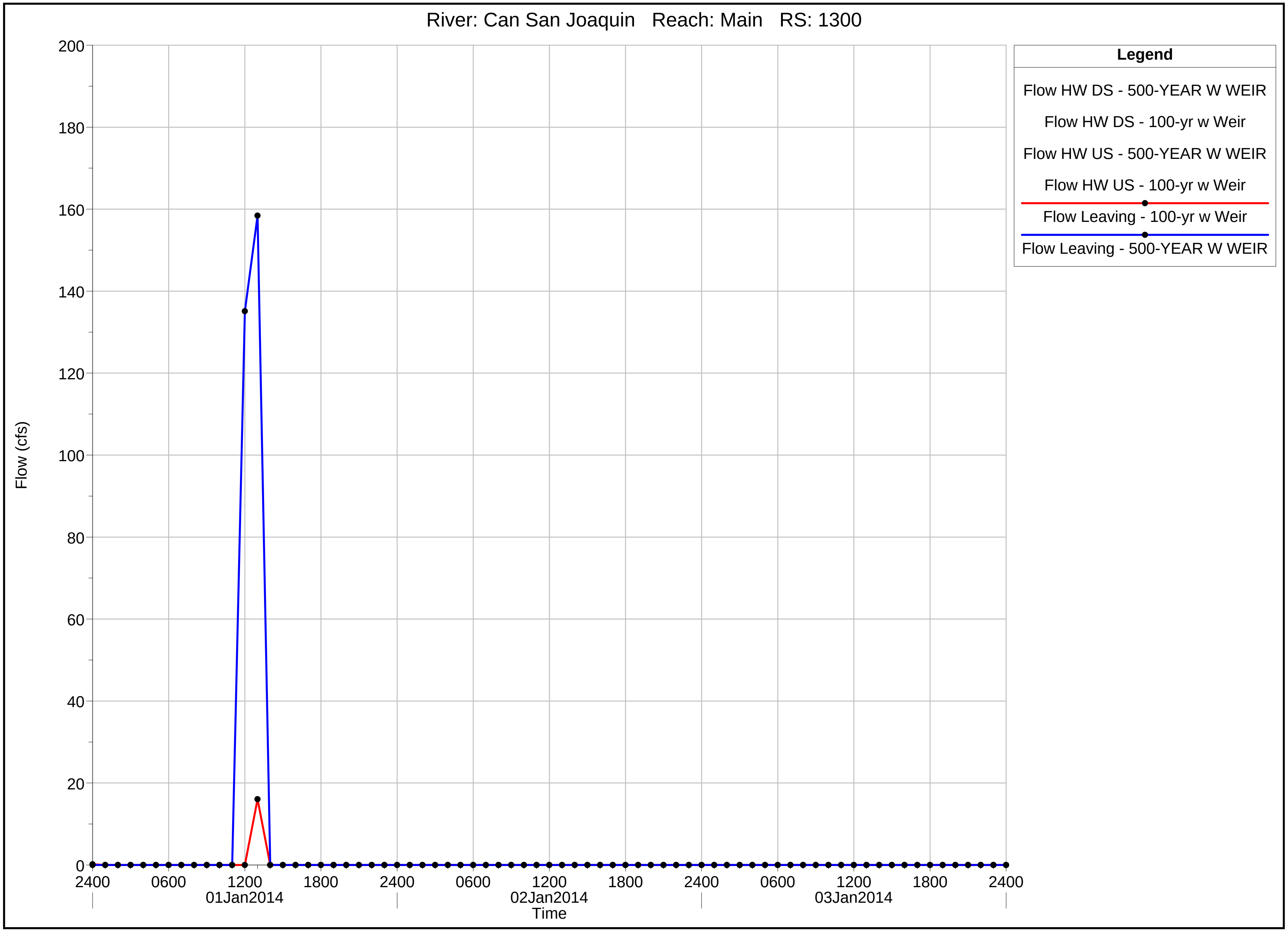
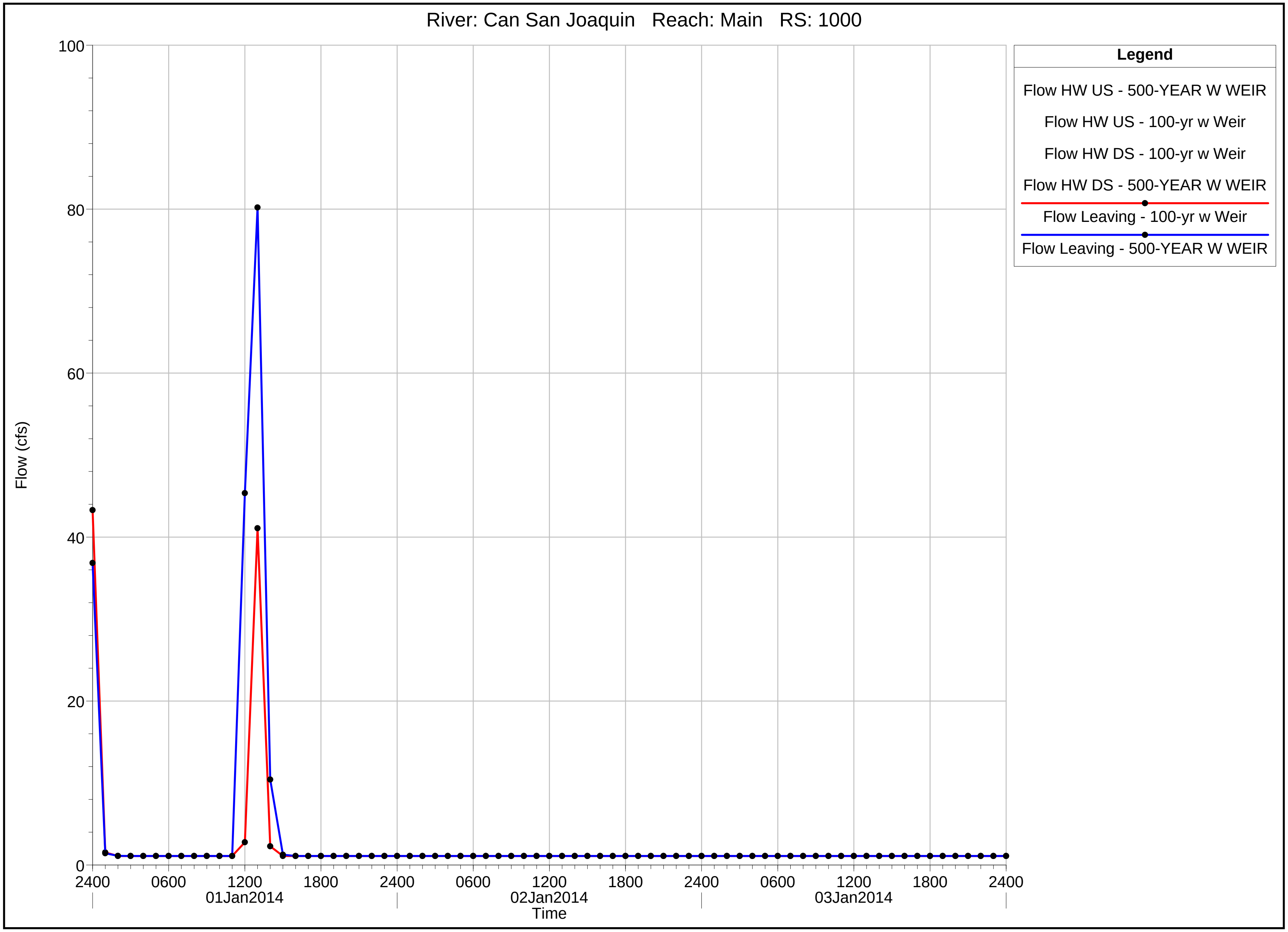
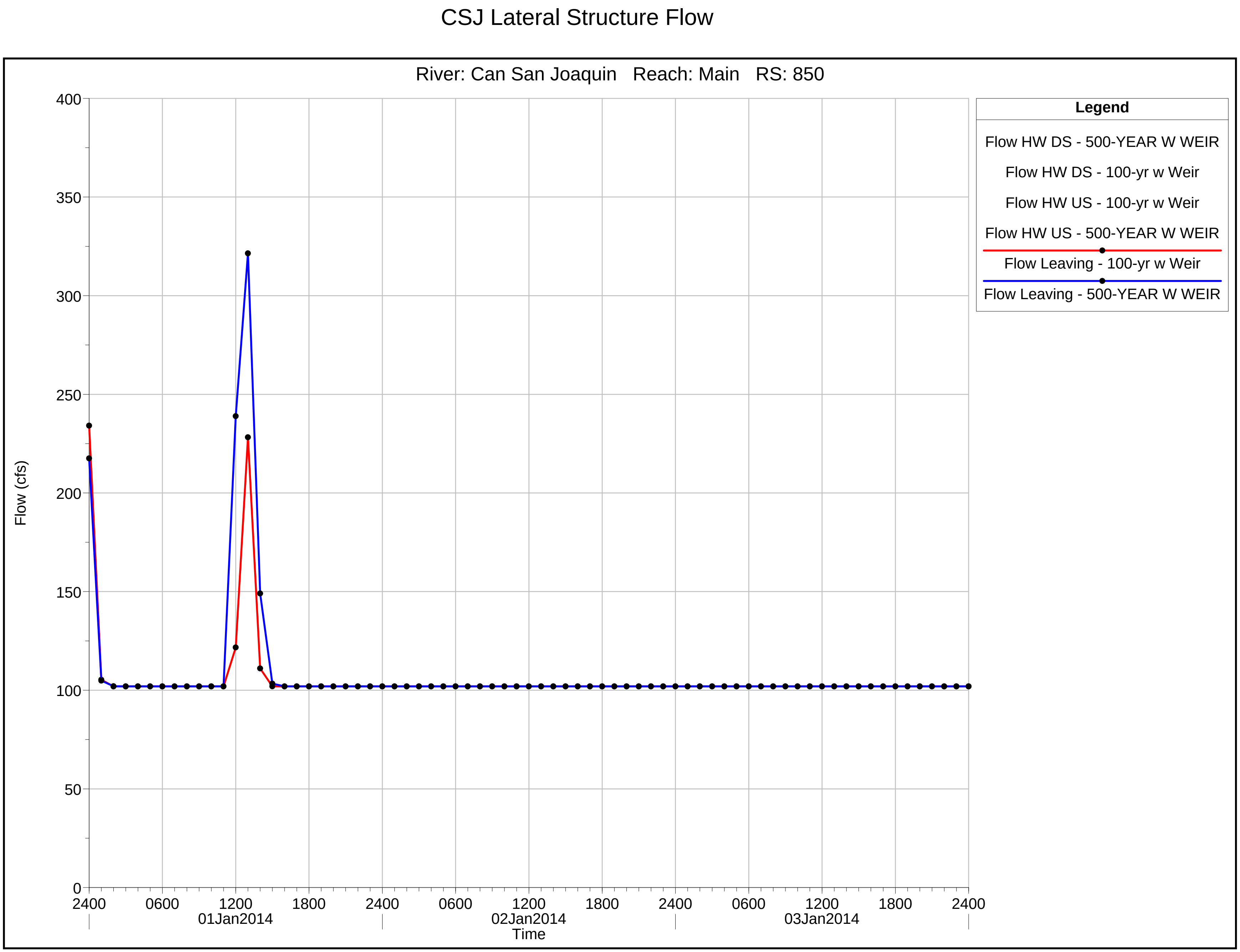


