San Joaquin River Restoration Program
Fish Passage Evaluation

Task 2
Draft Technical Memorandum

Evaluation of Partial Fish Passage Barriers

July 2012

This page was intentionally left blank

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES
Division of Integrated Regional Water Management
South Central Region Office

San Joaquin River Restoration Program
Fish Passage Evaluation

Task 2

DRAFT

July 2012

This report was prepared for the San Joaquin River Restoration Program
under the direction of

Paul Romero...Chief, River Investigations Branch
S. Greg Farley .... Senior Engineer

by

Amanda Peisch-Derby ....Engineer

with assistance from

Alexis Phillips-Dowell……………………………………………………………………..Engineer
XizaoYang………………………………………………………...……………………..Engineer
Abimael Leon-Cardona …………………………………………………………Environmental Scientist
Byron Willems……………………………………………………………………………...Engineer
Kandasamy Naventhan……………………………………………………………………..Engineer
Josh Bannister……………………………………………………………………………Engineer

This page was intentionally left blank

TABLE OF CONTENTS

INTRODUCTION 1
TASK 2 STRUCTURES 5
SECOND PASS EVALUATION CRITERIA 9
Depth 10
Velocity 10
Jump 10
Second Pass Criteria 13
SECOND PASS DATA COLLECTION 15
Elevation Data 15
Topographic Data 15
Design Drawings 16
Flow Data 16
Discharge and Water Surface Elevations 16
HYDRAULIC MODELING ASSUMPTIONS 19
Model Limitations 22
Modeled Flow Range 22
Calibration Results 22
SECOND PASS EVALUATION RESULTS 23
Summary of Criteria Results per Structure 35
CONCLUSIONS 36
REFERENCES 41
APPENDIX A A-1
Modeling Results A-1
APPENDIX B B-1
Data Collection B-1
APPENDIX C C-1
Friant Routing C-1

LIST OF FIGURES

Figure 1. Second Pass Sites 7
Figure 2. Leaping curves for Chinook, coho and sockeye salmon (Powers & Orsborn, 1985) .. 12
Figure 3. Maximum swimming distance for Chinook, coho and sockeye salmon (Powers & Orsborn, 1985) 13
Figure 4. Monitored flows at each structure compared to flow downstream Friant Dam and the bypass system.. C-4
Figure 5. Recommended Beaver Dam Specifications……………………………………..…35

LIST OF TABLES

Table 1. Second Pass Locations.. 6
Table 2. Maximum Allowable Average Culvert Velocity for Adult Chinook Salmon............... 10
Table 3. Task 2 Adult Chinook Salmon Criteria 13
Table 4. Fish Passage Criteria per Structure... 14
Table 5. Location of Second Pass Topographic Surveys.. 16
Table 6. CDEC Stations referenced for Task 2... 16
Table 7. DWR Discharge and WSE Details 17
Table 8. HEC-RAS Topography Status (Dec. 2011).. 20
Table 9. Second Pass Evaluation Results 35
Table 10. Recommended Task 3 Structures 38

INTRODUCTION

In 1988, a coalition of environmental groups, led by the Natural Resources Defense Council (NRDC), filed a lawsuit challenging the renewal of long-term water service contracts between the United States and California's Central Valley Project Friant Division contractors. After more than 18 years of litigation, the lawsuit, known as NRDC et al. v. Kirk Rodgers et al., reached a Stipulation of Settlement (Settlement). The Settling Parties, including NRDC, Friant Water Users Authority, and the U.S. Departments of the Interior and Commerce, agreed on the terms and conditions of the Settlement, which was subsequently approved on October 23, 2006. In response to the Settlement, the implementing agencies, consisting of the U.S. Department of Interior, Bureau of Reclamation (Reclamation) and U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), California Department of Fish and Game (CDFG), and California Department of Water Resources (DWR) organized a Program Management Team and associated Work Groups to begin work implementing the Settlement (SJRRP, 2010a). The Settlement establishes two primary goals:

Restoration Goal – To restore and maintain fish populations in "good condition" in the mainstem San Joaquin River below Friant Dam to the confluence with the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish.

Water Management Goal – To reduce or avoid adverse water supply impacts to all of the Friant Division long-term contractors that may result from the Interim Flows and Restoration Flows provided for in the Settlement.

An important part of the Restoration Goal is to restore a self-sustaining Chinook salmon fishery in the San Joaquin River. One of the strategies to achieve this goal, deemed the Restoration Goal, will be for the SJRRP to ensure restoration of naturally reproducing and self-sustaining populations of salmon and other fish in the San Joaquin River. The Settlement requires providing adequate flows and performing structural modifications, as necessary, to ensure fish passage during the migration periods of both spring- and fall-run Chinook salmon as well as native fish. Under the SJRRP, the Fisheries Management Work Group (FMWG) is responsible for planning and coordinating the efforts to implement the sections in the Settlement related to maintaining fish in good condition, including the reintroduction of Chinook salmon and obtaining self-sustaining populations that meet the Restoration Goal and ensure adequate fish passage. Action F5 of the Fisheries Management Plan recommends ensuring fish passage is sufficient at all structures and potential barriers (SJRRP, 2010). To this end, the FMWG established a habitat objective to provide passage conditions that allow 90 percent of migrating adult and 70 percent of migrating juvenile Chinook salmon to successfully pass to suitable upstream and downstream habitat, respectively, during all base flow schedule component periods and water year types of the Settlement, except the Critical-Low water year type (SJRRP, 2010a).

The Fish Passage Evaluation Plan was developed to evaluate potential structural barriers to fish migration in the main channel of the San Joaquin River and the bypass system. The evaluation was divided into three different tasks.

