Task 2 Addendum Technical Memorandum

Evaluation of Partial Fish Passage Barriers in the Chowchilla and Eastside Bypass

July 2014

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State of California
Natural Resources Agency
DEPARTMENT OF WATER RESOURCES
Division of Integrated Regional Water Management
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San Joaquin River Restoration Program
Fish Passage Evaluation

Task 2 Addendum

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INTRODUCTION

This document is an addendum to the San Joaquin River Restoration Program (SJRRP), *Task 2 Draft Technical Memorandum, Evaluation of Partial Fish Passage Barriers* dated July 2012. This effort is part of a three-task fish passage evaluation that is being conducted to identify passage impediments to the migration of adult Chinook salmon. **Task 1**, deemed first pass, included the identification and limited data collection of potential fish passage barriers and the identification of fundamental passage criteria to allow an initial evaluation of potential barriers. **Task 2**, deemed second pass, includes data collection and hydraulic evaluation of the potential fish passage barriers that were identified for further study in Task 1. **Task 3** (if needed), which has not been completed, could provide conceptual alternatives for modification for the structures that are deemed a potential fish passage impediment during either Task 1 or Task 2.

The methods used in this analysis to collect data, develop the hydraulic models, and evaluate the fish passage criteria, are the same as those used in the original Task 2 Technical Memorandum. Any exception is noted within this addendum. This addendum will also reference specific sections and pages of the original Task 2 Technical Memorandum that are discussed in this document. The original Task 2 Technical Memorandum can be downloaded from the SJRRP website at: *http://restoresjr.net/flows/data-reporting/2012/2012_PartialFishBarrier_Reporting.pdf*

Task 2 was continued to include structures in the Eastside and Chowchilla Bypasses upstream of the Sand Slough Connector (referred to as the Upper Eastside Bypass and Chowchilla Bypass). This portion of the bypass was not included in the original Task 2 Technical Memorandum. However, the SJRRP has since determined that there is a potential for fish to migrate within these portions of the bypass system. The Chowchilla Bypass Control Structure, bridges at Avenue 18-1/2 and Avenue 21, and additional structures have been identified as potential barriers either in the *Framework for Implementation Plan* (SJRRP, 2012) prepared by the SJRRP, or by other agencies including the Department of Water Resources (DWR). The six additional structures analyzed in this addendum are listed in Table 1. Since these potential barriers have not been identified as part of a site-specific project, the planning for structural improvements for fish passage have not been completed. This addendum is needed to determine the range of flows necessary to accommodate upstream migration of adult Chinook salmon at the structures in this section of the bypass system for SJRRP planning purposes until modification to the structures is complete. In addition, these structures could potentially be included in the Task 3 evaluation for design of modification, if applicable.

Table 1. Additional Second Pass Locations

Identification Number	Reach	Description
58	4A/EB	Avenue 21Bridge
60	4A/EB	Eastside Bypass Pipe Crossing
61	4A/EB	Avenue 18-1/2 Bridge
64	3/EB	Eastside Bypass Drop 1
65	3/CB	Eastside Bypass Drop 2
21	2A/CB	Chowchilla Bypass Control Structure

Key:
CB – Chowchilla Bypass
EB – Eastside Bypass

SECOND PASS EVALUATION CRITERIA

Fish passage guidelines have been developed in California for anadromous salmonids primarily by the California Department of Fish and Wildlife (CDFW), formerly the California Department of Fish and Game (DFG), and the National Marine Fisheries Service (NMFS). These guidelines establish passage criteria for structures that include culverts, bridges, and low-flow crossings. Criteria developed by the SJRRP for site-specific projects like the Mendota Pool and Reach 2B Improvements Project; Reach 4B, Eastside Bypass, and Mariposa Bypass Channel and Structural Improvements Project; as well as the Arroyo Canal Fish Screen and Sack Dam Fish Passage Project, were also considered for consistency. Fish passage was evaluated at all Task 2 identified structures based on three main passage criteria: jump into the structure, flow depth in the structure, and velocity in the structure. Other factors including temperature, oxygen, straying, and predation can impact fish passage, but evaluation of these factors are outside the scope of this document.

The guidelines and passage criteria used in this Task 2 addendum are consistent with the original Task 2 evaluations and are described in detail in the Second Pass Evaluation Criteria section on pages 9 through 13 of the original Task 2 Technical Memorandum. The specific criteria for the second pass and this addendum are listed in Table 3, in the original Task 2 Technical Memorandum, and are included in Table 2 in this addendum for clarity.

Table 2. Adult Chinook Salmon Criteria

r	Value	Location
Depth	1.2 feet	Within the structure
Maximum Velocity	Figure 3 (Original Task 2) for long structures 22.4 fps, Burst Speed 10.8 fps, Sustained Speed Table 2 (Original Task 2) for culverts	Maximum velocity at the inlet, outlet, sill, or baffles
Jump	Figure 1 (Original Task 2) Origin of Leap at 1.5 x Jump Height	Inlet or outlet, if jump is required for passage

Key:
fps = feet per second

The original Task 2 Technical Memorandum should be referenced when reviewing the results and criteria. The fish passage criteria are dependent on the type of structure and the passage criteria for each of the structures. The criteria for each of the structures in this Task 2 addendum are summarized in Table 3.

Table 3. Fish Passage Criteria per Structure

Structure	Minimum Depth (feet)	Maximum Velocity (fps)	Maximum Jump Height Curve4	Calculated Minimum Pool Height (feet)	Minimum Hydraulic Drop (feet)
Avenue 21Bridge[1]	1.2	6	60%	3.1	1
Eastside Bypass Pipe Crossing[1]	1.2	8[2]	40%	3.5	1
Avenue 18-1/2 Bridge[1]	1.2	6	N/A[3]	N/A[3]	N/A[3]
Eastside Bypass Drop 1	1.2	6[2]	60%	3.6	1
Eastside Bypass Drop 2	1.2	6[2]	60%	N/A[5]	1
Chowchilla Bypass Control Structure	1.2	6[2]	60%	2.0[6]	1

Notes:
[1] There is riprap present, so minimum depth could be increased to two-feet-depth over the riprap
[2] Burst speed criteria of 10.8 fps assumed when weir, sill, or pipe is overtopped
[3] If jump is not present at the structure then it is designated with N/A (Not Applicable)
[4] The curve lists the angle of jump assumed for each condition (good and poor)
[5] The minimum pool depth was not calculated since jump is not possible at any flow
[6] Minimum pool depth of two feet needed

Most of the fish passage criteria has remained the same as the original Task 2, so to clarify, this addendum provides additional details on how the application of criterion for depth through riprap, maximum velocity, and jump are applied. This information is provided to build upon the criteria summarized in the original Task 2.

Depth

Minimum flow depth within the structure is applied by calculating the difference of water surface elevation from the channel bed or structure apron at each flow modeled. Unimpeded passage flow is achieved when the depth is at or above the criterion for minimum depth. Considerations for flow depth over riprap may need to be higher because low flows tend to flow through the rock layer and could be very turbulent. A flow depth of two feet or more over riprap could be needed to allow for unimpeded fish passage (DWR, 2007). This criterion for flow depth through riprap was not used for the original Task 2 but is used and discussed within the results section of this addendum for a fish in poor condition.

Maximum Velocity

For some structures, the application of the burst speed or average velocity criteria depends on the structure type. For example, the velocity under a bridge or through a culvert should not exceed 6 fps, based on Table 2 (original Task 2 Technical Memorandum, Table 2, page 10), for structures less than 60 feet in width. The velocity criterion for maximum flow velocity for low-flow crossings is determined from the curves in Figure 3 (original Task 2 Technical Memorandum, page 13). Once flows overtop hydraulic features, like weirs or low-flow crossings, the maximum velocity of 10.8 fps for burst speed is applied. These factors were considered and are discussed in the results section of this addendum.

Jump

A combination of several different criterion defines the jump criteria for an adult Chinook salmon. The limiting jump criterion for unimpeded passage is determined at each jump feature, for each flow modeled, to determine the jump height and the pool height required for the jump. The jump height, also referred to as the hydraulic drop when the structure is overtopped, is the difference between the water surface elevation at the jump feature and the water surface elevation just downstream of the jump. The pool height is determined by multiplying 1.5 to the jump height with a minimum requirement of two feet depth. The jump height varies for each flow, since the hydraulic drop decreases as flows increase over the jump feature. Therefore, the required pool height also varies.

The parabolic jump curve from Figure 2 on page 12 of the original Task 2 was compared to the jump height and structure length for each structure when the criterion for pool height is achieved. The parabolic curves vary based on the condition (good or poor) of the salmon, which was determined based on the distance it is from its spawning ground (original Task 2 Technical Memorandum, pages 10 through 13). The jump pool depth, when jump is possible, is displayed in the calculated minimum pool height column in Table 3. When both the jump pool height and the parabolic jump curve are achieved, the jump meets the criteria.

Jump is no longer necessary once the jump feature is fully submerged, the hydraulic drop is less than one foot, and the depth is sufficient for an adult Chinook salmon to swim over at the depth criterion of 1.2 feet. The minimum hydraulic drop criterion, in Table 3, was compared to the hydraulic conditions of the structure once the jump feature is fully submerged by 1.2 feet of water. If there is a hydraulic drop of less than one foot then the criterion for passage without jump is met.

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DATA COLLECTION

Data used for this analysis, separate from the original Task 2 data collection efforts, includes flow, depth, and topographic elevations that were collected in 2011 and 2012. For background on the existing data and collection procedures, refer to the Second Pass Data Collection section of the original Task 2 Technical Memorandum.

To better define the structures and nearby channel topography, DWR collected topographic data at the structures identified for this evaluation. The topographic data collected at each structure from the DWR surveys is detailed in Appendix B-2 of this addendum. The vertical datum of all of the topography collected is the North American Vertical Datum of 1988 (NAVD88), which is consistent with that of the original Task 2 Technical Memorandum. DWR also collected flow data and water surface elevations for the Upper Eastside and Chowchilla Bypasses on April 6 through 7, 2011, during flood flows. This data was used to calibrate the hydraulic models.

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FLOW DURATION ANALYSIS

This analysis used guidance for fish passage evaluation that were developed by DFW and NMFS. The guidance documents that were used to identify the structures that are in need of modification to pass fish unimpeded include:

- California Salmonid Stream Habitat Restoration Manual (DFG, 2010)
- Culvert Criteria for Fish Passage (DFG, 2002)
- Guidelines for Salmonid Passage at Stream Crossings (NMFS, 2001)

The guidance documents recommend a flow duration analysis to identify the range of passage flows for migrating fish. According to the guidelines, flow duration curves are developed to determine the upper and lower flow limits that a structure should allow for unimpeded fish passage. The upper fish passage flow limit for adult salmonids is defined as the 1 percent exceedance flow during an average year. For all adult salmonids, the lower fish passage flow equals the 50 percent exceedance flow (DFG, 2010).

It is unknown when adult Chinook salmon would be migrating in the Upper Eastside and Chowchilla Bypasses since Restoration Flows are not routed through this section of the bypass. Therefore, fish migration is only likely to occur during higher flood flows, when flows are being routed into the bypasses. Flows into the Chowchilla Bypass are controlled at the head of the bypass at the Chowchilla Bifurcation Structure and depend on the operational rules for the system. There are two main considerations when routing flood flows through the San Joaquin River and bypass system. The first is routing of flood flows from Friant Dam. The Chowchilla Bifurcation Structure is used to control and route flood releases from Friant Dam into Reach 2B or the Chowchilla Bypass based on capacities and flood operating rules. The second is routing of flows when flood flows are being released from Pine Flat Dam into Mendota Pool in Reach 2B. Flood flows from Friant and Pine Flat dams combined, should not exceed the capacity of Reach 3 that is downstream of the Mendota Dam. During inflows from Pine Flat, flood flows may increase within the Chowchilla Bypass instead of being routed into Reach 2B to prevent Reach 3 from exceeding capacity. The bypass is primarily operated as a flood control channel, so inflows into the bypass are predominantly driven by the capacity of the SJR, making the bypass a non-natural controlled waterway. Flows within the system typically peak quickly with short durations of low flows on the rise and fall of the hydrograph. In addition, some years the bypass will not convey any flows.

A mean daily flow duration curve was developed at the head of the Chowchilla Bypass to determine the 1 percent and 50 percent exceedance flows. The curve was generated from the historical gage data at the head of the Chowchilla Bypass. The 12-year historical record[1] for the head of the Chowchilla Bypass includes a range of flood-year types, and includes one of the wettest years on record.

[1] October 1979 through September 1991

Since this analysis is considering the flow routing within the bypasses, a curve was developed that only considers when there is a potential for fish to be present, which excludes periods when the bypass is dry. For comparison purposes, Figure 1 shows two duration curves, one with zero flow events and one without. The flow duration curve where the zero flows were removed is going to be used in this Task 2 addendum to determine the upper and lower passage flows for determining the unimpeded flow range for fish passage. These passage flow limits will specify the range of flows that the structures will need to accommodate for unimpeded fish passage, and will be recommended for modification in Task 3.

For the bypass, when fish are present, the estimated 1 percent exceedance flow is approximately 8,800 cfs and the 50 percent exceedance flow is near 1,900 cfs. Because historical gage data is not available for flows within the bypass downstream of the major tributaries, like the Fresno River, which may increase the exceedance flow for the downstream reaches of the bypass, the curves in Figure 1 only reflect the passage flows for the inflows at the head of the Chowchilla Bypass.

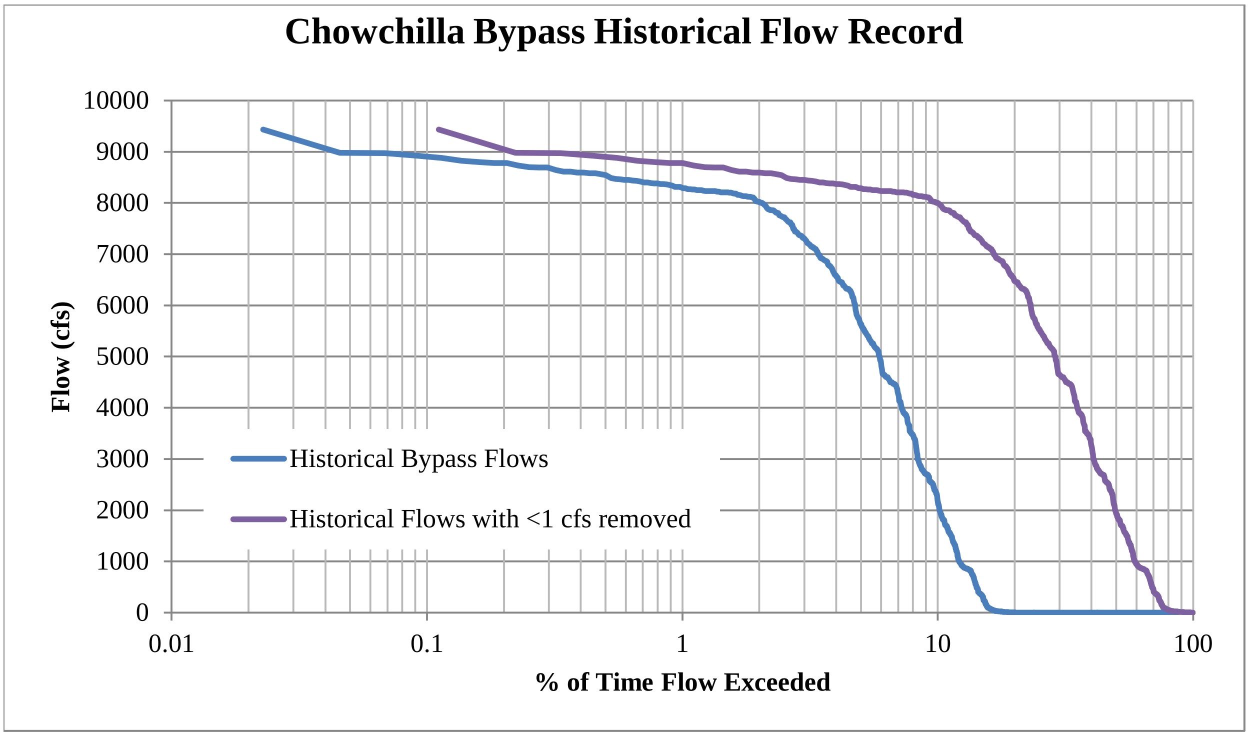

Figure 1. The Head of Chowchilla Bypass Flow Duration Curve

HYDRAULIC MODELING ASSUMPTIONS

Hydraulic data is used to evaluate the conditions needed for fish passage at the structures along the Chowchilla and Eastside Bypasses under a variety of flow conditions, such as flow depth, velocity, and discharge. Hydraulic data is evaluated in relation to fish capabilities and criteria to determine Chinook salmon passage success. The Hydrologic Engineering Center's River Analysis System (HEC-RAS) version 4.1.0 software, which was developed by the United States Army Corps of Engineers (USACE), was used to complete the hydraulic modeling. The HEC-RAS model simulates one-dimensional flow that assumes steady, gradually varied flow.
The hydraulic assessment was completed (same as the original Task 2) in three phases including assessing existing base models, modifying the base models with updated structural and channel topography, and calibrating the models with available water surface elevations and flow measurements. The updated models included a range of flows to evaluate unimpeded fish passage. The hydraulic results and data used for calibration are referenced in Appendix A-2. The hydraulic results are presented so that passage criteria for any fish species or life stage can be compared for velocity and depth at each structure.

Subsidence

Subsidence is known to impact the Upper Eastside Bypass and Chowchilla Bypass. In order to consider the potential changes in hydraulic conditions at the structures due to the subsidence, DWR used 2012 topographic surveys of the levee crowns to adjust the hydraulic models and to estimate the subsidence impacts in the bypass. A summary of the annual ground subsidence rates determined by DWR are shown in Table 4.

Table 4. DWR Annual Subsidence Rates Along the Chowchilla Bypass and the Upper Eastside Bypass

Bridge Structures	DWR 2012 Survey rate, feet/year
Avenue 14	~0.37
Road 9	~0.48
Triangle T	~0.39
Avenue 18 1/2	~0.33
Road 4	~0.88
Avenue 21	~0.52
Highway 152	~0.52

Key:
DWR = California Department of Water Resources

All of the structures from this addendum are within reaches that have experienced subsidence. Therefore, the hydraulic models have been adjusted to account for the subsidence for calibration purposes based on DWR's 2012 estimated annual subsidence rates summarized in Table 4. Since the calibration flow data was collected in 2011, the hydraulic model was calibrated to reflect elevations that were observed during that time.

Modeled Flow Range

The flows used to evaluate fish passage at each structure ranged between 25 and 8,500 cfs, which are within the range of the upper and lower passage flows to determine unimpeded fish passage. The flow range represents the local flow at the structure, which does not reflect the flow released at Friant Dam. The tables that are provided in Appendix A-2 for each structure include the hydraulic data for flows up to 8,500 cfs, but the result curves are presented for flows up to 4,500 cfs since most of the details for impeded flows for fish passage within this range would be difficult to view on curves that extend to the higher flows. This analysis does not factor in the inflows from tributaries to the SJR and bypass system, or the operational rules of the bypass itself. Further evaluation of the hydrology and routing of flows at each structure will be considered during the Task 3 analysis.

Model Limitations

The results from the model are a guide for making management decisions for fish passage at structures on the river and bypass system. These results generally depict the current hydraulic conditions at each structure, but additional monitoring is needed to evaluate fish passage under all flow and backwater conditions. Generally, calibration was limited to one flow event, so the hydraulic conditions at very low flows and at very high flows may not provide reasonable results.

Operations controlling the gated structures, which can impede fish passage, were not considered in this analysis. The four gates at the head of the Chowchilla Bypass are operated by the Lower San Joaquin Levee District on an as-needed basis by manual operation to control flow into the bypass system and the SJR. During most of the routing of flood flows, the gates are fully opened, so this gate scenario is the focus of the discussion of passage at the Chowchilla Control Structure.

SECOND PASS EVALUATION RESULTS

The fish passage criteria in Table 3 for jump, velocity, and depth were compared to the hydraulic model results for each structure to determine the unimpeded fish passage flow range. The fish passage results are discussed in two ways: the first assumes that the fish are in good condition, which is referred to as optimum response; and the second assumes that the fish are in poor condition, which is referred to as minimum response. The results from the comparison are summarized and are presented in Table 5.

Upper Eastside Bypass Avenue 21 Bridge

A two-lane concrete bridge is located at the Avenue 21 crossing on the Upper Eastside Bypass. The bridge does not span the entire bypass channel and only extends the width of the low-flow channel. The bridge is slightly skewed to the channel with one- to three-foot diameter rough boulder riprap and cobble on the abutments and heavy riprap in the channel bottom under the bridge. Just downstream of the bridge, the channel is void of major vegetation. There is a significant drop (headcut) protected by riprap that extends about 50 feet with a two-foot-wide asphalt sill that is located about 15 feet downstream from the bridge that spans the low flow channel bottom. There is a drop from the sill to the riprap just downstream that varies three to five feet. Migrating fish would need to jump this sill during low flow events. The riprap just downstream of the asphalt sill gradually slopes down to the channel bottom. There is currently a ten-foot elevation difference from the sill to the natural channel bed at the edge of the riprap toe about 35 feet downstream of the sill.

Avenue 21 Eastside Bypass downstream bridge crossing

Determining depth under the bridge is complex since the channel is lined with one- to three-foot diameter rough boulder riprap, which could create a hazard for adult migrating fish. The flow under the bridge meets the 1.2 feet depth criterion at 25 cfs, but the actual flow depth for fish passage may be reduced by the riprap since the height of the riprap is greater than 1.2 feet. The maximum depth over the sill, just before the drop, does not meet the 1.2 feet depth passage criterion until around 250 cfs. If a two-foot-depth over the riprap is used for the passage depth criterion under the bridge, then the minimum passage flow would be around 500 cfs. Even though there is depth for passage to swim through the structure, the jump pool just downstream of the sill does not meet the jump criterion at flows below 1,700 cfs.

The velocity criterion for a 60-foot bridge or less should not exceed 6 fps (Table 2). Flows above 1,500 cfs exceed the velocity criterion at the sill. There is potential for migrating fish to swim through the bridge at flows above 3,500 cfs. However, due to a hydraulic drop at the bridge that is greater than one foot, and the velocities exceeding 6 fps at the bridge inlet, the velocity criterion for swimming through the structure when flows are above 3,500 cfs is exceeded.

In conclusion, the Avenue 21 Bridge does not meet fish passage criteria and is potentially a complete barrier to migrating fish.

Upper Eastside Bypass Pipe Crossing

The pipeline crossing is located on the Upper Eastside Bypass just upstream of the confluence with Ash Slough (north of Avenue 18-1/2). It is assumed that the pipe is used to deliver irrigation (ditch water) for agricultural use based on the presence of gated structures to the east and west of the bypass levees, which is located in line with the pipe that feeds the irrigation canals. The circular concrete pipe is exposed with riprap at the base, and extends the width of the low flow channel. The riprap is estimated to extend 35 feet beyond the downstream pipeline crossing. The pipe is raised on fill and riprap that is about seven feet higher than the average channel bed elevation. The fill serves as a vehicular and equipment crossing. The top of the pipe is about three feet above the fill and riprap. The channel is incised in this section of the bypass with depths estimated between 10 and 20 feet. This structure is evaluated as a low-flow crossing.


Pipeline in the Eastside Bypass looking east

Depth over the cross section just downstream of the pipe does not meet the flow depth criterion until flows are around 100 cfs, but flows greater than 100 cfs may be needed to safely pass the large riprap. If a depth of two-feet-over the riprap is used to meet the flow depth criterion then the minimum flow needed for passage would be 300 cfs. However, sufficient pool depth to meet the jumping criterion is not met until flows are over 1,300 cfs. Depth over the pipe meets the flow depth criterion for flows above 2,150 cfs, so it is possible for an adult salmon in good and in poor condition to jump the pipe for flows between 1,300 – 2,150 cfs.

