Appendix C

Gate Technical Memorandums

TECHNICAL MEMORANDUM

Date:	April 14, 2014
To:	Project File
From:	Chris Campbell
Project:	13-1027 – Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project
Subject:	Sacramento Weir Alternative and Gate Configuration

1 SACRAMENTO WEIR GATED CHANNEL

This Technical Memorandum (TM) details the development of the Sacramento Weir Gated Channel Alternative in HEC-RAS (RAS) for use in the calibrated and validated TUFLOW Classic hydrodynamic model developed to support the California Department of Water Resources (DWR) and US Bureau of Reclamation (USBR) Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project (Project) Environmental Impact Statement and Environmental Impact Report (EIS/EIR). The Sacramento Weir Gated Channel Alternative is one of four alternatives being carried forward through the screening phase.

The Sacramento Weir Gated Channel Alternative was assumed to be constructed just north of the southern Sacramento Bypass levee, connecting the Sacramento River with the Tule Canal (see Figure 1). The proposed channel has an invert elevation of 7 feet NAVD88 with a 225 foot bottom width and 3:1 side slopes (see Figure 2). The channel profile and the gate configuration were analyzed in RAS to 1) understand the backwater effects on the gates from Yolo Bypass inundation given that proposed upstream inverts at the river are below the baseline water levels in the Tule Canal, and 2) optimize the gate openings for non-overtopping flows with the objective to maximize diversions from the Sacramento River up to 6000 cfs while minimizing head losses across the gate. Gate optimization was performed in RAS because such a function is not yet available in TUFLOW and gate logic is relatively new in TUFLOW.

2 WATER SURFACE PROFILES

For this analysis, the Tule Canal was assumed to have baseline flow contributions of 500 cfs, 350 cfs, 50 cfs, and 300 cfs from KLRC, Cache Creek Settling Basin, Willow Slough, and Putah Creek, respectively. To better understand system performance and hydraulic constraints prior to proceeding with configuring the gates, three steady state inflows of 500cfs, 1500 cfs and 6000 cfs were introduced into the

Sacramento Bypass. The water surface elevations in the RAS model at the confluence with the Tule Canal were based on calibrated TUFLOW simulations using the above stated flow conditions. Steady state water surface profiles for the Sacramento Bypass Gated Channel Alternative are shown in Figure 3.

Water surface profiles in the Sacramento Bypass are controlled by the low flow conveyance capacity within Tule Canal and the Yolo Bypass. The minimum water surface elevation in Tule Canal at the confluence with the Sacramento Bypass during baseline flows (i.e., 850 cfs as contributed by KLRC and Cache Creek) was 10.65 feet NAVD88. At stages below 11 feet NAVD88, flow through the Sacramento Bypass was limited due to the assumed backwater from Tule Canal, and was not included in the reported tables. It should also be noted that 2300 feet downstream of the gated channel connection to the Tule Canal is an agricultural crossing maintained by Swanston Ranch. The earthen crossing impounds water in the canal for diversion and consists of three culverts, one six foot open culvert and two four foot culverts with boards at the intakes and earth fill. If the earthen fill is not removed and stockpiled at the beginning of the wet season, it will be washed out as flows increase in the canal. The culvert features are more permanent. The washed out condition is included in the TUFLOW model based on the cbec 2010 survey with the invert measuring 8.5 feet NAVD88, which is approximately 5 feet higher than the bed profile in the vicinity of the gated channel connection to the canal.

3 GATE CONFIGURATION

A series of 6 new gates at the Sacramento Weir were used to regulate flows into the Sacramento Bypass up to 6000 cfs. For this analysis, it was assumed that the new gates were installed directly below the existing bays of the Sacramento Weir on the southern end of the weir (see Figure 4). The new gate dimensions are provided in Table 1, and generally consist of 30 foot wide gates with inverts of 7 feet NAVD88. Gate operations were optimized to maximize discharges into the Sacramento Bypass up to 6000 cfs for river stages in front of the Sacramento Weir up to elevations corresponding to the I Street water surface elevation trigger of 30.04 feet NAVD88. After the I Street elevation trigger is met, the Sacramento Weir is opened and the new gates will remain open per their last know configuration.

Sluice gates or radial gates could be used, but radial gates may offer the greatest flexibility in terms of real-time operations as well as constructability to minimize debris accumulation on the lift components. A gate optimization routine in RAS (see Section 4) was used to configure the size and number of gates as well as determine the individual gate openings relative to river stage. In general, gate widths were limited to 30 feet with 12 foot pillars between them. The pillars are wider than the Fremont Weir alternatives because the 30 foot new gates are situated directly beneath individual bays of the Sacramento Weir which are generally 40 feet wide. Gates 1 and 2 were limited in height to prevent the top of the gate from extending above the existing weir sill (24 feet NAVD 88) during a flood event when the Sacramento Weir is open and the new gate is open. The resulting gate configuration is shown in Table 1 and depicted in Figure 4. The gate opening schedules are shown in Table 2. The river stage versus total gate flow relationship is shown in Figure 5.

Table 1. Gate Configuration

Gate #	Gate Invert (NAVD 88 ft)	Gate Height (ft)	Gate Width (ft)
Gate 1	7	7	30
Gate 2	7	11	30
Gate 3 to Gate 6	7	14	30

Table 2. Gate Operations

Sacramento River Stage (ft)	Total flow (cfs)	Gate 1 Opening (ft)	Gate 2 Opening (ft)	Gate 3 Opening (ft)	Gate 4 Opening (ft)	Gate 5 Opening (ft)	Gate 6 Opening (ft)	Gate 1 Velocity (fps)	Gate 2 Velocity (fps)	Gate 3 Velocity (fps)	Gate 4 Velocity (fps)	Gate 5 Velocity (fps)	Gate 6 Velocity (fps)
11.0	131	7	11	14	14	14	14	0.2	0.2	0.2	0.2	0.2	0.2
12.0	498	7	11	14	14	14	14	0.6	0.6	0.6	0.6	0.6	0.6
13.0	1005	7	11	14	14	14	14	0.9	0.9	0.9	0.9	0.9	0.9
14.0	1566	7	11	14	14	14	14	1.24	1.2	1.2	1.2	1.2	1.2
15.0	2715	7	11	14	14	14	14	1.79	1.9	1.9	1.9	1.9	1.9
16.0	3719	7	11	14	14	14	14	1.73	2.5	2.5	2.5	2.5	2.5
17.0	5180	7	11	14	14	14	14	2.08	3.2	3.2	3.2	3.2	3.2
17.1	5387	7	11	14	14	14	14	2.13	3.3	3.3	3.3	3.3	3.3
17.2	5623	7	11	14	14	14	14	2.20	3.4	3.4	3.4	3.4	3.4
17.3	5852	7	11	14	14	14	14	2.29	3.5	3.5	3.5	3.5	3.5
17.4	5952	7	11	14	14	9.8	0	2.80	4.4	4.4	4.4	4.22	
17.5	5955	7	11	14	9.8	0	0	3.45	5.8	5.8	5.41		
17.6	5952	7	11	14	7.5	0	0	4.01	6.6	6.6	4.01		
17.7	5953	7	11	14	2.5	0	0	4.49	7.3	7.3	4.49		
17.8	5965	7	11	10.5	0	0	0	4.91	7.8	7.65			
17.9	5973	7	11	9.8	0	0	0	5.30	8.2	7.41			
18.0	5983	7	11	9.3	0	0	0	5.68	8.49	6.86			
18.1	5965	7	11	9.1	0	0	0	6.04	8.77	6.61			
18.2	5957	7	11	8.6	0	0	0	6.38	9.00	6.38			
18.3	5958	7	11	7.5	0	0	0	6.70	9.23	6.70			
18.4	5961	7	11	6.6	0	0	0	6.99	9.42	6.99			
18.5	5958	7	11	5.8	0	0	0	7.29	9.57	7.29			
18.6	5958	7	11	5.1	0	0	0	7.56	9.73	7.56			

Table 2. Gate Operations (continued)

Sacramento River Stage (ft)	Total flow (cfs)	Gate 1 Opening (ft)	Gate 2 Opening (ft)	Gate 3 Opening (ft)	Gate 4 Opening (ft)	Gate 5 Opening (ft)	Gate 6 Opening (ft)	Gate 1 Velocity (fps)	Gate 2 Velocity (fps)	Gate 3 Velocity (fps)	Gate 4 Velocity (fps)	Gate 5 Velocity (fps)	Gate 6 Velocity (fps)
18.7	5952	7	11	4.5	0	0	0	7.84	9.84	7.84			
18.8	5955	7	11	4	0	0	0	8.09	9.95	8.09			
18.9	5951	7	11	3.5	0	0	0	8.35	10.07	8.35			
19.0	5959	7	11	3.1	0	0	0	8.58	10.18	8.58			
20.0	5960	7	10.9	0	0	0	0	10.82	11.28				
21.0	5953	7	8.2	0	0	0	0	13.06	13.06				
22.0	5976	7	6.2	0	0	0	0	15.09	15.09				
23.0	5968	7	5.4	0	0	0	0	16.04	16.04				
24.0	5953	7	5	0	0	0	0	16.54	16.54				
25.0	5973	7	4.7	0	0	0	0	17.02	17.02				
26.0	5979	7	4.4	0	0	0	0	17.48	17.48				
27.0	5973	7	4.1	0	0	0	0	17.94	17.94				
28.0	5955	7	3.8	0	0	0	0	18.38	18.38				
29.0	5982	7	3.6	0	0	0	0	18.81	18.81				
30.0	6001	7	3.3	0	0	0	0	19.24	19.24				

4 GATE LOGIC

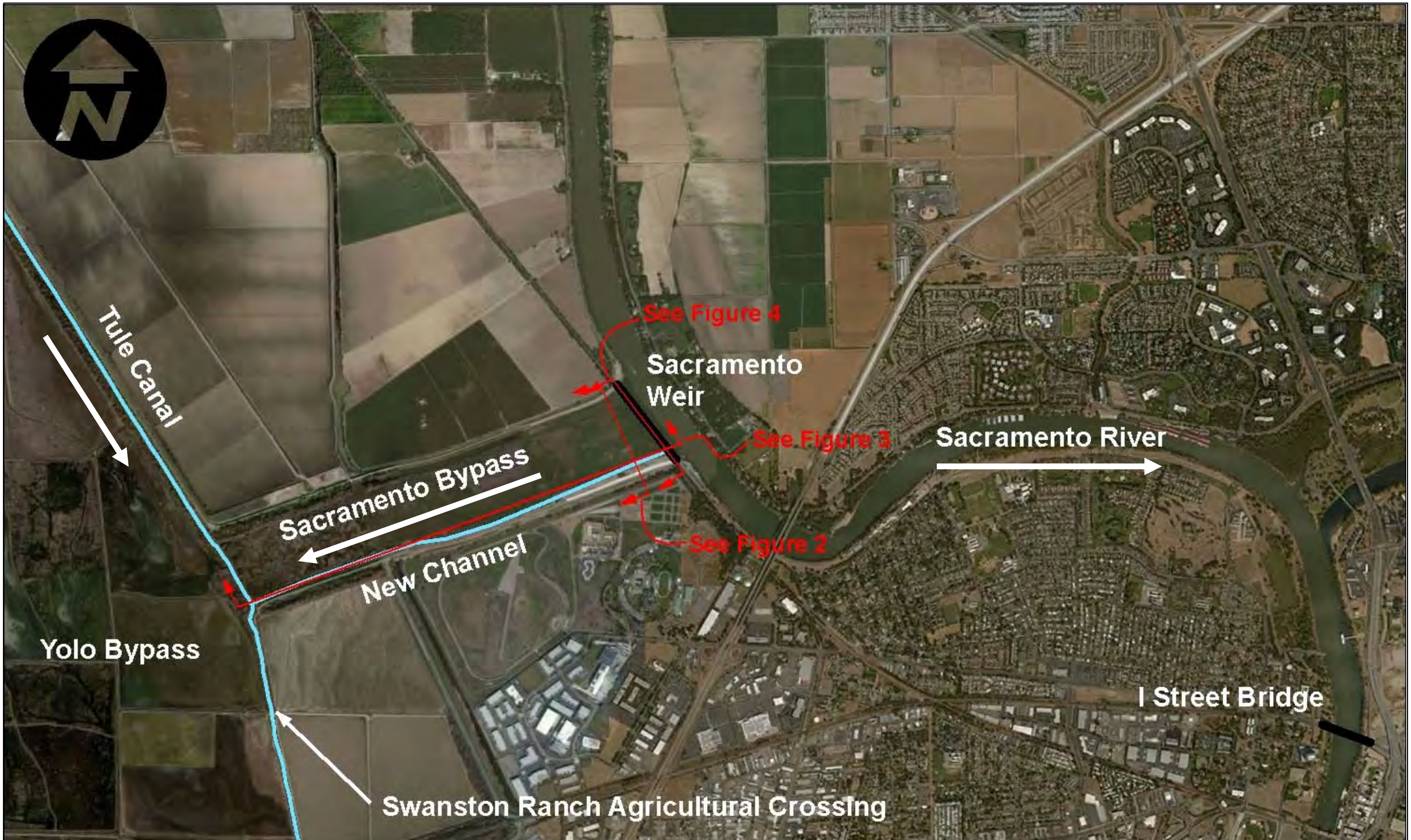
Rule operations in the RAS unsteady flow editor were used to optimize gate operations. For this analysis, the gates were allowed to open and close at a rate of one foot per minute during an unsteady flow analysis that used a stepped stage time series at the Sacramento River and a stage-discharge rating curve at Tule Canal based on calibrated TUFLOW simulations. The relatively quick opening rate of one foot per minute was used to speed up solution convergence, but can be set to something larger in TUFLOW to represent realistic rates or to accommodate model stability. The following logic was used in RAS to determine gate operations to maximize flows up to 6000 cfs based on Yolo Bypass and Sacramento River water surface elevations:

Define variable: TotalGateFlow = Sum of flow for all gates at current time step
Define variable: Gate1Opening = Opening of gate 1 at current time step
Define variable: Gate2Opening = Opening of gate 2 at current time step
Define variable: Gate3Opening = Opening of gate 3 at current time step
Define variable: Gate4Opening = Opening of gate 4 at current time step
Define variable: Gate5Opening = Opening of gate 5 at current time step
Define variable: Gate6Opening = Opening of gate 6 at current time step
Define variable: MaximumGateOpening = maximum gate opening of gates 3 to 6
Define variable: MaximumGateOpening1 = maximum gate opening of gate 1
Define variable: MaximumGateOpening2 = maximum gate opening of gate 2