CSJ Lateral Structure Flow



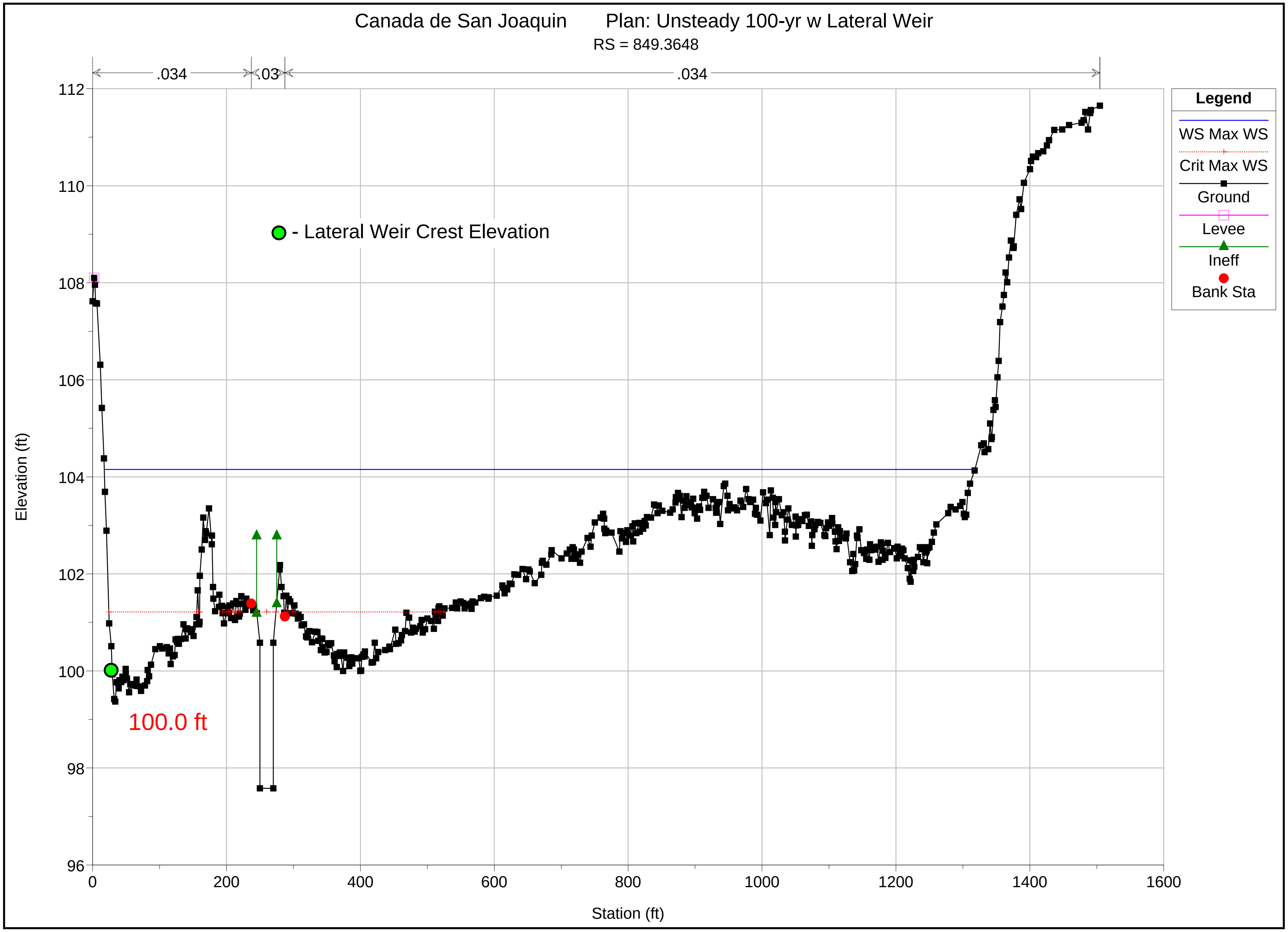
CSJ Lateral Structure Flow



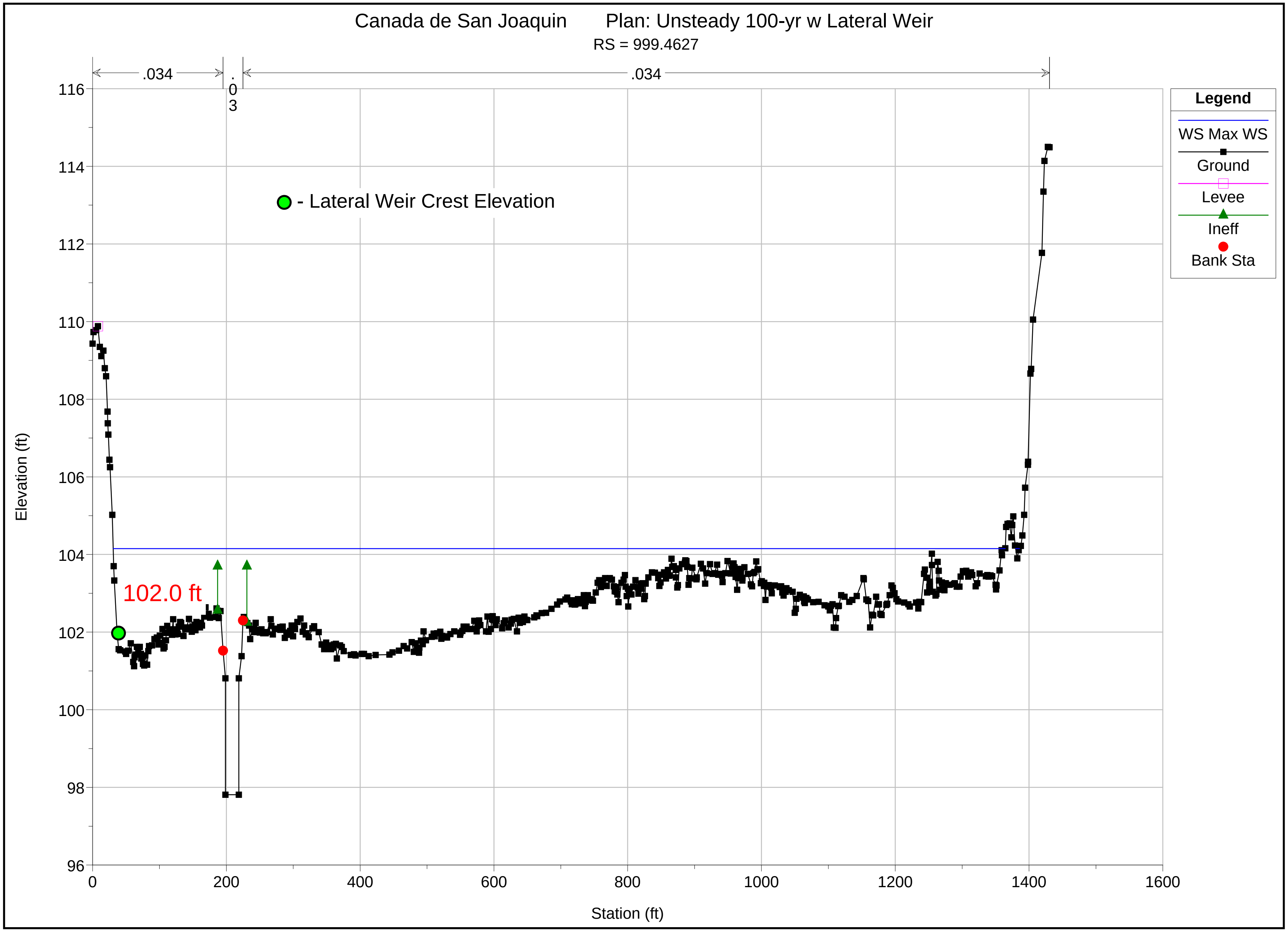


CSJ Lateral Structure Flow
River: Can San Joaquin   Reach: Main   RS: 850
Flow (cfs)
400
350
300
250
200
150
100
50
0
2400
0600
1200
1800
2400
0600
1200
1800
2400
0600
1200
1800
2400
01Jan2014
02Jan2014
03Jan2014
Time
Legend
Flow HW DS - 500-YEAR W WEIR
Flow HW DS - 100-yr w Weir
Flow HW US - 100-yr w Weir
Flow HW US - 500-YEAR W WEIR
Flow Leaving - 100-yr w Weir
Flow Leaving - 500-YEAR W WEIR