The velocity criterion for the entire low-flow crossing length, 45 feet, is used to determine the unimpeded passage flow until the pipe and fill for the crossing is fully submerged with sufficient depth at 2,150 cfs. The velocity criterion for a structure with a length of 45 feet is around 8 fps for a fish in good condition (Table 2). The velocity criterion is not exceeded over the fill but is exceeded over the pipe for flows between 3,000 – 5,000 cfs. Since passage flows exceed the velocity criterion only at the pipe when the structure is fully submerged, but not upstream and downstream of the pipe, this analysis will assume that an adult Chinook salmon could burst past the pipe because velocities over the pipe do not exceed the burst speed criterion of 10.8 cfs. If the velocity through the entire length of structure for a fish in poor condition is applied then the maximum velocity is about 3.5 fps. The velocity criterion of 3.5 fps is exceeded for a fish in poor condition at the pipe and the fill downstream the pipe for all flows modeled.

In conclusion, this structure meets passage criteria from 1,300 – 8,500 cfs assuming optimum response. However, when considering minimum response, a fish in poor condition does not meet the passage criteria for any flows.

Upper Eastside Bypass Avenue 18-1/2 Bridge

Avenue 18-1/2 Eastside Bypass downstream bridge crossing

The Avenue 18-1/2 crossing is a two-lane concrete bridge located on the Upper Eastside Bypass and is upstream of Avenue 21. This bridge, like the Avenue 21 Bridge, only spans the low flow channel with abutments that extend to the levees. The bridge is slightly skewed to the channel with cobble on the abutments and one- to three-foot-diameter rough boulder riprap in the channel bottom under the bridge. The riprap in the channel under the bridge averages about two feet in depth and extends about 50 feet upstream. The channel upstream is mostly silty sand, void of major vegetation, and shallow. The channel downstream of the bridge is incised with a significant drop (headcut) that is protected from further erosion with riprap that extends about 50 feet downstream of the bridge. There is a two-foot-wide asphalt sill about 15 feet downstream of the bridge that spans the low-flow channel bottom. There is no immediate drop in the riprap just past the asphalt sill as it slopes gradually down to the channel bottom, so unlike the Avenue 21 crossing, migrating fish would not need to jump the sill, and could swim through the structure.

Like the Avenue 21 crossing, determining depth under the bridge is complex since there is large, rough riprap with heights greater than two feet that could create a hazard for adult migrating fish. The minimum passage depth of 1.2 feet under the bridge meets the criterion at 25 cfs, but the actual passage depth may be reduced by the height and large voids in the riprap. The minimum flow depth over the sill does not meet the 1.2 foot criterion for passage until around 300 cfs. If a depth of two-feet-over the riprap is used for the minimum depth flow criterion, then the minimum passage depth could be around 700 cfs.

The velocity under the bridge should not exceed 6 fps for bridges less than 60 feet in width (Table 2). Flows above 1,000 cfs exceed the velocity criterion at the sill but fish could potentially burst past since velocities do not exceed the burst speed criterion of 10.8 fps. Flows within the bridge exceed the velocity criterion at the bridge outlet at around 2,500 cfs. If fish are not able to burst past the sill at flows above 1,000 cfs, then passage flows could be limited to flows below 1,000 cfs.

In conclusion, the Avenue 18-1/2 Bridge meets passage criteria for flows between 300 – 2,500 cfs assuming optimum response. However, when considering minimum response, if a depth of two feet is needed over the riprap, then the minimum flow depth could be 700 cfs. Because of the uncertainty about whether fish can burst past the sill at flows above 1,000 cfs passage flows could be between 700 cfs – 1,000 cfs for a fish in poor condition.

Upper Eastside Bypass Drop 1

Drop 1 is a concrete weir structure within the Upper Eastside Bypass that is downstream of the Fresno River confluence with the bypass and Road 9. The weir extends the width of the low-flow channel. It has a height of around 5 feet, and the total length of the structure from the inlet to outlet is 24 feet. The structure has a concrete apron with concrete baffles and a short sill, which is approximately one foot in height, and is located downstream of the weir. The structure has large concrete wingwalls and an earthen levee that extends to connect the bypass levees with the structure. The structure diverts all of the flows into and over the weir, so the weir cannot be bypassed. The channel downstream the weir is void of major vegetation with riprap scour protection near the structure's wingwalls and downstream of the structure. Road 9 (Hemlock) Bridge is about 200 feet downstream of the weir. About 2,000 feet upstream the weir there is a second drop structure, Drop 2.

Drop 1 looking upstream within the Eastside Bypass

The flow depth through the drop structure is greater than the minimum flow depth criterion of 1.2 feet due to backwatering behind the downstream sill; therefore, passage is not limited for flow depth at any flows. Flow depth over the weir and the downstream sill may limit passage but these structural features can be jumped by adult Chinook salmon at some flows. Once flows are around 3,000 cfs, the flow depth criterion of 1.2 feet is met at the weir, so it is assumed that the migrating fish could swim over the weir.

When flows are just over 800 cfs, the pool depth meets the criterion for jumping at the weir for a fish in good condition. An adult Chinook salmon in good condition should be able to jump the total height of the hydraulic drop from the fall of the jump pool to the water surface upstream of the weir. For flows below 1,600 cfs, the jump height at the weir meets the jump criterion for a fish in poor condition.

Because the maximum swimming distance to clear the width of the structure is 25 feet, the velocity criterion of 6 fps for a fish in poor condition is applied to the structure for the entire length (Table 2). The velocity criterion is exceeded at flows over 1,600 cfs at the weir. However, velocities at the weir are less than 10.8 fps, so a fish in good condition may be able to swim through the structure, since the burst speed is not exceeded. Baffles at this structure are 1.5 feet deep by 1.5 feet wide and 2.7 feet in height with spacing between each baffle of 1.3 feet. The baffles are located upstream of the outlet of the bay to dissipate the flows prior to exiting the structure. The baffles are not a solid feature and can be traversed at all flows if the burst speed criterion is assumed to be 10.8 fps. The velocities at the baffles do not exceed criteria. The baffles are overtopped at flows above 500 cfs.

Upper Eastside Bypass Drop 1 meets passage criteria when flows are above 800 cfs assuming optimum response. However, assuming minimum response, if fish are not able to burst over the weir once the weir is overtopped, then the structure could be a barrier.

Upper Eastside Bypass Drop 2

The Eastside Bypass Drop Structure 2 is a structure that is similar in design to Drop 1, but it is narrower by about 110 feet and located upstream of the Fresno River confluence with the bypass. Drop 2 is located about 2,000 feet upstream the Drop 1 structure.

Like Drop 1, flow depth through the structure is not limiting passage due to the backwater caused by the downstream sill. The depth of flow over the weir does not meet the depth criterion of 1.2 feet until flows are above 4,500 cfs. Throughout the flow range there is a hydraulic drop greater than one foot that could impede fish passage. At 4,500 cfs when an adult can swim over the weir, there is still a hydraulic drop that exceeds one foot from upstream the weir to downstream at the jump pool, so swimming over the weir may not be possible at any passage flows.

Until the flow depth criterion at the weir is achieved, a fish in good condition would need to jump over the weir to pass. The jump pool depth does not meet the jump criterion for flows under 4,500 cfs. A fish in poor condition meets the velocity criterion of 6 fps (Table 2) for a swimming distance of 25 feet. The velocity criterion of 6 fps is applied to the structure for the entire length, but it is exceeded at flows over 1,000 cfs at the weir. Velocities at the weir exceed the burst speed criterion of 10.8 fps at flows around 5,000 cfs. Like Drop 1, Drop 2 has baffle blocks that do not have velocities that exceed the burst speed criterion of 10.8 fps. The baffles are overtopped at flows above 600 cfs.

Drop 2 looking upstream within the Eastside Bypass

Upper Eastside Bypass Drop 2 does not meet passage criteria for any flows, assuming optimum response. Migrating fish may not be able to jump over the weir or burst through the velocities once the weir is overtopped and the hydraulic drop at the weir exceeds one foot for the entire passage flow range, so the structure could be a complete barrier.

Chowchilla Bypass Control Structure

The Chowchilla Bypass Control Structure is part of the Chowchilla Bifurcation Structure located at the head of the Chowchilla Bypass at the San Joaquin River. The control structure is gated with four large radial gates that are controlled manually. The gates are typically open during flood flows, and generally remain closed during Restoration Flows or water deliveries. The structure is similar to the control structures on the San Joaquin River and Eastside Bypass. There are four large concrete bays with baffle blocks located at each outlet, and a short sill at the end of the concrete apron that flow is directed into. Riprap protects the channel from erosion just downstream of the sill, at grade, for about 30 feet. This structure is a complete fish passage barrier when gates are closed and potentially during partial gate closure, due to the potentially high velocities that pass beneath the gates. For this evaluation, the gates are assumed to be fully opened.

Chowchilla Bypass Control Structure outlet looking upstream

Depth within the structure meets the minimum flow depth criterion at all flows due to the 2.5-foot tall sill at the end of the apron. The flow depth over the sill meets the 1.2-foot flow depth criterion when flows exceed 700 cfs, so for flows below 700 cfs fish would need to jump the sill.

The jump criterion is not met until flows are over 275 cfs because of the lack of sufficient pool depth needed for the jump. Jumping at the sill meets the criterion for flows between 275 – 700 cfs, even for a fish in poor condition.

The velocity in the structure should not exceed 6 fps since the structure length is less than 60 feet (Table 2). Velocity at the sill exceeds the criterion at around 2,000 cfs, but does not exceed the burst velocity criterion until flows are above 7,000 cfs. Around 4,500 cfs, velocities at several locations within the structure exceed the velocity criterion. The velocity criterion at the sill for burst speed is met for flows between 700 – 4,500 cfs. Baffles at this structure are two-feet-deep by two-feet-wide and four-feet in height with spacing between each baffle of 1.7 feet. The baffles are located just upstream of the outlet of the bay to dissipate the flows prior to exiting the culvert. These structures can be traversed at all flows if burst speed is assumed at 10.8 fps. The velocities at the baffles do not exceed the burst speed criterion. The baffles are overtopped at around 1,500 cfs.

The Chowchilla Bypass Control Structure meets passage criteria when flows are between 275 – 4,500 cfs assuming optimum response. However, assuming minimum response, flows at the structure only meet passage criteria between 275 – 2,000 cfs if the burst speed criterion cannot be applied to meet passage at the sill.

Summary of Criteria Results per Structure

Table 5 summarizes the passage results for each criterion; depth, jump, and velocity, for each structure assuming optimum and minimum response. The optimum response unimpeded passage flow range represents the range of flows that assume that the fish are in good condition for jumping, or can overcome velocities at burst speed at some of the structures' features (where noted above), or an allowable minimum flow depth of 1.2 feet at riprap is sufficient for passage. The minimum response passage flow range represents an alternative range of passage flows if migrating fish are in poor condition, unable to overcome velocities at burst speed, or if flow depths are two feet over riprap, which potentially could impede passage.

Table 5. Optimum and Minimum Response Flows Exceeded For Each Criterion

Structure	Optimum Response Flow (cfs)			Minimum Response Flow (cfs)		
	Depth	Jump	Velocity	Depth	Jump	Velocity
Avenue 21 Bridge	> 250	>1,700	<1,500	>500	NP	<1,500
Eastside Bypass Pipe Crossing	> 100	>1,300	N/A	>300	>1,300	NP
Avenue 18-1/2 Bridge	>300	N/A	<2,500	>700	N/A	<1,000
Eastside Bypass Drop 1	N/A	>800	N/A	N/A	>1,600	<1,600
Eastside Bypass Drop 2	N/A	NP	<5,000	N/A	NP	<1,000
Chowchilla Bypass Control Structure[2]	N/A	>275	<4,500	N/A	>275	<2,000

Notes:
N/A represents Not Applicable since the criterion is unimpeded
NP represents No Passage since all flows modeled exceed the criterion
Key:
cfs = cubic feet per second

Table 6 summarizes the resulting unimpeded flow range for each structure for the successful passage of adult Chinook salmon based on the passage criteria for optimum and minimum response. A structure is determined to be a barrier if there are no flows that can pass an adult Chinook salmon based on the passage criteria. The percent of time there are unimpeded passage flows (Flow Probability) is estimated from the flow duration curve when fish are present for historical flows that enter the Chowchilla Bypass. The percent of time there are unimpeded flows for the structures downstream the tributaries to the Bypass have the potential to improve if inflows from the tributaries are present.

Table 6. Second Pass Evaluation Results and Potential Task 3 Structures

Structure	Optimum Response		Minimum Response	
	Unimpeded Passage Flow Range (cfs)[1]	Flow Probability (% of Time)	Unimpeded Passage Flow Range (cfs)[1]	Flow Probability (% of Time)
Avenue 21 Bridge	Barrier	0	Barrier	0
Eastside Bypass Pipe Crossing	1,300 – 8,500	57	Barrier	0
Avenue 18-1/2 Bridge	300 – 2,500	26	700 – 1,000	8
Eastside Bypass Drop 1	800 – 8,500	66	Barrier	0
Eastside Bypass Drop 2	Barrier	0	Barrier	0
Chowchilla Bypass Control Structure[2]	275 – 4,500	41	275 – 2,000	24

Notes:
[1] Flow range modeled for the bypass system 25–8,500 cfs. This table should not be used for flows outside this range, but does not imply that flows that exceed the top range are barriers.
[2] Assuming gates fully opened

Key:
cfs = cubic feet per second

To assess which structures need modification to pass migrating adult Chinook salmon unimpeded, the results from Table 6 were compared to the upper and lower passage flow limits from the flow duration curve, shown in Figure 1, for the historical flows when fish are present scenario.

Structures that need modification have impeded passage during the range of 1 percent exceedance flow of 8,800 cfs and the 50 percent exceedance flow of 1,900 cfs. These are the structures, assuming optimum response, which need modification according to the passage flow limits:

- Avenue 21 Bridge
- Avenue 18-1/2 Bridge
- Eastside Bypass Drop 2
- Chowchilla Bypass Control Structure

If a structure is defined as a barrier, it has impeded passage during the upper and lower passage flow limits and is in need of modification. All the structures that have a range of passage flow have unimpeded passage at the lower limit of 1,900 cfs. The Avenue 18-1/2 Bridge and Chowchilla Bypass Control Structure have impeded flows at the upper passage flow limit, so these structures would meet the barrier definition and will require modification. However, for the remaining structures that have unimpeded passage at the lower limit, velocity is the only criterion that is potentially impeding migrating adult Chinook salmon, since criteria for minimum depth and jumping are typically satisfied for unimpeded passage at 8,800 cfs. Since the upper limit of the hydraulic modeling flow range was 8,500 cfs, the velocities at 8,500 cfs were assessed at the Eastside Bypass Pipe Crossing and Eastside Bypass Drop 1. For both structures, the velocities at 8,500 cfs were decreasing so it is assumed that velocities at 8,800 cfs would be either equal to or less than 8,500 cfs. Therefore, velocities for these structures at 8,800 cfs are passable for a fish in optimum condition.

Unfortunately, when the flow ranges for the minimum response passage criteria is assumed the only structure that would not require modification would be the Eastside Bypass Drop 1 structure.

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CONCLUSIONS AND RECOMMENDATIONS

This analysis shows that there are potentially four structures that would be partial or complete barriers to adult Chinook salmon when flows are in the Chowchilla and the Upper Eastside Bypasses as a result of flood flows that may be concurrent with Restoration Flows. The results of this evaluation suggest that adult Chinook salmon would not be able to pass the four structures identified by this evaluation unless improvements are completed. Based on these findings, the structures identified for modification (with the exception of the Eastside Bypass Drop 1 and the Pipe Crossing) are recommended for further evaluation during Task 3 to develop passage alternatives.

In addition, any future work should consider the following:

- Subsidence has the potential to change the hydraulic conditions at most of the structures in this analysis. For this evaluation, subsidence was considered. However, because subsidence will continue to occur to some degree, any future studies and designs would need to consider subsidence impacts.

- The operation of the Chowchilla Bifurcation flood control facilities has the potential to impact the fish passage conditions during operation of the gates. For this evaluation, the gates were assumed to be fully opened during salmon migration. However, future analysis would need to consider the actual operation of the structure to ensure that the typical operational changes would not impede passage.

- Upstream passage was the focus of this study, but future evaluation of downstream passage (outmigration) when flows recede in the bypass may be needed.

For the structures that are deemed partial barriers, additional monitoring of hydraulic conditions may be needed during adult Chinook salmon migration, including potentially refining the depth criterion for riprap for a fish in good condition. As decisions are made on routing paths and flows, the results of the original Task 2 Technical Memorandum and this addendum may need to be reevaluated.

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SJRRP. (2012, June 19). Framework for Implementation. San Joaquin River Restoration Program.

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APPENDIX A-2
Modeling Results

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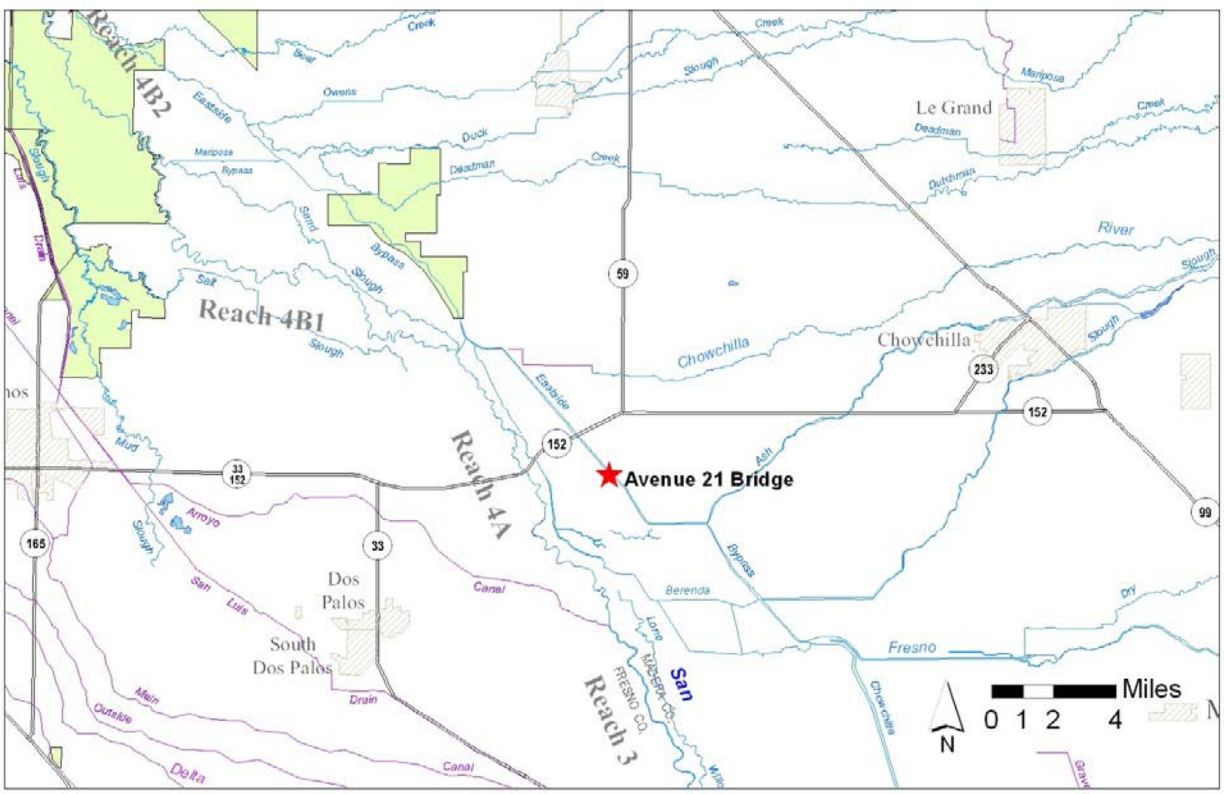
BEARINGS			
Site Name[2]: Avenue 21		**I.D. Number[1]:** 58	**Reach:** Eastside Bypass
River Mile:	**Barrier Type[1]:** Bridge		**Rank[1]:** **Red**



[2] SJRRP Fish Passage Evaluation, Task 1 Draft Technical Memorandum, February 2011

STRUCTURE DESCRIPTION

Avenue 21 is a two lane concrete bridge located on the Eastside Bypass. The bridge does not span the entire bypass channel and only extends the width of the low flow channel. The bridge is slightly skew with large riprap and cobble on the abutments, and heavy riprap in the channel bottom under the bridge.

The channel upstream is clean, void of vegetation, and shallow. The riprap under the bridge extends upstream about five feet (Photo 58_A). The channel just downstream is clean with a significant drop (headcut) with riprap that extends about 50 feet downstream of the bridge (Photo 58_B). There is a two-foot-wide asphalt sill about 15 feet downstream of the bridge that spans the channel bottom. There is a three to five foot drop from the sill to the riprap just downstream (Photo 58_C). The riprap just past the asphalt sill gradually slopes down to the channel bottom. The channel substrate is mostly silty sand. The floodplain has mostly short annual grasses with sparse patches of tall annual grasses.