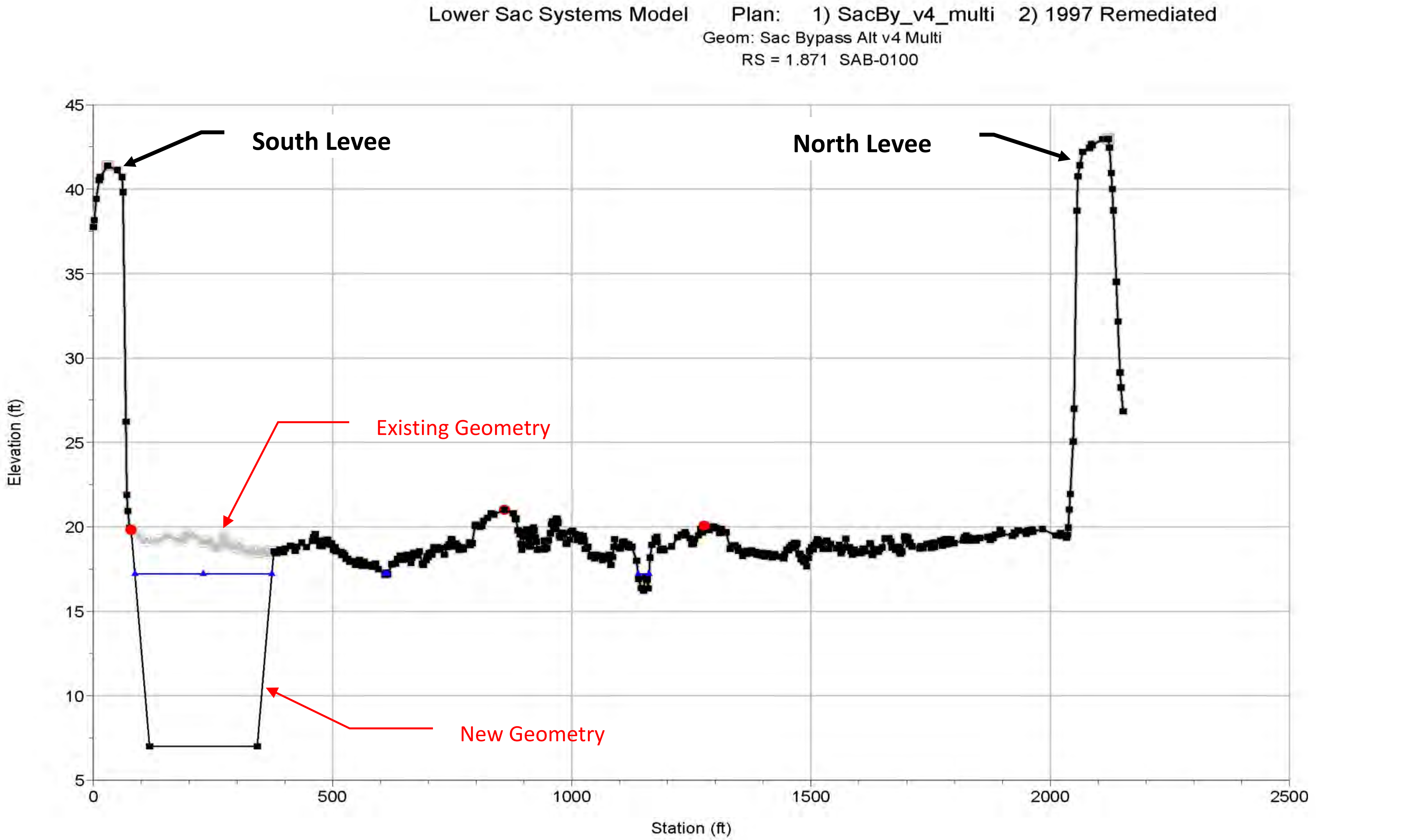
If TotalGateFlow < 5950 Then
    If Gate1Opening < MaximumGateOpening1 Then
    Set Opening of Gate 1 = Gate1Opening + 0.5
    Else, If Gate2Opening < MaximumGateOpening2 Then
    Set Opening of Gate 2 = Gate2Opening + 0.5
    Else, If Gate3Opening < MaximumGateOpening Then
    Set Opening of Gate 3 = Gate3Opening + 0.5
    Else, If Gate4Opening < MaximumGateOpening Then
    Set Opening of Gate 4 = Gate4Opening + 0.5
    Else, If Gate5Opening < MaximumGateOpening Then
    Set Opening of Gate 5 = Gate5Opening + 0.5
    Else, If Gate6Opening < MaximumGateOpening Then
    Set Opening of Gate 6 = Gate6Opening + 0.5
    End If
Else, If TotalGateFlow > 6000 Then
    If Gate6Opening > 0 Then
    Set Opening of Gate 6 = Gate6Opening - 0.5
    Else, If Gate5Opening > 0 Then
    Set Opening of Gate 5 = Gate5Opening - 0.5
    Else, If Gate4Opening > 0 Then
    Set Opening of Gate 4 = Gate4Opening - 0.5

Else, If Gate3Opening > 0 Then
Set Opening of Gate 3 = Gate3Opening - 0.5
Else, If Gate2Opening > 0 Then
Set Opening of Gate 2 = Gate2Opening - 0.5
Else, If Gate1Opening > 0 Then
Set Opening of Gate 1 = Gate1Opening - 0.5
End If

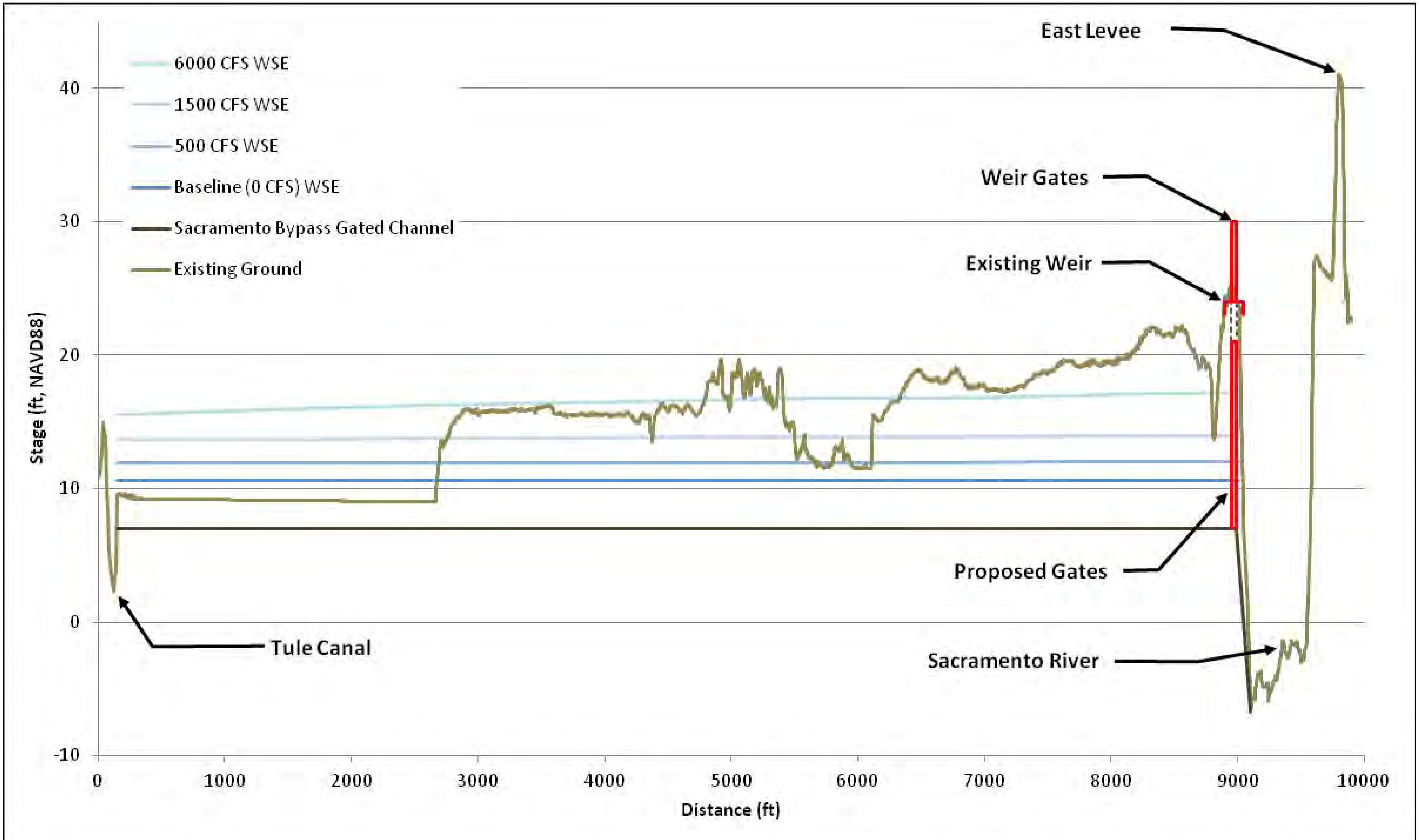
End If



Notes: background courtesy of Bing Maps	cbec eco engineering	*Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project* **Sacramento Weir Alternative Location Map**		
		Project No. 13-1027	Created By: CRC	**Figure 1**



Notes: elevations are NAVD 88	cbec	*Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project* **Sacramento Bypass Channel Cross Section**		
		Project No. 13-1027	Created By: CRC	**Figure 2**

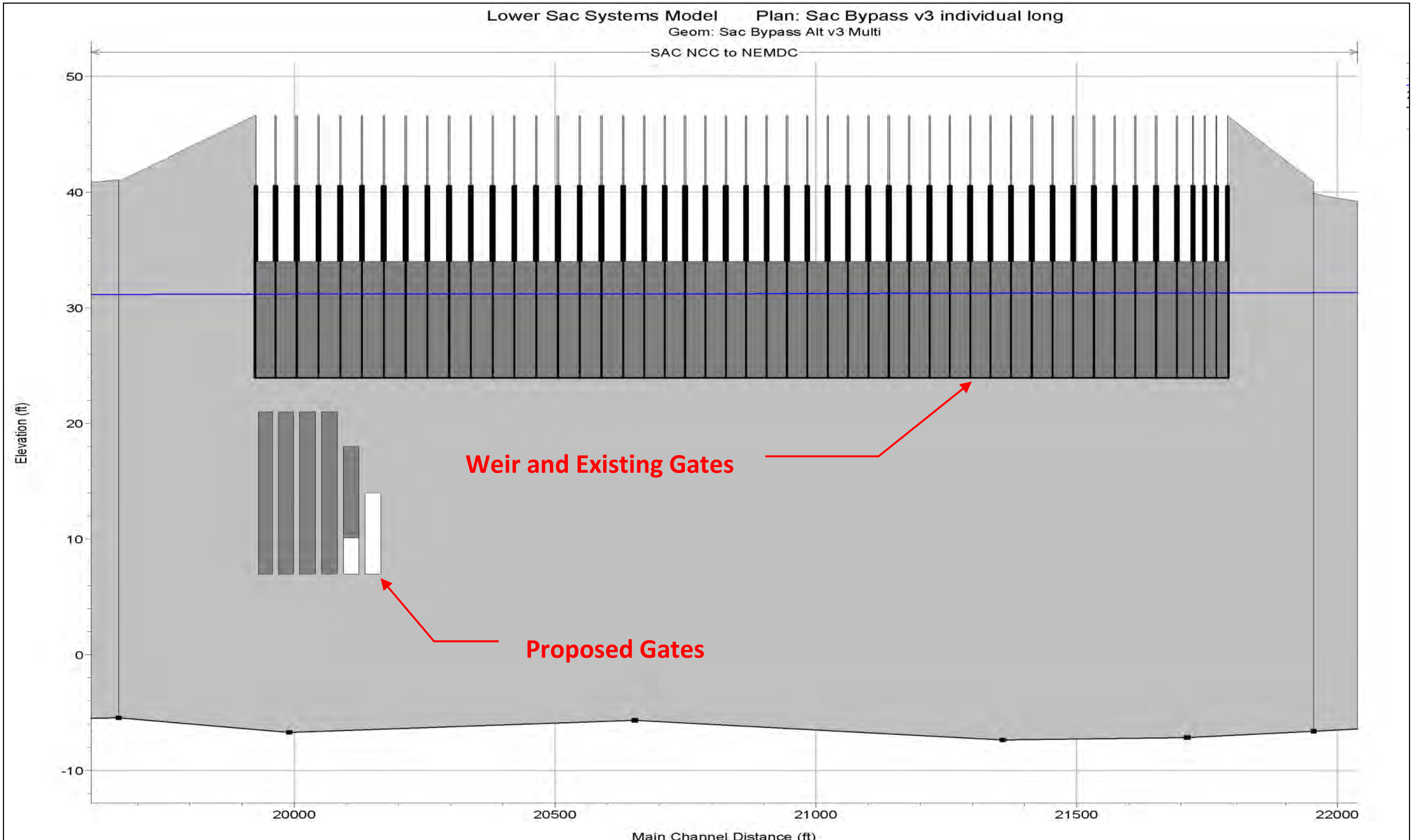


Notes:

Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project

Sacramento Bypass Water Surface Profiles

Project No. 13-1027	Created By: CRC	**Figure 3**

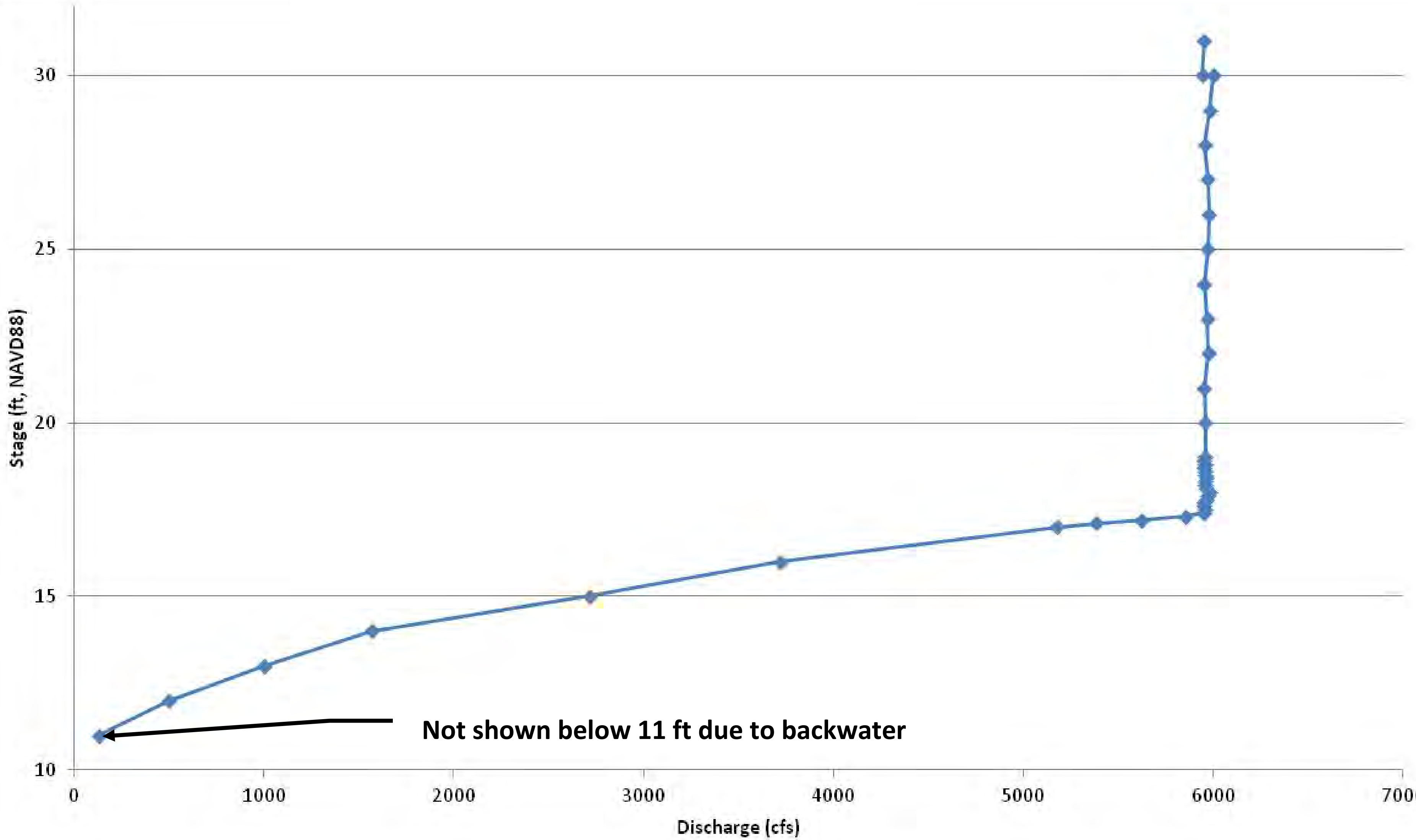


Notes: Elevations are NAVD 88

Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project

Sacramento Weir Alternative – Proposed Gates

Project No. 13-1027	Created By: CRC	**Figure 4**



Notes: gate operations are optimized for 6000 cfs flow rate

Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project

Sacramento Weir Alternative Gate Rating Curve

Project No. 13-1027	Created By: CRC	**Figure 5**

TECHNICAL MEMORANDUM

Date:	April 14, 2014
To:	Project File
From:	Chris Campbell
Project:	13-1027 – Yolo Bypass Salmonid Habitat Restoration and Fish Passage Projects
Subject:	Fremont Weir Channel Alternatives and Gate Configurations

1 CHANNEL ALTERNATIVES

This Technical Memorandum (TM) details the development of the Fremont Weir Gated Channel Alternatives in HEC-RAS (RAS) for use in the calibrated and validated TUFLOW Classic hydrodynamic model developed to support the California Department of Water Resources (DWR) and US Bureau of Reclamation (USBR) Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project (Project) Environmental Impact Statement and Environmental Impact Report (EIS/EIR). The Fremont Weir Gated Channel Alternatives include three of four alternatives being carried forward through the screening phase.

For the Fremont Weir Gated Channel Alternatives, each alternative was assumed to be graded along the east end of Fremont Weir and parallel to the flood levee, connecting the Sacramento River with the Tule Canal (see Figure 1). The channel profile and the gate configuration were analyzed in RAS to 1) understand the backwater effects on the gates from Yolo Bypass inundation given that proposed upstream inverts at the river are below the baseline water levels in the Tule Canal, and 2) optimize the gate openings for non-overtopping flows with the objective to maximize diversions from the Sacramento River up to 6000 cfs while minimizing head losses across the gate. Gate optimization was performed in RAS because such a function is not yet available in TUFLOW and gate logic is relatively new in TUFLOW.