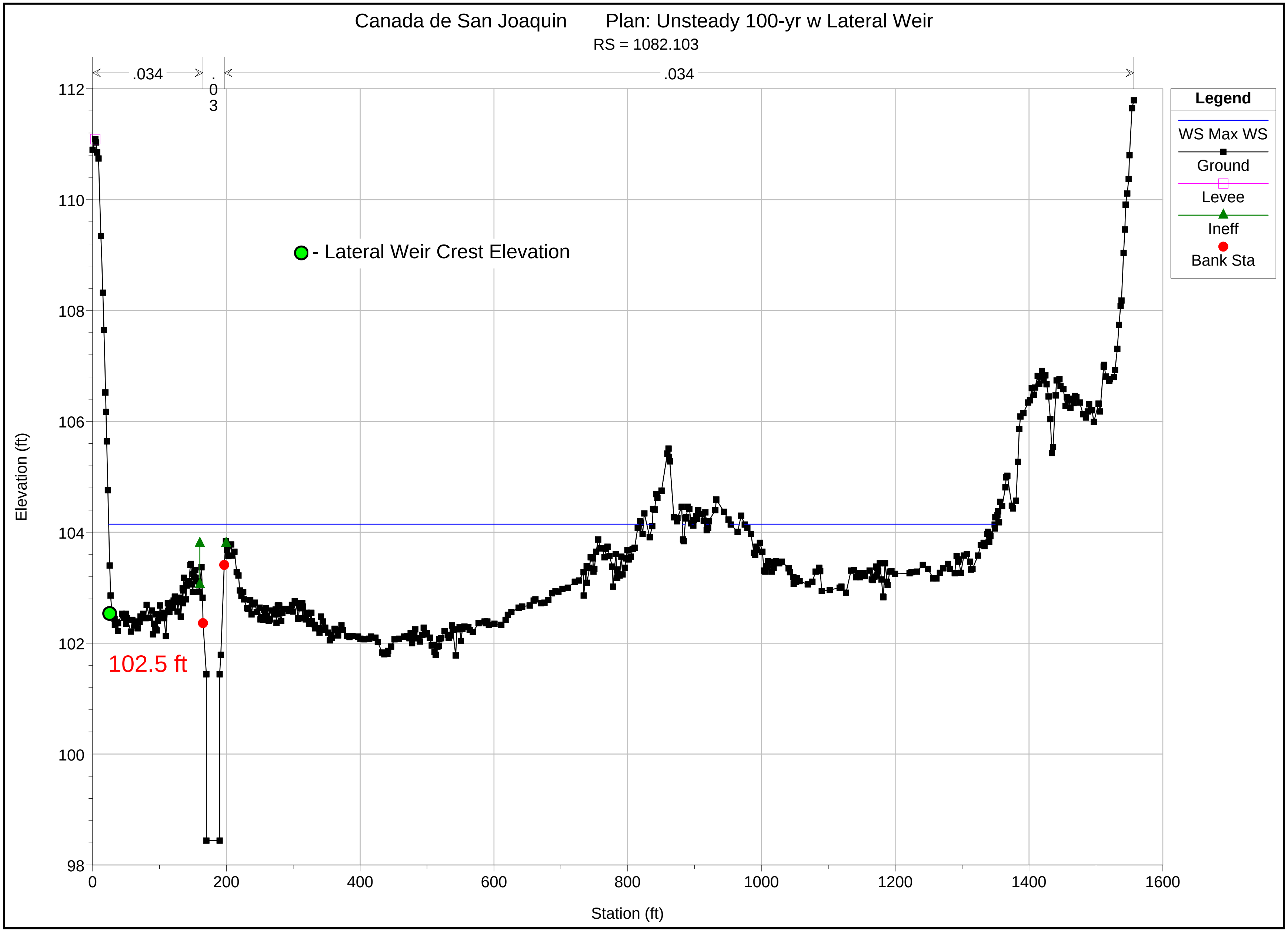
CSJ Lateral Weirs



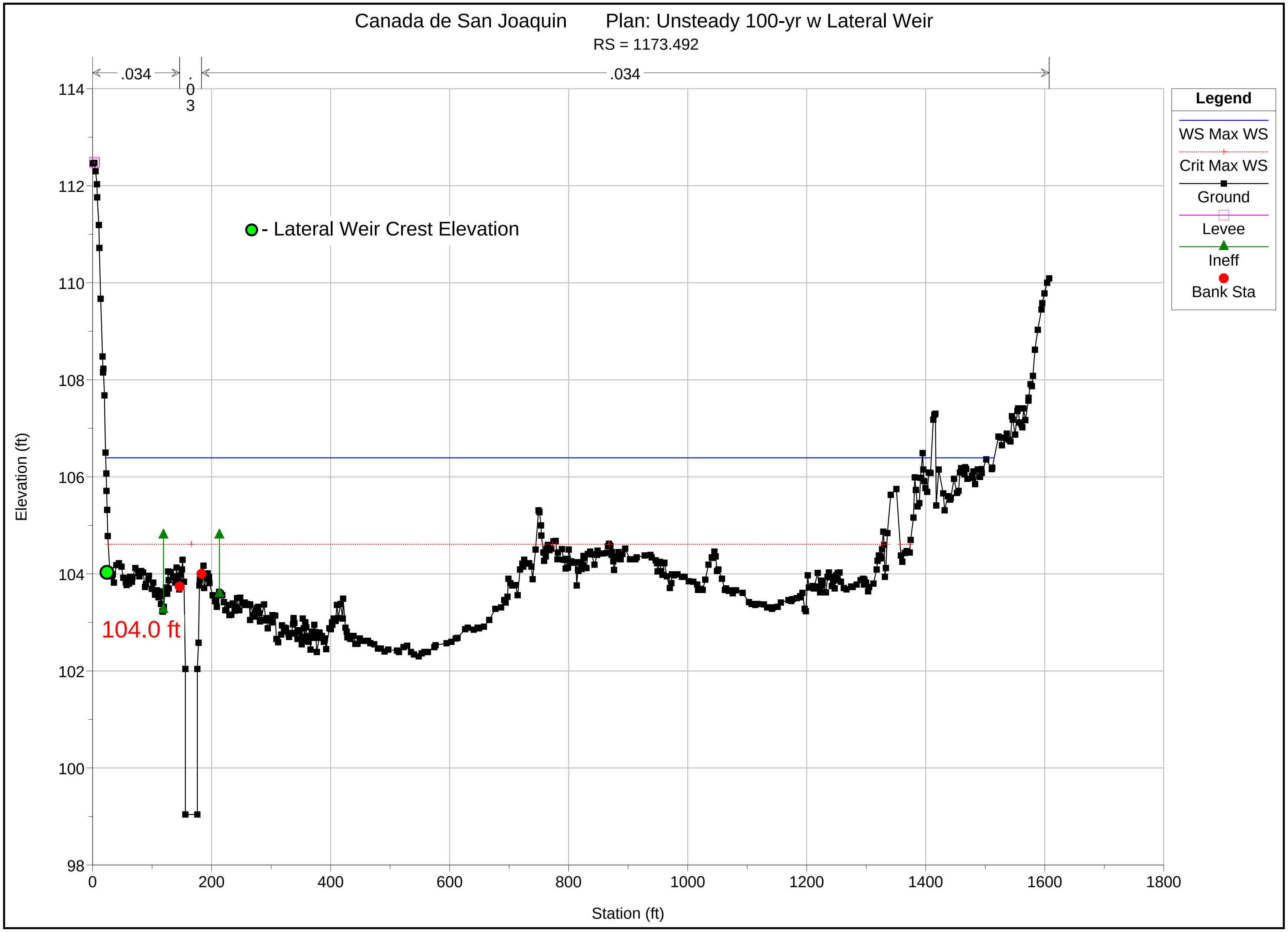
CSJ Lateral Weirs



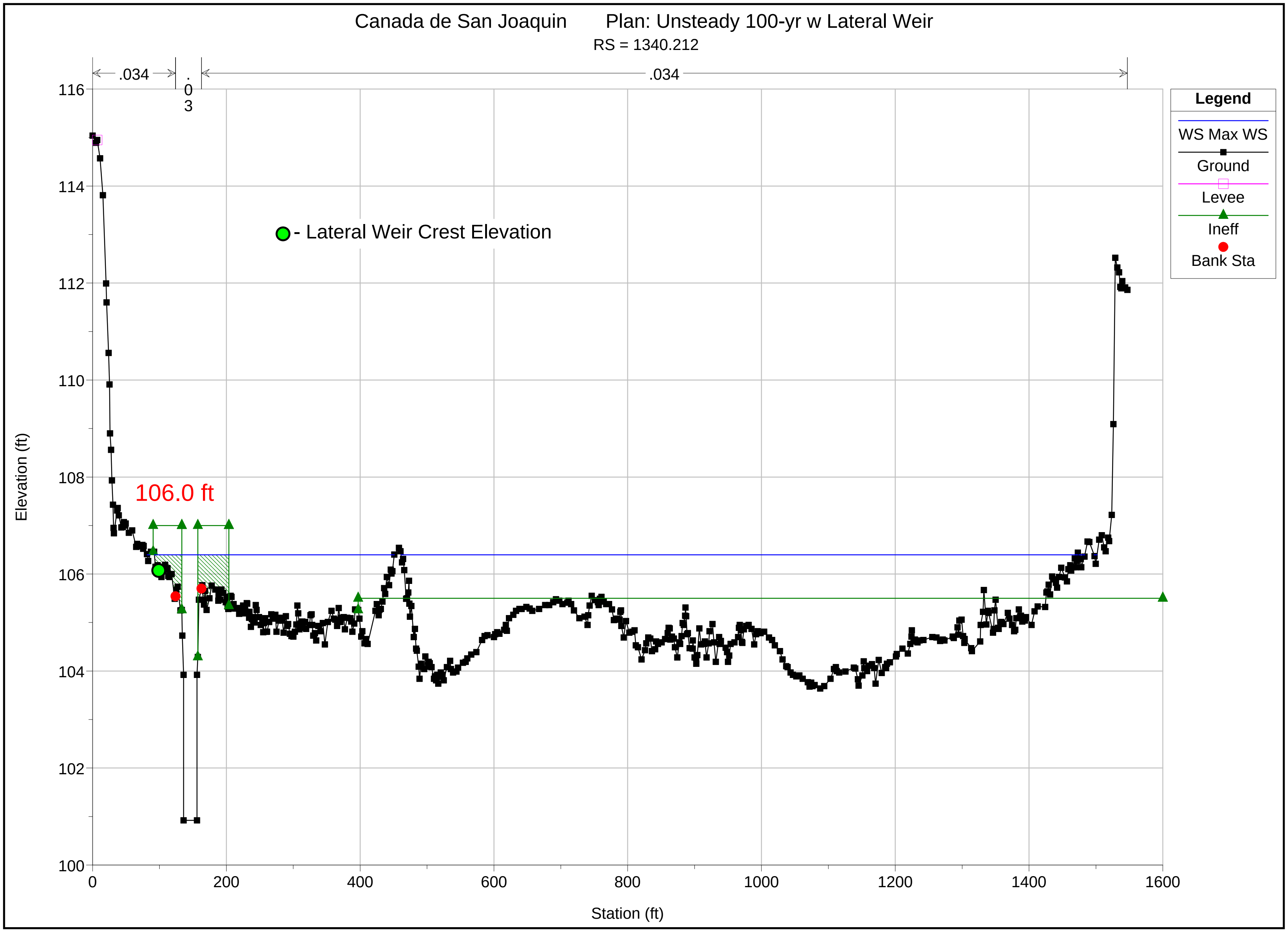
CSJ Lateral Weirs



CSJ Lateral Weirs



CSJ Lateral Weirs



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FLO-2D MODEL RESULTS AND OUTPUT

(Also see Appendix D: Digital Data CD)

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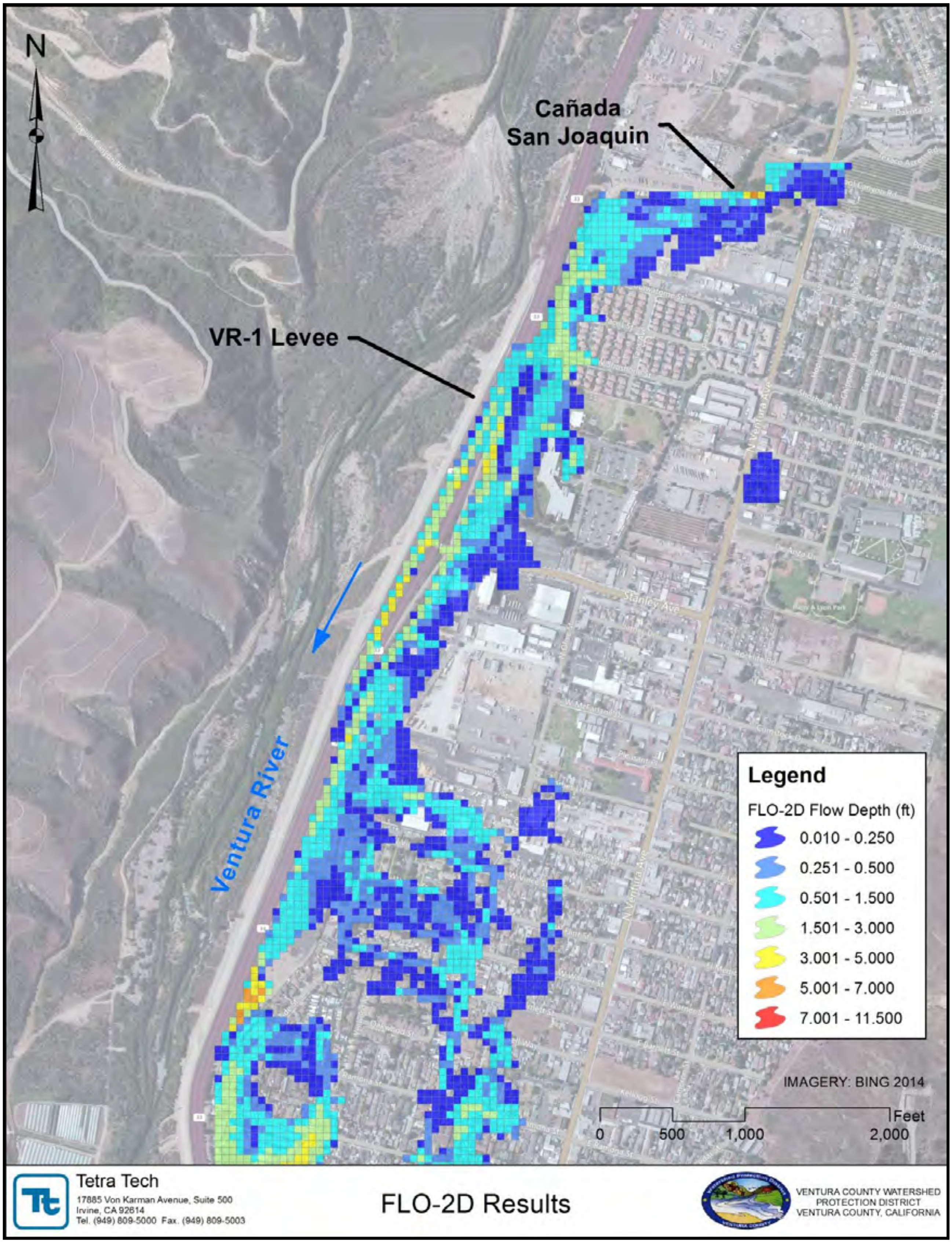

Figure B3: FLO-2D Flow Depth at Cell

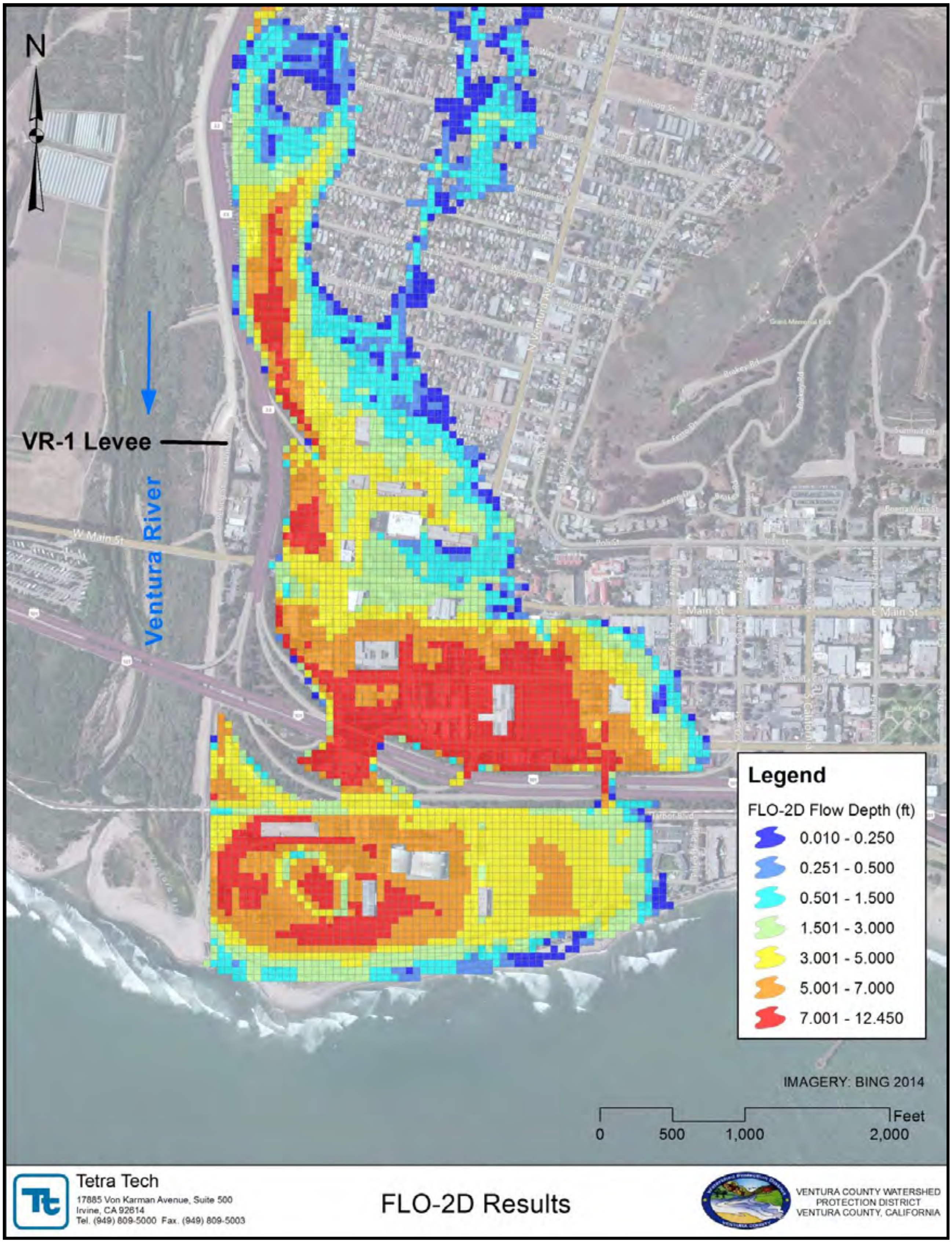

Figure B4: FLO-2D Flow Depth at Cell

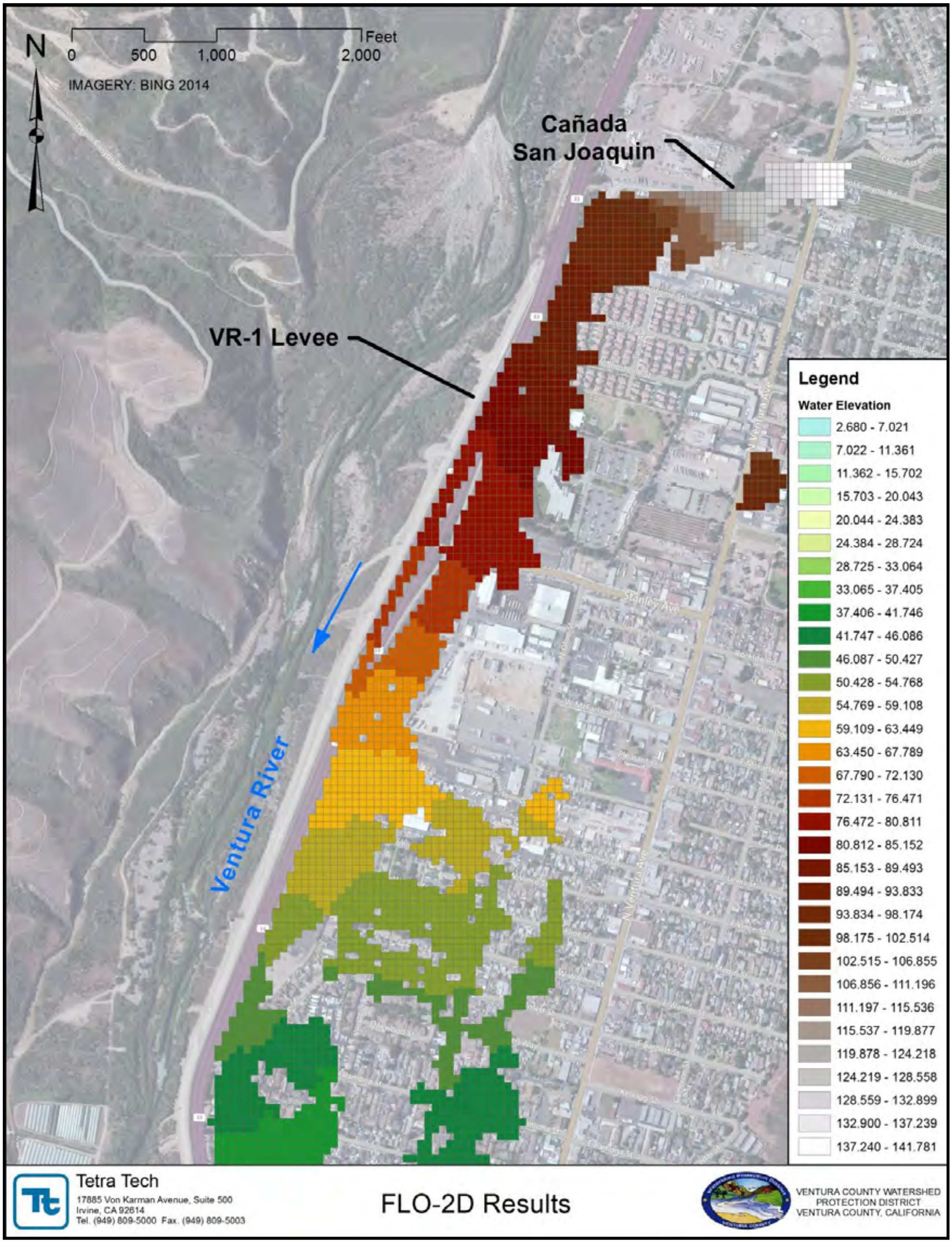

Figure B5: FLO-2D WSE at Cell (ft)