Photos:

Photo 58_A. Avenue 21 Bridge looking upstream

Photo 58_B. Avenue 21 Bridge looking downstream

Photo 58_C. Avenue 21 Bridge looking at sill

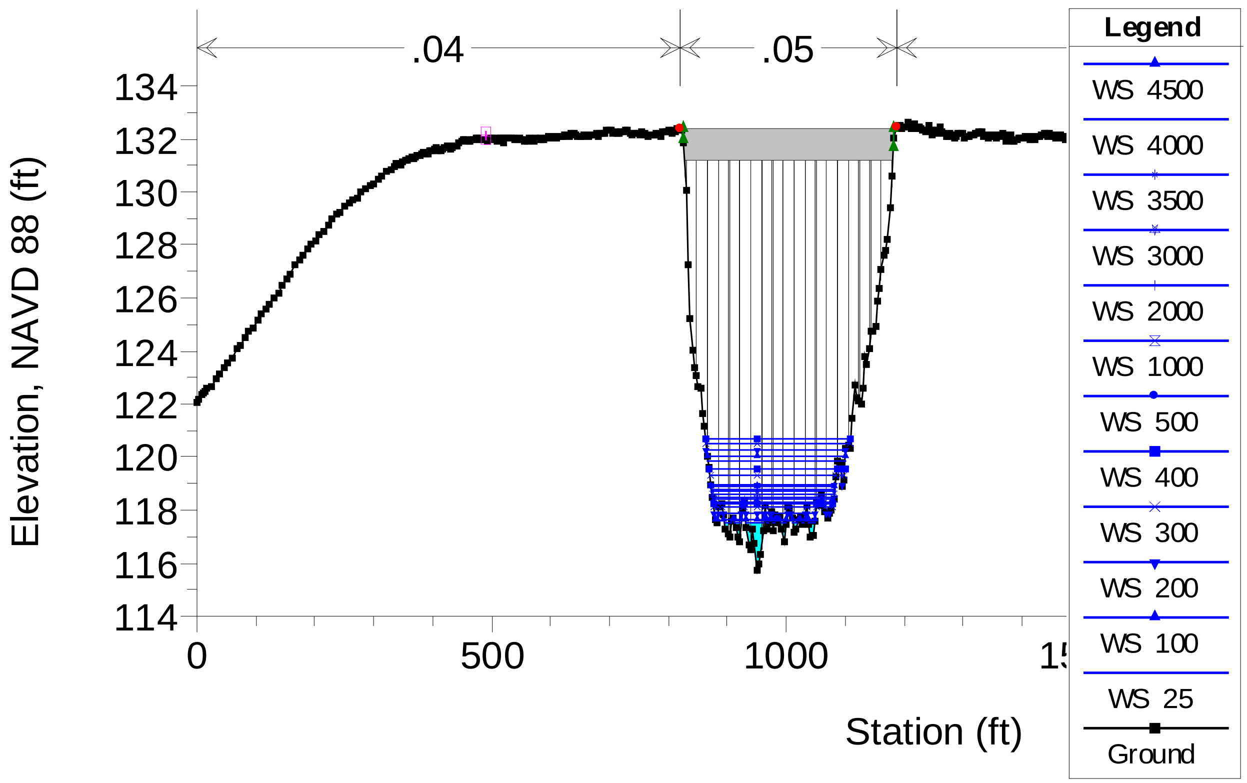
HEC-RAS MODEL SUMMARY TABLE

Avenue 21 Bridge Inside Downstream (D/S)

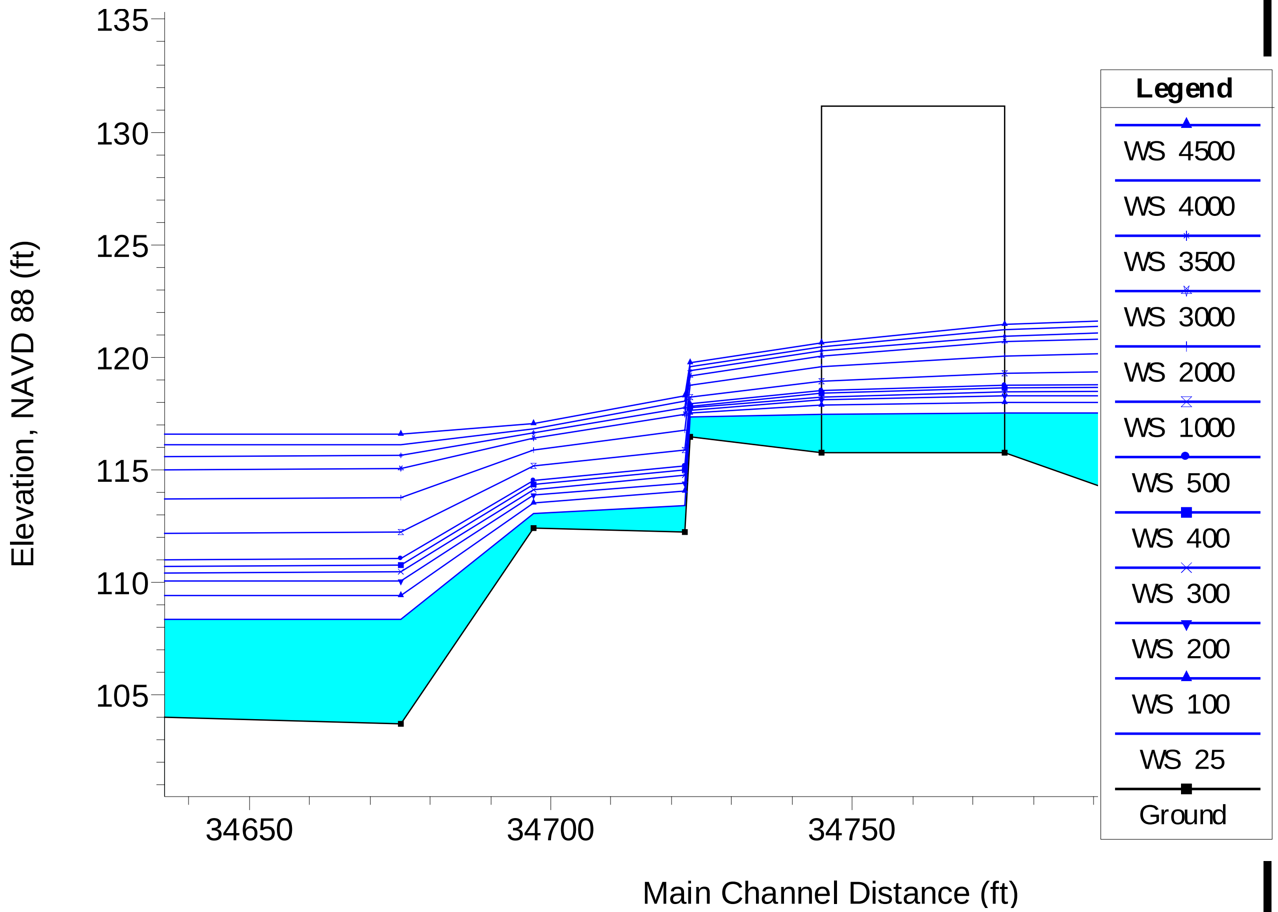
Flow	Maximum Depth	Channel Velocity	Maximum Water Surface Elevation Change
cfs	ft	fps	ft
25	1.74	0.67	0.2
50	1.91	0.95	0.3
100	2.1	1.31	0.5
200	2.34	1.79	0.7
300	2.5	2.15	0.8
350	2.57	2.3	0.8
400	2.63	2.44	0.9
500	2.74	2.71	0.9
600	2.85	2.94	1.0
700	2.94	3.15	1.1
800	3.02	3.36	1.1
900	3.11	3.53	1.1
1000	3.19	3.71	1.2
1500	3.53	4.43	1.4
2000	3.82	5.02	1.6
2500	4.08	5.51	1.7
3000	4.3	5.97	1.8
3500	4.52	6.37	1.9
4000	4.73	6.71	2.1
4500	4.91	7.04	2.1
5000	5.08	7.37	2.2
5500	5.25	7.67	2.3
6000	5.41	7.96	2.4
6500	5.57	8.22	2.5
7000	5.72	8.48	2.6
7500	5.87	8.71	2.6
8000	6.01	8.96	2.7
8500	6.15	9.17	2.8

The maximum water surface elevation change was estimated based on the difference between the cross sections immediately upstream and downstream the bridge.

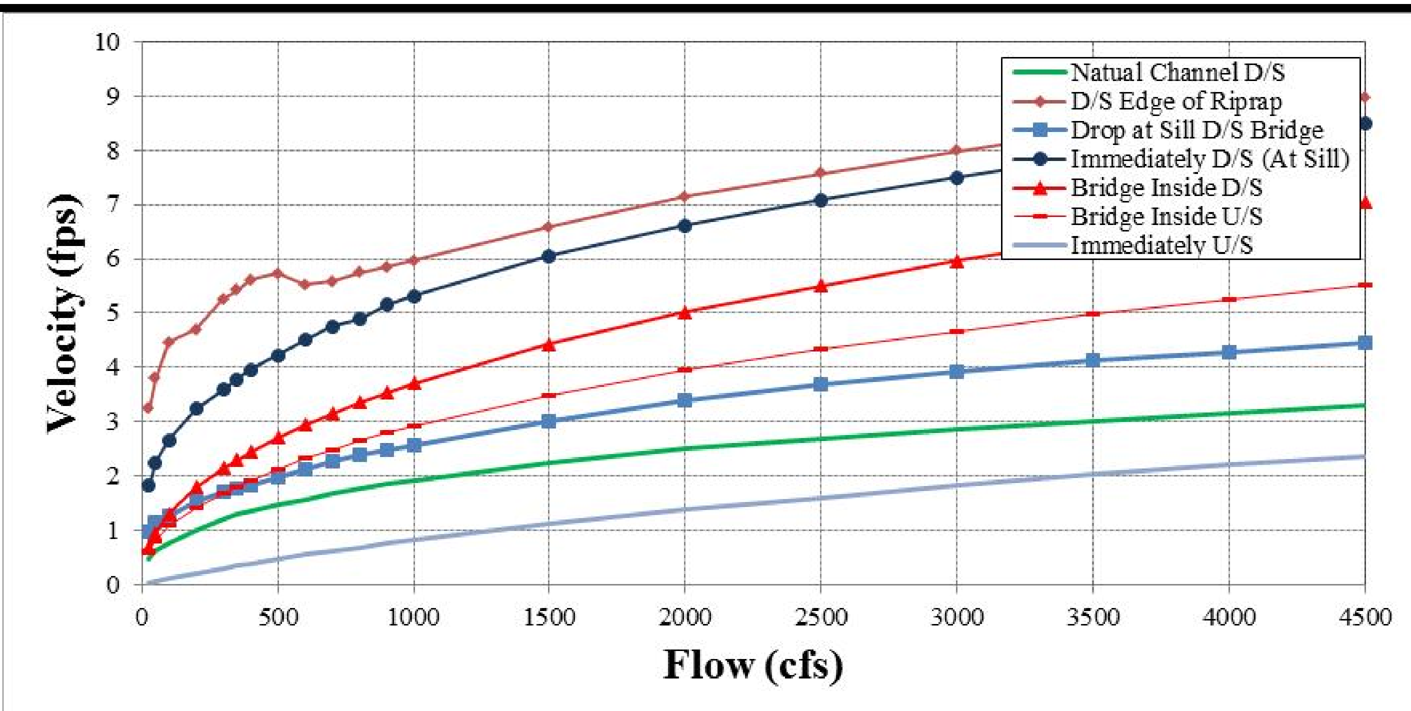
HEC-RAS MODEL STRUCTURE CROSS SECTION



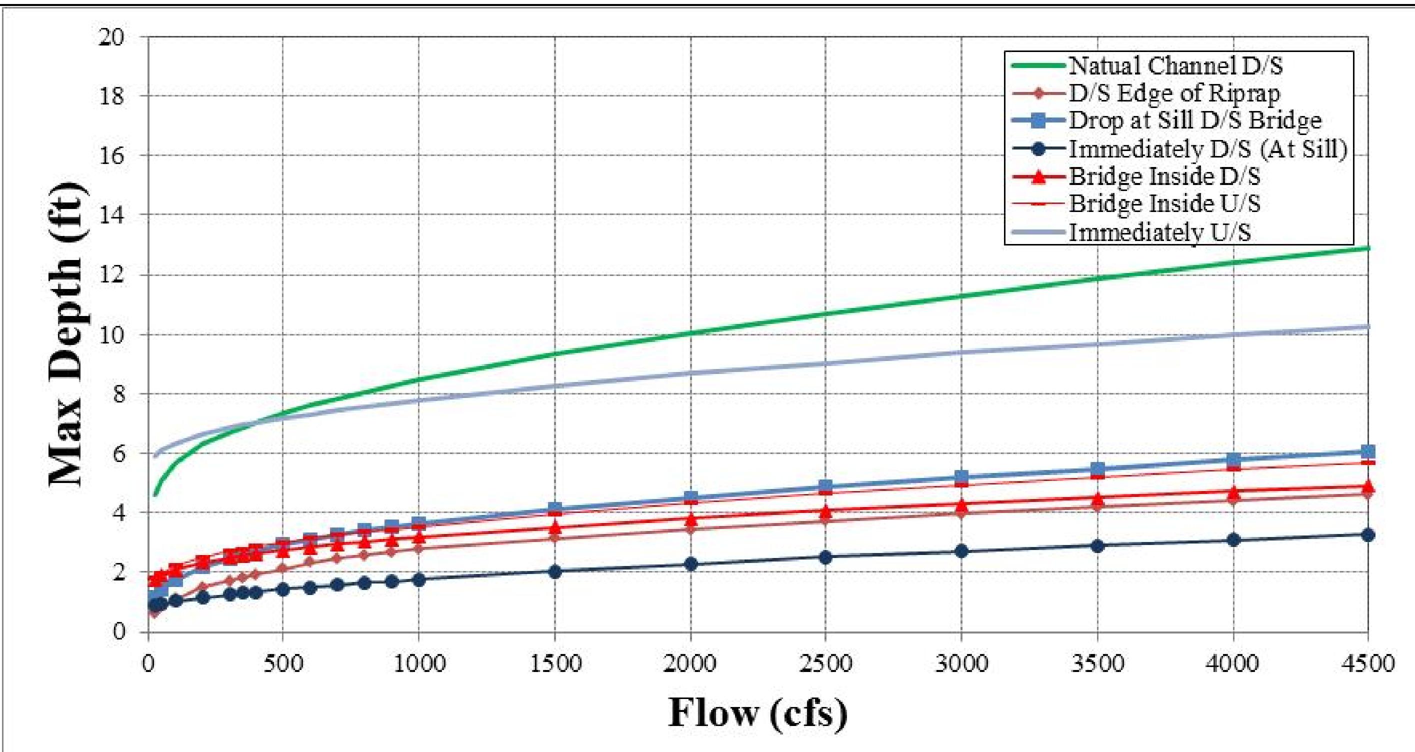
HEC-RAS MODEL BED AND WATER SURFACE PROFILE



HEC-RAS FLOW MODEL RESULTS



Velocity vs. Flow



Max Depth vs. Flow

HEC-RAS FLOW MODEL METADATA

TOPOGRAPHY[1]	
Year:	2008
Creator/Source:	Towill Inc.
Type:	LiDAR Topo
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)

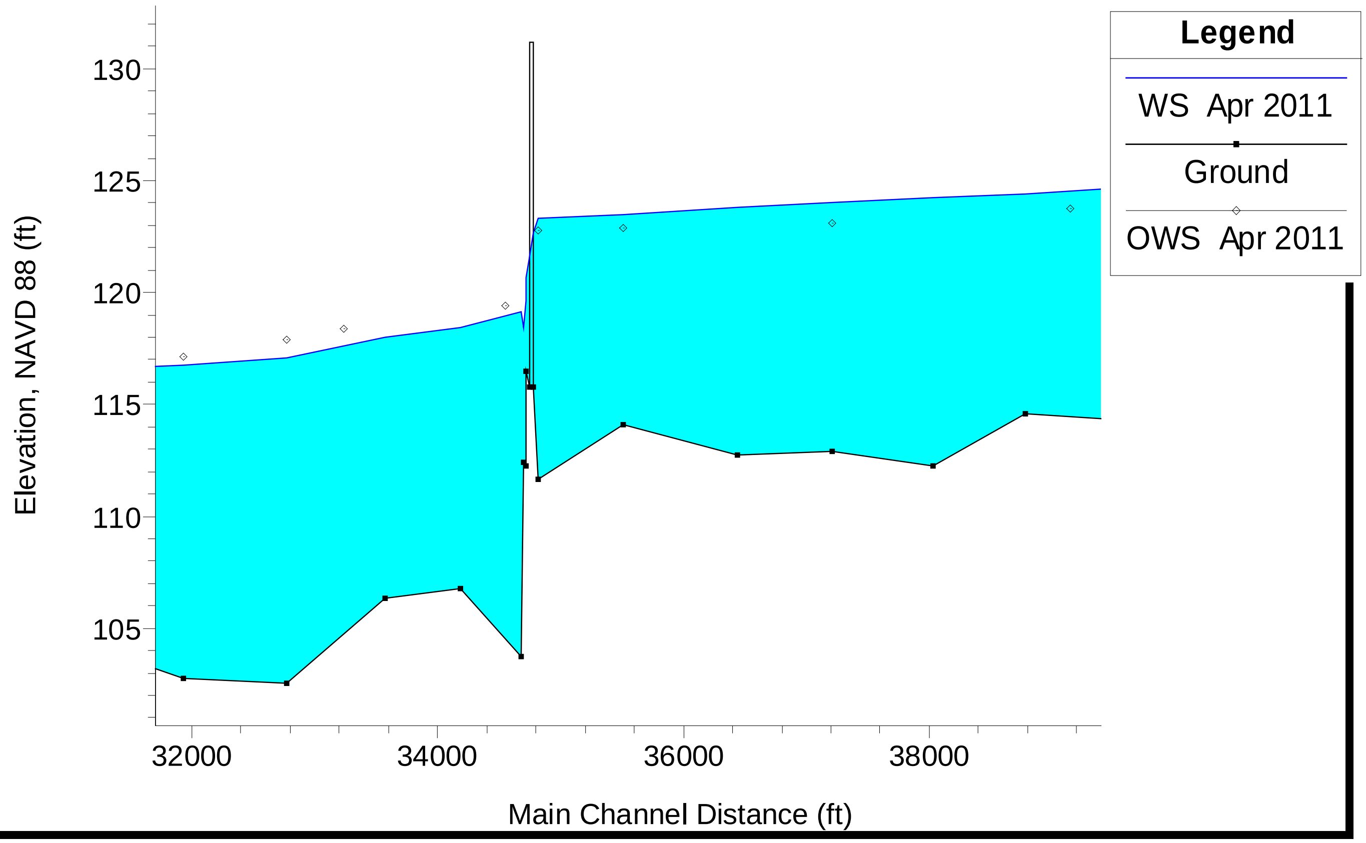
[1]The 2008 LiDAR topography has been adjusted to the varying annual subsidence rates to reflect 2011 conditions.

Summary

- Model - Flows through Avenue 21 were simulated using the HEC-RAS Chowchilla Bypass and Upper Eastside Bypass model developed by DWR's South Central Region Office (SCRO) modeling team.
- Geometry - The structure was based on the as-built design drawing. The geometry was adjusted for subsidence and reflects 2011 conditions.
- Boundary Condition - The reach-wide model has a downstream rating curve developed using Tetra Tech's latest Middle Eastside Bypass model with vertically varied n-values.
- Calibration - The model was calibrated using the water surface elevation data collected by DWR on April 7, 2011; the flow was measured to be 7,470 cfs using an ADCP device. The model water surface elevations were compared to the 2011 measured water surface elevations and were within +/- 1'.

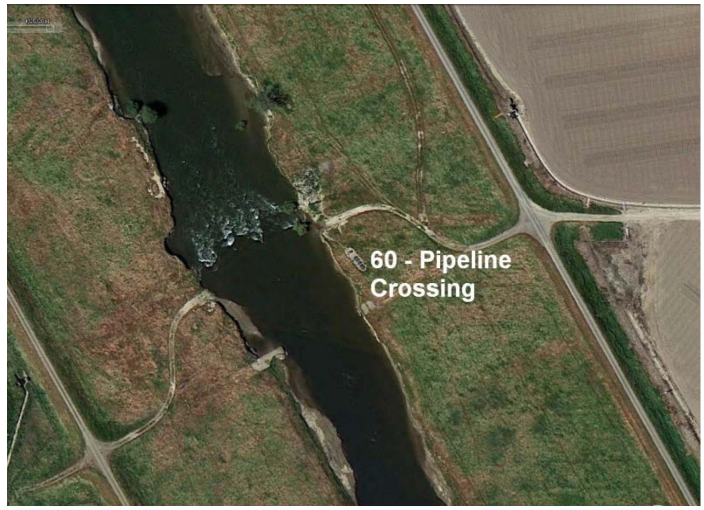
MODEL CALIBRATION

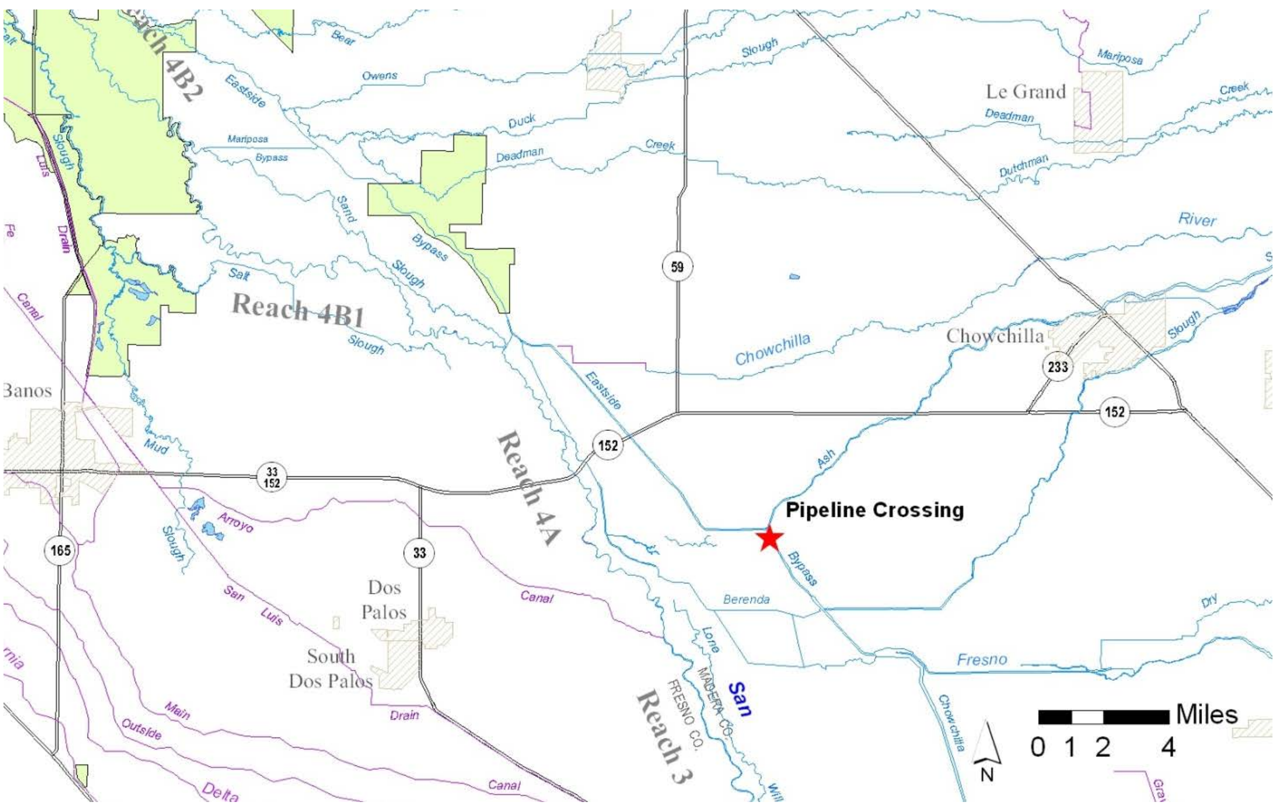
Date: April 7, 2011	Flow (cfs): 7,470	Mean Velocity (ft/s):



BEARINGS

Site Name[3]: EB Pipeline Crossing	I.D. Number[1]: 60	Reach: Eastside Bypass
River Mile:	Barrier Type[1]: Pipe	Rank[1]: Red





STRUCTURE DESCRIPTION

The pipeline crossing is located on the Eastside Bypass just upstream of the confluence with Ash Slough (North of Avenue 18-1/2). The circular pipe is exposed with riprap at the base, and extends the width of the low flow channel (Photo 60_A). The pipe is raised on fill and riprap about 7 feet from the average channel bed elevation. The fill is also used as a vehicular and equipment crossing. The top of the pipe is about 3 feet above the fill and riprap. The pipe appears to be used for irrigation (ditch water) for agricultural use. There are gated structures to the east and west of the bypass levees in line with the pipe.

During the time of the inspection the channel had no flow. The channel is incised in this section of the bypass with depths estimated at 10-20 feet. The channel is mostly silty sand with sparse woody vegetation. The riprap is estimated to extend over 35 feet downstream of the crossing.