The channel dimensions of the three Fremont Weir alternatives are provided in Table 1. For the reach of the proposed channels between the Sacramento River and Fremont Weir, a length of approximately 800 feet, the channel was graded from Fremont Weir to the Sacramento River at a slope of 0.0025 with a bottom width of 225 feet and 3:1 side slopes. This was done to reduce head losses within the channel upstream of the gate and minimize the change in the water surface elevation between the river and the weir.

Table 1. Fremont Weir Alternatives Channel Dimensions

Channel Size	Invert at Fremont Weir (ft, NAVD88)	Bottom Width (ft)	Slope	Side Slopes
Small	14.0	20	0.00016	3:1
Medium	17.5	225	0.00035	3:1
Large	14.0	225	0.00016	3:1

Downstream of the gated channel, there are three agricultural crossings on the Tule Canal between Tule Pond and the confluence with Knights Landing Ridge Cut (KLRC) (see Figure 1). Ag Crossing #1 is an earthen berm at the bottom of Tule Pond that impounds irrigation water for RD 1600 so it can be conveyed through the levee to the Elkhorn Basin. This berm can become degraded during Fremont Weir overtopping events. Ag Crossing#2 is 0.5 miles further south and is an earthen berm with one 32-inch culvert. Ag Crossing #3 is 0.6 miles further south and is an earthen berm with three 24-inch culverts.

The Small and Large channels tie into the Tule Canal just downstream of Ag Crossing #2. The Medium channel ties into the Tule Canal just upstream of Ag Crossing #2. As a result, all three channel alternatives require the partial removal and modification of the earthen berm forming Ag Crossing #1, but only the Small and Large channels require the additional modification to Ag Crossing #2. For the purposes of this analysis, and as demonstrated by the backwater effects from the existing channel capacity on the future gate location at the river during low flows in the canal (see Section 2), it was assumed that all three agricultural crossings were replaced with railcar bridges as part of the alternatives to maximize the frequency of inundation from the Sacramento River. The railcar bridges were assumed to be 90 feet long, 3 feet deep, and situated on 2 foot wide abutments with wing walls. Figures 2 to 7 show the paired existing and future crossings for Ag Crossing #1, #2, and #3, respectively. Under gate operations, all future agricultural crossings were assumed to be fully open. Only Ag Crossing #1 has a hardened bed or concrete sill to accommodate the potential use of flashboards for water level control during the irrigation season.

2 WATER SURFACE PROFILES

For this analysis, the Tule Canal was assumed to have flow contributions of 500 cfs, 350 cfs, 50 cfs, and 300 cfs from KLRC, Cache Creek Settling Basin, Willow Slough, and Putah Creek, respectivley, for existing conditions and all three alternatives. To better understand system performance and hydraulic constraints prior to proceeding with configuring the gates, three steady state inflows of 500 cfs, 1,500 cfs, and 6,000 cfs were introduced at the northern end of Tule Pond. The water surface elevations in the RAS model at the confluence with KLRC were based on calibrated TUFLOW simulations using the above stated flow conditions. Water surface profile comparisons for existing conditions and the Small, Medium, and Large channel alternatives are shown in Figures 8 to 10, respectively. Table 2 lists the water surface elevations at the northern limit of Tule Pond as well as at Ag Crossing #1, #2, and #3.

The differences in water surface elevations between existing conditions and the alternatives are largely controlled by the backwater effects from the limited capacity of the Tule Canal downstream of KLRC and the agricultural crossings upstream of KLRC. For gate flows of 500 cfs, the existing agricultural crossings, especially Ag Crossing #1, control the water surface condition upstream of Tule Pond near the proposed gate and create as much as 3 feet of backwater relative to the Large channel. This is somewhat reduced for the Small channel with only 2 feet of backwater, but this is because the capacity of the Small channel is the limiting factor. For gate flows of 1,500 cfs, backwater from KLRC and Ag Crossing #1 create as much as 1 foot of backwater relative to the Large channel. For gate flows of 6,000 cfs under non-overtopping events, backwater from KLRC and Ag Crossing #1 create as much as 1 foot of backwater relative to the Large channel. Due to the desire to maximize the frequency of Yolo Bypass inundation, and limit backwater effects during gate operations, this water surface profile comparison reinforces the need to improve the conveyance capacity at the three agricultural crossings (i.e., rail car bridges).

Table 2. Water Surface Elevation Comparisons

Water Surface Elevation at Northern Limit of Tule Pond (ft, NAVD88)			
Channel / Discharge (cfs)	**500**	**1500**	**6000**
Existing	21.1	21.9	24.4
Small	19.3	21.3	24.3
Medium	18.6	21.0	23.9
Large	18.3	20.7	23.5
Water Surface Elevation at Ag Crossing #1 (ft, NAVD88)			
Channel / Discharge (cfs)	**500**	**1500**	**6000**
Existing	21.0	21.6	23.0
Small	18.4	20.6	23.0
Medium	18.4	20.8	22.9
Large	18.3	20.6	22.9
Water Surface Elevation at Ag Crossing #2 (ft, NAVD88)			
Channel / Discharge (cfs)	**500**	**1500**	**6000**
Existing	18.4	20.4	22.8
Small	18.3	20.5	22.8
Medium	18.3	20.6	22.8
Large	18.2	20.4	22.8
Water Surface Elevation at Ag Crossing #3 (ft, NAVD88)			
Channel / Discharge (cfs)	**500**	**1500**	**6000**
Existing	18.3	20.4	22.7
Small	18.2	20.4	22.7
Medium	18.2	20.4	22.7
Large	18.2	20.4	22.7

3 GATE CONFIGURATION

A series of gates at the channel connection with the Sacramento River were used to maximize the flow into the Yolo Bypass for non-overtopping flow events up to 6,000 cfs. A gate optimization routine in RAS (see Section 4) was used to configure the size and number of gates as well as determine the individual gate openings relative to river stage. In general, gate widths were limited to 30 ft in width with 3 ft pillars between them. Some of the gates were limited in height to prevent them from extending above the existing weir crest (32.8 feet NAVD 88) during an overtopping event. After Fremont Weir overtops, the gates will remain open per their last know configuration. Sluice gates or radial gates could be used, but radial gates may offer the greatest flexibility in terms of real-time operations as well as constructability to minimize debris accumulation on the lift components. The gates could also be operated individually or in unison. For the Small channel, the bottom width of the channel was widened to accommodate three gates to minimize the head loss across the gate structure. The resulting gate configurations are shown in Table 3 for individual and unison operations. The gate configurations for individual operation are shown in Figures 11, 14, and 16 for the Small, Medium, and Large channels, respectively. The gate configurations for the unison operation are shown in Figures 12, 15, and 17 for the Small, Medium, and Large channels, respectively. The resulting gate opening schedules are shown in Tables 4, 5, and 6 for the Small, Medium, and Large channels, respectively. However, for the purposes of the TUFLOW modeling, the gates were assumed 1) to be radial such that lift components do not protrude above the top of the weir crest, and 2) operate individually assuming that a few gates with taller openings would be more favorable to fish passage than all gates open with potentially very short openings.

The river stage versus gate flow relationships are shown in Figure 18. For example, at a river stage of 24 feet NAVD88, the Small, Medium, and Large gated channels can convey 2201 cfs, 4313 cfs, and 5886 cfs, respectively. Relative to the Small channel, the Medium channel conveys twice as much flow and the Large channel conveys three times as much flow at elevation 24 feet.

Table 3. Gate Configurations

Channel Size	Invert at River (ft, 88)	Bottom Width at Gate (ft)	Gate Invert (ft)	Gate Height (ft)	Gate Width (ft)	Number of Gates
Individual Operation						
Small	14	115	14	8, 14	30	3
Medium	17.5	225	17.5	6, 12	30	6
Large	14	225	14	7.5, 10	30	6
Unison Operation						
Small	14	115	14	11.5	30	3
Medium	17.5	225	17.5	7.5	30	6
Large	14	225	14	10	30	6

Table 4. Small Individual Gate Operations

Sacramento River Stage (ft, 88)	Total Gate Flow (cfs)	Gate 1 Opening (ft)	Gate 2 Opening (ft)	Gate 3 Opening (ft)	Gate 1 Velocity (fps)	Gate 2 Velocity (fps)	Gate 3 Velocity (fps)
15.5	5	8	8	14	0.04	0.04	0.04
16.0	42	8	8	14	0.2	0.2	0.2
17.0	112	8	8	14	0.4	0.4	0.4
18.0	198	8	8	14	0.5	0.5	0.5
19.0	321	8	8	14	0.7	0.7	0.7
20.0	518	8	8	14	1.0	1.0	1.0
21.0	805	8	8	14	1.3	1.3	1.3
22.0	1111	8	8	14	1.5	1.5	1.5
23.0	1590	8	8	14	2.1	2.1	2.2
24.0	2201	8	8	14	2.3	2.3	3.6
25.0	2957	8	8	14	3.0	3.0	4.6
26.0	3910	8	8	14	3.7	3.7	5.9
27.0	5001	8	8	14	4.6	4.6	7.2
27.1	5119	8	8	14	4.7	4.7	7.3
27.2	5237	8	8	14	4.7	4.7	7.5
27.3	5355	8	8	14	4.8	4.8	7.6
27.4	5473	8	8	14	4.9	4.9	7.8
27.5	5591	8	8	14	5.0	5.0	7.9
27.6	5706	8	8	14	5.1	5.1	8.0
27.7	5822	8	8	14	5.2	5.2	8.1
27.8	5938	8	8	14	5.3	5.3	8.2
27.9	5951	8	8	13.01	5.6	5.6	7.8
28.0	5951	8	8	12.47	6.0	6.0	7.3
28.1	5952	8	8	12.14	6.3	6.3	8.0
28.2	5950	8	8	11.87	6.6	6.6	7.8
28.3	5951	8	8	11.66	6.9	6.9	7.5
28.4	5951	8	8	11.43	7.2	7.2	7.2
28.5	5950	8	8	10.4	7.5	7.5	7.5
28.6	5951	8	8	9.5	7.8	7.8	7.8
28.7	5951	8	8	8.68	8.0	8.0	8.0
28.8	5951	8	8	7.93	8.3	8.3	8.3
28.9	5951	8	8	7.25	8.5	8.5	8.5
29.0	5951	8	8	6.62	8.8	8.8	8.8
29.1	5951	8	8	6.04	9.0	9.0	9.0
29.2	5951	8	8	5.50	9.2	9.2	9.2

Sacramento River Stage (ft, 88)	Total Gate Flow (cfs)	Gate 1 Opening (ft)	Gate 2 Opening (ft)	Gate 3 Opening (ft)	Gate 1 Velocity (fps)	Gate 2 Velocity (fps)	Gate 3 Velocity (fps)
29.3	5951	8	8	5.00	9.4	9.4	9.4
29.4	5950	8	8	4.53	9.7	9.7	9.7
29.5	5951	8	8	4.10	9.9	9.9	9.9
29.6	5951	8	8	3.68	10.1	10.1	10.1
29.7	5951	8	8	3.29	10.3	10.3	10.3
29.8	5951	8	8	2.92	10.5	10.5	10.5
29.9	5952	8	8	2.58	10.7	10.7	10.7
30.0	5952	8	8	2.25	10.9	10.9	10.9
30.1	5950	8	8	1.93	11.1	11.1	11.1
30.2	5951	8	8	1.64	11.2	11.2	11.2
30.3	5952	8	8	1.36	11.4	11.4	11.4
30.4	5952	8	8	1.09	11.6	11.6	11.6
30.5	5951	8	8	0.78	11.8	11.8	11.8
30.6	5952	8	8	0.49	12.0	12.0	12.0
30.7	5950	8	8	0.20	12.2	12.2	12.2
30.8	5950	8	7.93	0.00	12.5	12.5	0.0
30.9	5952	8	7.68	0.00	12.7	12.7	0.0
31.0	5952	8	7.43	0.00	12.9	12.9	0.0
31.1	5952	8	7.19	0.00	13.1	13.1	0.0
31.2	5952	8	6.96	0.00	13.3	13.3	0.0
31.3	5952	8	6.74	0.00	13.5	13.5	0.0
31.4	5950	8	6.52	0.00	13.7	13.7	0.0
31.5	5952	8	6.32	0.00	13.9	13.9	0.0
31.6	5951	8	6.12	0.00	14.0	14.0	0.0
31.7	5952	8	5.93	0.00	14.2	14.2	0.0
31.8	5951	8	5.7399	0.00	14.4	14.4	0.0
31.9	5950	8	5.5599	0.00	14.6	14.6	0.0
32.0	5951	8	5.3899	0.00	14.8	14.8	0.0
32.1	5951	8	5.22	0.0	15.0	15.0	0.0
32.2	5952	8	5.06	0.0	15.2	15.2	0.0
32.3	5951	8	4.90	0.0	15.4	15.4	0.0
32.4	5952	8	4.75	0.0	15.6	15.6	0.0
32.5	5951	8	4.60	0.0	15.7	15.7	0.0
32.6	5953	8	4.46	0.0	15.9	15.9	0.0
32.7	5953	8	4.32	0.0	16.1	16.1	0.0
32.8	5998	8	4.32	0.0	16.2	16.2	0.0

Table 5. Medium Individual Gate Operations

Sacramento River Stage (ft, 88)	Total Gate Flow (cfs)	Gate 1 Opening (ft)	Gate 2 Opening (ft)	Gate 3 Opening (ft)	Gate 4 Opening (ft)	Gate 5 Opening (ft)	Gate 6 Opening (ft)	Gate 1 Velocity (fps)	Gate 2 Velocity (fps)	Gate 3 Velocity (fps)	Gate 4 Velocity (fps)	Gate 5 Velocity (fps)	Gate 6 Velocity (fps)
17.8	60	6	6	6	12	12	12	1.1	1.1	1.1	1.1	1.1	1.1
18.0	150	6	6	6	12	12	12	1.7	1.7	1.7	1.7	1.7	1.7
19.0	466	6	6	6	12	12	12	1.7	1.7	1.7	1.7	1.7	1.7
20.0	841	6	6	6	12	12	12	1.9	1.9	1.9	1.9	1.9	1.9
21.0	1286	6	6	6	12	12	12	2.0	2.0	2.0	2.0	2.0	2.0
22.0	1995	6	6	6	12	12	12	2.5	2.5	2.5	2.5	2.5	2.5
23.0	3079	6	6	6	12	12	12	3.1	3.1	3.1	3.1	3.1	3.1
24.0	4313	6	6	6	12	12	12	3.8	3.8	3.8	3.8	3.8	3.8
25.0	5549	6	6	6	12	12	12	3.9	3.9	3.9	5.1	5.1	5.1
25.3	5925	6	6	6	12	12	12	3.8	3.8	3.8	5.5	5.5	5.5
25.4	5952	6	6	6	12	12	5.5	4.2	4.2	4.2	6.3	6.3	4.2
25.5	5952	6	6	6	12	12	0.7	4.7	4.7	4.7	6.9	6.9	4.7
25.6	5951	6	6	6	12	7.0	0	5.1	5.1	5.1	7.3	6.7	0.0
25.7	5937	6	6	6	12	6.5	0	5.6	5.6	5.6	7.6	5.8	0.0
25.8	5952	6	6	6	12	4.6	0	5.9	5.9	5.9	7.8	5.9	0.0
25.9	5956	6	6	6	12	3.0	0	6.2	6.2	6.2	8.0	6.2	0.0
26.0	5953	6	6	6	12	1.6	0	6.6	6.6	6.6	8.2	6.6	0.0
26.1	5952	6	6	6	12	0.4	0	6.9	6.9	6.9	8.3	6.9	0.0
26.2	5960	6	6	6	8.0	0.0	0	7.2	7.2	7.2	8.6	0.0	0.0
26.3	5959	6	6	6	7.5	0.0	0	7.5	7.5	7.5	8.5	0.0	0.0
26.4	5966	6	6	6	7.2	0.0	0	7.8	7.8	7.8	8.2	0.0	0.0
26.5	5954	6	6	6	6.6	0.0	0	8.1	8.1	8.1	8.1	0.0	0.0
26.6	5951	6	6	6	5.8	0.0	0	8.3	8.3	8.3	8.3	0.0	0.0