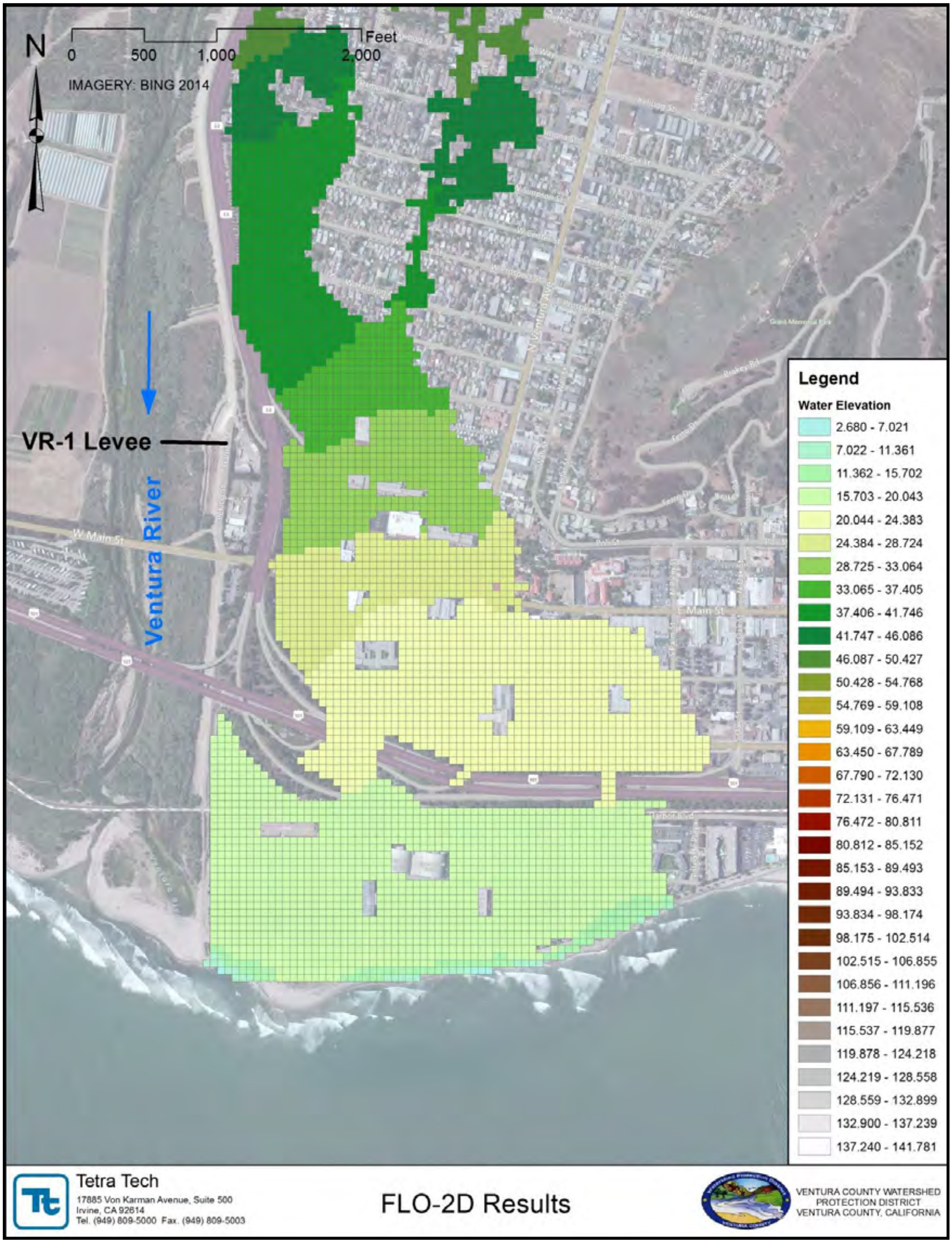

Figure B6: FLO-2D WSE at Cell (ft)

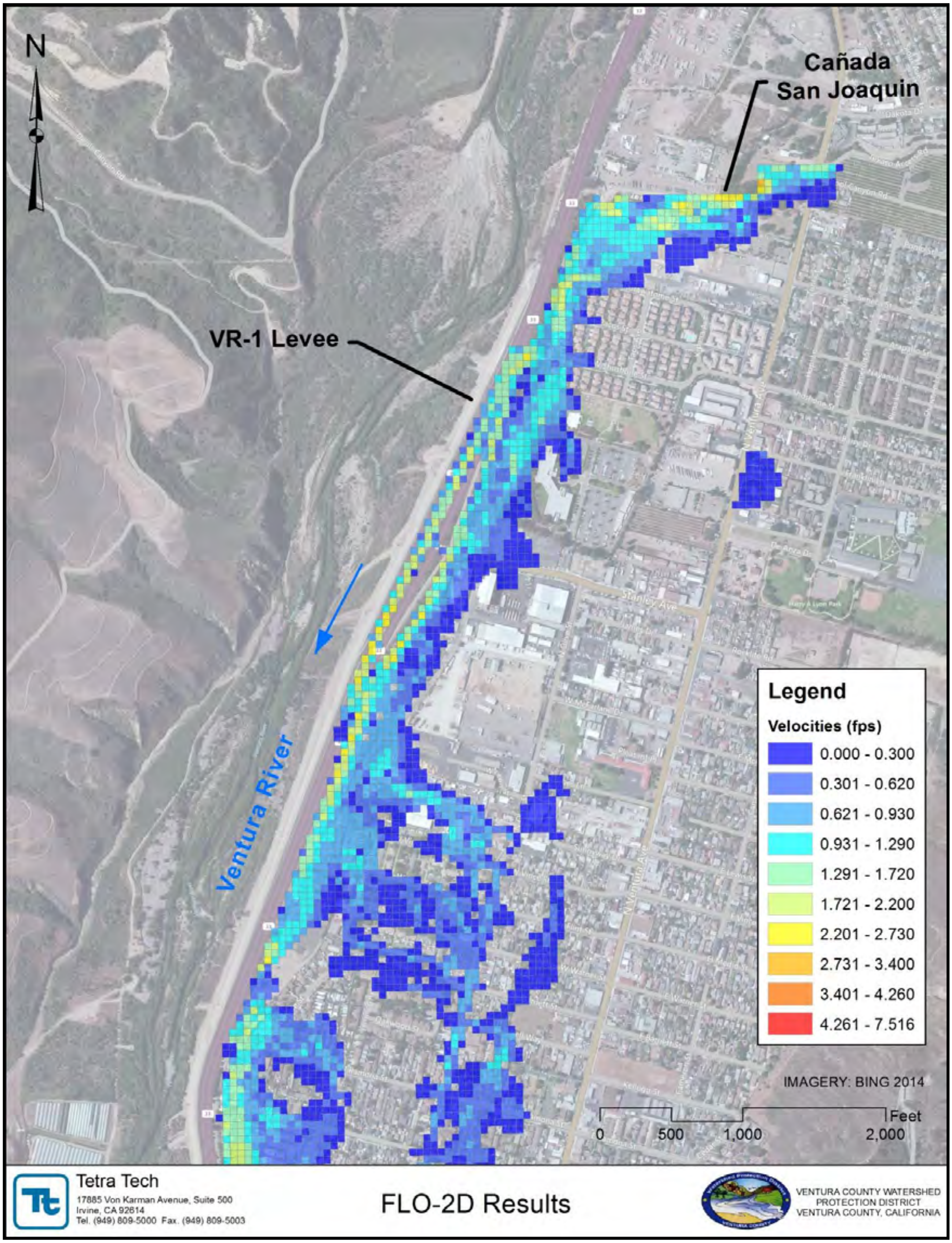

Figure B7: FLO-2D Velocities at Cell

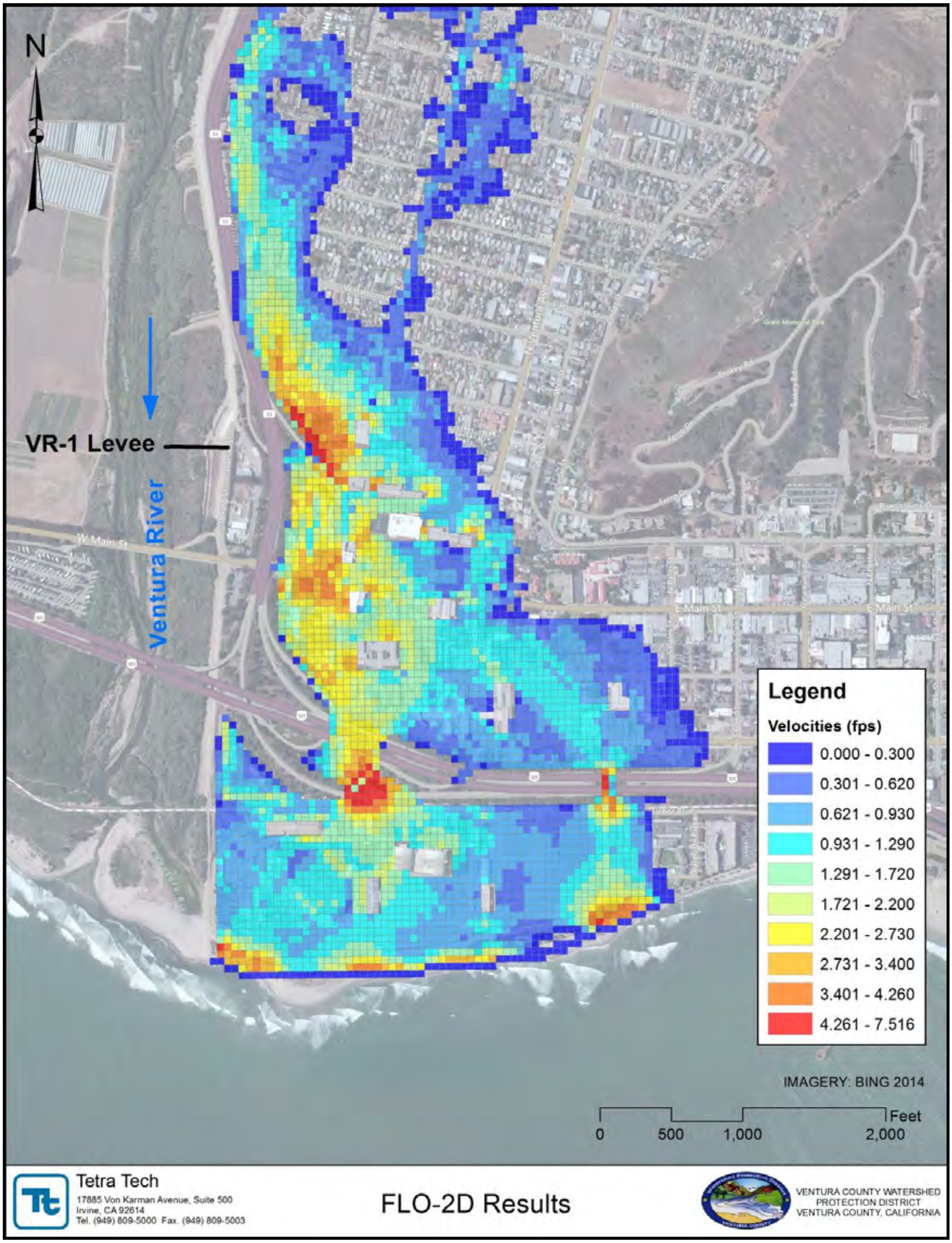

Figure B8: FLO-2D Velocities at Cell

FLO-2D PRO and FLO-2D 2009 COMPARISON

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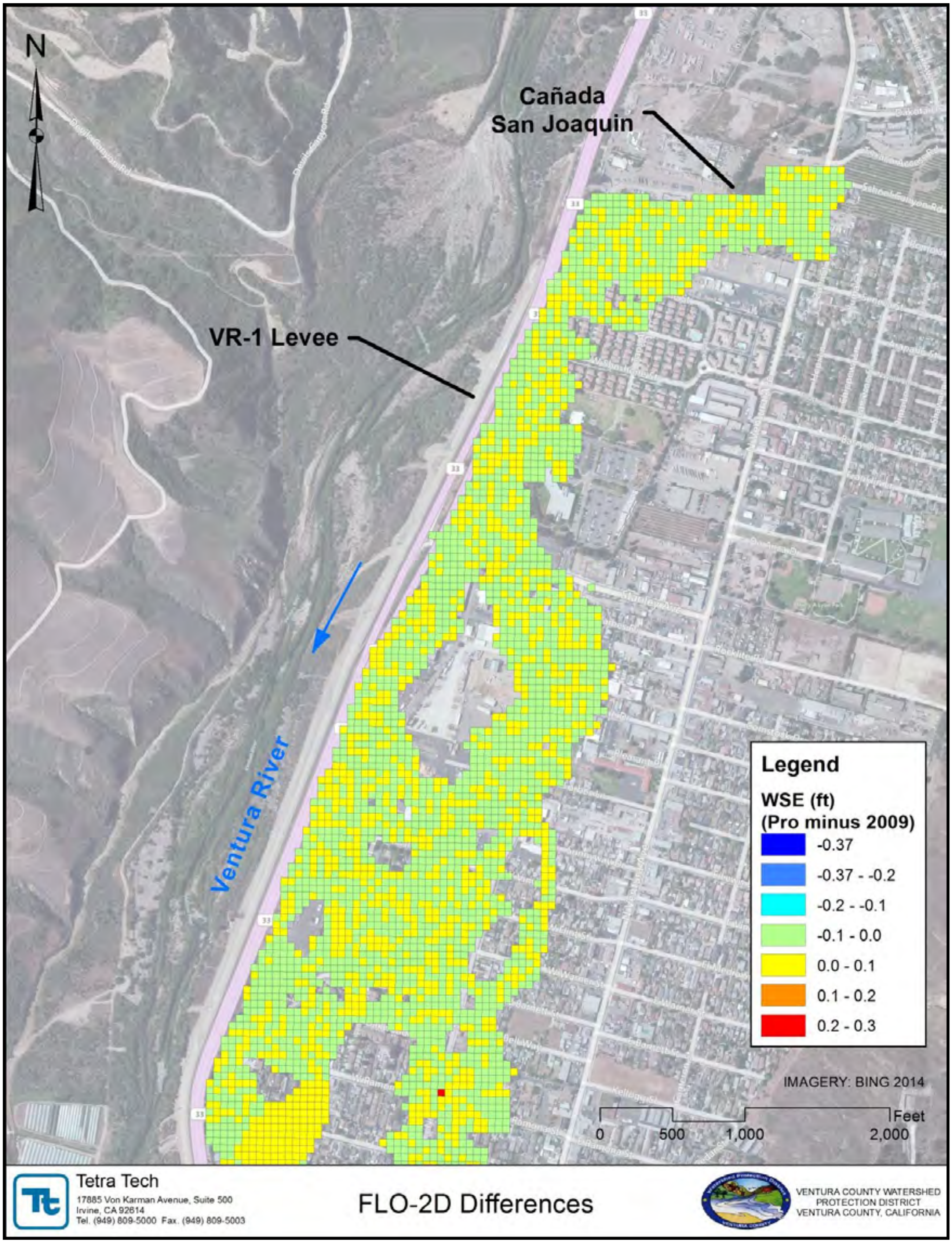