Photos:

Photo 60_A. Pipe Crossing looking downstream

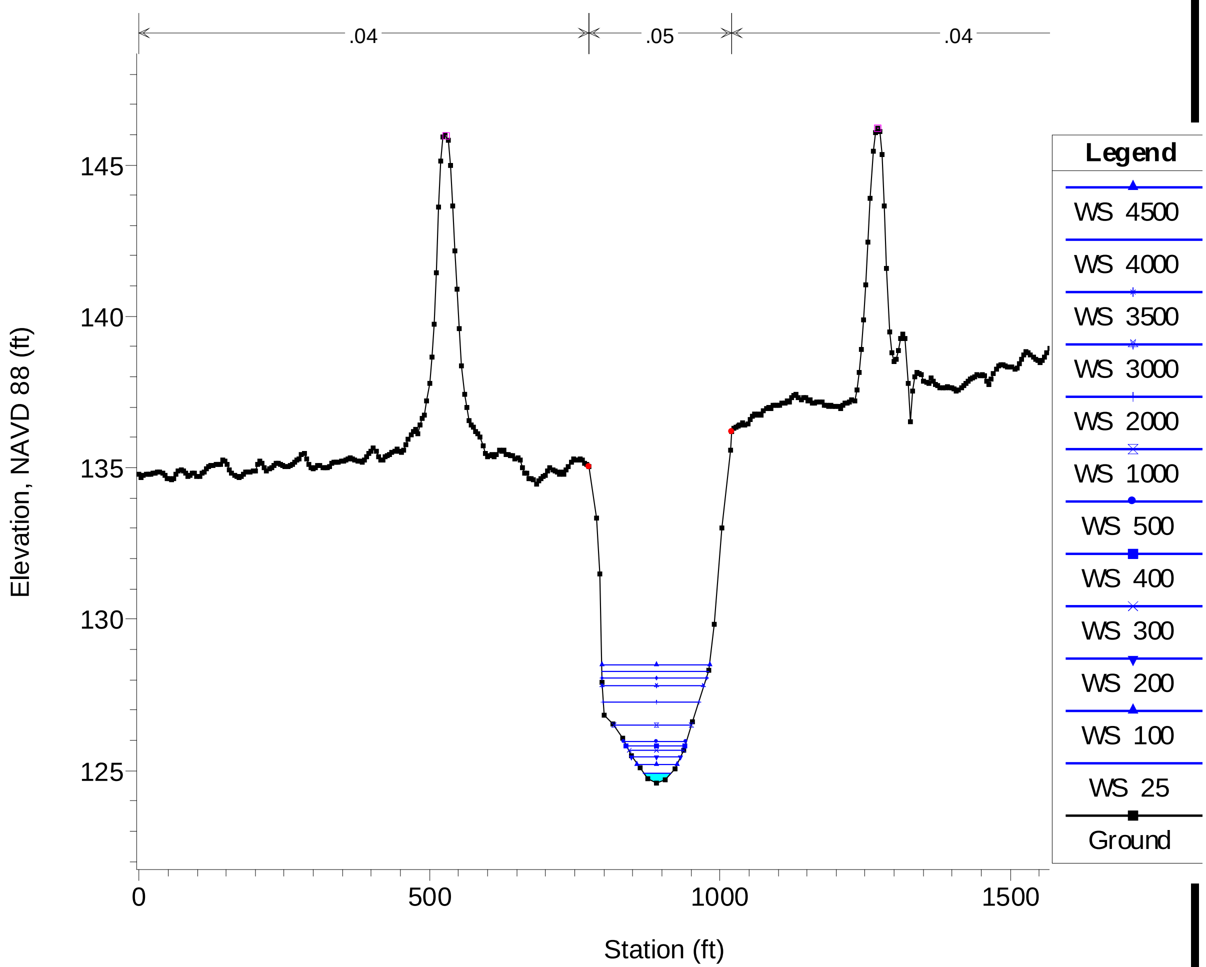
HEC-RAS MODEL SUMMARY TABLE

At Top of Pipe

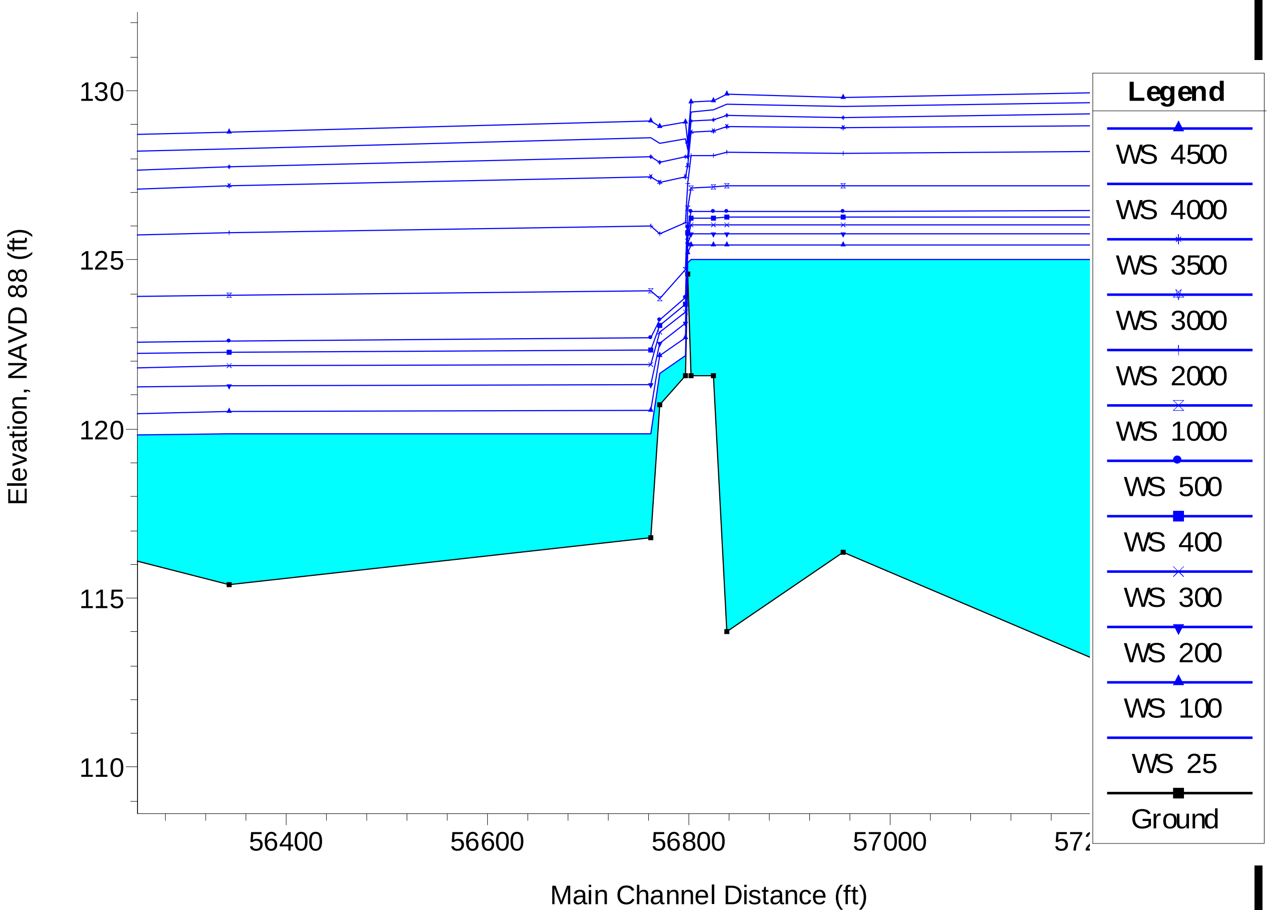
Flow	Maximum Depth	Channel Velocity	Maximum Water Surface Elevation Change
cfs	ft	fps	ft
25	0.32	2.62	3.4
50	0.45	3.06	3.3
100	0.63	3.61	3.3
200	0.88	4.26	3.2
300	1.07	4.69	3.2
350	1.16	4.85	3.2
400	1.23	5.04	3.2
500	1.37	5.33	3.2
600	1.5	5.57	3.2
700	1.62	5.75	3.3
800	1.72	5.94	3.3
900	1.83	6.07	3.3
1000	1.93	6.23	3.3
1500	2.34	6.76	2.9
2000	2.67	7.32	2.3
2500	2.95	7.8	1.9
3000	3.21	8.22	1.5
3500	3.45	8.57	1.3
4000	3.68	8.9	1.0
4500	3.89	9.22	0.8
5000	4.42	8.51	0.6
5500	5	7.87	0.5
6000	5.52	7.52	0.4
6500	5.97	7.32	0.4
7000	6.38	7.22	0.4
7500	6.77	7.16	0.3
8000	7.14	7.13	0.3
8500	7.5	7.11	0.3

The maximum water surface elevation change was estimated based on the difference between the cross sections immediately upstream and downstream the weir.

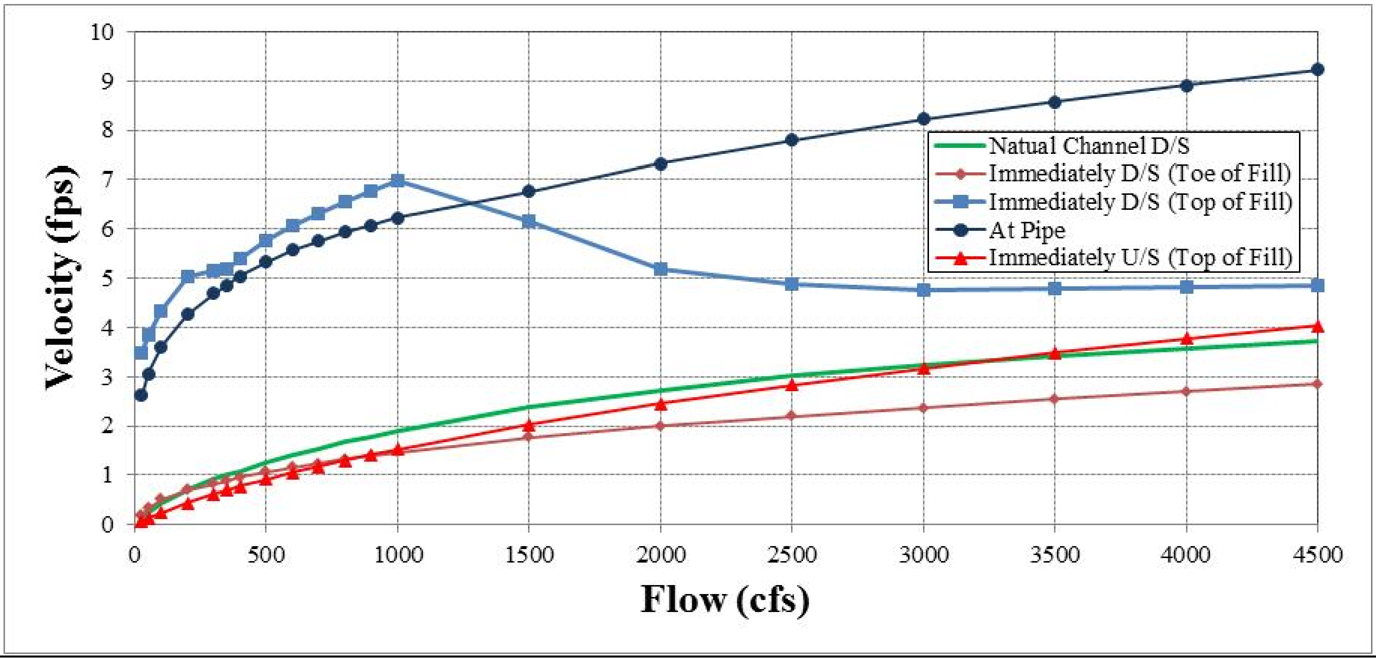
HEC-RAS MODEL STRUCTURE CROSS SECTION



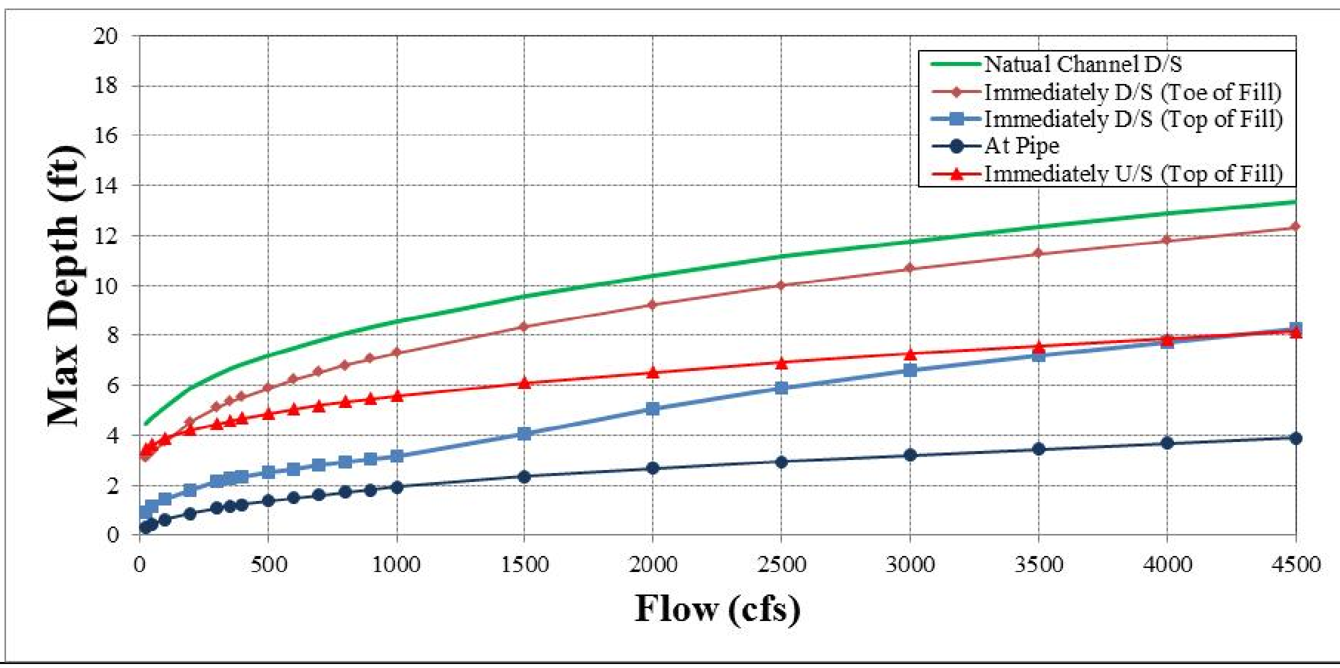
HEC-RAS MODEL BED AND WATER SURFACE PROFILE



HEC-RAS FLOW MODEL RESULTS



Velocity vs. Flow



Max Depth vs. Flow

HEC-RAS FLOW MODEL METADATA

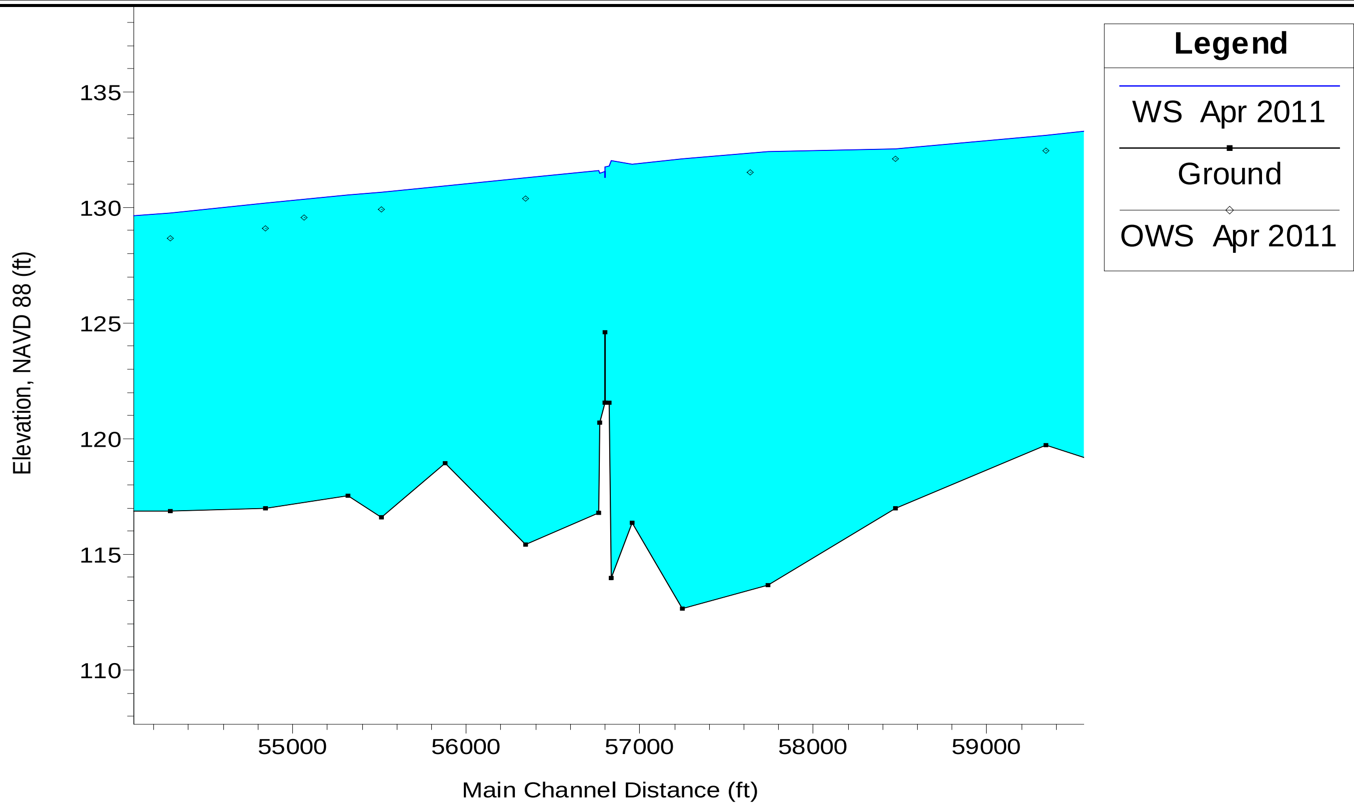
TOPOGRAPHY[1]	
Year:	2008
Creator/Source:	Towill Inc.
Type:	LiDAR Topo
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)

[1]The 2008 LiDAR topography has been adjusted to the varying annual subsidence rates to reflect 2011 conditions.

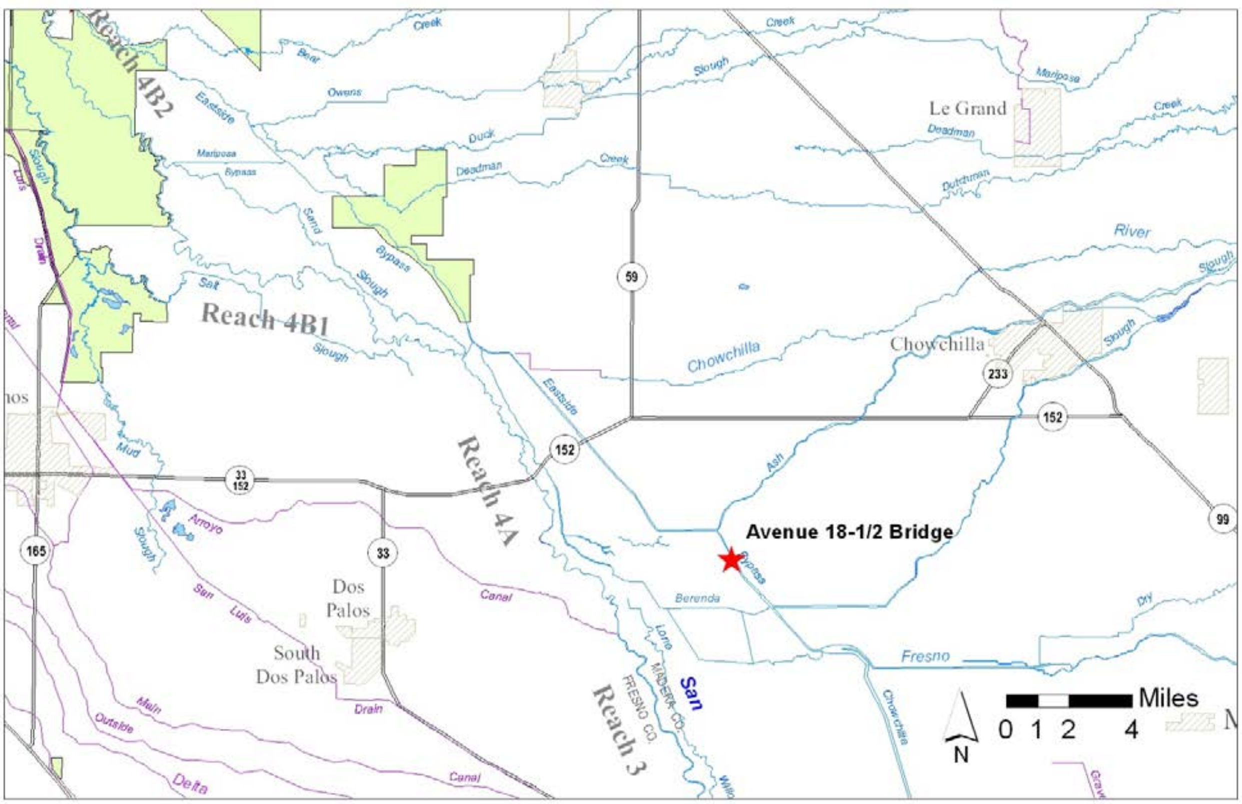
Summary

- Model - Flows through the pipeline crossing were simulated using the HEC-RAS Chowchilla Bypass and Upper Eastside Bypass model developed by DWR-SCRO modeling team.
- Geometry - The structure was based on survey information collected by DWR via P&P. The geometry was adjusted for subsidence and reflects 2011 conditions.
- Boundary Condition - The reach-wide model has a downstream rating curve developed using Tetra Tech's latest Middle Eastside Bypass model with vertically varied n-values.
- Calibration - The model was calibrated using the water surface elevation data collected by DWR on April 6, 2011; the flow was measured to be 7,160 cfs using an ADCP device. The model water surface elevations were compared to the 2011 measured water surface elevations and were within +/- 1'.

MODEL CALIBRATION		
Date: April 6, 2011	**Flow (cfs):** 7,160	**Mean Velocity (ft/s):**



BEARINGS		
Site Name[4]: Avenue 18-1/2	**I.D. Number[1]:** 61	**Reach:** Eastside Bypass
River Mile:	**Barrier Type[1]:** Bridge	**Rank[1]:** **Red**



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4 SJRRP Fish Passage Evaluation, Task 1 Draft Technical Memorandum, February 2011

STRUCTURE DESCRIPTION

Avenue 18-1/2 is a two lane concrete bridge located on the Eastside Bypass. The bridge does not span the entire bypass channel and only extends the width of the low flow channel. The bridge is slightly skew with large riprap and cobble on the abutments, and heavy riprap in the channel bottom under the bridge. The riprap averages about two feet in depth.

The channel upstream is void of major vegetation and shallow. The riprap under the bridge extends upstream about 50 feet (Photo 58_A). The channel just downstream is incised with a significant drop (headcut) with riprap that extends about 50 feet downstream of the bridge (Photo 85_B). A two- foot-wide asphalt sill is about 15 feet downstream of the bridge and spans the channel bottom. The riprap just past the asphalt sill gradually slopes down to the channel bottom. The channel substrate is mostly silty sand. The floodplain has mostly short annual grasses with sparse patches of tall annual grasses.