Sacramento River Stage (ft, 88)	Total Gate Flow (cfs)	Gate 1 Opening (ft)	Gate 2 Opening (ft)	Gate 3 Opening (ft)	Gate 4 Opening (ft)	Gate 5 Opening (ft)	Gate 6 Opening (ft)	Gate 1 Velocity (fps)	Gate 2 Velocity (fps)	Gate 3 Velocity (fps)	Gate 4 Velocity (fps)	Gate 5 Velocity (fps)	Gate 6 Velocity (fps)
26.7	5951	6	6	6	5.1	0.0	0	8.6	8.6	8.6	8.6	0.0	0.0
26.8	5956	6	6	6	4.4	0.0	0	8.9	8.9	8.9	8.9	0.0	0.0
26.9	5957	6	6	6	3.7	0.0	0	9.2	9.2	9.2	9.2	0.0	0.0
27.0	5952	6	6	6	3.0	0.0	0	9.4	9.4	9.4	9.4	0.0	0.0
27.1	5953	6	6	6	2.4	0.0	0	9.7	9.7	9.7	9.7	0.0	0.0
27.2	5961	6	6	6	1.9	0.0	0	10.0	10.0	10.0	10.0	0.0	0.0
27.3	5951	6	6	6	1.3	0.0	0	10.3	10.3	10.3	10.3	0.0	0.0
27.4	5966	6	6	6	0.9	0.0	0	10.5	10.5	10.5	10.5	0.0	0.0
27.5	5960	6	6	6	0.4	0.0	0	10.8	10.8	10.8	10.8	0.0	0.0
27.6	5967	6	6	6	0.0	0.0	0	11.0	11.0	11.0	0.0	0.0	0.0
27.7	5952	6	6	5.5	0.0	0.0	0	11.3	11.3	11.3	0.0	0.0	0.0
27.8	5968	6	6	5.2	0.0	0.0	0	11.6	11.6	11.6	0.0	0.0	0.0
27.9	5962	6	6	4.8	0.0	0.0	0	11.8	11.8	11.8	0.0	0.0	0.0
28.0	5952	6	6	4.4	0.0	0.0	0	12.1	12.1	12.1	0.0	0.0	0.0
29.0	5978	6	6	2.7	0.0	0.0	0	13.6	13.6	13.6	0.0	0.0	0.0
30.0	5984	6	6	2.1	0.0	0.0	0	14.1	14.1	14.1	0.0	0.0	0.0
31.0	5958	6	6	1.5	0.0	0.0	0	14.7	14.7	14.7	0.0	0.0	0.0
32.0	5995	6	6	1.1	0.0	0.0	0	15.3	15.3	15.2	0.0	0.0	0.0
32.8	5972	6	6	0.7	0.0	0.0	0	15.7	15.7	15.7	0.0	0.0	0.0

Table 6. Large Individual Gate Operations

Sacramento River Stage (ft, 88)	Total Gate Flow (cfs)	Gate 1 Opening (ft)	Gate 2 Opening (ft)	Gate 3 Opening (ft)	Gate 4 Opening (ft)	Gate 5 Opening (ft)	Gate 6 Opening (ft)	Gate 1 Velocity (fps)	Gate 2 Velocity (fps)	Gate 3 Velocity (fps)	Gate 4 Velocity (fps)	Gate 5 Velocity (fps)	Gate 6 Velocity (fps)
15.5	15	7.5	7.5	7.5	10	10	10	0.1	0.1	0.1	0.1	0.1	0.1
16.0	94	7.5	7.5	7.5	10	10	10	0.3	0.3	0.3	0.3	0.3	0.3
17.0	260	7.5	7.5	7.5	10	10	10	0.5	0.5	0.5	0.5	0.5	0.5
18.0	434	7.5	7.5	7.5	10	10	10	0.6	0.6	0.6	0.6	0.6	0.6
19.0	725	7.5	7.5	7.5	10	10	10	0.8	0.8	0.8	0.8	0.8	0.8
20.0	1138	7.5	7.5	7.5	10	10	10	1.1	1.1	1.1	1.1	1.1	1.1
21.0	1713	7.5	7.5	7.5	10	10	10	1.4	1.4	1.4	1.4	1.4	1.4
22.0	2899	7.5	7.5	7.5	10	10	10	2.1	2.1	2.1	2.1	2.1	2.1
23.0	4335	7.5	7.5	7.5	10	10	10	2.5	2.5	2.5	3.3	3.3	3.3
24.0	5886	7.5	7.5	7.5	10	10	10	2.9	2.9	2.9	4.4	4.4	4.4
24.1	5951	7.5	7.5	7.5	10	10	4.7	3.3	3.3	3.3	5.4	5.4	3.3
24.2	5955	7.5	7.5	7.5	10	9	0	3.9	3.9	3.9	6.2	5.4	0
24.3	5952	7.5	7.5	7.5	10	6.9	0	4.4	4.4	4.4	7.0	4.4	0
24.4	5952	7.5	7.5	7.5	10	3.1	0	4.8	4.8	4.8	7.5	4.8	0
24.5	5954	7.5	7.5	7.5	10	0.4	0	5.2	5.2	5.2	7.8	5.2	0
24.6	5960	7.5	7.5	7.5	9.5	0	0	5.6	5.6	5.6	7.6	0	0
24.7	5946	7.5	7.5	7.5	9.1	0	0	6.0	6.0	6.0	7.3	0	0
24.8	5958	7.5	7.5	7.5	8.7	0	0	6.3	6.3	6.3	6.5	0	0
24.9	5958	7.5	7.5	7.5	7.5	0	0	6.6	6.6	6.6	6.6	0	0
25.0	5959	7.5	7.5	7.5	6.2	0	0	6.9	6.9	6.9	6.9	0	0
25.1	5954	7.5	7.5	7.5	5	0	0	7.2	7.2	7.2	7.2	0	0
25.2	5957	7.5	7.5	7.5	4	0	0	7.5	7.5	7.5	7.5	0	0
25.3	5958	7.5	7.5	7.5	3.1	0	0	7.8	7.8	7.8	7.8	0	0

Sacramento River Stage (ft, 88)	Total Gate Flow (cfs)	Gate 1 Opening (ft)	Gate 2 Opening (ft)	Gate 3 Opening (ft)	Gate 4 Opening (ft)	Gate 5 Opening (ft)	Gate 6 Opening (ft)	Gate 1 Velocity (fps)	Gate 2 Velocity (fps)	Gate 3 Velocity (fps)	Gate 4 Velocity (fps)	Gate 5 Velocity (fps)	Gate 6 Velocity (fps)
25.4	5962	7.5	7.5	7.5	2.3	0	0	8.0	8.0	8.0	8.0	0	0
25.5	5956	7.5	7.5	7.5	1.5	0	0	8.3	8.3	8.3	8.3	0	0
25.6	5955	7.5	7.5	7.5	0.8	0	0	8.5	8.5	8.5	8.5	0	0
25.7	5959	7.5	7.5	7.5	0.2	0	0	8.8	8.8	8.8	8.8	0	0
25.8	5957	7.5	7.5	7.1	0	0	0	9.0	9.0	9.0	0	0	0
25.9	5963	7.5	7.5	6.6	0	0	0	9.2	9.2	9.2	0	0	0
26.0	5964	7.5	7.5	6.1	0	0	0	9.4	9.4	9.4	0	0	0
26.1	5959	7.5	7.5	5.6	0	0	0	9.6	9.6	9.6	0	0	0
26.2	5966	7.5	7.5	5.2	0	0	0	9.8	9.8	9.8	0	0	0
26.3	5952	7.5	7.5	4.7	0	0	0	10.1	10.1	10.1	0	0	0
26.4	5963	7.5	7.5	4.3	0	0	0	10.3	10.3	10.3	0	0	0
26.5	5953	7.5	7.5	3.8	0	0	0	10.6	10.6	10.6	0	0	0
26.6	5956	7.5	7.5	3.4	0	0	0	10.8	10.8	10.8	0	0	0
26.7	5955	7.5	7.5	3	0	0	0	11.0	11.0	11.0	0	0	0
26.8	5970	7.5	7.5	2.7	0	0	0	11.2	11.2	11.2	0	0	0
26.9	5962	7.5	7.5	2.3	0	0	0	11.5	11.5	11.5	0	0	0
27.0	5970	7.5	7.5	2	0	0	0	11.7	11.7	11.7	0	0	0
27.1	5954	7.5	7.5	1.6	0	0	0	12.0	12.0	12.0	0	0	0
27.2	5956	7.5	7.5	1.3	0	0	0	12.2	12.2	12.2	0	0	0
27.3	5954	7.5	7.5	1	0	0	0	12.4	12.4	12.4	0	0	0
27.4	5973	7.5	7.5	0.8	0	0	0	12.6	12.6	12.6	0	0	0
27.5	5966	7.5	7.5	0.5	0	0	0	12.8	12.8	12.8	0	0	0
27.6	5956	7.5	7.5	0.2	0	0	0	13.1	13.1	13.1	0	0	0
27.7	5968	7.5	7.5	0	0	0	0	13.3	13.3	0	0	0	0

Sacramento River Stage (ft, 88)	Total Gate Flow (cfs)	Gate 1 Opening (ft)	Gate 2 Opening (ft)	Gate 3 Opening (ft)	Gate 4 Opening (ft)	Gate 5 Opening (ft)	Gate 6 Opening (ft)	Gate 1 Velocity (fps)	Gate 2 Velocity (fps)	Gate 3 Velocity (fps)	Gate 4 Velocity (fps)	Gate 5 Velocity (fps)	Gate 6 Velocity (fps)
27.8	5952	7.5	7.2	0	0	0	0	13.5	13.5	0	0	0	0
27.9	5960	7.5	7	0	0	0	0	13.7	13.7	0	0	0	0
28.0	5965	7.5	6.8	0	0	0	0	13.9	13.9	0	0	0	0
29.0	5960	7.5	5.3	0	0	0	0	15.5	15.5	0	0	0	0
30.0	5964	7.5	4.9	0	0	0	0	16.0	16.0	0	0	0	0
31.0	5950	7.5	4.5	0	0	0	0	16.5	16.5	0	0	0	0
32.0	5970	7.5	4.2	0	0	0	0	17.0	17.0	0	0	0	0
32.8	5997	7.5	4	0	0	0	0	17.4	17.4	0	0	0	0

Table 7. Small Unison Gate Operations

Sacramento River Stage (ft, 88)	Total Gate Flow (cfs)	Gate Opening (ft)	Gate Velocity (fps)
14.1	1	11.5	0.08
14.3	2	11.5	0.09
14.5	5	11.5	0.11
14.8	11.4	11.5	0.16
15	15.8	11.5	0.18
16	39.8	11.5	0.22
17	107	11.5	0.39
18	190	11.5	0.53
19	308	11.5	0.68
20	491	11.5	0.91
21	759	11.5	1.21
22	1030	11.5	1.43
23	1325	11.5	1.64
24	1806	11.5	2.01
25	2458	11.5	2.48
26	3248	11.5	3.14
27	4151	11.5	4.01
28	4988	11.5	4.82
29	5725	11.5	5.53
29.1	5801	11.5	5.60
29.2	5877	11.5	5.68
29.3	5951	11.5	5.76
29.4	5951	10.8	6.11
29.5	5951	10.3	6.43
29.6	5952	9.8	6.75
29.7	5951	9.4	7.05
29.8	5951	9.0	7.34
29.9	5951	8.7	7.62
30.0	5952	8.4	7.88
30.1	5951	8.1	8.14
30.2	5952	7.9	8.39
30.3	5952	7.7	8.63
30.4	5951	7.5	8.87
30.5	5950	7.3	9.11
30.6	5952	7.1	9.33
30.7	5953	6.9	9.54

Sacramento River Stage (ft, 88)	Total Gate Flow (cfs)	Gate Opening (ft)	Gate Velocity (fps)
30.8	5954	6.8	9.76
30.9	5951	6.6	9.97
31.0	5953	6.5	10.18
31.1	5951	6.4	10.38
31.2	5950	6.3	10.58
31.3	5952	6.1	10.77
31.4	5955	6.0	10.95
31.5	5950	5.93	11.15
31.6	5954	5.84	11.33
31.7	5955	5.75	11.51
31.8	5954	5.66	11.69
31.9	5956	5.58	11.86
32.0	5950	5.49	12.04
32.1	5954	5.42	12.21
32.2	5953	5.33	12.41
32.3	5950	5.24	12.62
32.4	5951	5.16	12.81
32.5	5956	5.09	13.00
32.6	5953	5.01	13.20
32.7	5955	4.94	13.39
32.8	5999	4.94	13.49

Table 8. Medium Unison Gate Operations

Sacramento River Stage (ft, 88)	Total Gate Flow (cfs)	Gate Opening (ft)	Gate Velocity (fps)
17.6	11	7.5	0.87
17.8	50	7.5	0.93
18	109	7.5	1.21
19	466	7.5	1.73
20	842	7.5	1.87
21	1286	7.5	2.04
22	1995	7.5	2.46
23	3070	7.5	3.10
24	4321	7.5	3.69
25	5635	7.5	4.17
25.1	5773	7.50	4.28
25.2	5910	7.50	4.38
25.3	5951	6.75	4.90

Sacramento River Stage (ft, 88)	Total Gate Flow (cfs)	Gate Opening (ft)	Gate Velocity (fps)
25.4	5952	6.49	5.10
25.5	5957	6.40	5.17
25.6	5955	6.35	5.21
25.7	5951	5.97	5.54
25.8	5953	5.60	5.91
25.9	5954	5.29	6.25
26.0	5952	5.02	6.59
26.1	5955	4.79	6.91
26.2	5952	4.58	7.22
26.3	5952	4.40	7.52
26.4	5952	4.24	7.80
26.5	5954	4.10	8.07
26.6	5953	3.97	8.33
26.7	5951	3.85	8.59
26.8	5953	3.73	8.87
26.9	5952	3.61	9.16
27.0	5952	3.50	9.45
27.1	5953	3.40	9.73
27.2	5956	3.31	10.00
27.3	5954	3.22	10.27
27.4	5956	3.14	10.54
27.5	5954	3.06	10.81
27.6	5957	2.99	11.07
27.7	5955	2.92	11.33
27.8	5960	2.86	11.58
27.9	5962	2.80	11.83
28	5960	2.74	12.08
29	5954	2.44	13.56
30	5958	2.34	14.15
31	5958	2.25	14.71
32	5958	2.17	15.25
32.8	5981	2.12	15.67

Table 9. Large Unison Gate Operations

Sacramento River Stage (ft, 88)	Total Gate Flow (cfs)	Gate Opening (ft)	Gate Velocity (fps)
15.5	15	10.0	0.06
16	94	10.0	0.26

Sacramento River Stage (ft, 88)	Total Gate Flow (cfs)	Gate Opening (ft)	Gate Velocity (fps)
17	260	10.0	0.48
18	434	10.0	0.60
19	725	10.0	0.81
20	1138	10.0	1.05
21	1713	10.0	1.36
22	2901	10.0	2.01
23	4360	10.0	2.69
24	5951	9.18	3.60
24.1	5953	8.39	3.94
24.2	5955	8.20	4.03
24.3	5951	7.54	4.38
24.4	5951	6.84	4.83
24.5	5951	6.30	5.25
24.6	5952	5.88	5.62
24.7	5951	5.53	5.98
24.8	5952	5.24	6.31
24.9	5953	4.99	6.63
25.0	5952	4.77	6.93
25.1	5952	4.58	7.22
25.2	5952	4.41	7.50
25.3	5954	4.26	7.76
25.4	5952	4.12	8.03
25.5	5956	4.00	8.27
25.6	5952	3.88	8.52
25.7	5956	3.78	8.75
25.8	5954	3.68	8.99
25.9	5954	3.59	9.21
26.0	5957	3.51	9.43
26.1	5956	3.43	9.65
26.2	5959	3.36	9.85
26.3	5958	3.29	10.06
26.4	5956	3.21	10.31
26.5	5960	3.14	10.55
26.6	5960	3.07	10.79
26.7	5955	3.00	11.03
26.8	5958	2.94	11.26
26.9	5958	2.88	11.49

Sacramento River Stage (ft, 88)	Total Gate Flow (cfs)	Gate Opening (ft)	Gate Velocity (fps)
27	5953	2.82	11.73
28	5960	2.38	13.91
29	5978	2.14	15.52
30	5973	2.07	16.03
31	5979	2.01	16.53
32	5970	1.95	17.01
32.8	5976	1.91	17.38