Figure B9: WSE Difference (FLO-2D Pro Minus FLO-2D 2009)

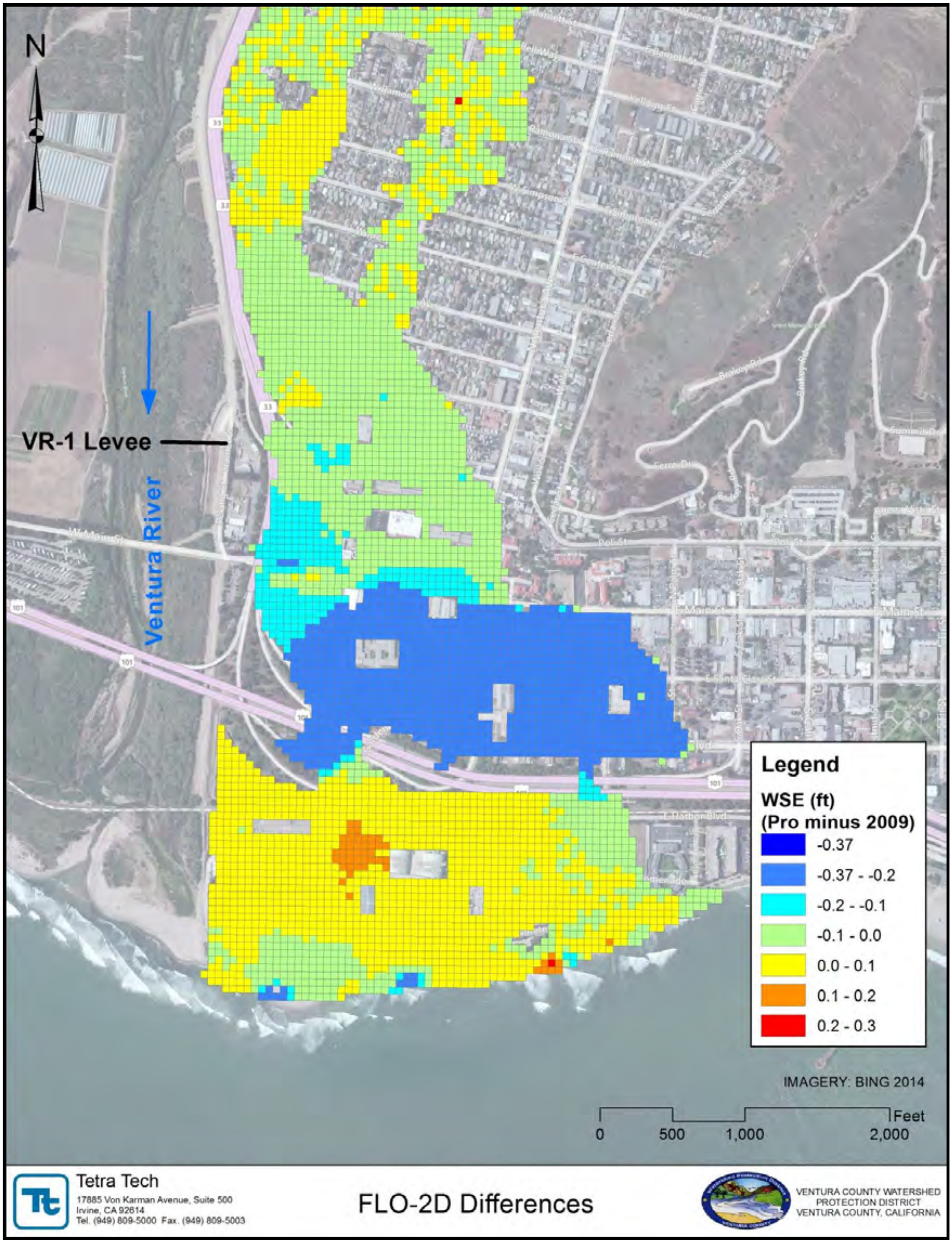

Figure B10: WSE Difference (FLO-2D Pro Minus FLO-2D 2009)

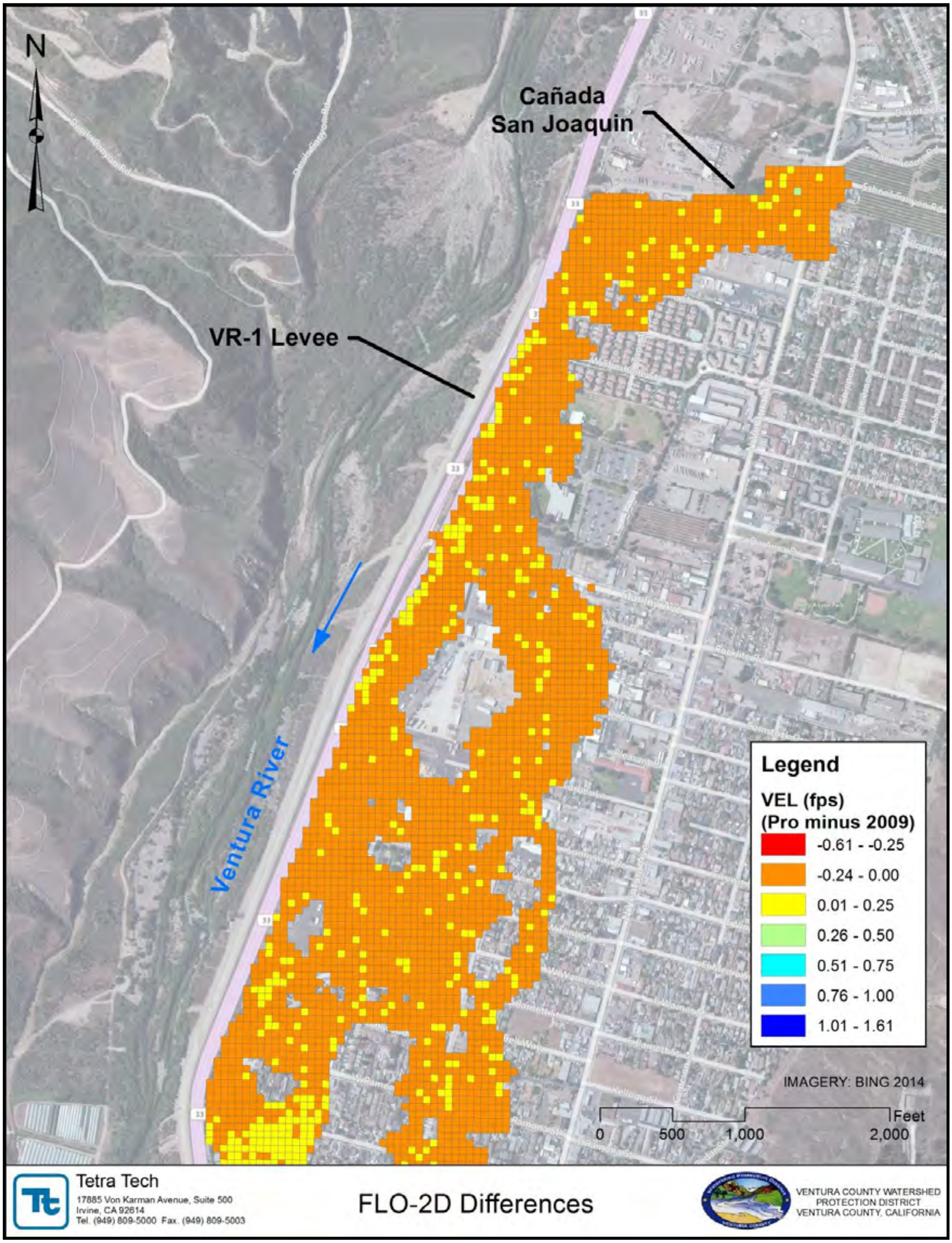

Figure B11: FLO-2D Pro vs. 2009 Differences (Velocity)

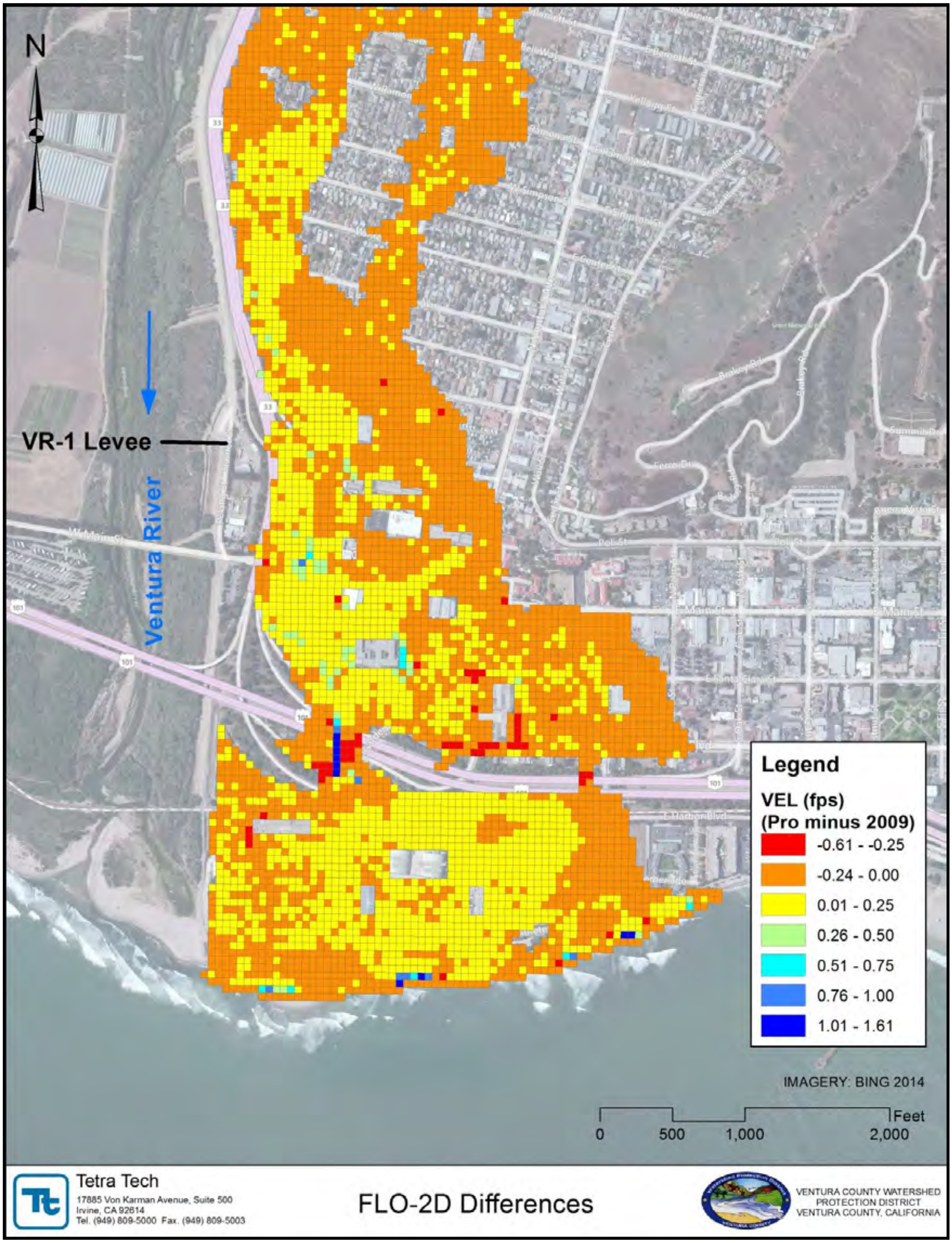

Figure B12: FLO-2D Pro vs. 2009 Differences (Velocity)

CERTIFICATION OF COMPLIANCE

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CERTIFICATION OF COMPLIANCE

Project Name:	Flood Insurance Studies for the Lower Ventura River and Cañada de San Joaquin - CTP Program
Statement of Work No.:	
Interagency Agreement No.:	
CTP Agreement No.:	AE 11-047
Statement/Agreement Date:	VCWPD Contract AE 11-047/January 15, 2014
Certification Date:	

Tasks/Activities Covered by This Certification (Check All That Apply)

☐	**Entire Project**
☐	**Topographic Data Development**
☐	**Hydrologic Analyses**
☑	**Hydraulic Analyses**
☐	**Coastal Flood Hazard Analyses**
☑	**Floodplain Mapping**
☐	**Other (Specify):**

This is to certify that the work summarized above was completed in accordance with the statement/agreement cited above and all amendments thereto, together with all such modifications, either written or oral, as the Regional Project Officer and/or Assistance Officer or their representative have directed, as such modifications affect the statement/agreement, and that all such work has been accomplished in accordance with the provisions contained in *Guidelines and Specifications for Flood Hazard Mapping Partners* cited in the contract document, and in accordance with sound and accepted engineering practices within the contract provisions for respective phases of the work.

Name:

Title:

Firm/Agency Represented:

Registration No.:

Signature:

This form must be signed by a representative of the firm contracted to perform the work who is registered as a Professional Engineer or by the responsible official of a government agency.