Photos:

Photo 58_A. Avenue 18-1/2 Bridge looking upstream

Photo 58_B. Avenue 18-1/2 Bridge looking downstream

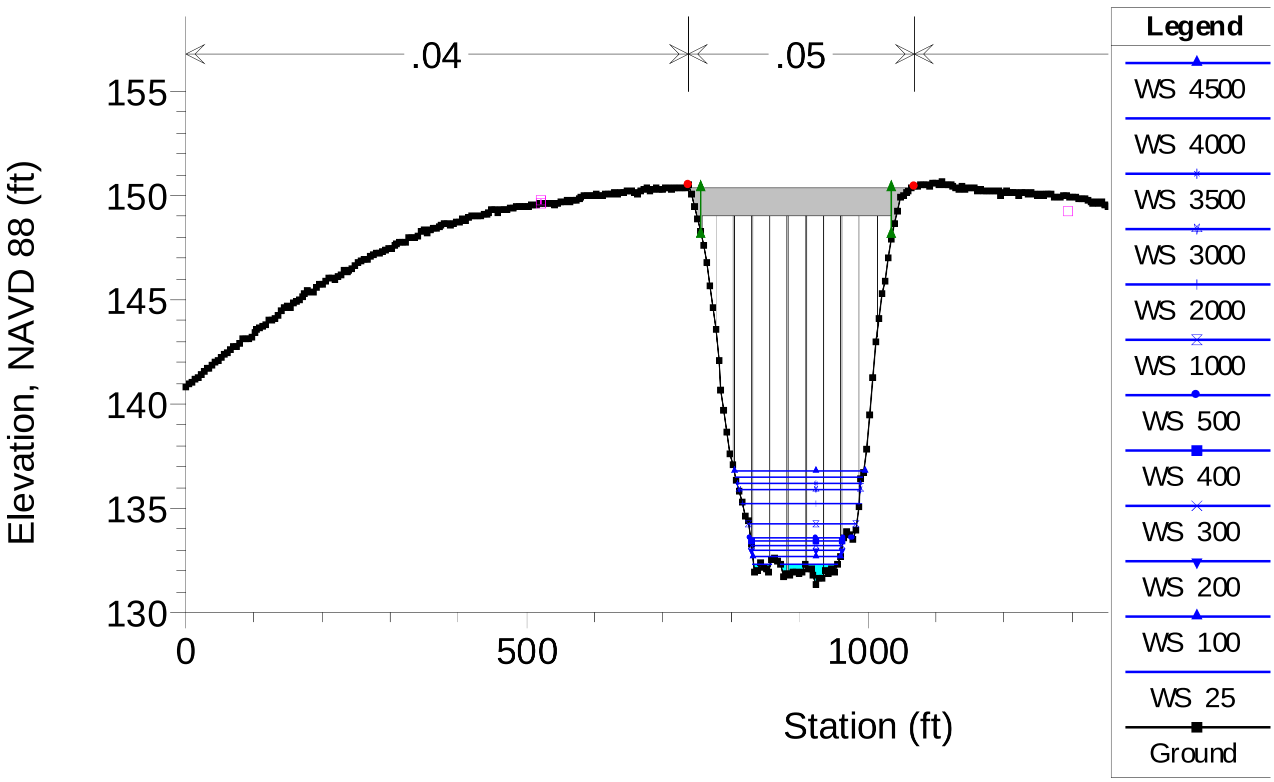
HEC-RAS MODEL SUMMARY TABLE

Avenue 18-1/2 Bridge Inside Downstream (D/S)

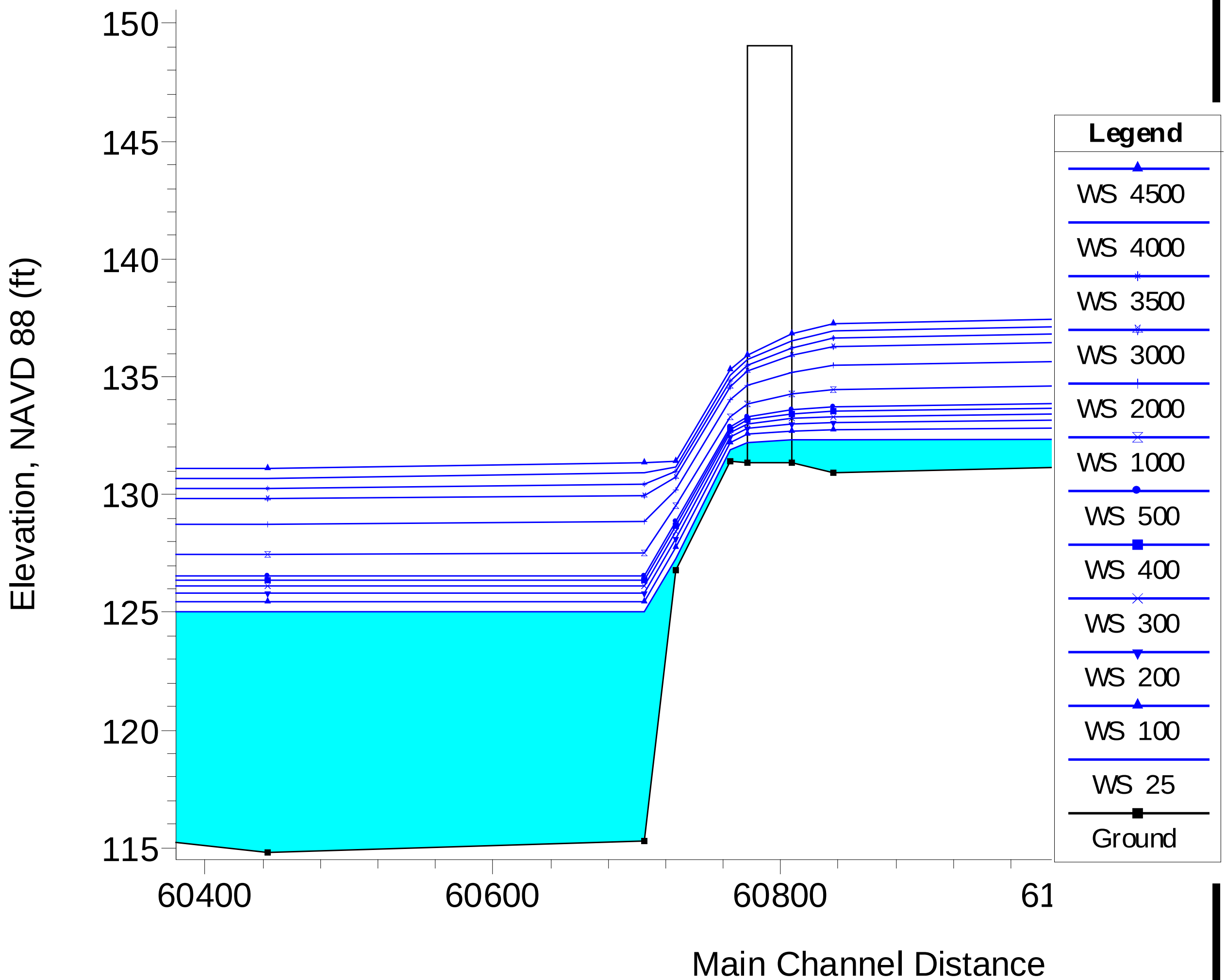
Flow	Maximum Depth	Channel Velocity	Maximum Water Surface Elevation Change
cfs	ft	fps	ft
25	0.81	1	0.4
50	0.96	1.24	0.4
100	1.17	1.59	0.5
200	1.44	2.08	0.6
300	1.62	2.51	0.7
350	1.71	2.7	0.8
400	1.78	2.88	0.8
500	1.92	3.19	0.8
600	2.05	3.47	0.9
700	2.16	3.74	1.0
800	2.27	3.96	1.1
900	2.38	4.16	1.1
1000	2.48	4.33	1.2
1500	2.9	5.11	1.3
2000	3.26	5.75	1.5
2500	3.58	6.28	1.6
3000	3.86	6.76	1.7
3500	4.11	7.24	1.8
4000	4.33	7.69	1.9
4500	4.55	8.08	2.0
5000	4.75	8.46	2.1
5500	4.94	8.81	2.2
6000	5.13	9.12	2.3
6500	5.31	9.44	2.3
7000	5.48	9.71	2.4
7500	5.62	10.05	2.4
8000	5.76	10.37	2.5
8500	5.89	10.7	2.5

The maximum water surface elevation change was estimated based on the difference between the cross sections immediately upstream and downstream the bridge.

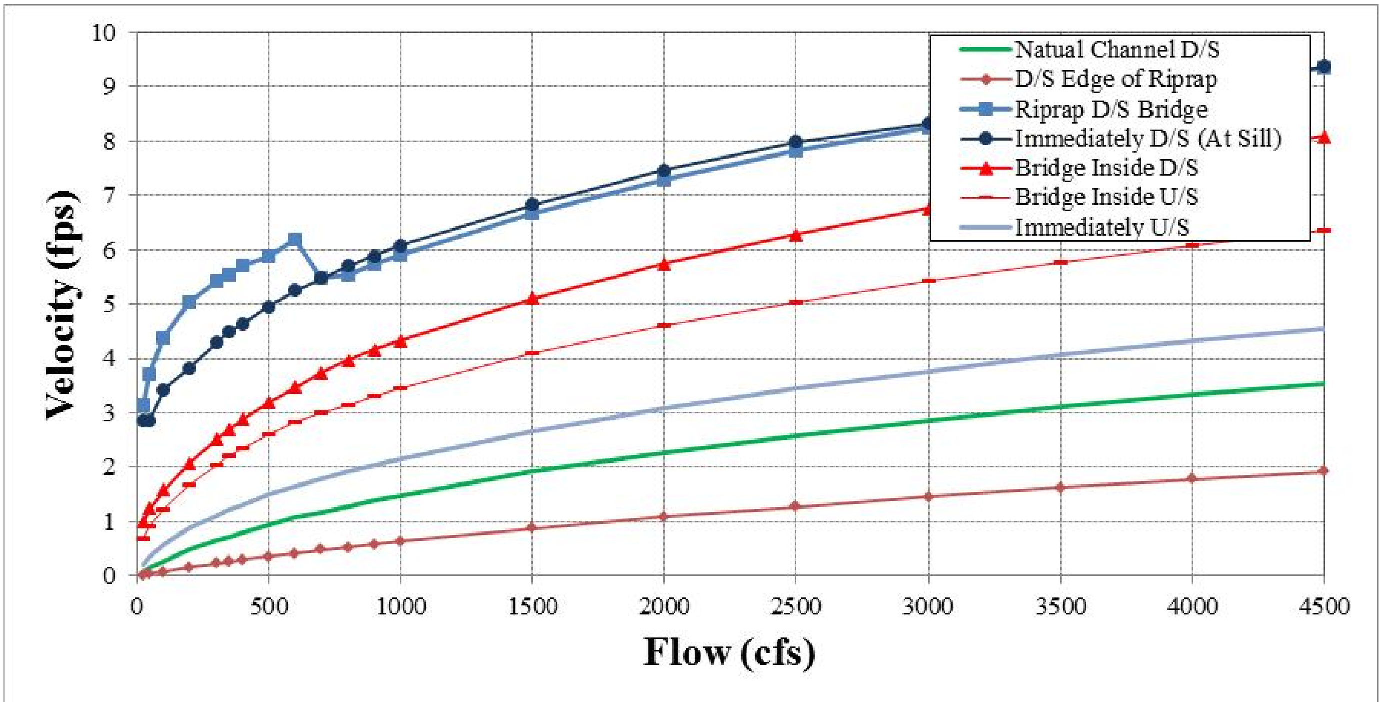
HEC-RAS MODEL STRUCTURE CROSS SECTION



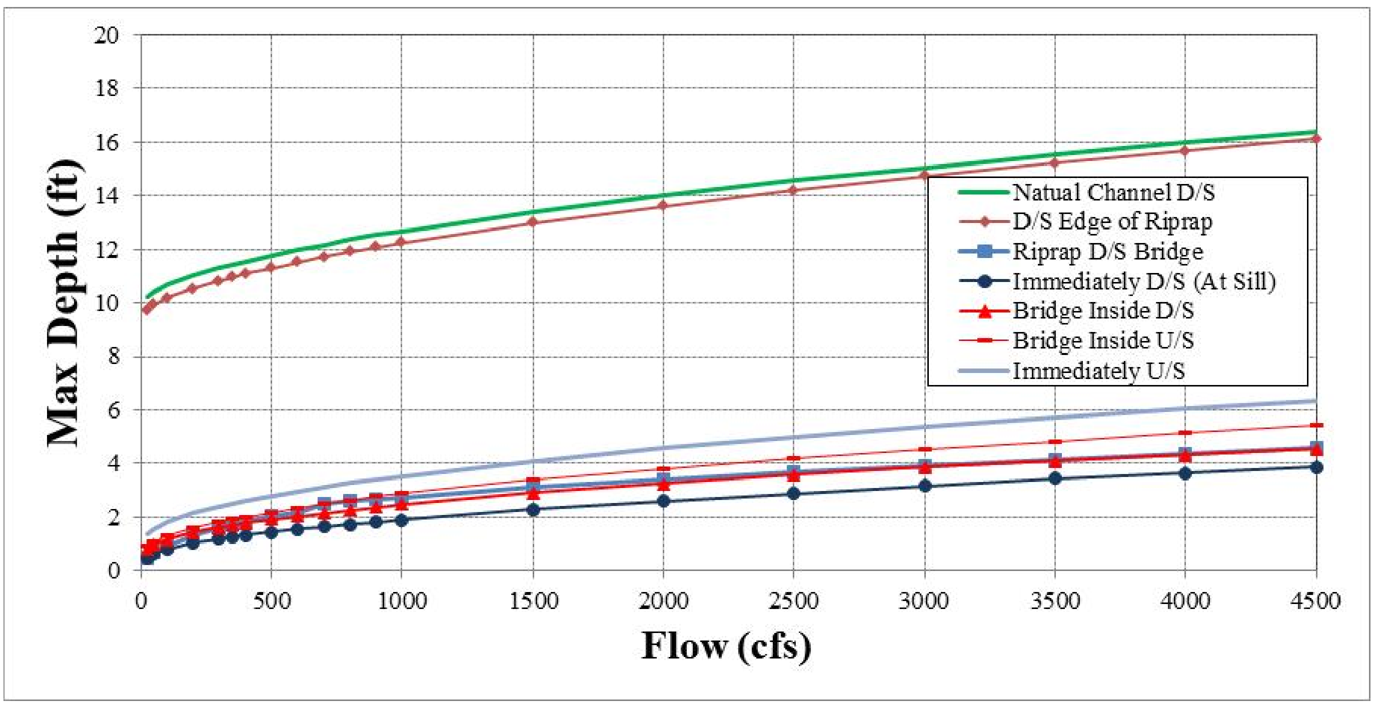
HEC-RAS MODEL BED AND WATER SURFACE PROFILE



HEC-RAS FLOW MODEL RESULTS



Velocity vs. Flow



Max Depth vs. Flow

HEC-RAS FLOW MODEL METADATA

TOPOGRAPHY[1]	
Year:	2008
Creator/Source:	Towill Inc.
Type:	LiDAR Topo
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)

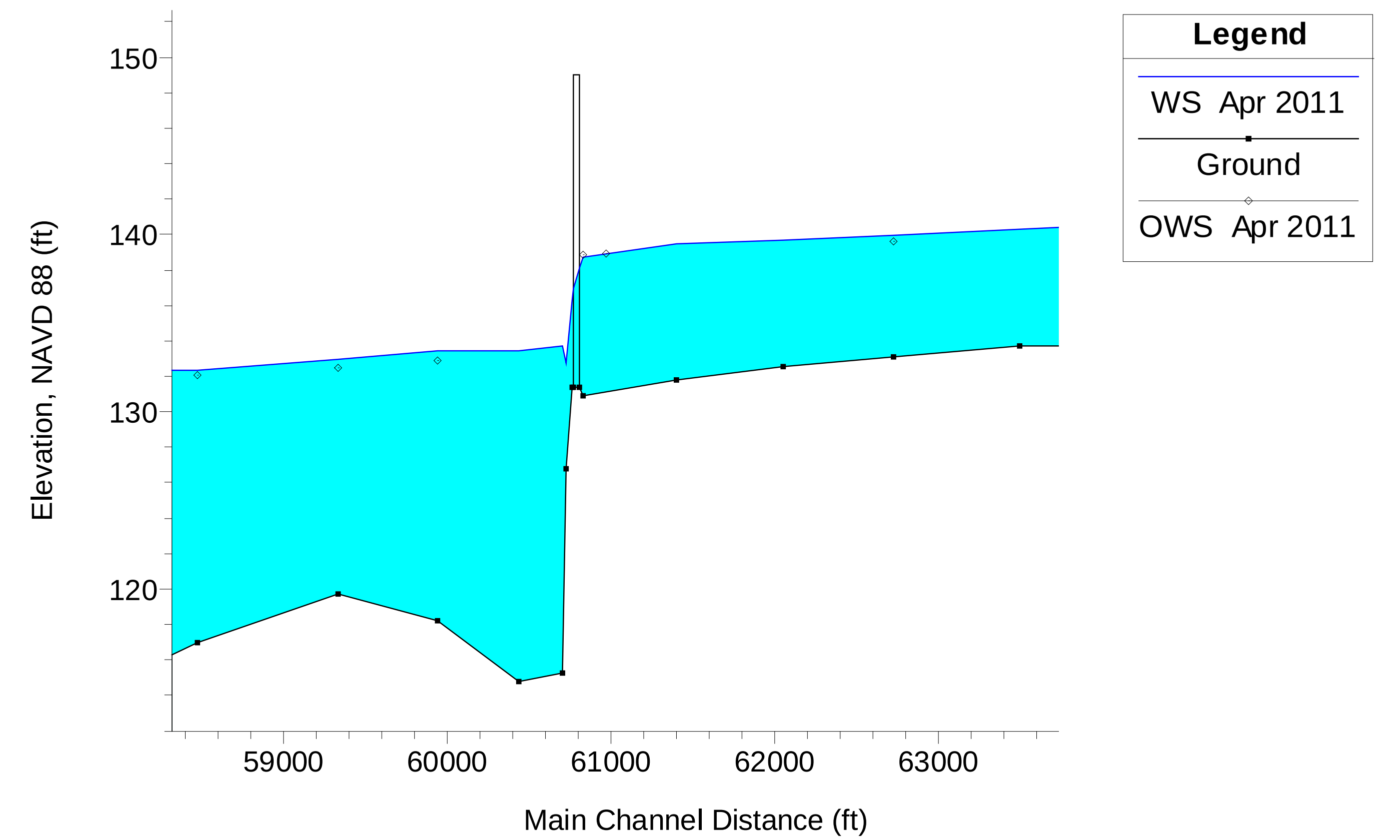
[1]The 2008 LiDAR topography has been adjusted to the varying annual subsidence rates to reflect 2011 conditions.

Summary

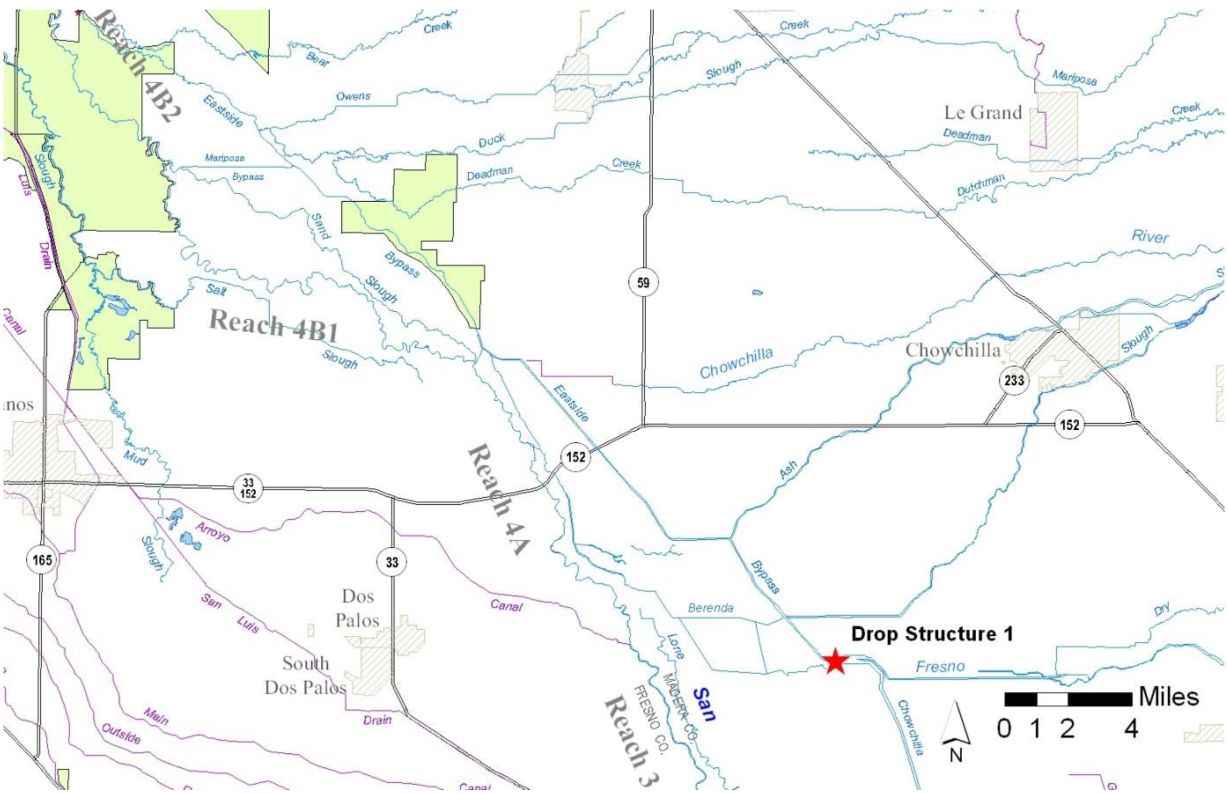
- Model - Flows through Avenue 18-1/2 were simulated using the HEC-RAS Chowchilla Bypass and Upper Eastside Bypass model developed by DWR-SCRO modeling team.
- Geometry - The structure was based on the as-built design drawing. The geometry was adjusted for subsidence and reflects 2011 conditions.
- Boundary Condition - The reach-wide model has a downstream rating curve developed using Tetra Tech's latest Middle Eastside Bypass model with vertically varied n-values.
- Calibration - The model was calibrated using the water surface elevation data collected by DWR on April 6, 2011; the flow was measured to be 7,160 cfs using an ADCP device. The model water surface elevations were compared to the 2011 measured water surface elevations and were within +/- 1'.

MODEL CALIBRATION

Date: April 6, 2011	**Flow (cfs):** 7,160	**Mean Velocity (ft/s):**



BEARINGS			
Site Name[5]: EB Drop Structure 1		**I.D. Number[1]:** 64	**Reach:** Eastside Bypass
River Mile:	**Barrier Type[1]:** Weir		**Rank[1]:** **Red**



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[5] SJRRP Fish Passage Evaluation, Task 1 Draft Technical Memorandum, February 2011

STRUCTURE DESCRIPTION

Drop 1 is a concrete weir located on the Eastside Bypass just downstream of the Fresno River confluence with the Bypass (East of Road 9). The weir extends the width of the low flow channel and cannot be bypassed. The weir has a concrete apron with concrete baffles downstream of the weir (Photo 64_A). There are large concrete wingwalls and an earthen levee that extends to the bypass levees to divert all flows into and over the weir.

During the time of the inspection the channel had no flow. The channel upstream is clean, void of major vegetation, with a low flow channel and scour pools about three to four feet deep. There is a second drop structure, Drop 2 (ID No. 65), about 2,000 feet upstream (Photo 64_B). The channel just downstream is clean with riprap scour protection near the structures' wingwalls (Photo 64_C). Road 9 (Hemlock) Bridge (ID No. 63) is just downstream of the weir about 200 feet. The channel substrate is mostly silty sand. The floodplain has mostly tall annual grasses.