4 GATE LOGIC

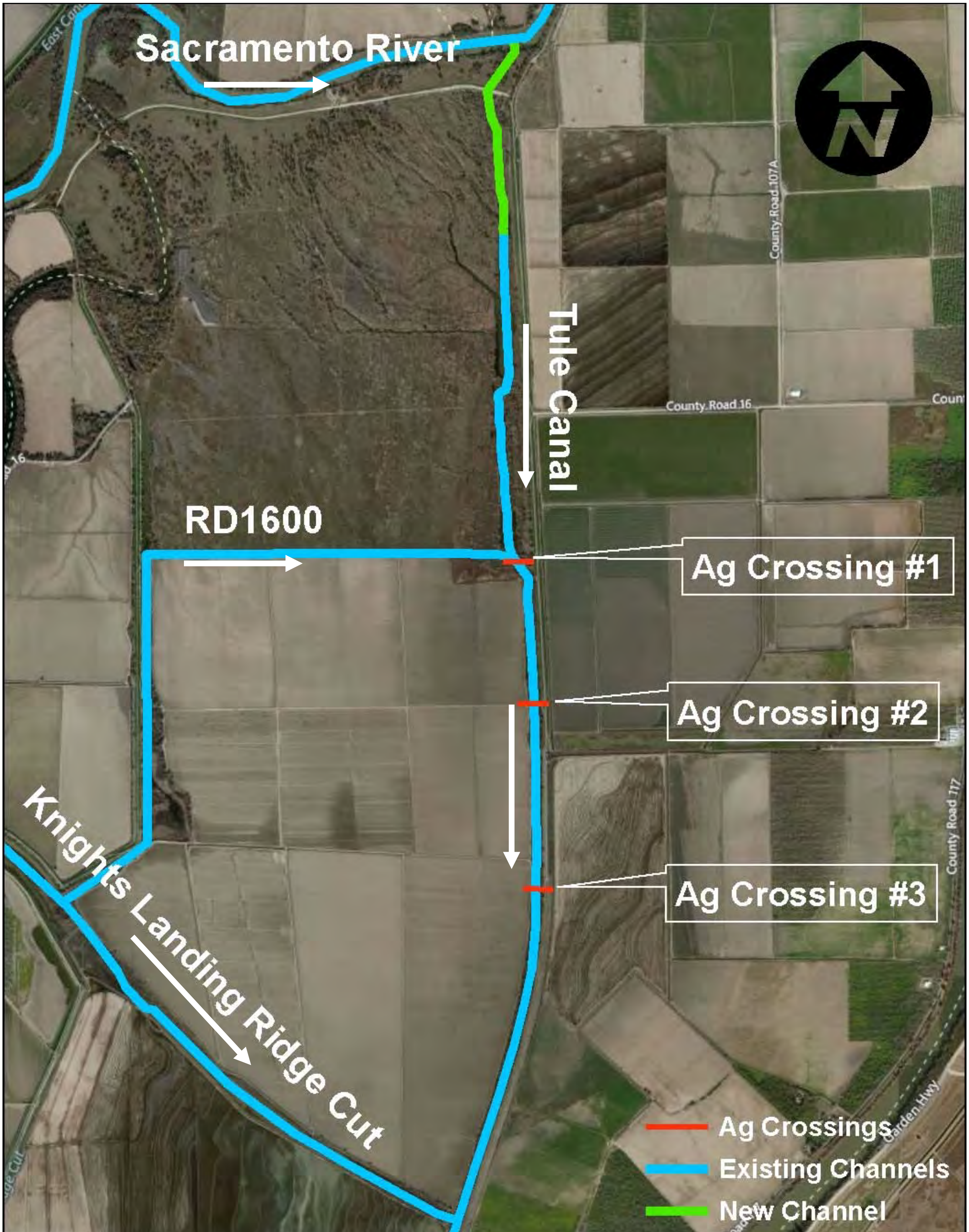
Rule operations in the RAS unsteady flow editor were used to optimize gate operations for the various gated channel alternatives. A special operational parameter available in RAS called *Structure-Flow (Desired)* was used to determine gate operations to maximize a flow up to 6,000 cfs. The operational parameter *Structure-Flow (Desired)* adjusts the gate openings based on the Sacramento River water surface elevations and the gate characteristics. For this analysis, the gates were allowed to open and close at a rate of one foot per minute during an unsteady flow analysis that used a stepped stage time series at the river and a stage-discharge rating curve as the downstream boundary condition at KLRC. The relatively quick opening rate of one foot per minute was used to speed up solution convergence, but can be set to something larger in TUFLOW to represent realistic rates or accommodate model stability. The following logic was used in RAS to determine gate operations to maximize flows up to 6000 cfs based on Yolo Bypass and Sacramento River water surface elevations:

Define variable: TotalGateFlow = Sum of flow for all gates at current time step
Define variable: Gate1Opening = Opening of gate 1 at current time step
Define variable: Gate2Opening = Opening of gate 2 at current time step
Define variable: Gate3Opening = Opening of gate 3 at current time step
Define variable: Gate4Opening = Opening of gate 4 at current time step
Define variable: Gate5Opening = Opening of gate 5 at current time step
Define variable: Gate6Opening = Opening of gate 6 at current time step
Define variable: MaximumGateOpening1 = maxium gate opening (size 1)
Define variable: MaximumGateOpening2 = maxium gate opening (size 2)

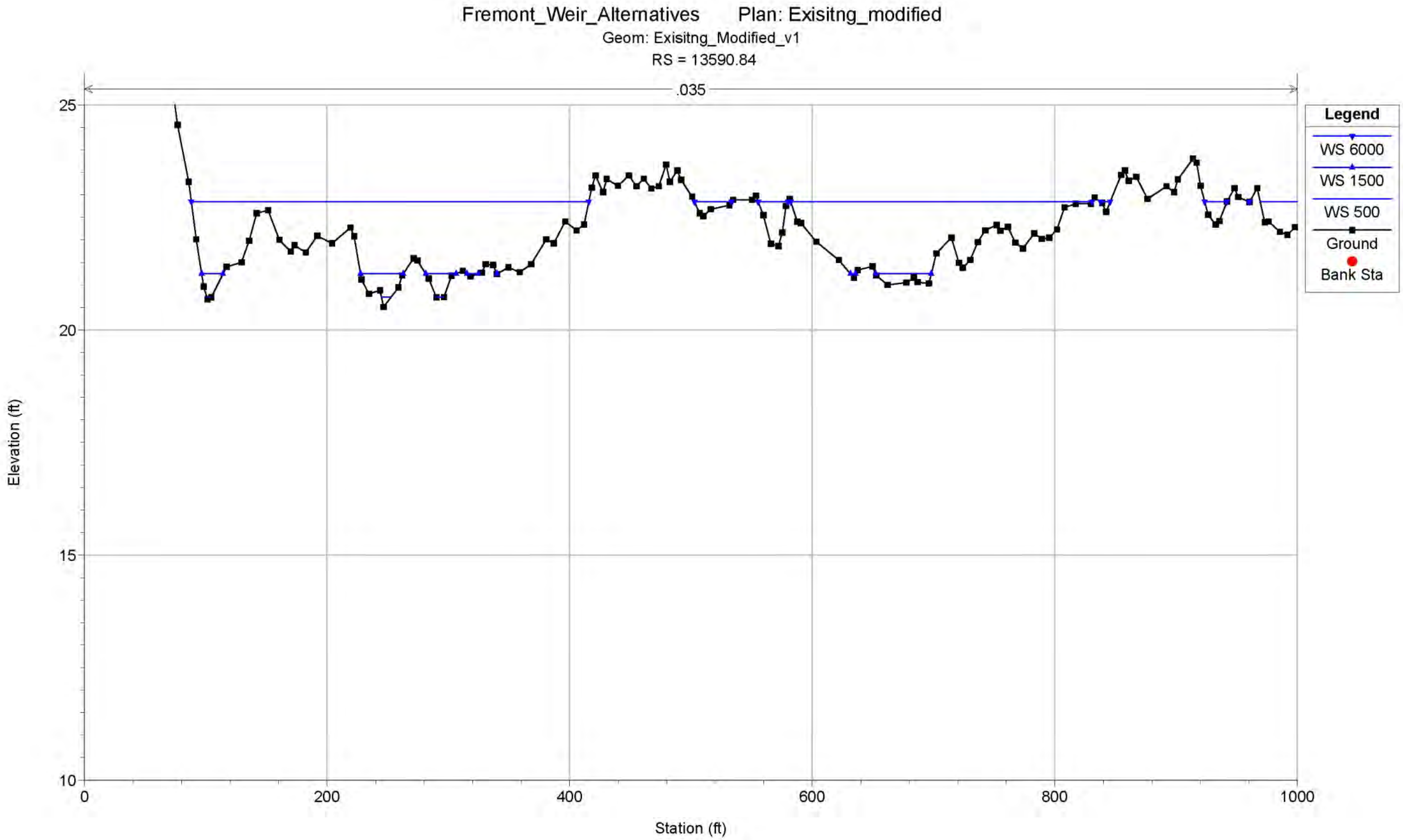
If TotalGateFlow < 5950 Then

> **If** Gate1Opening < MaximumGateOpening1 Then
> Set Opening of Gate 1 = Gate1Opening + 0.1
> Else, If Gate2Opening < MaximumGateOpening1 Then
> Set Opening of Gate 2 = Gate2Opening + 0.1
> Else, If Gate3Opening < MaximumGateOpening1 Then
> Set Opening of Gate 3 = Gate3Opening + 0.1

Else, If Gate4Opening < MaximumGateOpening2 Then
Set Opening of Gate 4 = Gate4Opening + 0.1
Else, If Gate5Opening < MaximumGateOpening2 Then
Set Opening of Gate 5 = Gate5Opening + 0.1
Else, If Gate6Opening < MaximumGateOpening2 Then
Set Opening of Gate 6 = Gate6Opening + 0.1
End If
Else, If TotalGateFlow > 6000 Then
If Gate6Opening > 0 Then
Set Opening of Gate 6 = Gate6Opening - 0.1
Else, If Gate5Opening > 0 Then
Set Opening of Gate 5 = Gate5Opening - 0.1
Else, If Gate4Opening > 0 Then
Set Opening of Gate 4 = Gate4Opening - 0.1
Else, If Gate3Opening > 0 Then
Set Opening of Gate 3 = Gate3Opening - 0.1
Else, If Gate2Opening > 0 Then
Set Opening of Gate 2 = Gate2Opening - 0.1
Else, If Gate1Opening > 0 Then
Set Opening of Gate 1 = Gate1Opening - 0.1
End If
End If



Notes: background courtesy of Bing Maps	cbec eco engineering	*Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project* **Channel and Ag Crossing Locations**		
		Project No. 13-1027	Created By: CRC	**Figure 1**

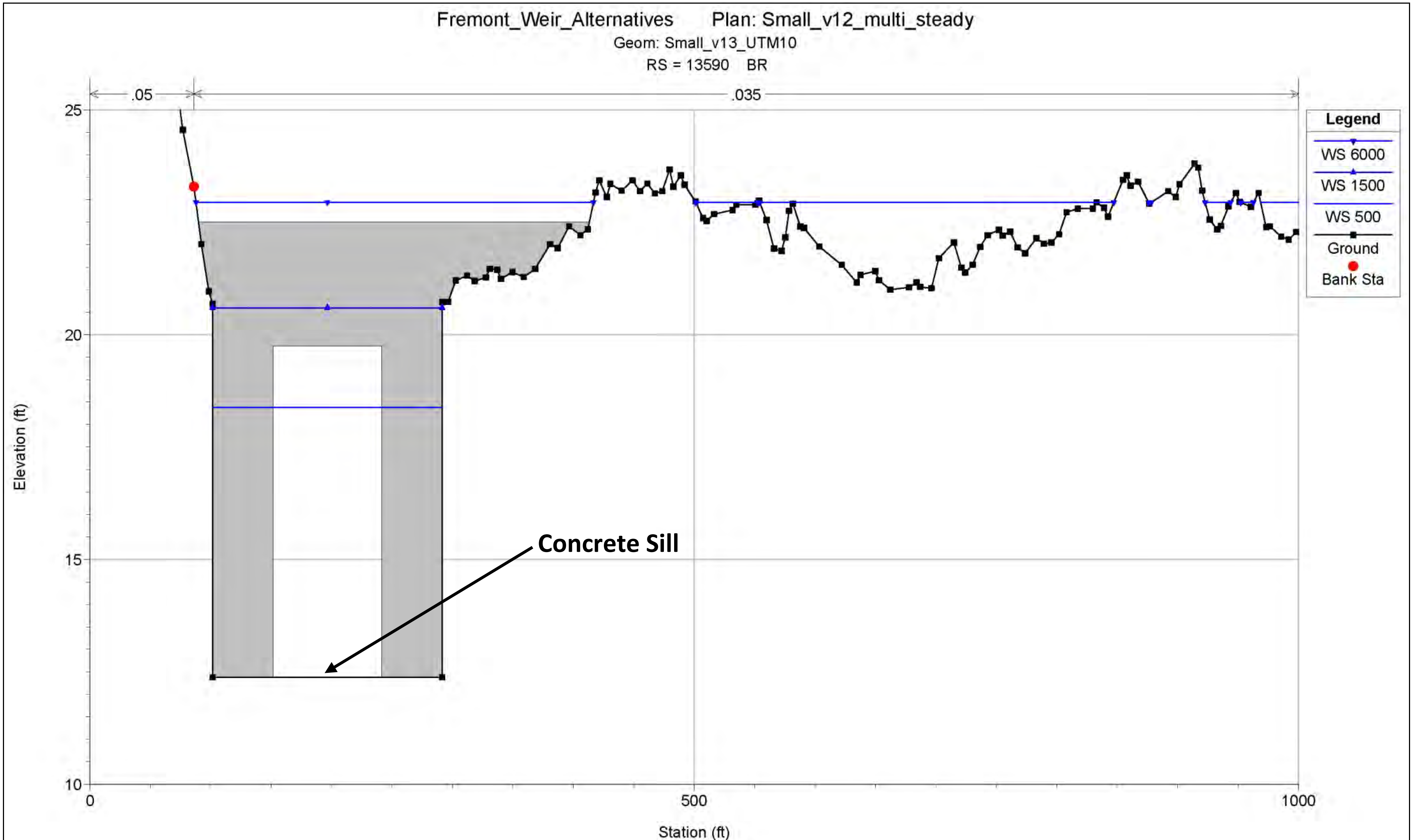


Notes:

Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project

Ag Crossing #1 - Existing

Project No. 13-1027	Created By: CRC	**Figure 2**

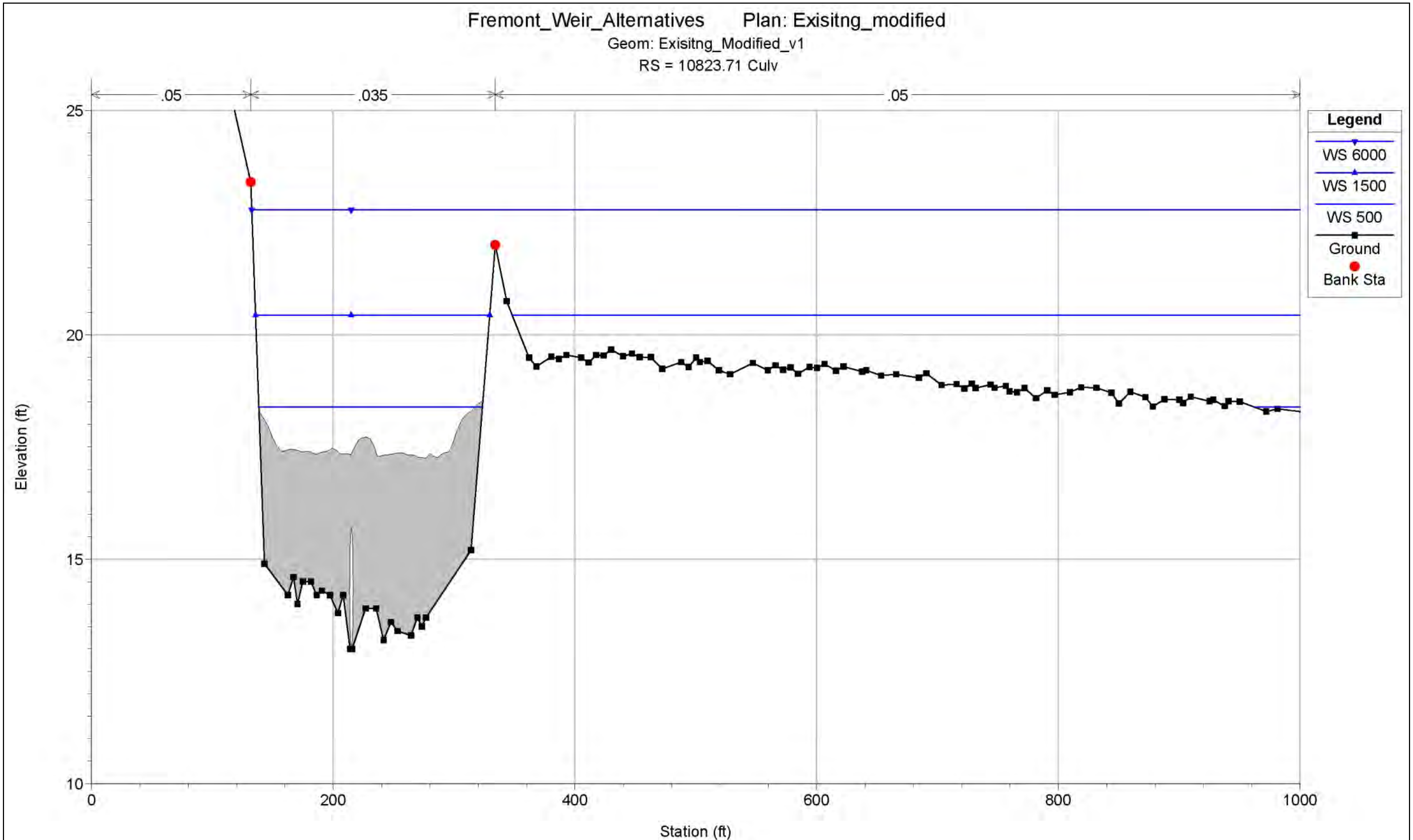


Notes: 90 foot long, 3 foot deep railcar bridge

Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project

Ag Crossing #1 - Project

Project No. 13-1027	Created By: CRC	**Figure 3**

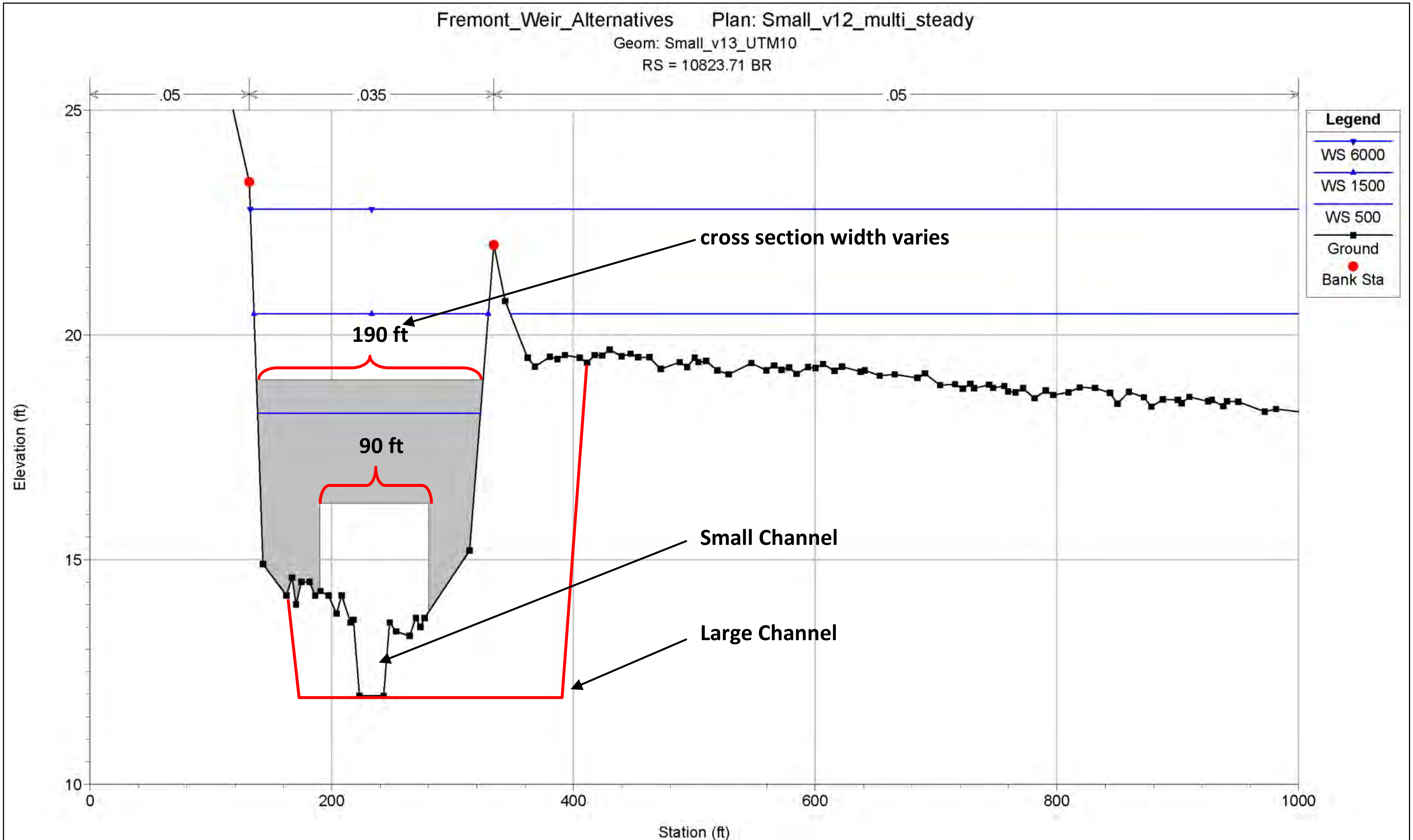


Notes: earthen berm with 1, 2.7 foot diameter culvert

Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project

Ag Crossing #2 - Existing

Project No. 13-1027	Created By: CRC	**Figure 4**



Notes: 90 foot long, 3 foot deep railcar bridge

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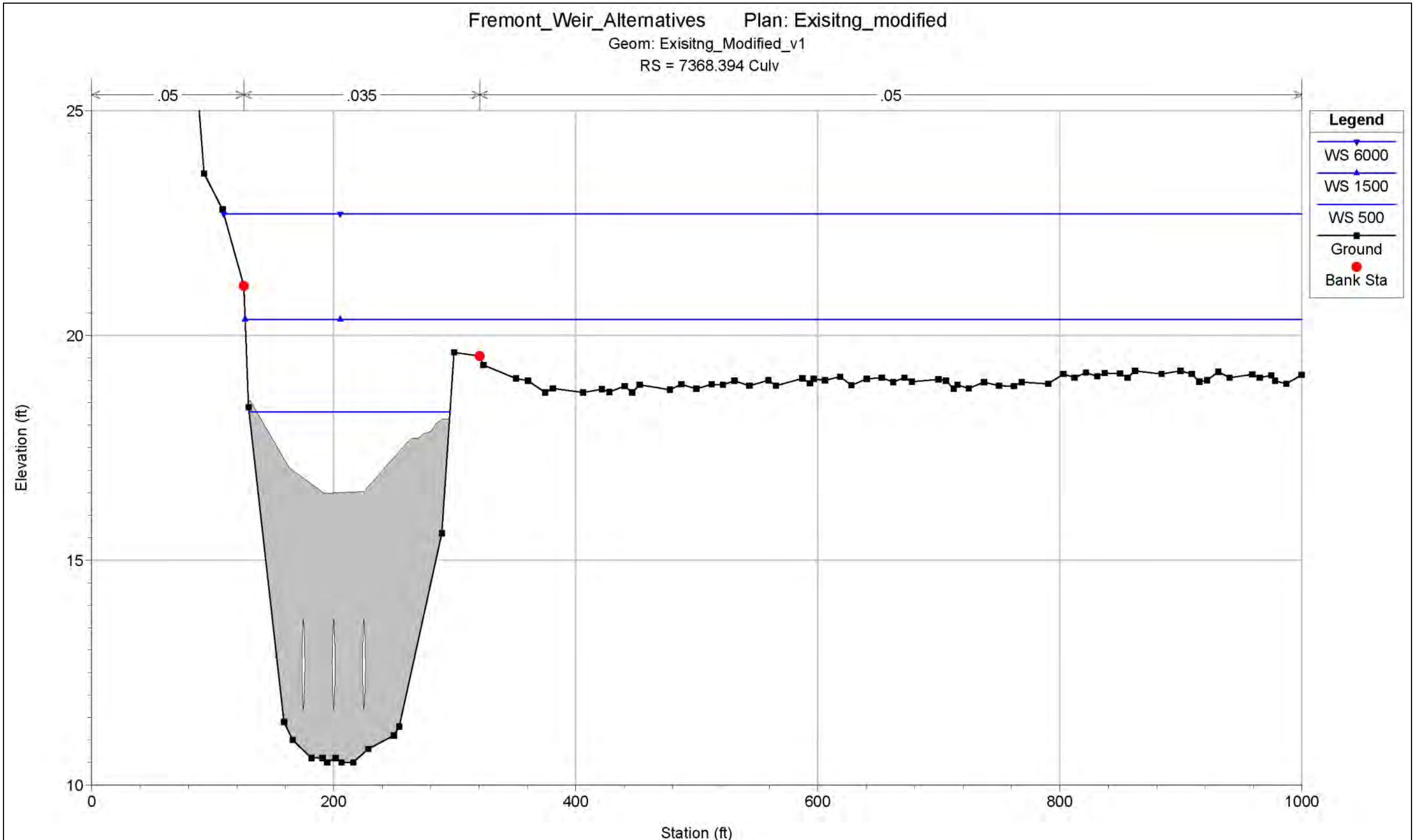
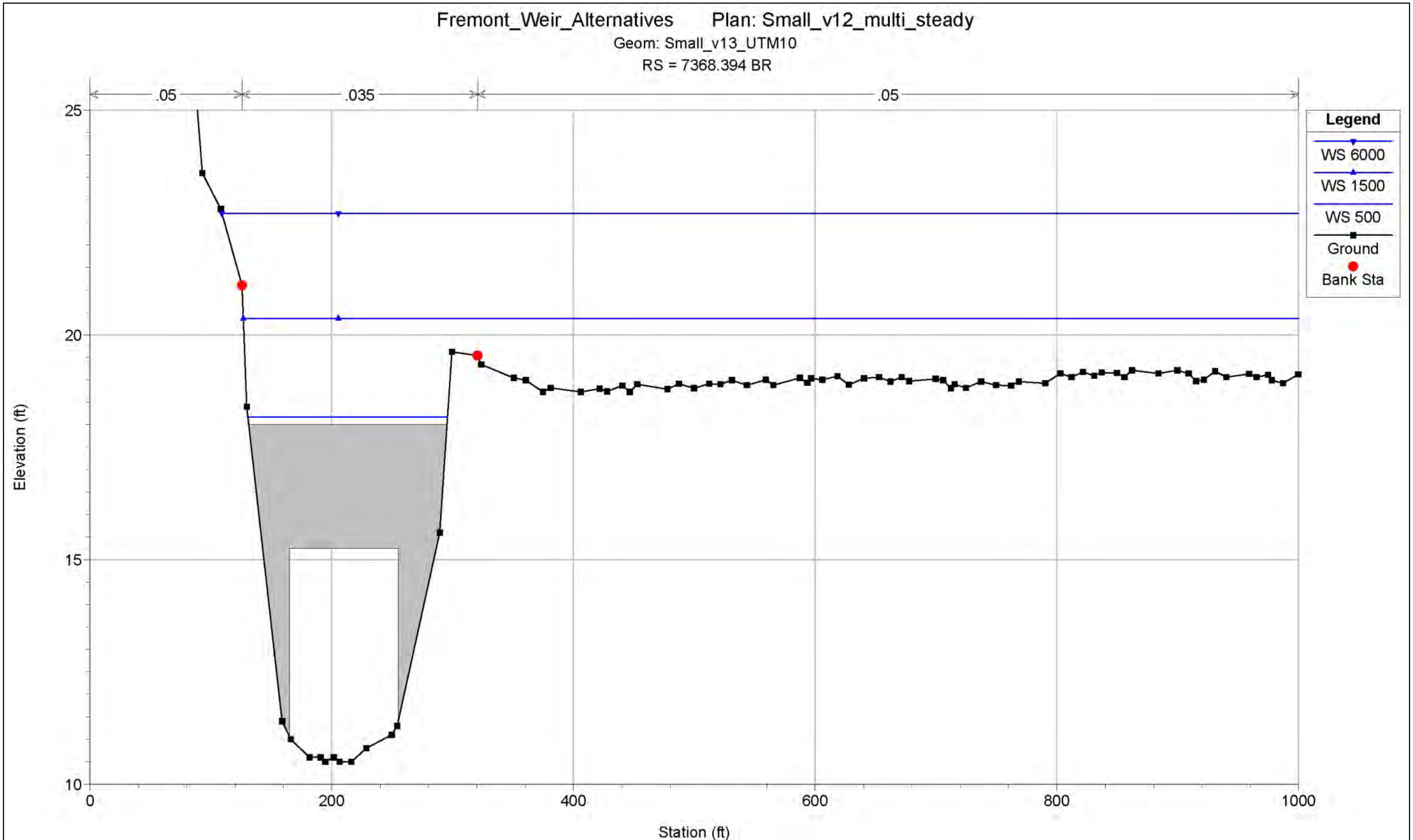
Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project

Ag Crossing #2 - Project

Project No. 13-1027	Created By: CRC	**Figure 5**



Notes: earthen berm with 3, 2 foot diameter culverts	cbec eco engineering	*Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project* **Ag Crossing #3 - Existing**
	Project No. 13-1027	Created By: CRC — **Figure 6**



Notes: 90 foot long, 3 foot deep railcar bridge

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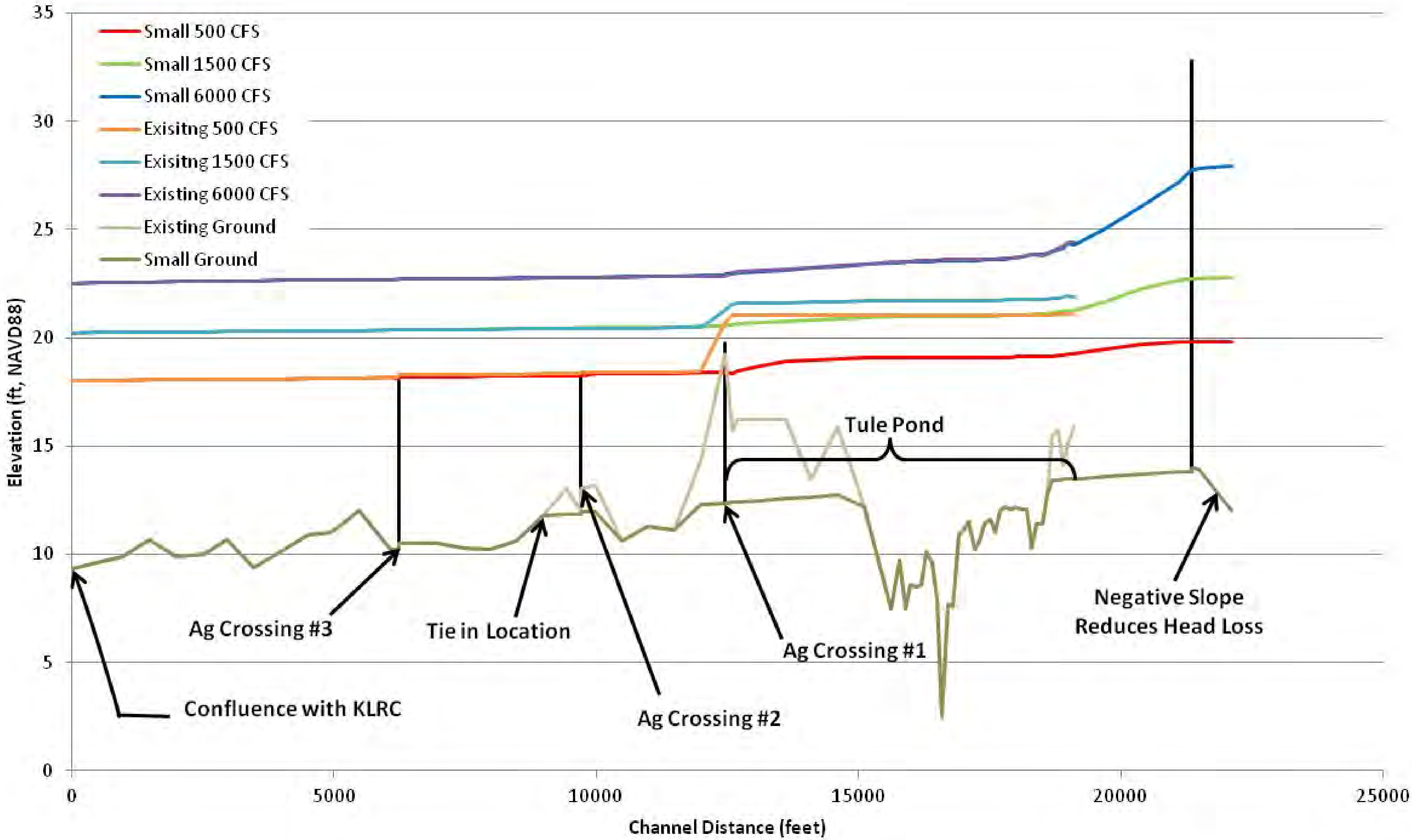
Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project