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FLOODPLAIN MAPPING

(See Report Back Sleeve and Appendix D: Digital Data CD for Workmap)

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MAPPING INFORMATION INDEX

Community Name:	City of Ventura	**State: California**
Community ID No.	060419	
Compiled By:	Tetra Tech	
Date TSDN Submitted:	September 25, 2014	

Type/Purpose of Map	Date	Paper Copy		Electronic Media			
		No. of Sheets	Exhibit No.	File Type	File Name	Projection	Exhibit No.
Workmap Exhibit 1	9/25/2014	2	1	PDF	See Type	NAD83 UTMZ11	1
Workmap Exhibit 2_revCSJ	9/25/2014	2	1	PDF	See Type	NAD83 UTMZ11	1

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WORK MAP DELINEATION SUMMARY

Community Name and State:	City of Ventura, California
Community ID No.	060419
Compiled By:	Tetra Tech
Date TSDN Submitted:	September 25, 2014
Work Map Scale:	1:4800
Work Map Contour Interval:	5-ft
Work Map Projection and Horizontal Datum:	NAD83, UTM Zone 11N
Work Map File Name:	Workmap_Exhibit1_ArchD (2 sheets), Workmap_Exhibit2_ArchD_revCSJ (2 sheets)
Work Map File Type:	PDFs
Work Map File Media:	Adobe Acrobat

General Comments on Work Map

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SITE VISIT PHOTOGRAPHS

(See Report Back Sleeve for Field Map)

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Figure 1. VR-1 Levee opening in the northern levee extension at Ventura River Bike Trail (stop-logs are used during the rainy season to close the gap) – looking south

Figure 2. VR-1 Levee opening in the northern levee extension at Ventura River Bike Trail – looking west from the top of the levee

Figure 3. VR-1 Levee at the northern extension – looking east from the Ventura River Bike Trail along the left overbank of Canada de San Joaquin (CSJ)

Figure 4. Building and pipes in CSJ channel – looking east

Figure 5. Pipe crossings over CSJ channel – looking west

Figure 6. Dirt crossing over CSJ channel – looking east

Figure 7. Bike path crossing over CSJ channel – looking west

Figure 8. Entrance to CSJ culvert under Ojai (33) Freeway – looking west

Figure 9. Ventura Avenue Crossing over CSJ – looking west

Figure 10. CSJ exit into Ventura River – looking east

Figure 11. Dent Drain exit into Ventura River – looking east

Figure 12. VR-1 Levee near W Shoshone Street – looking north

Figure 13. W Main Street Bridge over Ventura River – looking south

Figure 14. VR-1 Levee riverside north of W Main Street Bridge – looking north

Figure 15. UPRR at W Harbor Blvd – looking east

Figure 16. VR-1 Levee landward side at UPRR – looking south toward the ocean

Figure 17. Downstream end of VR-1 Levee at the ocean – looking west toward UPRR

Figure 18. S Olive Street – looking south toward US-101

Figure 19. S Garden Street at railroad (potential flow split) – looking west

Figure 20. S Garden Street at W Harbor Blvd – looking north toward US-101 underpass

Figure 21. W Harbor Blvd at Figueroa Street – looking west

Figure 22. Figueroa Street at W Harbor Blvd – looking north toward US-101 underpass

Figure 23. Shoreline Drive at the ocean – looking north toward wide open area

Figure 24. Shoreline Drive at the ocean – looking east toward Ventura Avenue

Figure 25. E Harbor Blvd at Ventura Pier – looking east

Figure 26. E Harbor Blvd at Ventura Pier – looking west toward US-101

Figure 27. Underpass between E Harbor Blvd and US-101 (east of S California Street) – looking north

Figure 28. N Ventura Avenue at E Warner Street – looking north

Figure 29. N Ventura Avenue at E Warner Street – looking south

Figure 30. S Olive Street between US-101 and S Garden Street – looking north

Figure 31. Drainage ditch at US-101 west of S Olive Street – looking west

Figure 32. Drainage ditch at US-101 west of S Olive Street – looking east

Figure 33. E Santa Clara Street at S Olive Street – looking west toward US-101

Figure 34. S Garden Street – looking south toward W Thompson Blvd

Figure 35. S Garden Street – looking north toward W Santa Clara Street

Figure 36. West of S Garden Street near US-101 (potential flow split) – looking south toward US-101

Figure 37. Drainage ditch east of S Garden Street near US-101 – looking east toward W Thompson Blvd

Figure 38. Box culvert exit under SR-33 at W Harbor Blvd – looking north

Figure 39. W Harbor Blvd – looking west

Figure 40. E Santa Clara Street at S Oak Street – looking west

Figure 41. E Santa Clara Street at Junipero Street – looking south toward open ground

Figure 42. E Thompson Blvd at S Palm Street – looking north

Figure 43. E Main Street at Figueroa Street – looking west

Figure 44. Julian Street across Ojai Valley Trail Extension – looking south

Figure 45. Ojai Valley Trail Extension SR-33 Ramp near Dubbers Street (potential flow split) – looking west

Figure 46. W Park Row Avenue at N Garden Street – looking east

Figure 47. Schoolyard on W Park Row Avenue near SR-33 – looking north

Figure 48. Ojai Valley Trail Extension near SR-33 south of W Park Row Avenue (potential flow concentration) – looking south

Figure 49. W Mission Avenue at N Olive Street – looking east

Figure 50. W Prospect Street at N Olive Street – looking east

Figure 51. Schoolyard on Sheridan Way – looking west toward SR-33

Figure 52. Riverside Street at W Ramona Street – looking north

Figure 53. W Barnett Street at N Olive Street – looking east

Figure 54. Apartment complex near W Vince Street across SR-33 (flow can go behind) – looking east

Figure 55. W McFarlane Drive at N Olive Street – looking east

Figure 56. Open area at N Olive Street across W McFarlane Drive – looking west toward Ventura River

Figure 57. E Shoshone Street – looking east

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APPENDIX C

Quality Assurance / Quality Control

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Independent Technical Review Comments		Project Name: Ventura River Levee – FIS Study			Location: Ventura, CA
Date: 6/4/2014		**Reviewer: Patti Sexton**	**Tel:** 949-809-5099	**Project Number: 100-SWW-T27259**	Back Check By: (initials)
Office: Tetra Tech - Irvine		**Type of Document** Report	**Discipline** Hydraulics		
Item No.	Page	**COMMENTS**	Action Taken:		By:
Report					
1	4	Need to explain the right overbank modeling as well.	Computation of the levee riverside and landside WSEs explained in text		
2	5	Are these effective discharges?	Yes. Effective discharges based on the HDR FIS 2010 report and VCWPD hydrographs (referenced in the report).		
3	4,8	Earlier in the report state what map we are providing that they can use to locate all the labeled cross sections (i.e. the workmap)	Figures 8 & 9 (with cross section stationing) referenced in the report. Maps updated to show extended cross sections.		
4	28	How is verification of FLO-2D Pro Version done?	By comparing max water surface elevations and maximum velocities (cell by cell) between FLO-2D 2009 and Pro versions. There wasn't a significant difference.		
5	12	High roughness of 0.07 5-0.09 in one reach in the channel needs more explanation. What is the reference/support for this adjustment? It no longer is representing the physical roughness so it needs to be justified.	The goal was to achieve a similar hydraulic loss with the removed pressure lid for the maximum water surface elevation (the pressure lid was causing instability during flood routing and was removed; this is a common work around in unsteady flow modeling). Also, added discussion on Priessmann slot in the report to emphasize the uncertain nature of the pressure lid flow computation in unsteady HEC-RAS.		
6	12	Friction slope at the d/s boundary. Does it match the actual channel slope? If a significant discrepancy that needs to be explained.	Unsteady flow models are very sensitive to d/s friction slope which does not need to match the actual channel slope (this is a steady flow approximation). FIS model used very low tidal elevation (2.53 ft) causing the boundary water surface to default to critical depth. The goal was to specify relatively mild friction slope (0.005) to raise the starting water surface elevation above critical depth (which is conservative and stable). It was verified that the results (i.e., overtopping flows) are not much sensitive to friction slope at the boundary.		
7	21	Need a section that describes the floodway. Provide floodway data table showing the surcharge and widths. Select cross sections to be lettered in the FWDT that FEMA will publish in the FIS.	Floodway completed, described and lettered sections added.		
8	33	Provide results for a weir coefficient of 0.5. Did you consider varying the weir coefficient between these reaches to better balance the WSE?	Results for weir coefficient of 0.5 are added. The WSEs were balanced in an average sense; there is too much uncertainty in flow transfer between the main channel and the overbank to warrant more detailed calibration. Added a paragraph for weirs south of US-101 (no overtopping due to high FLO-2D WSE on the landward side of the levee).		

Independent Technical Review Comments	Project Name: Ventura River Levee – CTP Study			Location: Ventura, CA
Date: 6/9/2014	**Reviewer:** Dai Thomas	**Tel:** 970-206-4209	**Project Number: 100-SWW-T27259**	Back Check By: (initials)
Office: Tetra Tech - Fort Collins	**Type of Document** Report & Model Files	**Discipline** Hydraulics		

Item No.	Section/Page	COMMENTS	Action Taken:	By:
Report				
1	Report	The report was reviewed and suggested text changes were documented in "track changes".	Comments incorporated as appropriate.	
Ventura River HEC-RAS Model				
3	X-Sec Geom.	A visual inspection was conducted and there were no obvious errors.	No action required.	
4	Profile	A visual inspection was conducted and there were no obvious errors.	No action required.	
5	N-values	The applied Manning's n-values seem representative of the channel and overbank roughness. The n-values are reasonably consistent along the reach, except in one location where an n-value of 0.04 was applied for stability purposes (this is explained in the report).	No action required.	
6	X-Sec Sta.	The cross-section spacing seems reasonable and there are no anomalous values.	No action required.	
7	Bank Sta.	The bank stationing was reviewed for consistency. It is difficult to check bank spacing without the original mapping, however, the following bank stations appear inconsistent with the bounding cross-sections: 162.9877 (low RB), 8686.77 (low RB), 13923.17 (high RB).	Adjusted. Would not affect lateral overtopping (only slightly for the 500-yr event in the most upstream reach)	
8	Ineffective Flow Areas	All ineffective flow areas set to "Not Permanent", probably because bridges experience weir flow. What are the contraction/expansion ratios applied to the ineffective flow areas?	Generally, ineffective flow limits were set at the existing levee to remove left overbank conveyance in the Natural Valley scenario (to maximize lateral flows as requested by FEMA). Ineffective limits near structures were set up for multiple openings (approximately within stagnation areas) in the base FIS model. Typically, expansion ratios are 3:1 and contraction 1:1, but there is not much room for transition here since the structures are close. Some portions of roadways are overtopped.	
9	Blocked Flow Areas	None applied.	No action required.	

Independent Technical Review Comments	Project Name: Ventura River Levee – CTP Study		Location: Ventura, CA	
Date: 6/9/2014	**Reviewer:** Dai Thomas	**Tel:** 970-206-4209	**Project Number: 100-SWW-T27259**	Back Check By: (initials)
Office: Tetra Tech - Fort Collins	**Type of Document** Report & Model Files	**Discipline** Hydraulics		

Item No.	Section/Page	COMMENTS	Action Taken:	By:
10	Lateral Weirs	The weir geometry and modeling methodology was reviewed. The geometry appears consistent with the topography. In general, a weir coefficient of 0.3 was applied. Some lateral structures have a weir coefficient of 0.0 to prevent lateral overtopping as described in the report.	No action required.	
11	Hydraulic Structures	All bridges modeled using similar approach and "Highest Energy Answer".	No action required.	
12	Model Input	Hydrographs checked and no anomalous data points.	No action required.	
13	Boundary Conditions	A normal depth approximation was applied at the downstream boundary.	No action required.	
14	Model Stability	The 100- and 500-year models were run and were stable.	No action required.	
Canada de San Joaquin HEC-RAS Model				
15	X-Sec Geom.	A visual inspection was conducted and there were no obvious errors. Interpolated cross-sections used in the model.	No action required.	
16	Profile	A visual inspection was conducted and there were no obvious errors.	No action required.	
17	N-values	The applied Manning's n-values seem representative of the channel and overbank roughness. Main channel N-values range from 0.031 to 0.09. The n-values are reasonably consistent along the reach, except in one area where an n-value of 0.09 was applied – why such a high value?	High roughness coefficients (0.09 for 100-year and 0.075 for 500-year event) were used in lieu of the pressure lid (from the base model) to stabilize unsteady runs. These coefficients were "calibrated" to produce similar max WSEs as the base model with peak flows. There is much uncertainty in HEC-RAS modeling of pressure flows and this approximation was deemed appropriate for the study purpose (added discussion on Priessmann slot for pressure lids in the report).	
18	X-Sec Sta.	The cross-section spacing seems reasonable and there are no anomalous values.	No action required.	
19	Bank Sta.	The bank stationing was reviewed for consistency. It is difficult to check bank spacing without the original mapping, however, the following bank stations appear inconsistent with the bounding cross-sections: e.g. 823.36	Adjusted. Would not affect lateral overtopping in this area.	