Photos:

Photo 64_A. Drop 1 looking upstream

Photo 64_B. Drop 2 upstream

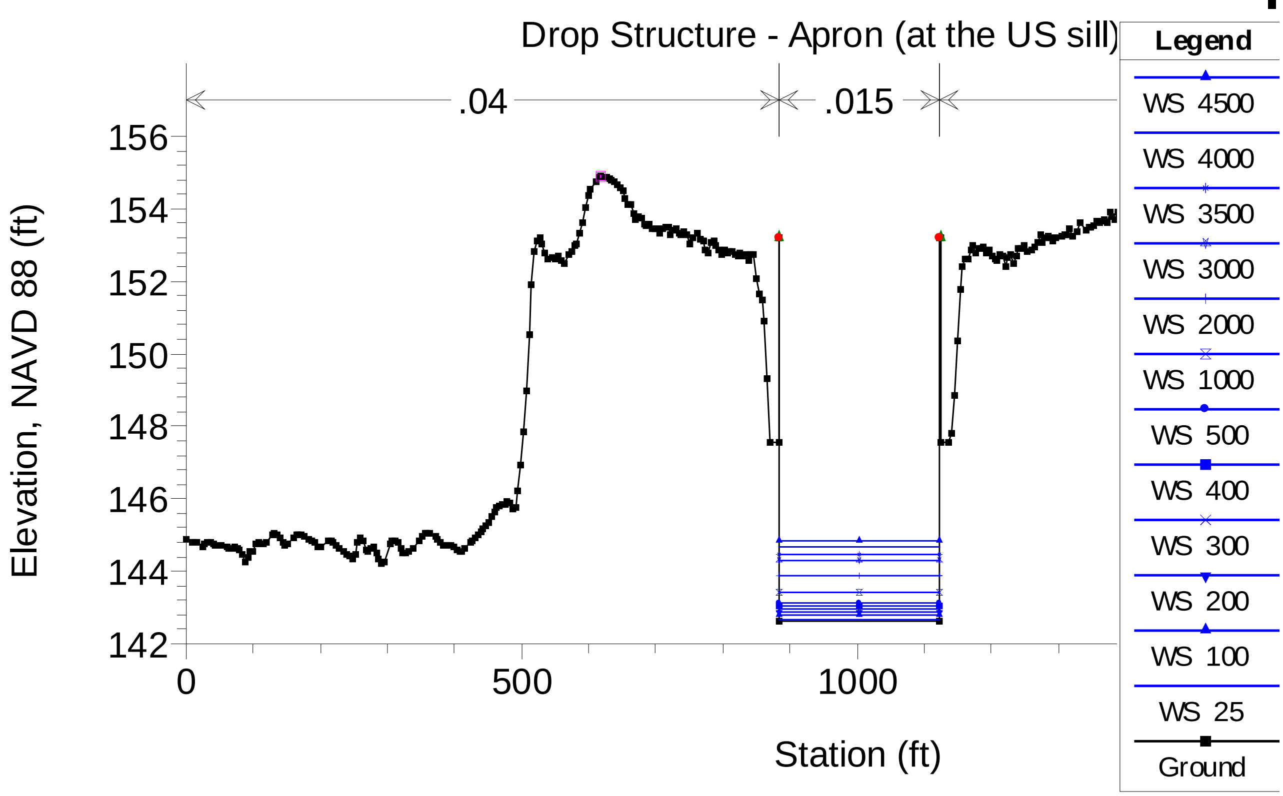
HEC-RAS MODEL SUMMARY TABLE

Drop 1 at Weir

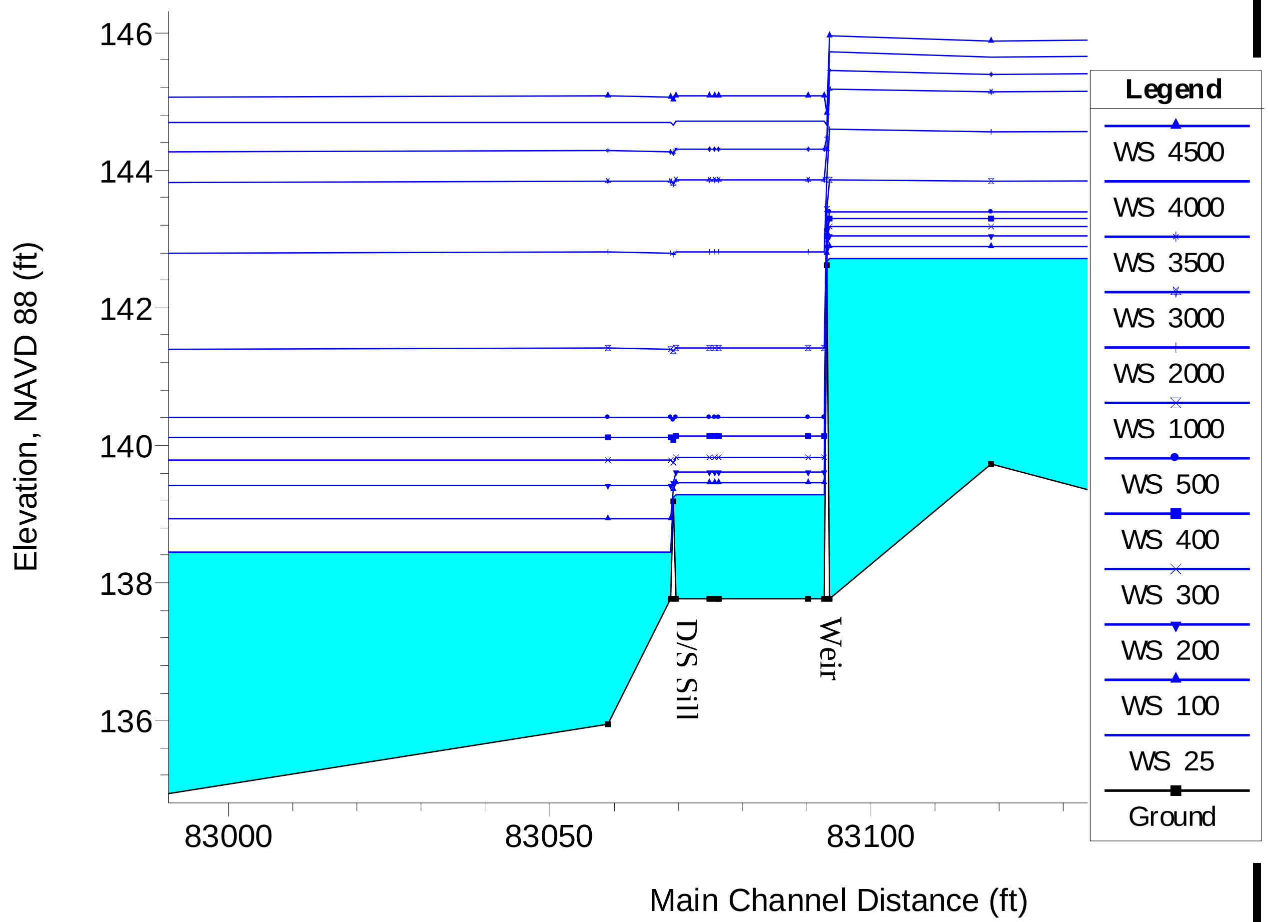
Flow	Maximum Depth	Channel Velocity	Maximum Water Surface Elevation Change
cfs	ft	fps	ft
25	0.07	1.48	3.4
50	0.11	1.89	3.4
100	0.17	2.39	3.4
200	0.27	3.04	3.4
300	0.37	3.39	3.3
350	0.4	3.64	3.3
400	0.44	3.81	3.2
500	0.51	4.05	3.0
600	0.58	4.31	2.8
700	0.64	4.52	2.7
800	0.7	4.75	2.6
900	0.76	4.92	2.5
1000	0.81	5.11	2.4
1500	1.07	5.87	2.1
2000	1.29	6.47	1.8
2500	1.5	6.93	1.5
3000	1.69	7.38	1.3
3500	1.87	7.8	1.2
4000	2.05	8.12	1.0
4500	2.22	8.46	0.9
5000	2.38	8.76	0.8
5500	2.54	9.02	0.6
6000	2.69	9.3	0.6
6500	2.92	9.26	0.5
7000	3.28	8.89	0.4
7500	3.57	8.75	0.4
8000	3.85	8.67	0.4
8500	4.1	8.64	0.4

The maximum water surface elevation change was estimated based on the difference between the cross sections immediately upstream and downstream the weir.

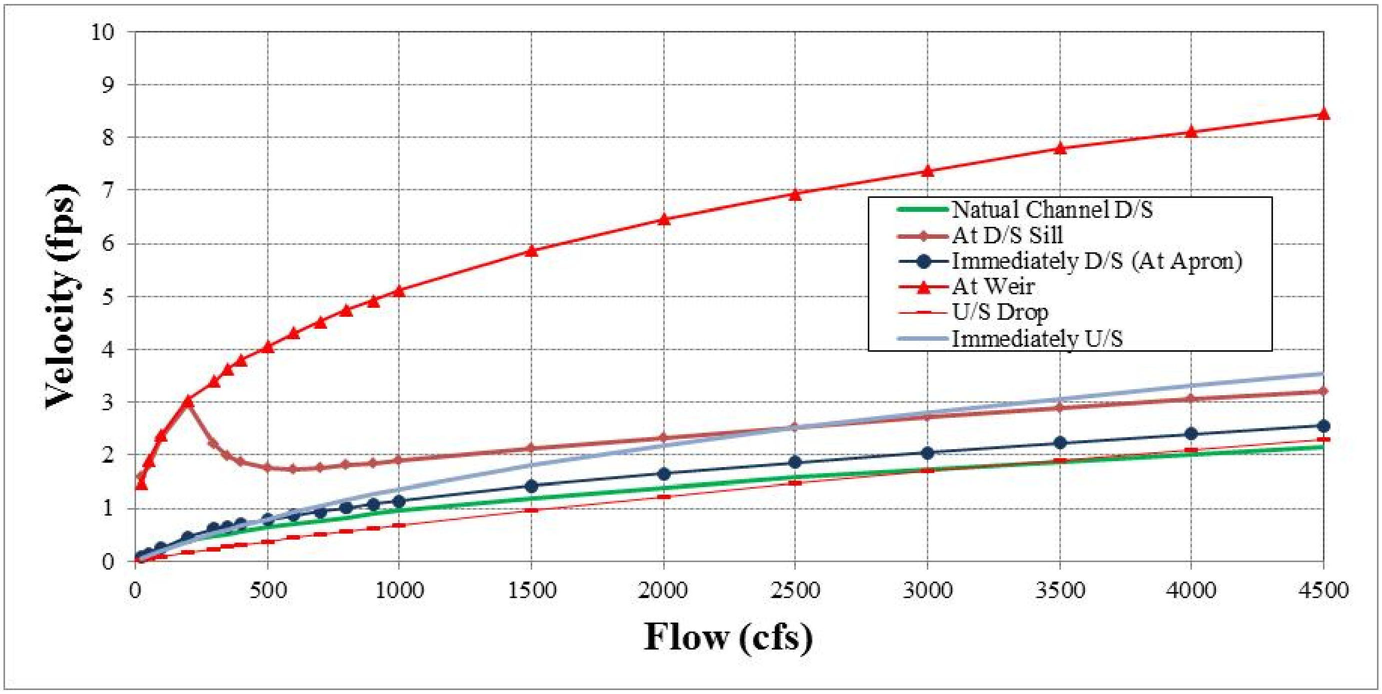
HEC-RAS MODEL STRUCTURE CROSS SECTION



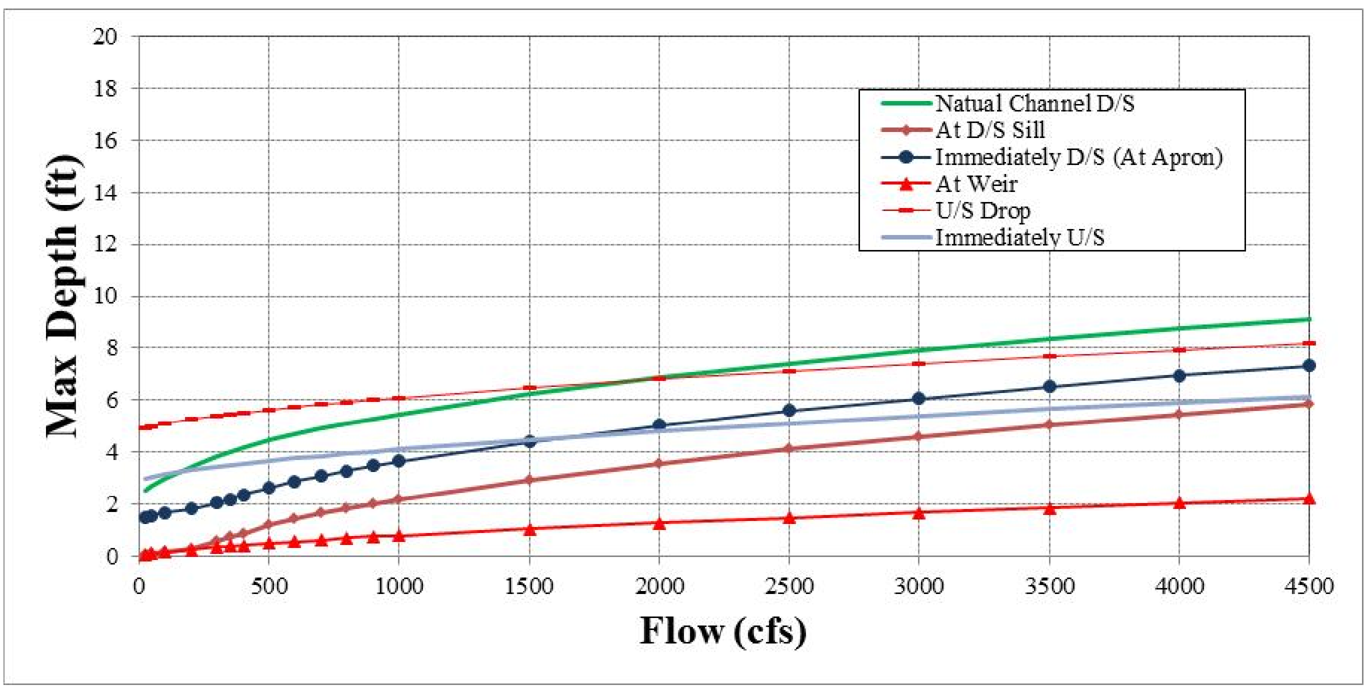
HEC-RAS MODEL BED AND WATER SURFACE PROFILE



HEC-RAS FLOW MODEL RESULTS



Velocity vs. Flow



Max Depth vs. Flow

HEC-RAS FLOW MODEL METADATA

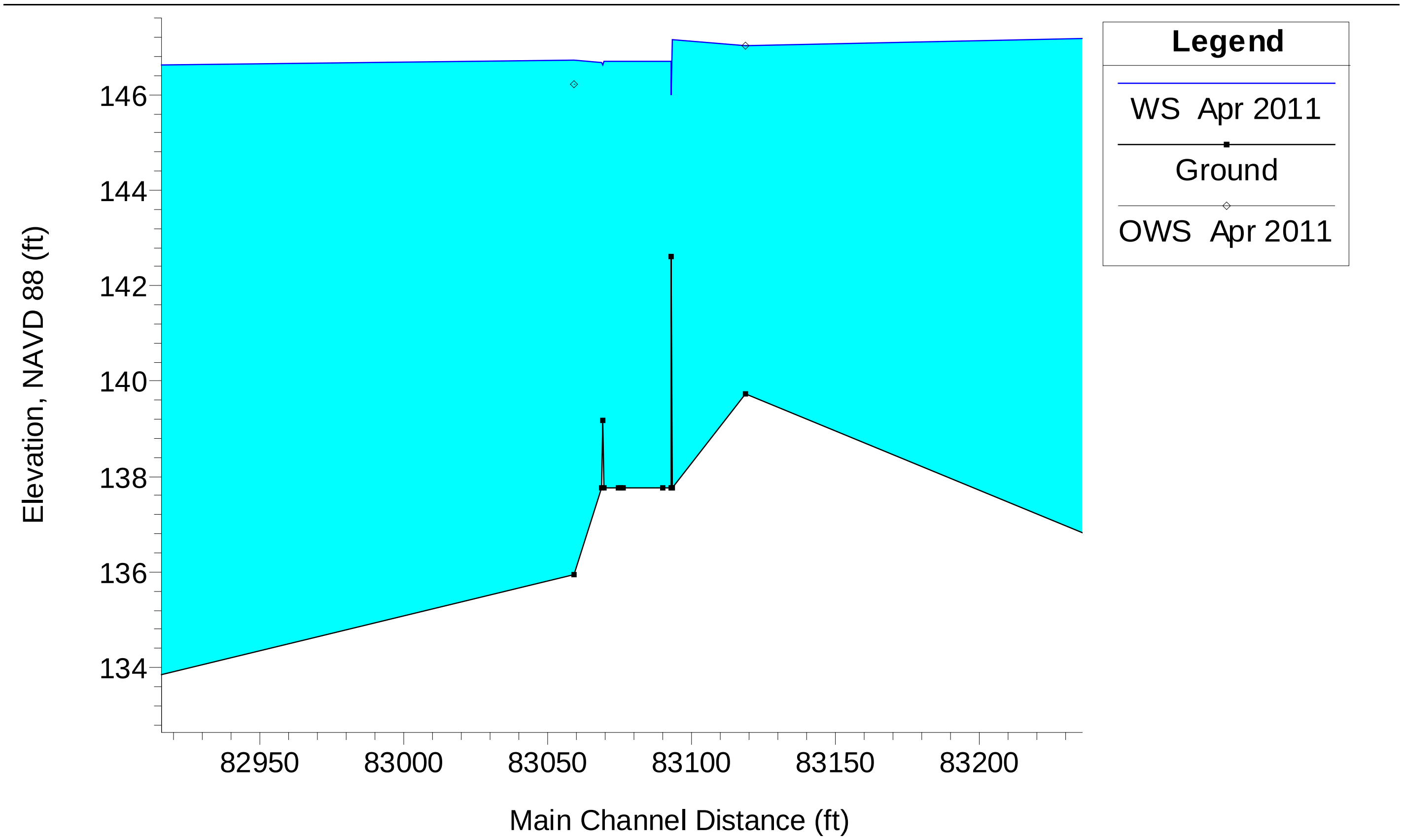
TOPOGRAPHY[1]	
Year:	2008
Creator/Source:	Towill Inc.
Type:	LiDAR Topo
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)

[1]The 2008 LiDAR topography has been adjusted to the varying annual subsidence rates to reflect 2011 conditions.

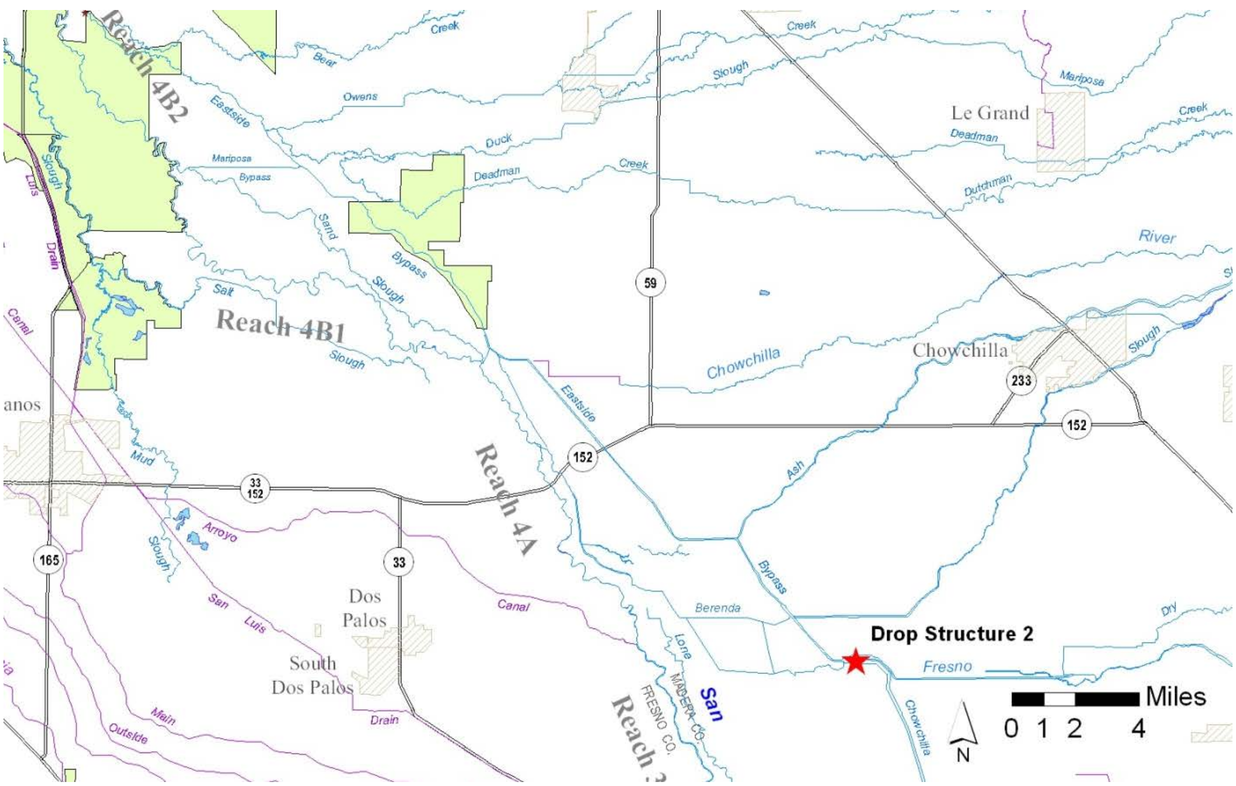
Summary

- Model - Flows through Drop Structure 1 (The Downstream Drop Structure) were simulated using the HEC-RAS Chowchilla Bypass and Upper Eastside Bypass model developed by DWR-SCRO modeling team.
- Geometry - The structure is based on survey data and the as-built design drawing. The geometry was adjusted for subsidence and reflects 2011 conditions.
- Boundary Condition - The reach-wide model has a downstream rating curve developed using Tetra Tech's latest Middle Eastside Bypass model with vertically varied n-values.
- Calibration - The model was calibrated using the water surface elevation data collected by DWR on April 6, 2011; the flow was measured to be 7,160 cfs using an ADCP device. The model water surface elevations were compared to the 2011 measured water surface elevations and were within +/- 1'.

MODEL CALIBRATION		
Date: April 6, 2011	**Flow (cfs):** 7,160	**Mean Velocity (ft/s):**



BEARINGS		
Site Name[6]: EB Drop Structure 2	**I.D. Number[1]:** 65	**Reach:** Eastside Bypass
River Mile:	**Barrier Type[1]:** Weir	**Rank[1]:** **Red**



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STRUCTURE DESCRIPTION

Drop 2 is a concrete weir located on the Eastside Bypass just upstream of the Fresno River confluence with the Bypass (East of Road 9). The weir extends the length of the low flow channel and cannot be bypassed at higher flows. The weir has a concrete apron that is about 20 feet long with concrete baffles about 15 feet downstream of the weir (Photo 65_A). There are large concrete wingwalls and an earthen levee that extends to the bypass levees to divert all flows into and over the weir. The channel just downstream is clean, void of major vegetation, with riprap scour protection downstream of the concrete apron and wingwalls for about 20 feet. Drop 1 (ID No. 64) is about 2,000 feet downstream.