Ag Crossing #3 - Project

Project No. 13-1027	Created By: CRC	**Figure 7**

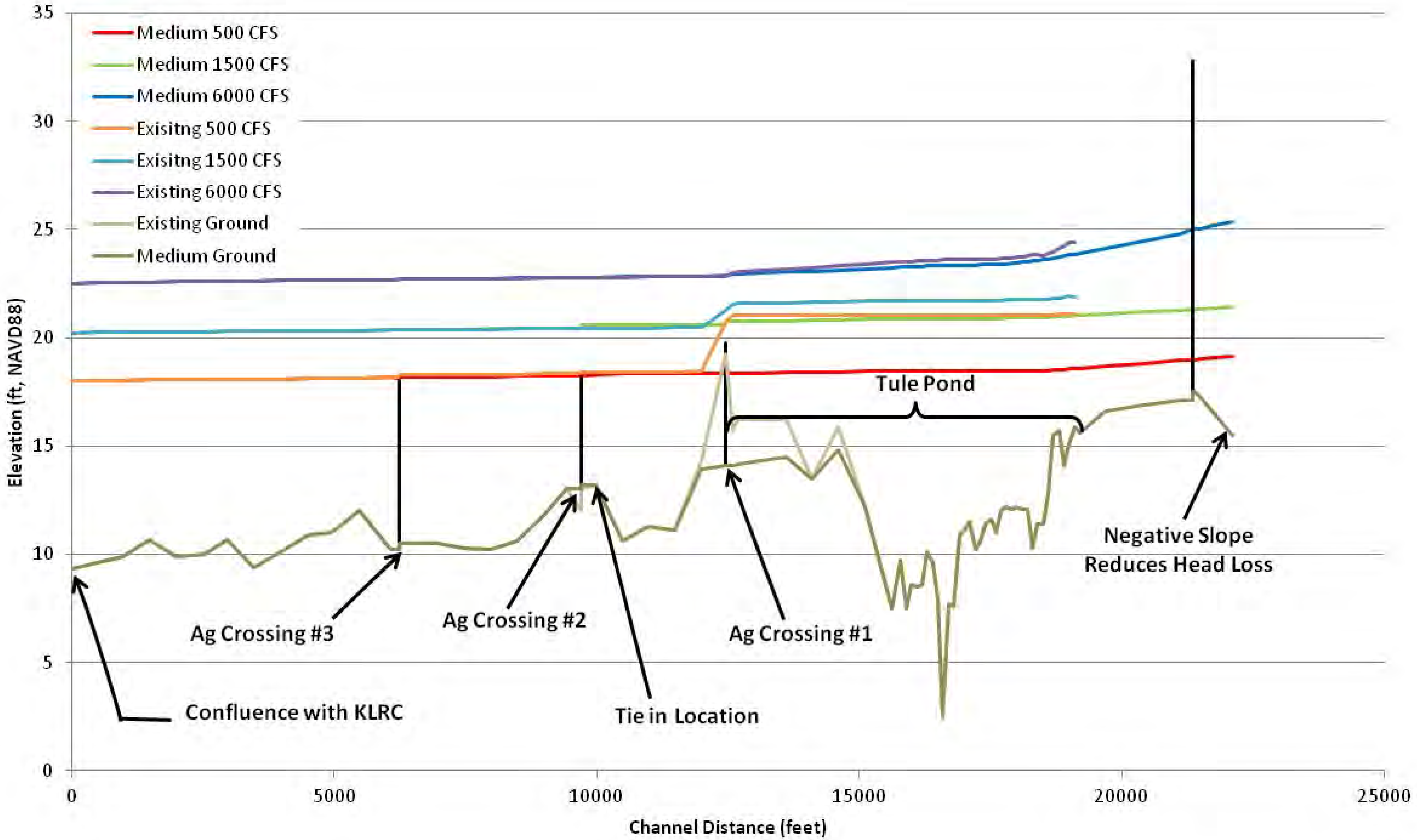


Notes: Water surface profile comparison between existing conditions and the Small Channel alternative.

Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project

Small Channel Water Surface Profile Comparison

Project No. 13-1027	Created By: CRC	**Figure 8**



Notes: Water surface profile comparison between existing conditions and the Medium Channel alternative.

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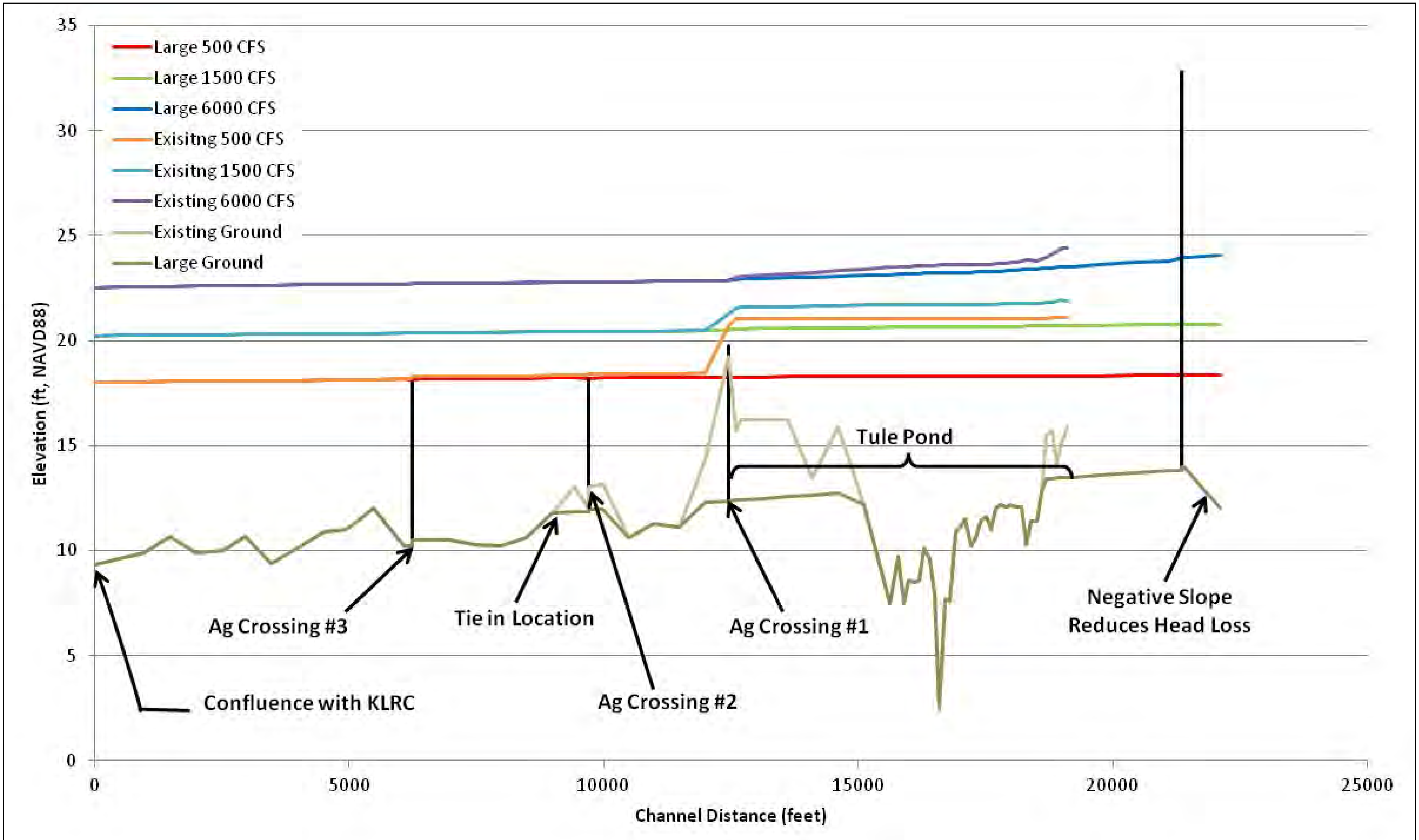
Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project

Medium Channel Water Surface Profile Comparison

Project No. 13-1027	Created By: CRC	**Figure 9**

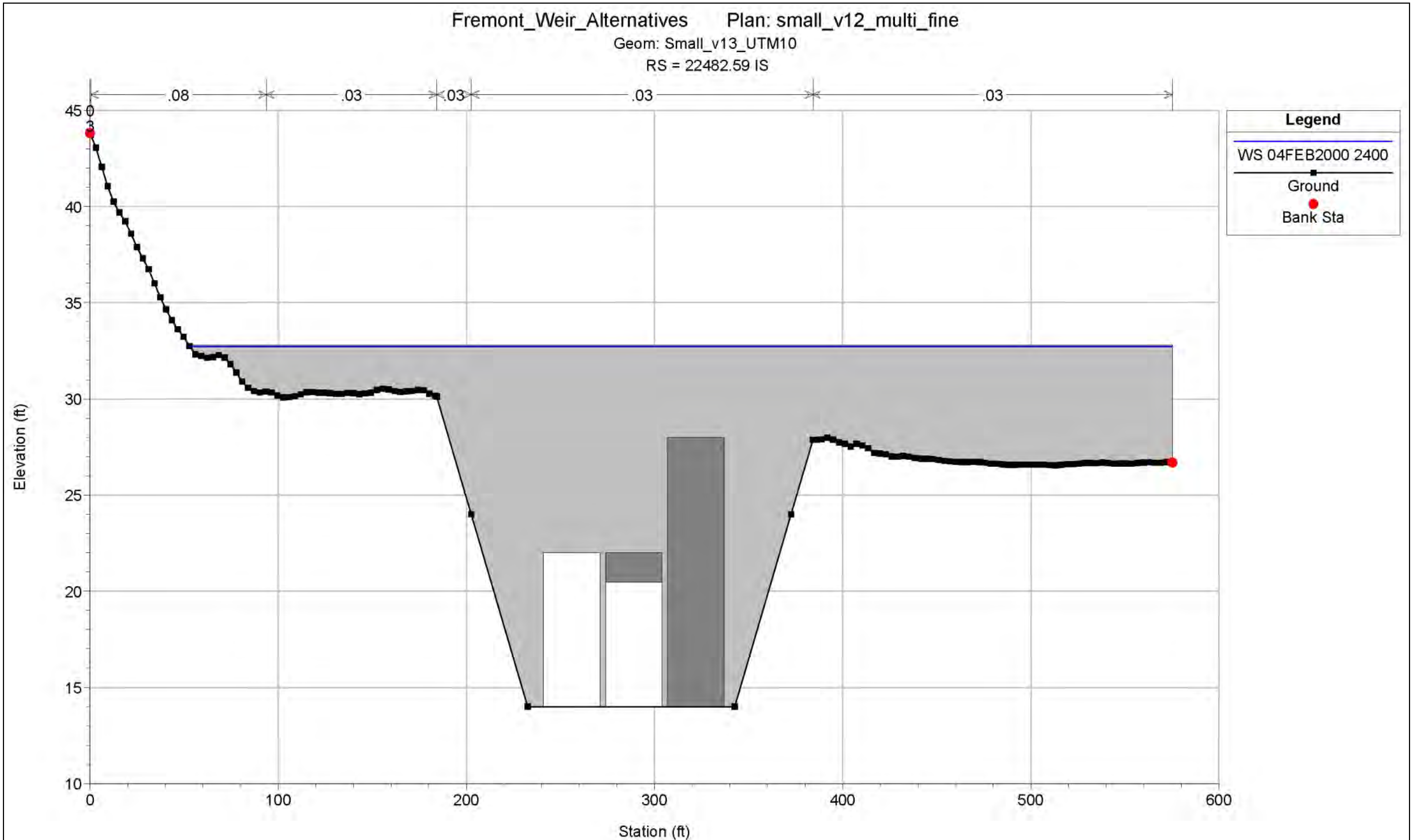


Notes: Water surface profile comparison between existing conditions and the Large Channel alternative.

Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project

Large Channel Water Surface Profile Comparison

Project No. 13-1027 | Created By: CRC | **Figure 10**



Notes: Gate closure shown represents 6000 cfs at maximum Sacramento River Stage before Fremont Weir begins to overtop for gates operated individually.

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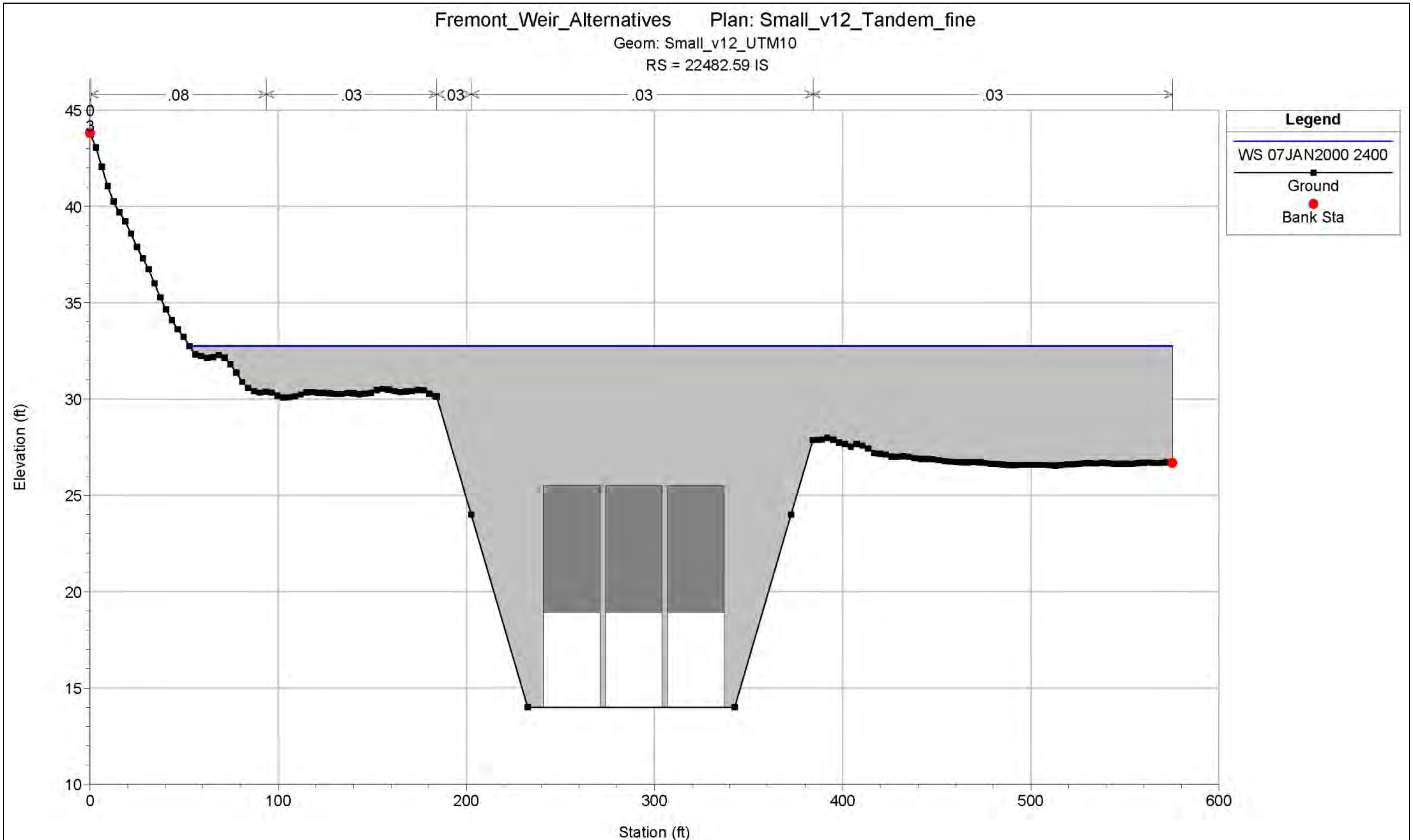
Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project

Small Individual Gate Configuration

Project No. 13-1027	Created By: CRC	**Figure 11**



Notes: Gate closure shown represents 6000 cfs at maximum Sacramento River Stage before Fremont Weir begins to overtop for gates operated in tandem.