Independent Technical Review Comments	Project Name: Ventura River Levee – CTP Study			Location: Ventura, CA
Date: 6/9/2014	**Reviewer:** Dai Thomas	**Tel:** 970-206-4209	**Project Number: 100-SWW-T27259**	Back Check By: (initials)
Office: Tetra Tech - Fort Collins	**Type of Document** Report & Model Files	**Discipline** Hydraulics		

Item No.	Section/Page	COMMENTS	Action Taken:	By:
20	Ineffective Flow Areas	All ineffective flow areas set to "Not Permanent". Some should be set to "Permanent", but probably does not matter since ineffective flow elevation is not overtopped.	Some ineffective elevations are overtopped but it was assumed that the weir flow would be able to activate ineffective areas.	
21	Blocked Flow Areas	Used and seem appropriately applied.	No action required.	
22	Lateral Weirs	The weir geometry and modeling methodology was reviewed. The geometry appears consistent with the topography. In general, a weir coefficient of 0.5 was applied. Weir value slightly different than Ventura River model.	CSJ is hydraulically complex system and due to modeling uncertainty (structures, pressure flow, steep slope), weir coefficient was maximized to provide conservative lateral flows.	
23	Hydraulic Structures	Only 1 bridge - computed using energy method for low and high flow. Why the different approach on the low flow compared to the Ventura River model?	For stability reasons. Occasionally switching between different methods may cause computational instability during unsteady runs.	
24	Model Input	Hydrographs checked and no anomalous data points.	No action required.	
25	Boundary Conditions	A normal depth approximation (S=0.005) was applied at the downstream boundary. Why were the 2 models not combined to provide better estimate of the boundary conditions at the downstream end of the CSJ model?	The two models were run separately for better efficiency and stability. CSJ is hydraulically very complex system with many structures, requiring a computational time step of 1 sec. The Ventura River model is more stable, with a time step of 1 min (but time consuming processing of multiple opening rating tables). It was verified that the Ventura River backwater does not affect the CSJ WSEs in the areas of lateral flows (the most downstream culvert 692.9 on CSJ is in inlet control while the Ventura River backwater is lower than critical depth in the culvert barrel; lateral structures are all placed u/s of the culvert and not sensitive to d/s boundary condition).	

Independent Technical Review Comments	Project Name: Ventura River Levee – CTP Study			Location: Ventura, CA	
Date: 6/9/2014	**Reviewer:** Dai Thomas	**Tel:** 970-206-4209		**Project Number: 100-SWW-T27259**	Back Check By: (initials)
Office: Tetra Tech - Fort Collins	**Type of Document** Report & Model Files	**Discipline** Hydraulics			

Item No.	Section/Page	COMMENTS	Action Taken:	By:
26	Model Stability	The 100- and 500-year models were run and were stable.	No action required.	
FLO-2D Model				
27	CONT.DAT	72-hour simulation, 1-hour output. Streets and ARF's.	No action required.	
28	ARF.DAT	569 elements totally blocked.	No action required.	
29	CADPTS.DAT	73697 elements	No action required.	
30	FPLAIN.DAT	All n-values set at 0.1. Elevations range from 1.65 to 1009.44'.	No action required.	
31	INFLOW.DAT	Values checked and correspond to HEC-RAS output.	No action required.	
32	MANNINGS_N.DAT	Not used	No action required.	
33	OUTFLOW.DAT	Outflow set at Ocean.	No action required.	
34	STREET.DAT	Curb height was increased to account for streets wider than element width. Seems reasonable approach to account for lost conveyance.	No action required.	
35	TOLER.DAT	Standard values used.	No action required.	
36	TOPO.DAT	Not used.	No action required.	
37	XSEC.DAT	Not used. No CHAN.DAT file.	No action required.	
38	Summary.out	Very good volume conservation.	No action required.	
39	Rough.out	Small changes in Manning's n-values along street	No action required.	
40	Depth.out	Values consistent with mapping	No action required.	
41	VelFP.out	Values consistent with mapping	No action required.	
SPECIFIC				
42		Not apparent why the 2 HEC-RAS models were not joined. Would provide better downstream boundary condition for the CSJ model.	See 25	

Independent Technical Review Comments	Project Name: Ventura River Levee – CTP Study			Location: Ventura, CA	
Date: 6/9/2014	**Reviewer:** Dai Thomas		**Tel:** 970-206-4209	**Project Number: 100-SWW-T27259**	Back Check By: (initials)
Office: Tetra Tech - Fort Collins	**Type of Document** Report & Model Files		**Discipline** Hydraulics		

Item No.	Section/Page	COMMENTS	Action Taken:	By:
43		Why not used FLO-2D modeling for all the modeling? Is it the lateral weir flow, or the bridge modeling routines?	Several reasons: 1) FLO-2D is not easy to properly set up with rating tables for bridges/culverts (especially for multiple openings and CSJ structures); 2) lateral flow exchange is complicated in the Natural Valley procedure where a levee has to physically stay in cross sections but to allow side overtopping; 3) not much control over FLO-2D side weir parameters (weir crest and discharge coefficient); 4) floodway analysis is more trusted and better documented in HEC-RAS	
Summary				
44		The review of the HEC-RAS and FLO-2D models indicates they appear to be very good quality models. The topography is recent and appears to represent the existing conditions. The parameters applied to the HEC-RAS model seem appropriate for the conditions. In cases of uncertainty, an appropriate sensitivity analysis was performed. The report describes in detail the model development and the steps necessary to ensure model stability. The HEC-RAS and FLO-2D models were run and were stable. The model output has been used appropriately to develop maximum depth, velocity and extents of flood mapping. The FLO-2D model output was used to develop FIRM mapping.	No action required.	

Independent Technical Review Comments		Project Name: Ventura River Levee – FIS Study			Location: Ventura, CA
Date: 4/5/2014		**Reviewer: Yunsheng Su**	**Tel:** 805-654-2454	Project Number: 100-SWW-T27259	Back Check By: (initials)
Office: VCWPD		**Type of Document** Hydraulic Model HEC-RAS	**Discipline** Hydraulics		

Item No.	Section/Page	COMMENTS	Action Taken:	By:
Report				
1	Lateral Weir Elevations	In this study, landward toe elevations of the levee are critical in determining the split flows. Please do not solely rely on Lidar topo for levee geometry. Please cross check with as-built drawings to confirm/correct landward toe elevations (weir crest elevations).	Lateral weir elevations were determined to approximately match average landward terrain elevations behind the levee or roadway (see Appendix B in the report for weir crests labeled by green dots in cross sections). This provides conservatively low weir elevations for computation of laterally overtopping flows.	
2	Supercritical Flow	Supercritical flow occurs in the study reach, because of the use of "Mixed Flow Regime". It is more appropriate to use sub-critical regime in a mostly natural river of this size. Please refer to User Manual for the use of "Mixed Flow Regime".	Supercritical flow in unsteady HEC-RAS occurs not because of the "Mixed Flow Regime" option used (this option when checked only introduces additional diffusion in the numerical method to help stabilize the solution where it transitions to supercritical regime). This is rather the consequence of a full dynamic wave propagation (expressed by Saint-Venant equations) and cannot be prevented by checking the "Subcritical Regime" box such as in steady flows. However, it is agreed that subcritical regime is more conservative for natural rivers of this size and we used critical depth (instead of supercritical results) for max WS profiles in those areas where the depth was calculated less than critical during unsteady flood routing (see section 3.6.3 in the report).	
3	Cross Section Plot	There is an error in plotting XS 1071.	Fixed.	

QC Review Checklist for Hydraulics and Mapping

1. Review Type	Hydraulics	4. Description of materials reviewed	Ventura River – VR1 Levee Natural Valley Unsteady HEC-RAS Model
2. Mapping Partner	Ventura County Watershed Protection District		
3. Final Approver & Date		5. Reference ID	

6. Reviewer & Date (list all reviews completed before final approval)

Stephen Blanton, AECOM	4/8/2014				
Stephen Blanton (SB), AECOM	4/21/2014				

7. Num	8. Question or Direction	9. Definition	10. NR/ Pass/Fail	11. Comments
1	**Hydraulic Review**			
2	Is the computer program used for hydraulic modeling approved by FEMA, and is it a current model version?	The list of models approved by FEMA can be found at www.fema.gov/fhm/en_modl.shtm	Pass	
3	Does the model cover the reach of detailed study shown on the workmap?		NR	Workmaps not submitted at this stage
4	Were both Multiple and Floodway models run?		Pass	100-yr and 500-yr Unsteady models were prepared per agreed-upon scope. Floodway not contained in submittal at this stage.
5	Does the flow used in the hydraulic model match with the Summary of Discharges table?		NR	Not Applicable for this review
6	Are the 1-percent–annual chance flows identical for both multiple & floodway models?		NR	No floodway run was included in the review
7	Is the starting water surface boundary condition of the model appropriate?		Pass	The downstream boundary condition is set to Normal Depth instead of the 2.53' tidal elevation per a sensitivity analysis performed by the contractor. SB Comment: Addressed

7. Num	8. Question or Direction	9. Definition	10. NR/ Pass/Fail	11. Comments
8	Is the Starting Water Surface Elevation for floodway run within 1-foot surcharge limit?		NR	No floodway run was reviewed.
9	Are all floodway surcharges less than or equal to 1.0 foot, or lesser value if required by State?		NR	No floodway run was reviewed.
10	Are all bridges visible on the workmap modeled or is a reason for not modeling provided?		Pass	Model includes 3 bridges: UPRR Highway 101 Main Street

7. Num	8. Question or Direction	9. Definition	10. NR/ Pass/Fail	11. Comments
1	Are bridges/culverts correctly modeled?	UPRR (#800) – Multiple Opening Highway 101 (#1975) – Multiple Opening Main Street (#2796) – Multiple Opening	Suggest to look at further prior to finalizing	Please justify the approaches or correct as needed per the following: UPRR – Only uses Energy for low and high flows. Momentum and Yarnell have coefficients and are checked but the radial button for Use is set only Energy. The stationing for the Multiple Openings Bridge designations does not seem correct based on the cross sections. There is a culvert near Seaside wilderness park that is not included in the bridge data. Cross section might not extend that far. The High Chord appears to be too variable for a railroad alignment. Comment: Please review the modeled Stagnation Points. The final locations appear to be equal to the set locations. This could mean an optimized solution was not found. Stagnation points repositioned to provide better convergence and consistency between 100- and 500-year profiles. Highway 101 – Influence of bridge section #2 and #3 appears to overlap too much for actual areas of flow influence. Comment: Please review the modeled Stagnation Points. The final locations appear to be equal to the set locations. This could mean an optimized solution was not found. Stagnation points repositioned to provide better convergence and consistency between 100- and 500-year profiles. Main Street – The stationing of the small opening, Approx 5500 is not placed at what appears to be the channel. SB Comment: Addressed

7. Num	8. Question or Direction	9. Definition	10. NR/ Pass/Fail	11. Comments
12	Have ineffective flow areas, if any, been identified and blocked?			See Note #2 below.
13	Does the model's stationing as represented on the profile, match the stream distances shown on the map?		Pass	River stationing and profile length are equal.
14	Are the left and right overbank distances adjusted for flow around curves?		Pass	LOB, ROB, and Channel downstream distances are variable. The placement of the overbank flow path is not provided so it is difficult to determine the accuracy of the overbank downstream lengths.
15	Are all Check-RAS error messages resolved?	This review does not include Check-RAS.	NR	
16	Are the n values used in the model within reasonable ranges?	Manning's n-values are designated for the: Channel – 0.033 to 0.05 LOB – 0.068 ROB – 0.068	Pass	There are 5 cross sections with either the 0.04 or 0.05 n-value. The changes do not appear to be related to changes in the channel. Perhaps the values are the result of calibration. SB Comment: computation stability required the n-values to be modified. The Values fall within a reasonable range for the land cover.
17	Are Levees, if present, modeled appropriately based on whether they are certified according to NFIP (65.10)?		NR	No levees are used in the model. Lateral structures are used to estimate flow leaving the channel.
18	For areas where non-certified levees are shown on the workmap has analysis been provided for With & Without Levee conditions?		NR	
19	Have sufficient backup hydraulic analysis been provided for any shallow flooding, or coastal areas, if any?		NR	

1) At the railroad bridge, the upstream WSE for the 1% event is slightly higher than the 0.2% event. Please confirm that this is reasonable and expected that the RR would overtop during 1% event.
SB Comment: Model was edited to include ineffective area on the LOB, the revised model did not have this issue with the maximum WSE.

2) The lateral structures are placed at the left bank station with flow leaving the system, and the model allows for conveyance in the left over bank area. Consider making the left over bank ineffective or removing from the cross section. This will result in higher WSE and more flow leaving.
SB Comment: Ineffective flow areas were added to the model and the model was reran and stabilized.

SB Comment: please verify the computational errors fall within the required limits.

The max error for 100-year flow is about 0.1 ft. The max error for 500-year flow is 0.7 ft in one cross section near bridge, but the majority of cross sections have max error less than 0.4 ft.

QC Review Checklist for Hydraulics and Mapping

1. Review Type	Hydraulics	4. Description of materials reviewed	Ventura River – VR1 Levee Landward FLO2D Model
2. Mapping Partner	Ventura County Watershed Protection District		
3. Final Approver & Date		5. Reference ID	

6. Reviewer & Date (list all reviews completed before final approval)						
	Stephen Blanton	07/02/2014				
	Tetra Tech	7/23/2014				

7. Num	8. Question or Direction	9. Definition	10. NR/ Pass/Fail	11. Comments
1	**Hydraulic Review**			
2	Is the computer program used for hydraulic modeling approved by FEMA, and is it a current model version?	The list of models approved by FEMA can be found at www.fema.gov/fhm/en_modl.shtm	OK	Modeler used FLO2D-Pro which is not yet approved, but per discussion between FEMA and WPD on 5/13, it is agreed to move forward with FLO2D-Pro.
3	Does the model cover the reach of detailed study shown on the workmap?		NR	FLO2D model domain is only for the landward portion of the VR-1 Levee
4	Were both Multiple and Floodway models run?		See comment	Only the 100-Year FLO2D model was provided. Is a 500-Year being submitted? 500-Year model was provided in the submittal package.
5	Does the flow used in the hydraulic model match with the Summary of Discharges table?		NR	Not Applicable for this review
6	Are the 1-percent–annual chance flows identical for both multiple & floodway models?		NR	No floodway run was included in the review
7	Is the starting water surface boundary condition of the model appropriate?		NR	The outlet boundary conditions are not set. The FLO2D assumes free outflow through the discharge nodes. Tidal elevation is low (2.53 ft) and cannot be forced. Free outflow BC (normal depth) gives higher WSE at the boundary.