Photos:

Photo 65_A. Drop 2 looking upstream

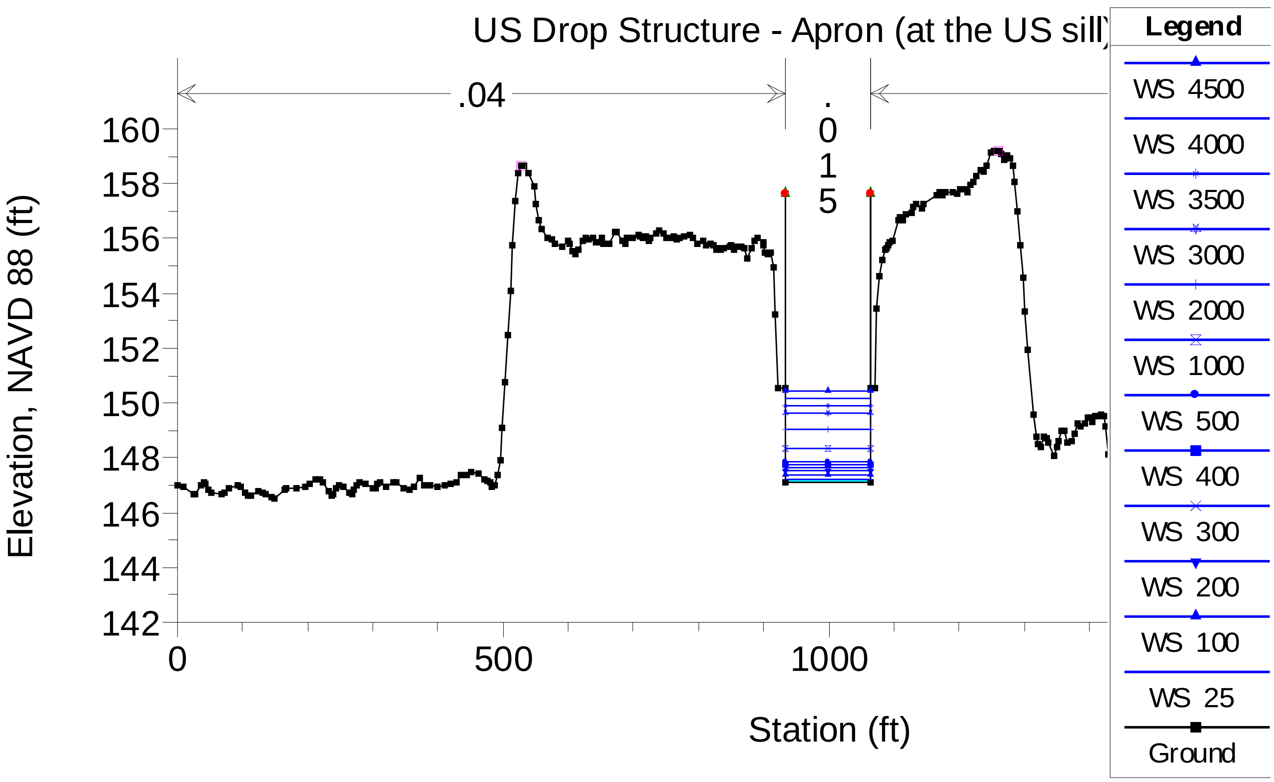
HEC-RAS MODEL SUMMARY TABLE

Drop 2 at Weir

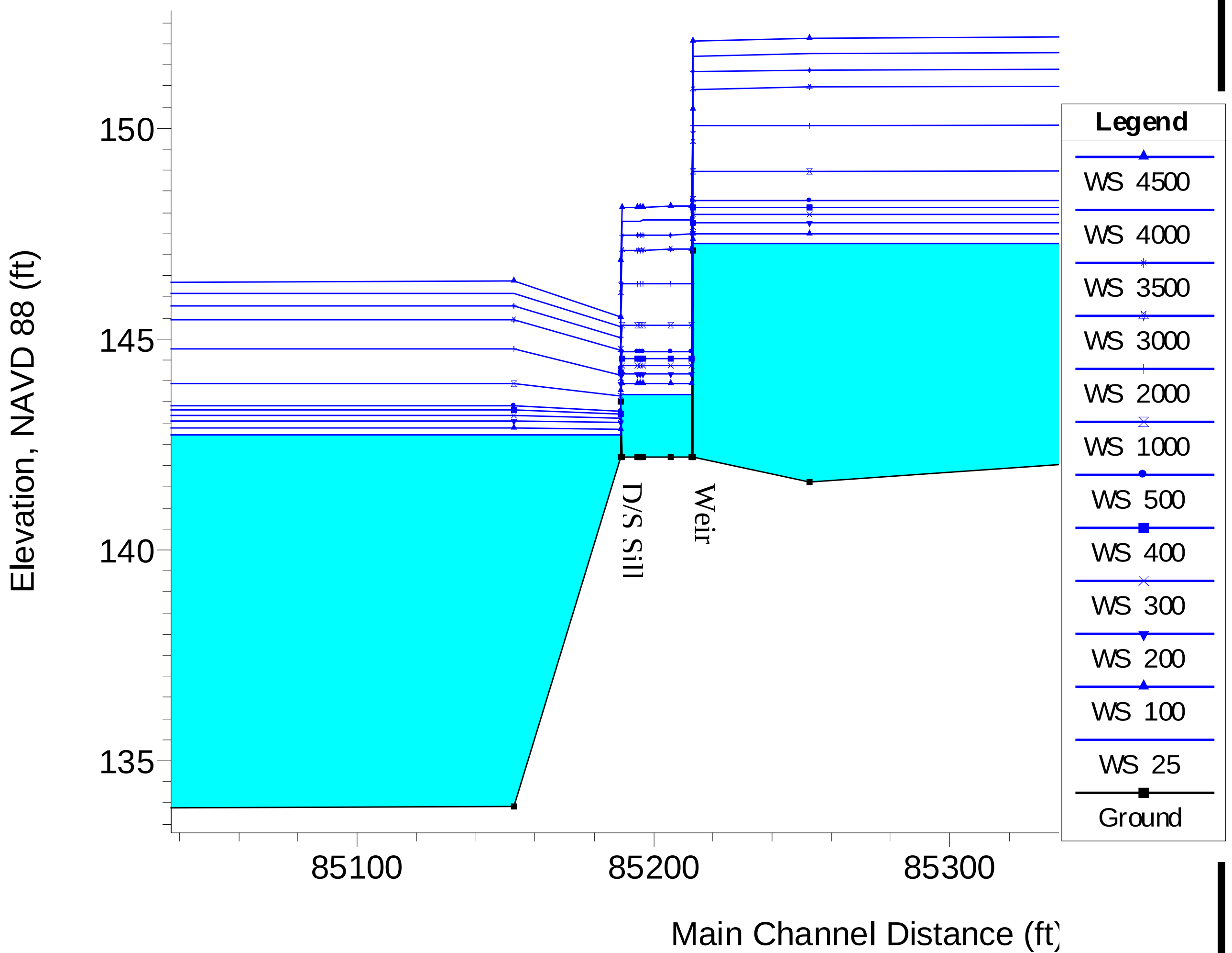
Flow	Maximum Depth	Channel Velocity	Maximum Water Surface Elevation Change
cfs	ft	fps	ft
25	0.11	1.82	3.6
50	0.16	2.35	3.6
100	0.27	2.88	3.6
200	0.42	3.67	3.6
300	0.55	4.22	3.6
350	0.61	4.43	3.6
400	0.66	4.65	3.6
500	0.77	4.98	3.6
600	0.87	5.31	3.6
700	0.97	5.58	3.6
800	1.05	5.85	3.6
900	1.14	6.09	3.6
1000	1.22	6.28	3.6
1500	1.6	7.2	3.7
2000	1.95	7.89	3.7
2500	2.26	8.51	3.8
3000	2.55	9.05	3.8
3500	2.82	9.55	3.9
4000	3.07	10.01	3.9
4500	3.34	10.36	3.9
5000	3.58	10.74	3.9
5500	3.82	11.09	4.0
6000	4.04	11.42	4.0
6500	4.27	11.72	4.1
7000	4.49	12	4.1
7500	4.7	12.28	4.1
8000	4.9	12.55	4.1
8500	5.1	12.82	4.2

The maximum water surface elevation change was estimated based on the difference between the cross sections immediately upstream and downstream the weir.

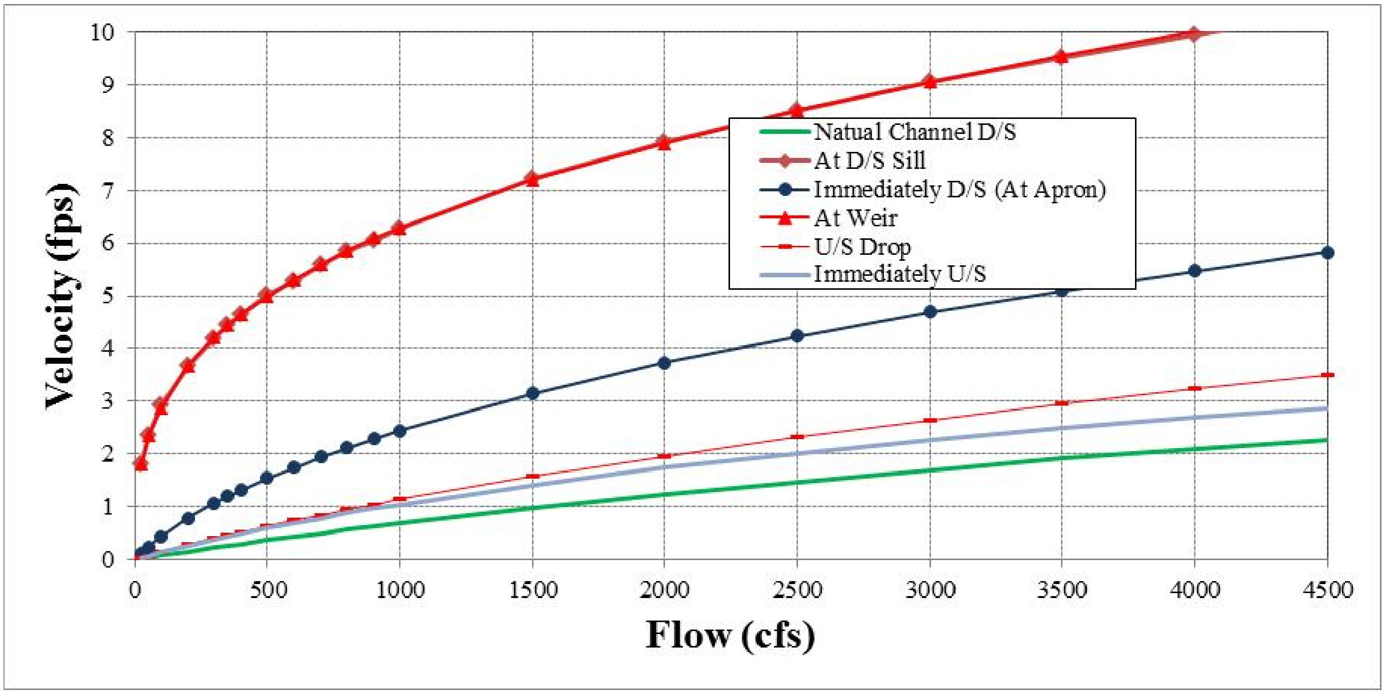
HEC-RAS MODEL STRUCTURE CROSS SECTION



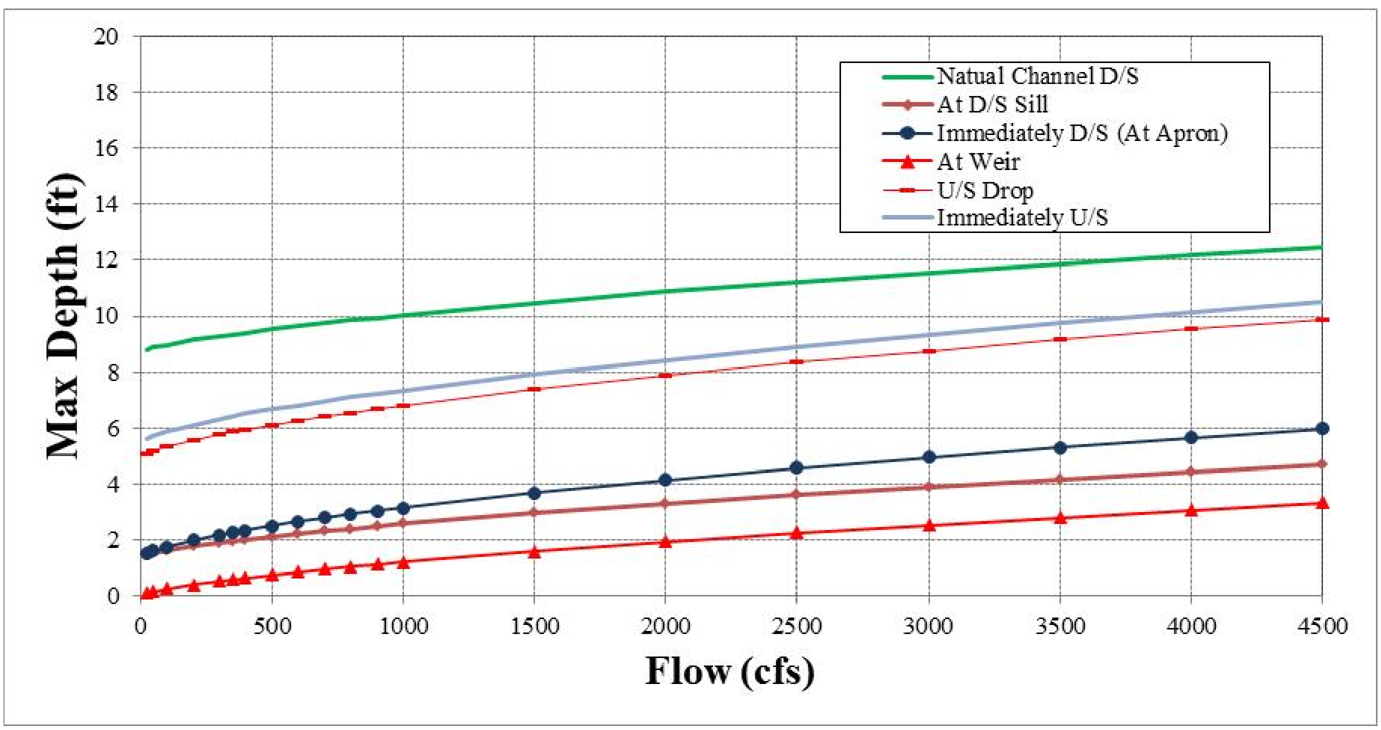
HEC-RAS MODEL BED AND WATER SURFACE PROFILE



HEC-RAS FLOW MODEL RESULTS



Velocity vs. Flow



Max Depth vs. Flow

HEC-RAS FLOW MODEL METADATA

TOPOGRAPHY[1]	
Year:	2008
Creator/Source:	Towill Inc.
Type:	LiDAR Topo
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)

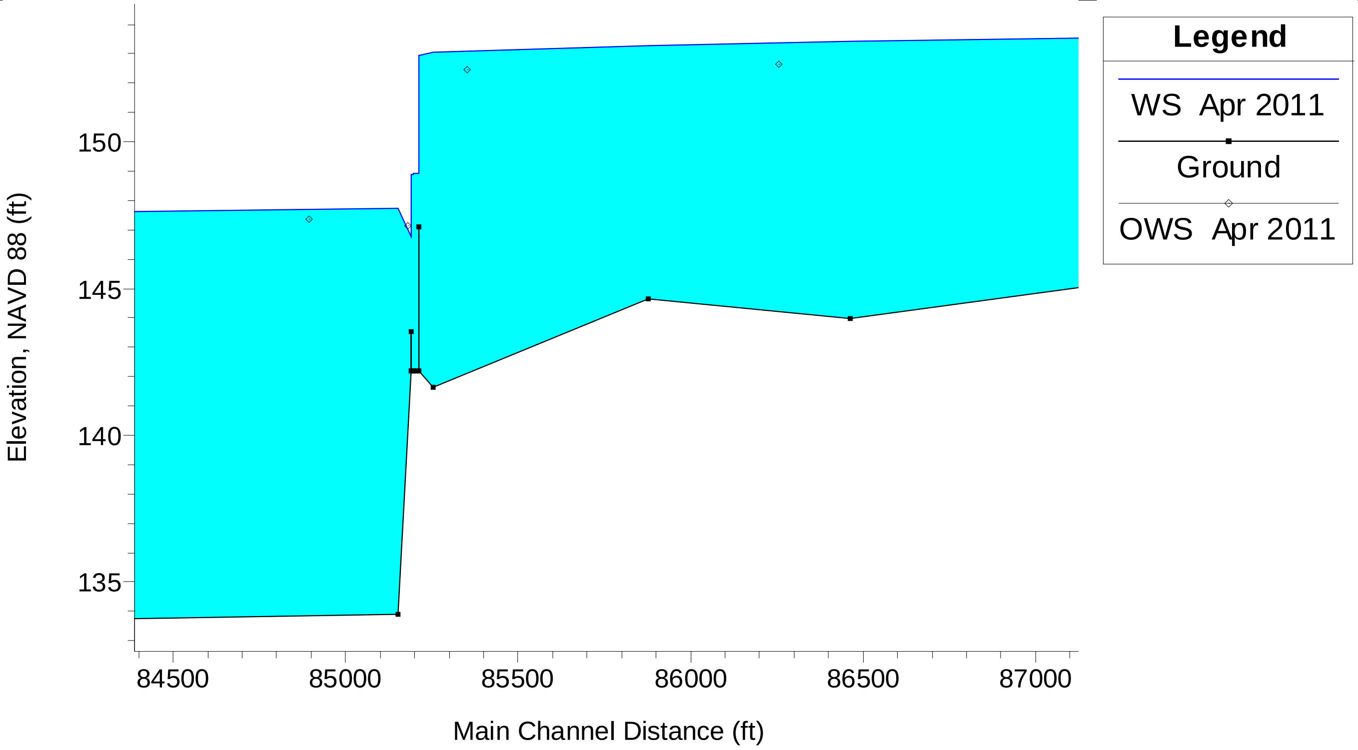
[1]The 2008 LiDAR topography has been adjusted to the varying annual subsidence rates to reflect 2011 conditions.

Summary

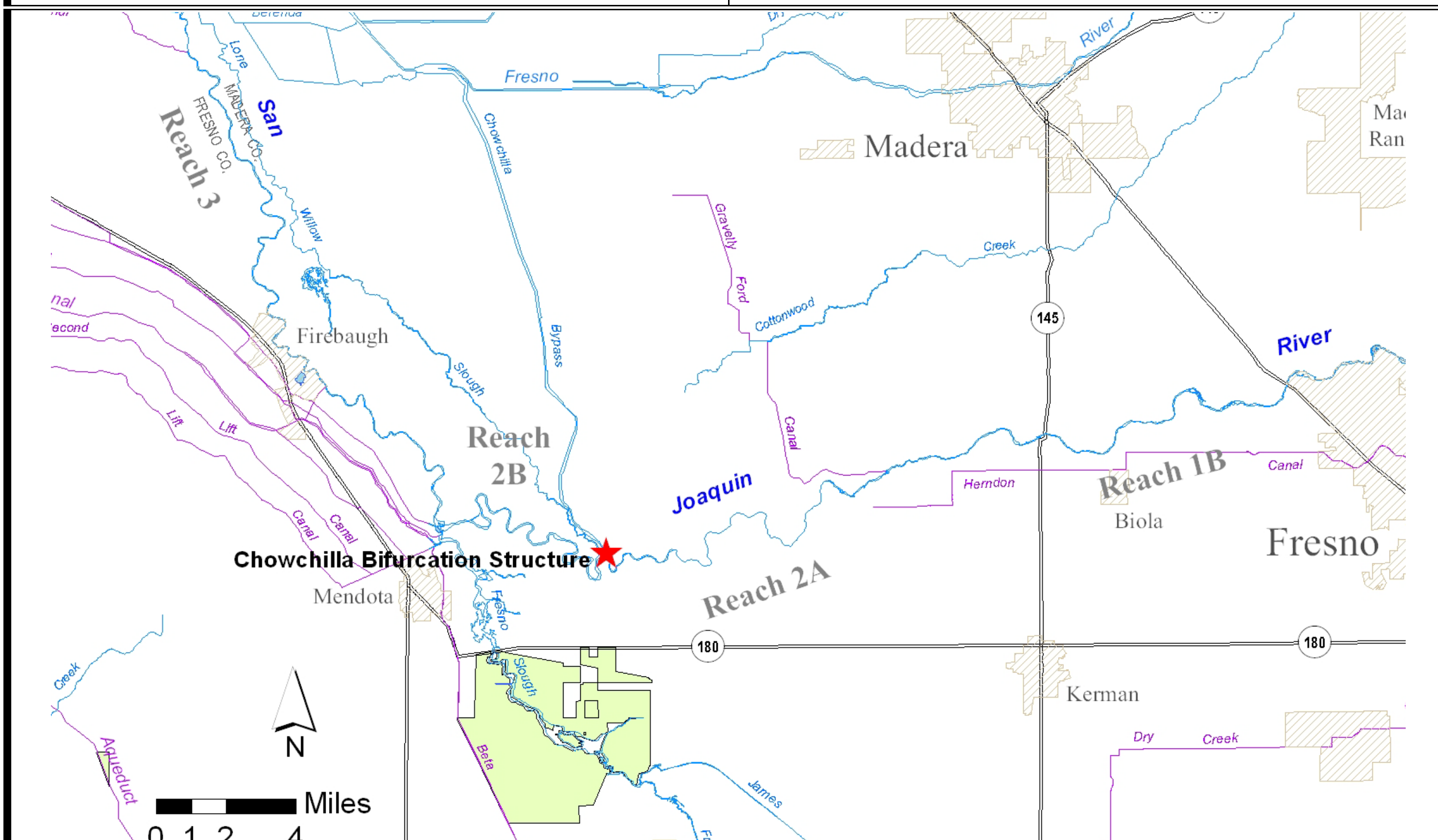
- Model - Flows through Drop Structure 2 (The Upstream Drop Structure) were simulated using the HEC-RAS Chowchilla Bypass and Upper Eastside Bypass model developed by DWR-SCRO modeling team.
- Geometry - The structure was based on the as-built design drawing and was surveyed by DWR via P&P. The geometry was adjusted for subsidence and reflects 2011 conditions.
- Boundary Condition - The reach-wide model has a downstream rating curve developed using Tetra Tech's latest Middle Eastside Bypass model with vertically varied n-values.
- Calibration - The model was calibrated using the water surface elevation data collected by DWR on April 6, 2011, the flow was measured to be 7,160 cfs using an ADCP device. The model water surface elevations were compared to the 2011 measured water surface elevations and were within +/- 1'. The Fresno River confluence is located just downstream of this structure. The additional flow contribution from Fresno River was not considered in the modeled flows but has the potential to create back water effect over this location.

MODEL CALIBRATION

Date: April 6, 2011	Flow (cfs): 5,800	Mean Velocity (ft/s):



BEARINGS		
Site Name[7]: Chowchilla Bypass Control	**I.D. Number[1]:** 21	**Reach:** 2B
River Mile:	**Barrier Type[1]:** Control Structure	**Rank[1]:** **Red**



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STRUCTURE DESCRIPTION

The Chowchilla Bypass Control Structure is part of the bifurcation structure located at the apex of the San Joaquin River and the Chowchilla Bypass near river mile 216.1 (Photo 21_A). The control structure has four radial gates, which were closed during the field inspection. This structure is very similar to the San Joaquin River Control Structure located just downstream.

There are four gated bay openings that measure 18 feet in height and 20 feet in width. The structure height is about 19.4 feet from the top of the deck to the channel bottom and measures 87.6 feet in total length from levee to levee. The structure has a maintenance road that crosses over the rear of the gate bay with an opening in the center to access the radial gate arms. The hoist motors are located at the top of each bay on the upstream end. There is a solid concrete headwall that extends from the levee to the east and west. The bays are 56.75 feet in length with a 15 foot concrete apron downstream. There are five 2 x 2 x 4 foot concrete block diffusers (baffles) about 28.6 feet from the radial gate (Photo 21_B). The concrete apron has a short weir (sill) downstream that is about 2.5 feet tall and 1 foot wide.

There is a large pool just downstream of the sill that is armored with rip rap to protect the concrete apron and weir from erosion. The rip rap protection extends about 30 feet downstream. The depth of the pool was not determined due to the depth exceeding what was able to be waded.