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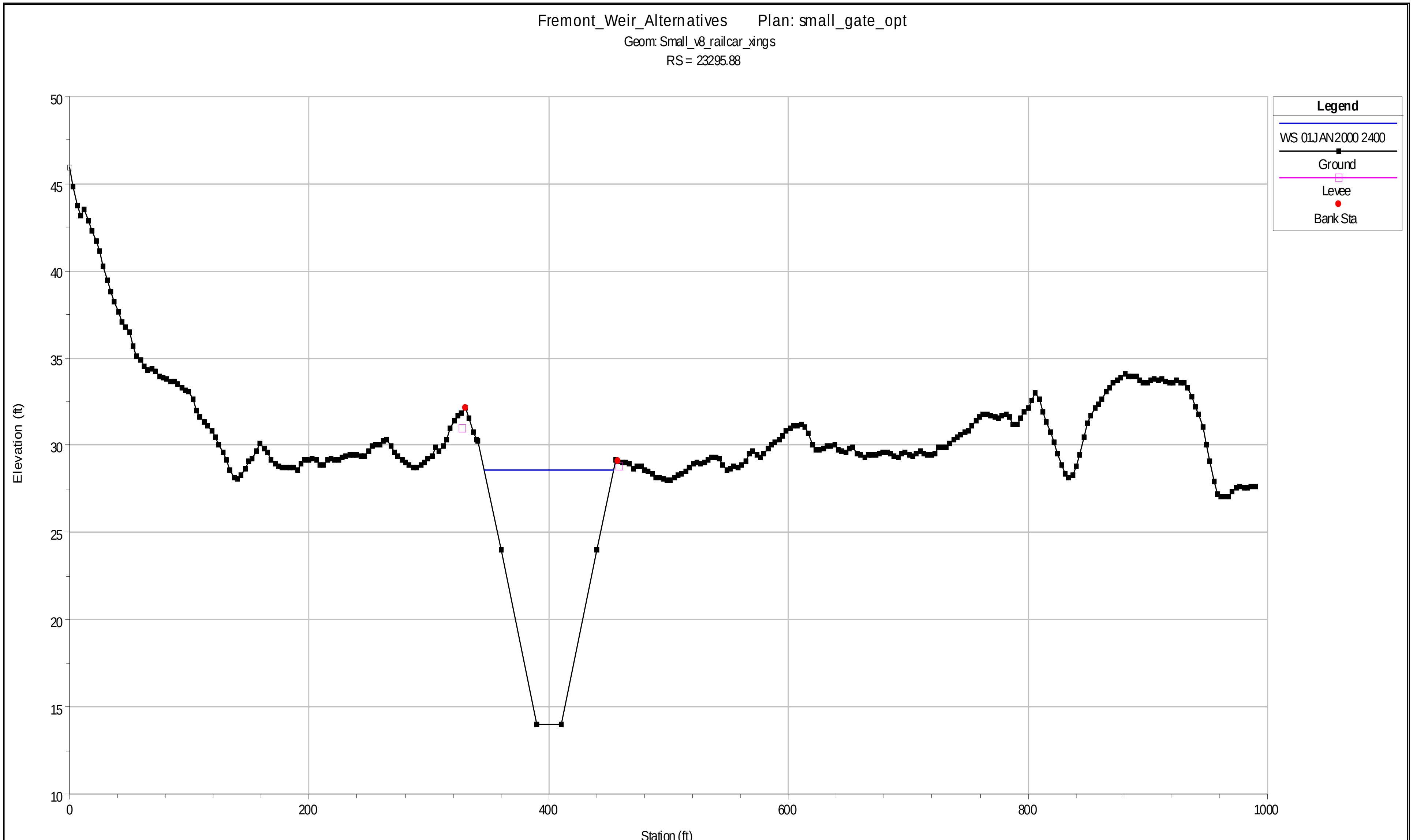
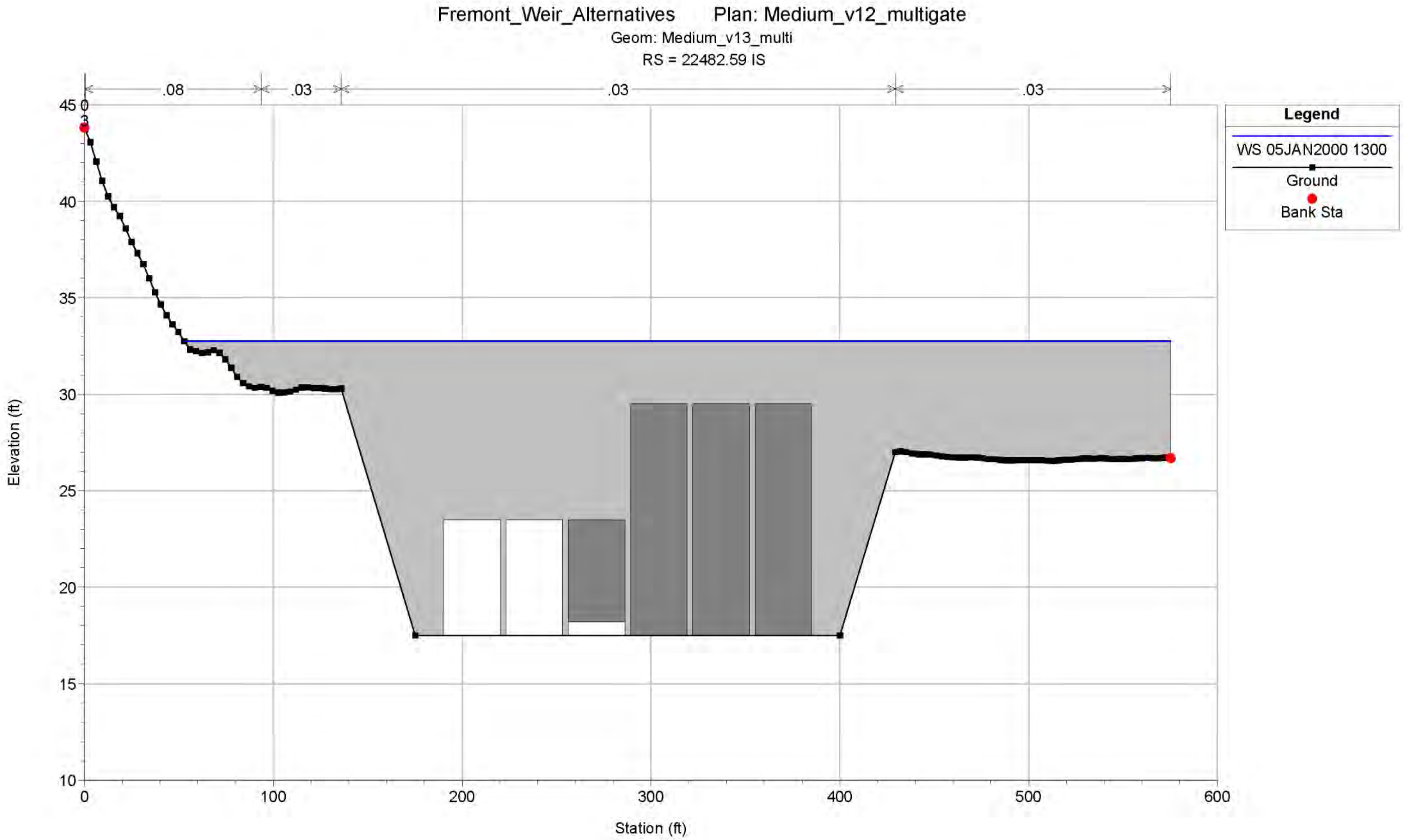
Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project

Small Unison Gate Configuration

Project No. 13-1027	Created By: CRC	**Figure 12**



Notes:	cbec eco engineering	*Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project* **Cross Section Downstream of Small Gate Structure**		
		Project No. 13-1027	Created By: CRC	**Figure 13**



Notes: Gate closure shown represents 6000 cfs at maximum Sacramento River Stage before Fremont Weir begins to overtop for gates operated individually.

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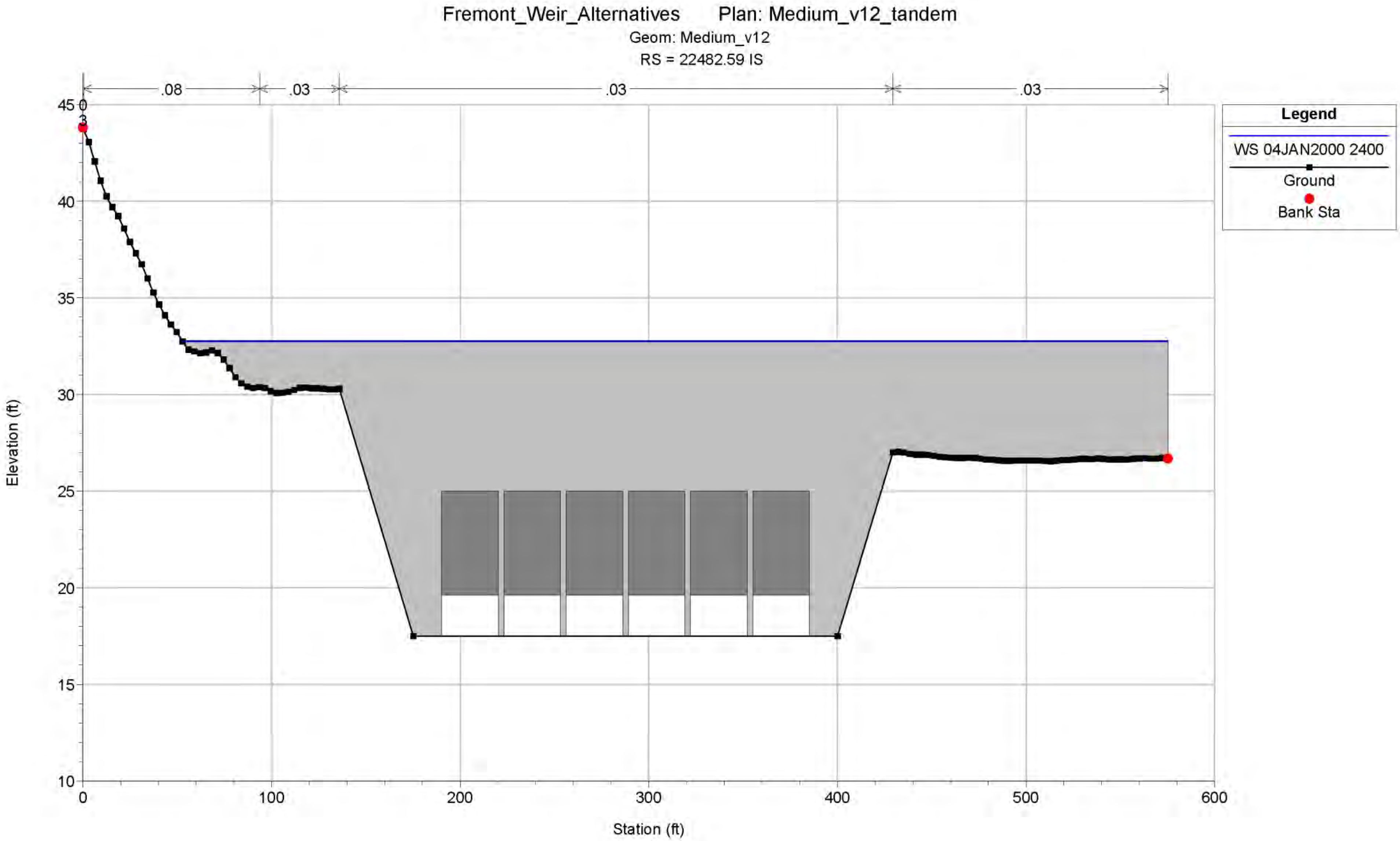
Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project

Medium Individual Gate Configuration

Project No. 13-1027	Created By: CRC	**Figure 14**



Notes: Gate closure shown represents 6000 cfs at maximum Sacramento River Stage before Fremont Weir begins to overtop for gates operated in tandem.

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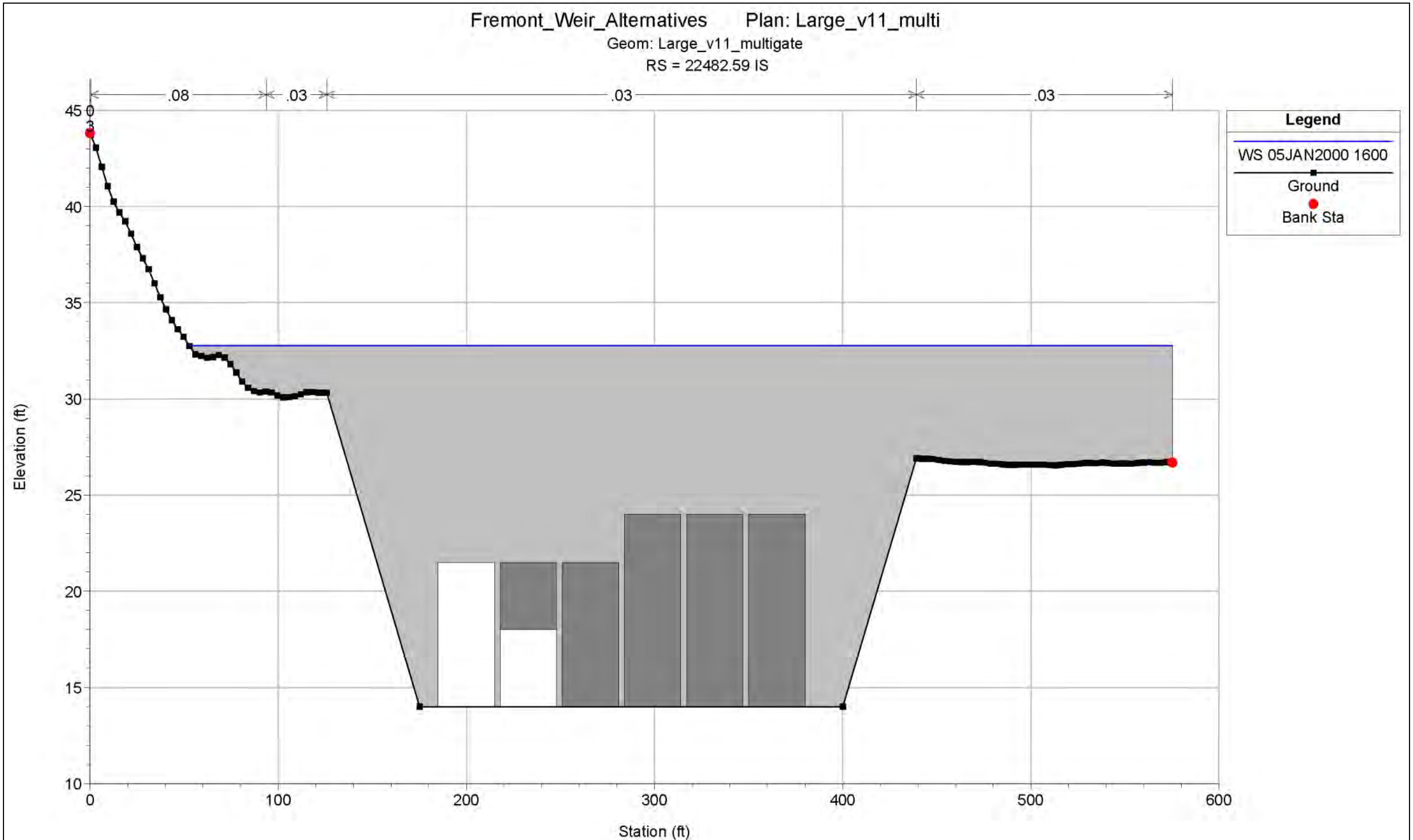
Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project

Medium Unison Gate Configuration

Project No. 13-1027	Created By: CRC	**Figure 15**



Notes: Gate closure shown represents 6000 cfs at maximum Sacramento River Stage before Fremont Weir begins to overtop for gates operated individually.

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Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project

Large Individual Gate Configuration

Project No. 13-1027	Created By: CRC	**Figure 16**