7. Num	8. Question or Direction	9. Definition	10. NR/ Pass/Fail	11. Comments
8	Is the Starting Water Surface Elevation for floodway run within 1-foot surcharge limit?		NR	No floodway run was reviewed.
9	Are all floodway surcharges less than or equal to 1.0 foot, or lesser value if required by State?		NR	The FLO2D model domain does not include the Floodway area of the model. That was developed using HEC-RAS
10	Are all bridges visible on the workmap modeled or is a reason for not modeling provided?		NR	No hydraulic structures are used in the FLO2D model domain. This is likely reasonable as the bridges structures do not impact the WSE. Concur.
11	Are bridges/culverts correctly modeled?		NR	No hydraulic structures are used in the FLO2D model domain. This is likely reasonable as the bridges structures do not impact the WSE. Concur.
12	Have ineffective flow areas, if any, been identified and blocked?		NR	
13	Does the model's stationing as represented on the profile, match the stream distances shown on the map?		NR	The FLO2D domain is not included in the Ventura River profile.
14	Are the left and right overbank distances adjusted for flow around curves?		NR	The FLO2D modeling approach does not require overbank distances.
15	Are all Check-RAS error messages resolved?		NR	
16	Are the n values used in the model within reasonable ranges?		Check	Used 0.05 for delineated roads and 0.1 for residential and commercial. The model also utilized ARF so please verify that the 0.1 value was not intended to represent the increased roughness from structures. ARFs were utilized to represent a few large contiguous buildings that would be difficult for flows to pass through. All other areas (houses, walls, backyards, etc.) were assigned the uniform 0.1 n value.
17	Are Levees, if present, modeled appropriately based on whether they are certified according to NFIP (65.10)?		NR	No levees are used in the model.

7. Num	8. Question or Direction	9. Definition	10. NR/ Pass/Fail	11. Comments
18	For areas where non-certified levees are shown on the workmap has analysis been provided for With & Without Levee conditions?		NR	
19	Have sufficient backup hydraulic analysis been provided for any shallow flooding, or coastal areas, if any?		NR	

1) **The FLO2D terrain is based on 2008 LiDAR. There has been significant redevelopment of the area near the race track and beach that may have lowered the previous ground elevations in the area. Looking at recent aerials it appears that the beach has been rebuilt and extended inland near the tip of the levee. It is possible that the elevation was reduced in this area; verification would have to come from the County with new surveying or as-built drawings not already provided for this project.**
2) **The ARF.DAT file would not open in the FLO2D v. 2009. There may be some formatting difference between FLO2D- Pro and v.2009. Please verify that the ARF file is valid. The ARF file is one of those with formatting changes in Pro version. It now includes a header which v. 2009 does not read.**
3) **There is 7-ft of head across HWY 101 that is driving the flow through the two Highway fill grade breaks. It seems like a large WSE difference given the volume of flows and the size of the openings. There are no other outlets for the flow that is overtopping the levee upstream. This can be seen in the ponding behind Hwy 101 as well.**
4) **Section 3.5: For the RAS-FLO2D integration, should there be a WSE difference at the interface? It would seem that with no head difference, there would not be water leaving the RAS system. You may want to clarify this in the report. Perhaps provide a reason it is occurring. Concur. The difference is due to the fact that two different models were used, each with different topography (land vs. river) near interface. The FLO-2D returning flow was also blocked, which created a significant adverse pressure gradient over the weir (from the overbank to the river) when the weir coefficient of 0.5 was used. The adverse pressure gradient was reduced by decreasing the amount of water spilling from the riverside.**
5) **Please include an explanation on why the Pro and v.2009 provide different results. The difference is coming from new stability criteria in Pro version (verified with Jim O'Brien). The results are still very close (less than 0.5 ft depth difference)**
6) **The Street Velocity output file (VELTIMEST.OUT) has some very high flow velocities in areas where the streets are flat. Please verify the results. Street velocities are high just north of Hwy 101 where the flow piles up against the embankment and is squeezed parallel to the road. This does not affect the water surface elevations significantly in this area (max difference with and without street runs shows less than 0.1 ft)**
7) **Table 4: FLO-2D Inflow Cells. Not all the cells listed actually have inflow hydrographs assigned. Either remove them from the table or provide some indication that no actual flows are associated with the Lateral Weir/Grid Cells. Concur. Some are active only for the 500-year flow. Will be explained in the report.**
8) **Please clarify the street width assumption of 33.5-ft. There is a statement the 95% of the 50-ft grid cell size can be assigned to streets, which is more than 33.5-ft. then there is the issue with diagonal street alignments. The streets below Main Street all align with the grid alignment, so I am not sure why they are modeled as 33.5-ft. The difficulty lies in the fact that the maximum width of a street (and thus its total area) that a cell can contain varies depending on whether the street is straight, or at an angle, with the additional complication at intersections where the partial segments combine. Determining the maximum width that fitted all these scenarios was the optimal solution, with curb heights tweaked to account for any lost street conveyance. It was verified that model runs with and without streets don't significantly change WSE (less than 0.5 ft), such that the adopted street modeling approach is acceptable.**
9) **The ARF.DAT file and Section 2.3.2.4 Obstructions need to be clarified. The ARF.DAT file has 612 completely blocked grid cells and 1023 grid cells that use Width Reduction Factor (WRF). Add description of WRFs and verify that ARF.DAT format using all 8 directions is correctly reading into the FLO2D. When the ARF.DAT is opened in FLO-2D Version 2009.06, the listed WRF values after the first 4 values are not included. There has been a change between the 2009 and Pro versions regarding ARF files. Completely blocked cells in Pro now automatically generate WRFs around them. This has no practical effect in models that only have hydrograph inflow cells, just for rainfall on buildings (verified with Jim O'Brien).**

QC Review Checklist for Hydraulics and Mapping

1. Review Type	Hydraulics		4. Description of materials reviewed	– HEC-RAS Model for Floodway only and Mapping
2. Mapping Partner	Ventura County Watershed Protection District			
3. Final Approver & Date			5. Reference ID	

6. Reviewer & Date (list all reviews completed before final approval)						
	Stephen Blanton	7/30/2014				
	Tetra Tech	9/25/2014				

7. Num	8. Question or Direction	9. Definition	10. NR/ Pass/Fail	11. Comments
1	**Hydraulic Review**			
2	Is the computer program used for hydraulic modeling approved by FEMA, and is it a current model version?			
3	Does the model cover the reach of detailed study shown on the workmap?			
4	Were both Multiple and Floodway models run?		Fail	A Floodway Plan is provided but the encroachment file is not provided HEC-RAS model with Floodway Plan and encroachment file provided.
5	Does the flow used in the hydraulic model match with the Summary of Discharges table?		Fail	This is not provided Table 1 in the report summarizes the flows used in the model.
6	Are the 1-percent–annual chance flows identical for both multiple & floodway models?		NR	
7	Is the starting water surface boundary condition of the model appropriate?		NR	Addressed earlier

7. Num	8. Question or Direction	9. Definition	10. NR/ Pass/Fail	11. Comments
8	Is the Starting Water Surface Elevation for floodway run within 1-foot surcharge limit?		NR	Only 100 and 500 starting boundary conditions are provided. Model defaults to critical depth at the downstream boundary even though 1-ft surcharge was set.
9	Are all floodway surcharges less than or equal to 1.0 foot, or lesser value if required by State?		Fail	RAS results table contains different values from Table 6 of the report. Results of the provided HEC-RAS model with Floodway Plan and encroachment file match Table 6.
10	Are all bridges visible on the workmap modeled or is a reason for not modeling provided?			
11	Are bridges/culverts correctly modeled?			
12	Have ineffective flow areas, if any, been identified and blocked?			
13	Does the model's stationing as represented on the profile, match the stream distances shown on the map?			
14	Are the left and right overbank distances adjusted for flow around curves?			
15	Are all Check-RAS error messages resolved?			
16	Are the n values used in the model within reasonable ranges?			
17	Are Levees, if present, modeled appropriately based on whether they are certified according to NFIP (65.10)?			
18	For areas where non-certified levees are shown on the workmap has analysis been provided for With & Without Levee conditions?			

7. Num	8. Question or Direction	9. Definition	10. NR/ Pass/Fail	11. Comments
19	Have sufficient backup hydraulic analysis been provided for any shallow flooding, or coastal areas, if any?			
20	**Mapping (To be reviewed after Hydraulics is corrected)**			
21	Has a clear index of workmaps been provided, and are all workmaps available? Are all studied flood sources clearly identified?			Two workmaps cover the entire model area. There is not an index provided.
22	Is the datum of the workmap topography shown?		Pass	NAVD 88
23	Does the range of the identified cross sections for each flood source match the range in the model and in the Key to Lettered Cross sections?		Pass	Table 6 of the TSDN report lists XS A-H. The workmaps contain A-H.
24	Are the mapped floodway widths within 5% of floodway model top-widths?		Fail	Needs to be verified still—please provide GIS files to aid this review. GIS data provided. Some areas of the HEC-RAS floodway had to be adjusted and tied back in. They were matched to the 100-yr floodplain where the two overlap, or smoothed into long curves (+-5%) for a more representative footprint.
25	Is the new floodway designed to match and tie in to the effective floodway if any?		Fail	Modeling effort uses the 2010 FIS model but deletes the areas upstream of the study reach. It is not shown as a tie-in for the FW. The workmaps do state that the Floodplain is tied in. There is no floodway provided in the FIS model by HDR. The new floodway was tied into the effective floodway as agreed with Ed Curtis (the revised floodway matches the 100-yr floodplain at the upstream extent of the model as well as also matching the HDR 100-yr extent/WSE at that tie-in location).
26	Do the floodplain boundaries of the individual flood sources tie in to other flood sources or to effective floodplain data, and are they smooth with sufficient vertices?		Pass	Appears the U/S boundary ties into a previous HDR study.

7. Num	8. Question or Direction	9. Definition	10. NR/ Pass/Fail	11. Comments
27	Does the range of the BFEs on the workmap agree with the range of BFEs on the Profile?		Pass	
28	Do the BFEs and floodplain boundaries agree with the contours?		Fail	See Additional Comment 2. The contours on the river side of the levee are not labeled and therefore this item could not be verified. Additional labels added.
29	Are BFEs properly placed near the confluences of the streams ?		NR	CSJ appears to be contained in a long culvert as the CSJ Floodplain is not connected to the VR Floodplain.
30	Are BFEs plotted at each significant break in Profile slope?		Fail	BFEs do not appear to be placed at significant breaks. Intervals are also variable. BFEs are placed at changes in the water surface slope (breaks), and include additional BFEs with intervals based on the number of BFEs per inch of map per FEMA guidelines.
31	**Profiles**			
32	Do the profiles meet FEMA format & font criteria?		Pass	
33	Have appropriate vertical and horizontal scales been chosen?		Fail	X-Axis is “Stream Distance in feet” with no reference to starting point…Ocean, mouth, etc. Updated to include “From Ocean”
34	Is the correct Datum shown?		Fail	NGVD 88 is shown on each panel. Should be NAVD 88 or NGVD 29?. Corrected to NAVD88
35	Does the title block show the correct community or county and State names?		Fail	Just mentions Ventura River. Not county or city. Added county and city.
36	Does the beginning station reference match the labeling of the left side of the first profile for each flooding source?		Pass	

7. Num	8. Question or Direction	9. Definition	10. NR/ Pass/Fail	11. Comments
37	Is the backwater or influence from the receiving stream shown on the profile?		Fail	No mention of Tide Level. The downstream boundary is controlled by critical depth, which is higher than tidal elevation of 2.53-ft.
38	Do the profiles have appropriately spaced lettered cross-sections?		Fail	P3-6 have no cross section labels to reference. Lettered sections were only placed at locations where the WSE in the floodway model increases over the base model by more than .75 feet. FEMA provides guidance for the placement of BFEs but not lettered XSs. If such criteria are available, please provide.
39	Are all the corporate limits and confluences shown on the profile?		Fail	No corporate or confluence are shown. Added.
40	Do the bridge and culvert labels match with the labels shown on the base map?		Fail	Bridges are not shown. Added.
41	Do the locations of the lettered cross sections with respect to bridges and confluences match with the mapped locations?		Fail	Not included in the profiles. Features added, the features and lettered XSs align.
42	**Floodway Data Tables**		NR	Floodway Data Table not provided. Table 6 in the report appears to be the Floodway table but is not formatted for the FIS Report. Table 6 also doesn't match RAS output. Items 43-52 will be reviewed when FDT is provided. Floodway table conformed to FIS report format provided in Appendix B.
43	Do the overall font & formatting meet FEMA criteria?			
44	Is the proper community name and stream name shown?			
45	Do the beginning station and measurement units match the profile?			

7. Num	8. Question or Direction	9. Definition	10. NR/ Pass/Fail	11. Comments
46	Do the Cross Section Letter distances match the stations shown on the Profile?			
47	Are the WIDTH and SECTION AREA in FDT exactly the same as the model output?			
48	Do the Velocity numbers match the Mean Velocity output?			
49	Are backwater elevations or influence elevations from the profile, if any, shown in the Regulatory Column?			
50	Are the With and Without Floodway WSELs shown "without consideration of backwater", and do they match the model output?			
51	Is the correct Datum shown?			
52	Does the INCREASE column, equal the difference between WITH & WITHOUT columns?			

Additional Comments

1) The delineate floodplain has multiple pockets of flooding, likely connected by shallow. Is this the proper method for representing this modeling result?
As this makes the floodplain less useable from a management perspective, disconnected AE zones were tied together with A zones contained in the streets to show connectivity. Various pockets of shallow flow were removed and/or consolidated into the 0.2% chance floodplain.

2) BFE lines 23' and 22' in the FLO2D domain do not appear to be tied into the appropriate contour, please verify. The BFEs do not tie into appropriate contours on the levee/west end because they were extended over the high ground of the levee and elevated roadways which are assumed to fail in the Natural Valley procedure.

3) Why are the intervals for the BFE lines variable? BFEs are placed at changes in the water surface slope (breaks), and include additional BFEs with intervals based on the number of BFEs per inch of map per FEMA guidelines.

4) It appears the floodplain delineation is shifted within the FLO2D domain. This is apparent at Highway 101 crossing but it appears to impact most of the floodplain delineation east of the levee.

The source of this elevation data shift was corrected. The FLO-2D mapping results have been updated slightly to account for the data misalignment.

5) The profiles need more land marks. It is difficult to determine the profile location when multiple consecutive panels do not have any identifiers. Landmarks added.

6) The Floodway near cross sections A-C expand and contract creating a "non-smooth" delineation. It does not appear that flow goes over the highway so most of the area should be ineffective flow with no velocity. Please check on this validity
Concurred and that is the reason for wide spread ponding areas between the UPRR, Hwy 101, and Main Street embankments and upstream of Main Street embankment.

APPENDIX D

CD/DVD with All Applicable Data

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