Photos:

Photo 21_A. Structure, upstream looking downstream

Photo 21_B. Downstream looking upstream from end of bay

HEC-RAS MODEL SUMMARY TABLE

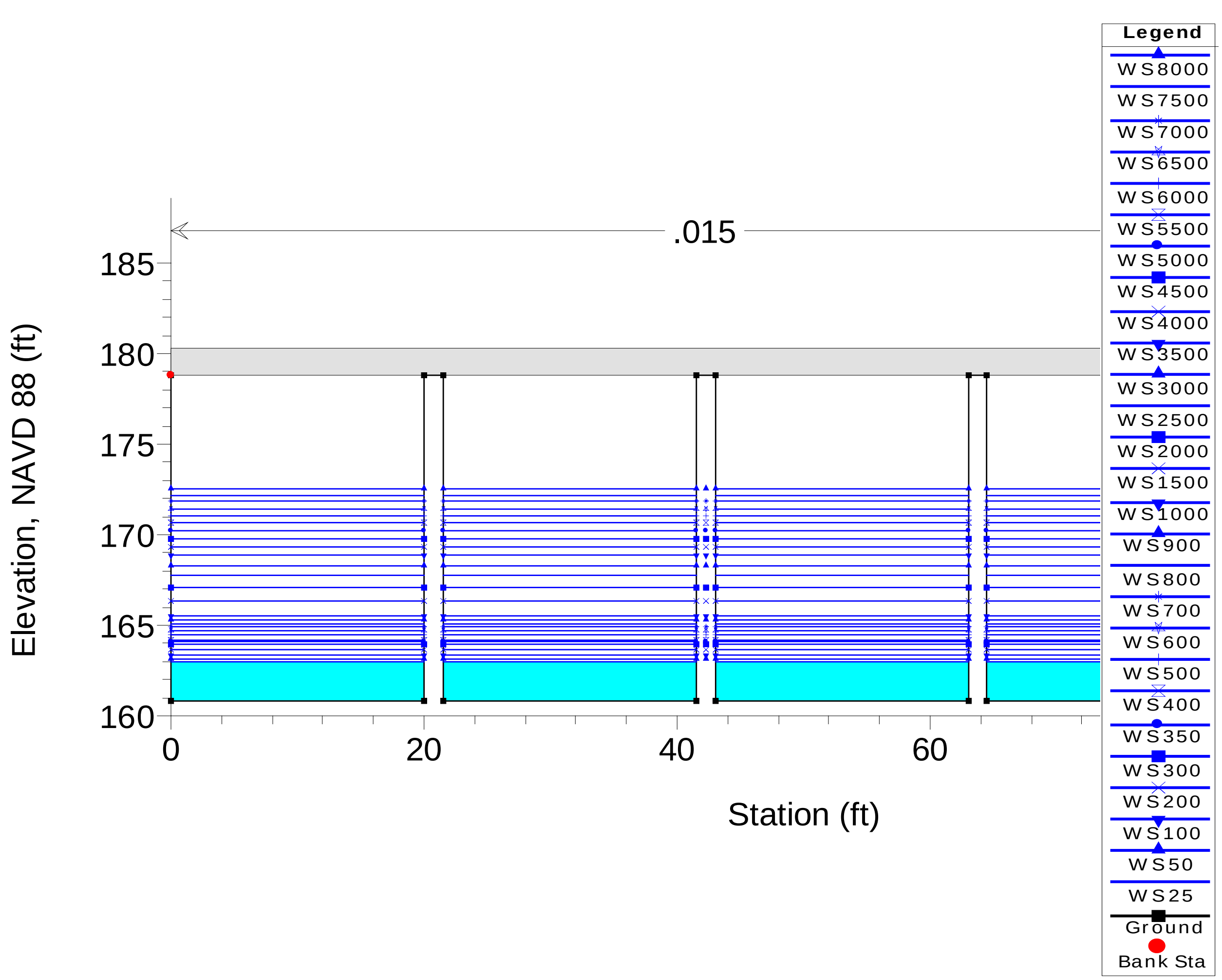
Chowchilla Bypass with Gates Open

Results for flows at sill

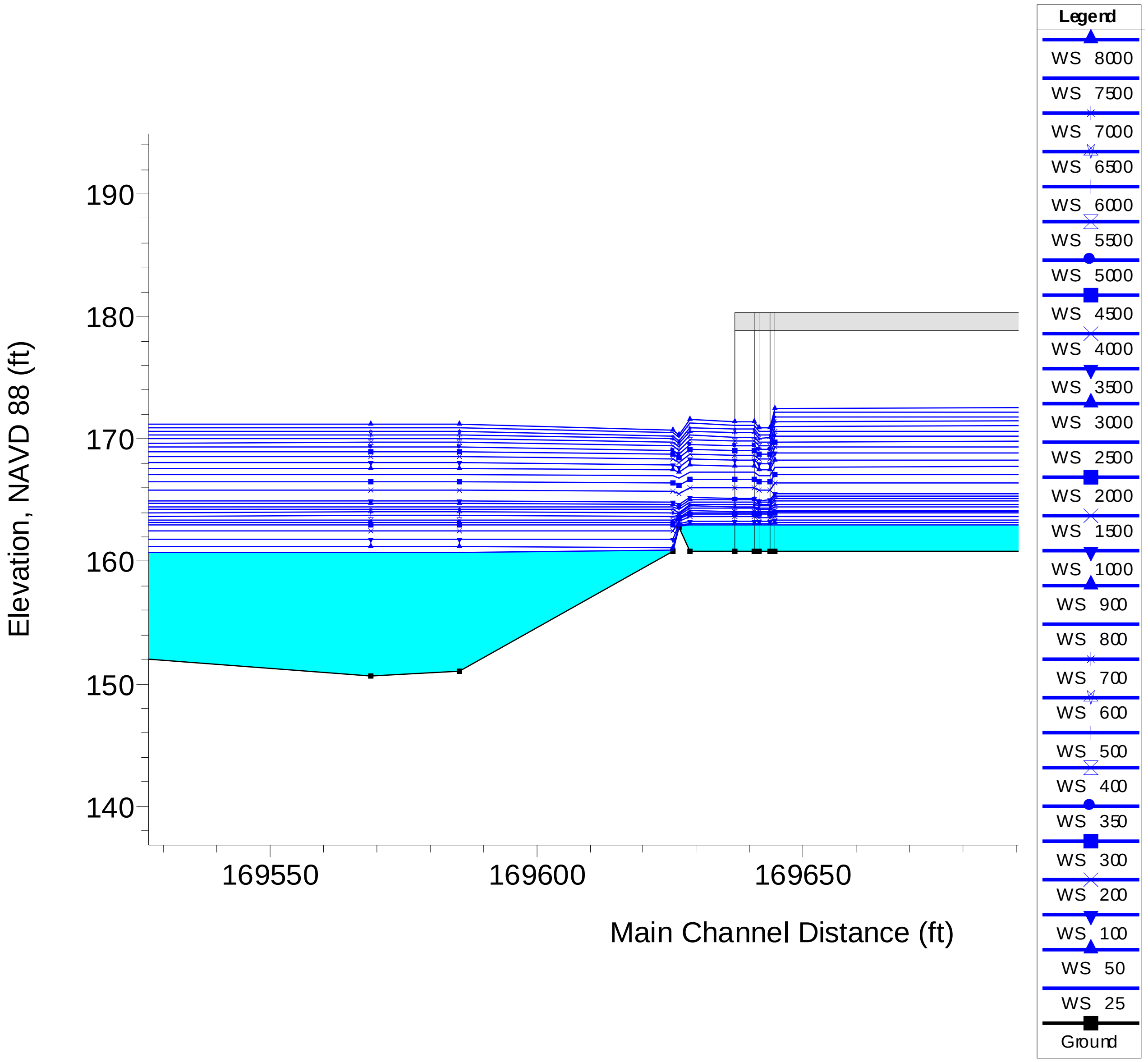
Flow	Maximum Depth	Channel Velocity	Maximum Water Surface Elevation Change
cfs	ft	fps	ft
25	0.1	2.1	2.1
50	0.2	2.6	2.0
100	0.3	3.2	1.5
200	0.5	4.1	1.2
300	0.7	4.7	0.9
350	0.8	4.9	0.8
400	0.8	5.2	0.8
500	1.0	5.6	0.6
600	1.1	5.9	0.5
700	1.2	6.2	0.5
800	1.4	5.9	0.4
900	1.7	5.7	0.3
1000	1.9	5.6	0.3
1500	2.8	5.7	0.3
2000	3.5	6.1	0.3
2500	4.0	6.6	0.3
3000	4.5	7.1	0.4
3500	4.9	7.5	0.4
4000	5.3	8.0	0.4
4500	5.7	8.4	0.5
5000	6.0	8.8	0.5
5500	6.3	9.2	0.5
6000	6.6	9.6	0.6
6500	6.8	10.0	0.6
7000	7.1	10.4	0.7
7500	7.3	10.8	0.8
8000	7.5	11.2	0.8
8500	7.7	11.6	0.9

The maximum water surface elevation change was estimated based on the difference between the cross sections immediately upstream and downstream the inlet boards and the outlet sill.

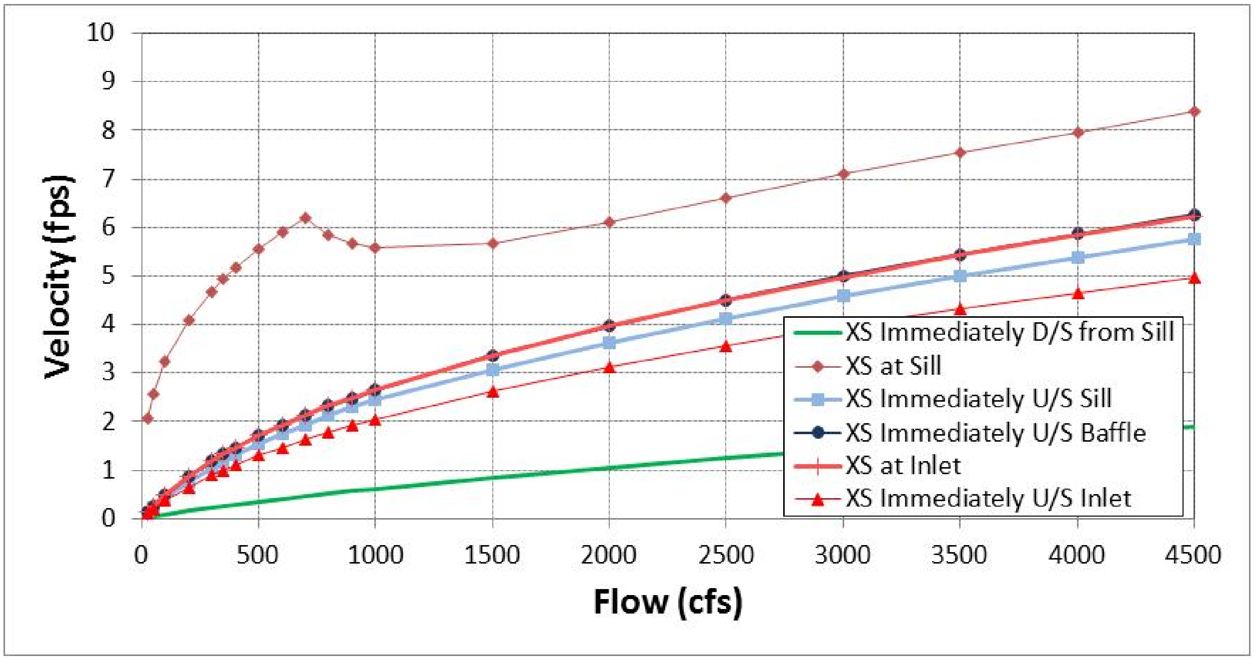
HEC-RAS MODEL STRUCTURE CROSS SECTION



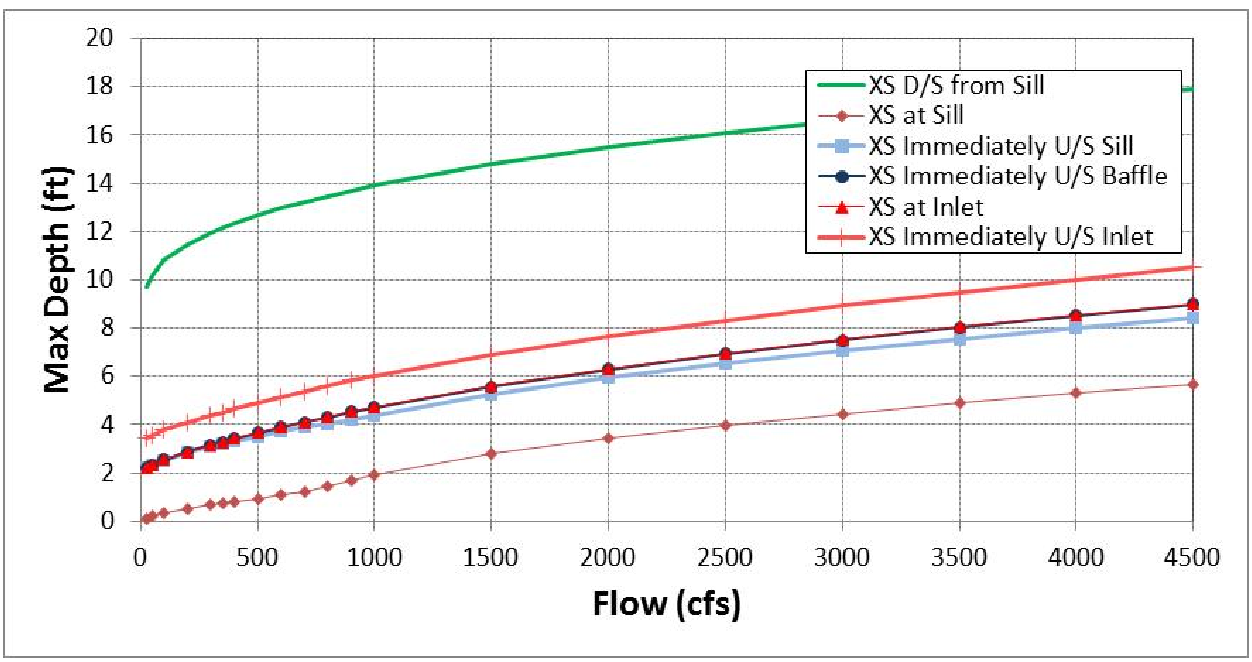
HEC-RAS MODEL BED AND WATER SURFACE PROFILE



HEC-RAS FLOW MODEL RESULTS



Velocity vs. Flow



Max Depth vs. Flow

HEC-RAS FLOW MODEL METADATA

TOPOGRAPHY[1]	
Year:	2008
Creator/Source:	Towill Inc.
Type:	LiDAR Topo
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)

[1]The 2008 LiDAR topography has been adjusted to the varying annual subsidence rates to reflect 2011 conditions.

Summary

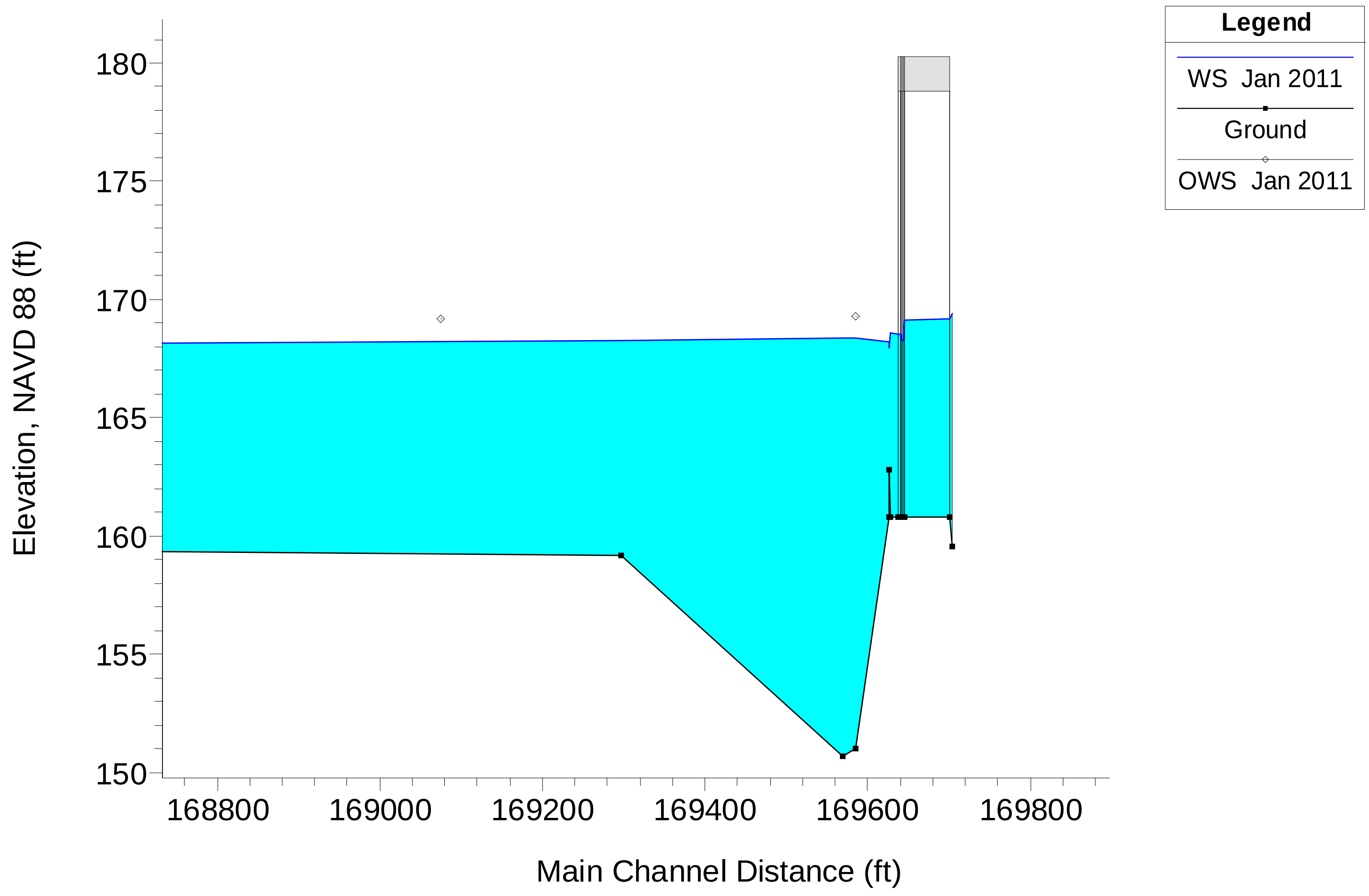
- Model - Flows through the Chowchilla bypass control structure were simulated using the HEC-RAS Chowchilla Bypass and Upper Eastside Bypass model developed by DWR-SCRO modeling team.

- Geometry - The structure was imported from MEI 2007 all-reach model and was surveyed by DWR via P&P. The geometry was adjusted for subsidence and reflects 2011 conditions.

- Boundary Condition - The reach-wide model has a downstream rating curve developed using Tetra Tech's latest Middle Eastside Bypass model with vertically varied n-values.

- Calibration - The model was calibrated using the water surface elevation data collected by DWR on January 9, 2011; the flow was measured to be 3,820 cfs using an ADCP device. The model water surface elevations were compared to the 2011 measured water surface elevations and were within +/- 1'.

MODEL CALIBRATION		
Date: January 9, 2011	**Flow (cfs):** 3,820	**Mean Velocity (ft/s):**



APPENDIX B-2
Data Collection

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TOPOGRAPHY

Topographic data was collected on October 2, 2012 by using GPS. Elevations were set based on surveyed control near the structure. Elevation data was focused on the structure to supplement elevations to build the structure into the model.

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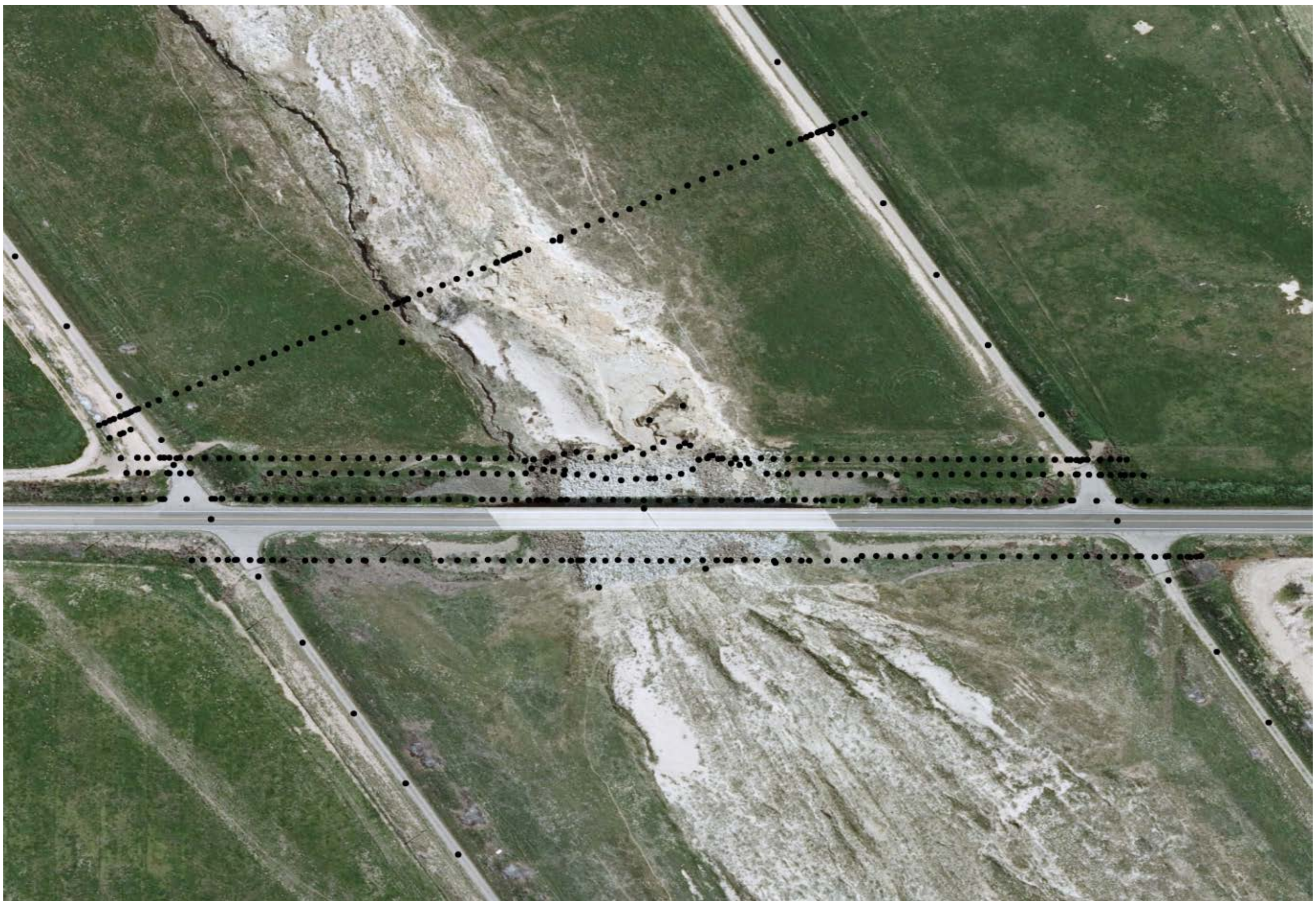

TOPOGRAPHY

Topographic data was collected on September 28, 2012 by using GPS. Elevations were set based on surveyed control near the structure. Elevation data was focused on the structure to supplement elevations to build the structure into the model.

TOPOGRAPHY

Topographic data was collected on September 28, 2012 by using GPS. Elevations were set based on surveyed control near the structure. Elevation data was focused on the structure to supplement elevations to build the structure into the model.

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