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. Structures were visited for a site description with photographs and limited measurements were made of the structure. The field observations were applied to a flow chart assessment using general passage criteria resulting in the identification of potential barriers for further study. Each structure was categorized as not a barrier (green), a definite barrier (red), and the need for more information on whether the structure is a barrier or not (gray). The Task 1 background and methods were reported in the November 2010 Annual Technical Report (ATR) in Appendix A, Section 25 (SJRRP, 2010b). A total of 49 potential barriers were evaluated during Task 1, with 28 structures identified as adequate for passage (green), 13 ranked as potential barriers (gray), and 8 definite barriers (red). The results from Task 1 are presented in the draft 2011 ATR in Appendix B, Section 20 (SJRRP, 2011).

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. The 13 ranked as potential barriers, in addition to two barriers, will be analyzed during Task 2. Field surveys and hydraulic models will be developed to determine the hydraulic constraints of each structure. Results will then be compared with refined fish passage criteria for adult salmon provided by the fisheries agencies to determine the range of suitable flows for passage and help prioritize structures for modification to improve passage. This task is the focus for this report.

Task 3, if needed, will provide alternatives for modification that include structural designs and cost estimates for the structures that are deemed a fish passage impediment during either Task 1 or 2.

This document details Task 2 of the SJRRP fish passage evaluation to identify passage impediments to migration of adult salmon. In this task, work includes the identification and data collection of potential fish passage barriers, identification of the passage criteria to allow hydraulic evaluation of potential barriers, and identification of potential barriers for improvements or repair. The California Department of Water Resources, South Central Region Office (DWR-SCRO), performed the work to identify potential fish passage issues along the Restoration Area and recruited fisheries expertise from the California Department of Fish and Game (CDFG) and the National Marine Fisheries Service (NMFS). The DWR-SCRO has performed similar fish passage evaluations on the Calaveras River and for stream crossings under California Department of Transportation highways. The DWR-SCRO consulted with the FMWG and the SJRRP Technical Advisory Committee on the plan to collect this information. This report and data collection was primarily performed by water resources engineers based on criteria that had been developed by the CDFG and the NMFS.

Deliverables include second pass hydraulic model results and final unimpeded passage flow range of barriers on the San Joaquin River (SJR) and lower bypass system from Sand Slough to the Bear Creek confluence with the SJR. Data collection for this task expanded on the first task and includes updates to the Fish Passage GeoDatabase. Those structures that indicate passage problems will be evaluated in Task 3 to develop plans to modify or replace the structures for unimpeded fish passage. At the completion of all three analyses, it is expected that a priority list of structures to replace or modify will be developed in coordination with fisheries agencies. These priorities will then be recommended to the SJRRP for inclusion as a Paragraph 12 action in the Settlement.

This page was intentionally left blank

TASK 2 STRUCTURES

The previous effort, Task 1, used physical measurements to compare general passage criteria identified in the Task 1 report to evaluate fish passage. These criteria included ratio of structure width to channel width, outlet drop, pool invert, and whether the channel substrate is continuous over or through the structure. Criteria that was not used for the first pass rankings included slope and elevation of the tailwater control relative to structure inlet, outlet, and pool invert.

A total of 49 potential barriers were evaluated during the first pass; 28 structures were identified as green, these locations are assumed adequate for passage of all salmonids life stages, thirteen ranked as gray (not enough information), and eight structures were identified as red (barriers). The 13 gray sites were revisited for a second pass evaluation in Task 2 since these need more information to make a determination for passage. Red barriers are not included in this study since the information processed in Task 1 suggests that these structures are barriers and need modification. The exception being two red barriers, the Eastside Bypass and Mariposa Bypass control structures, were also evaluated in Task 2. These red structures will be evaluated because the hydraulics have not been evaluated and were deemed red mainly due to the radial gates and potential operations like gate closure. It was decided to evaluate these in Task 2, assuming the gates can be operated as fully open, to determine at what degree these are barriers. The Chowchilla Bifurcation Structures and Mendota and Sack dams are known fish barriers so these structures were identified in Task 1 for modification to be addressed during Task 3, so these were not modeled during Task 2. Task 1 did not include the Chowchilla or Eastside Bypass system above Sand Slough since it was uncertain whether it would be a migration pathway of the salmon. Task 2, like Task 1, did not look at the Chowchilla or Eastside Bypass system above Sand Slough. There are several known potential barriers within the Chowchilla and upper Eastside Bypass that include several drop structures, Avenue 18 ½ Bridge, and Avenue 21 Bridge that have been identified by other agencies. Table 1and Figure 1 list all the structures that will be evaluated during Task 2.

Additional sites that were identified by the U.S. Bureau of Reclamation (Reclamation) as potential barriers that were not visited during Task 1 included Sack Dam, El Nido Road, and the Merced National Wildlife Refuge weirs in the Eastside Bypass. The Merced National Wildlife Refuge weirs will be assessed in Task 2, and are included in Table 1. El Nido Road was determined not to have a structure; DWR field visit notes from March 2010 did not have an elevated crossing and was cited to have a buried culvert (so no present culvert). This was deemed not a fish passage barrier during Task 1. El Nido Road will not be modeled in Task 2 since current conditions do not have an elevated structure or culvert present. The beaver dams will be represented by a single typical structure as a scenario to determine what if any passage impediments exist with these structures. These structures are natural and ever changing, so in order to capture the effect of newly constructed dams, the typical beaver dam model will be used to recommend management alternatives that provide the maximum dimensions and flows to allow unimpeded passage.

Table 1. Second Pass Locations

Identification Number	Reach	Description
4	1A	Lost Lake Rock Weir #1
5	1A	Lost Lake Rock Weir #2
17	1B	Donny Bridge
23	2A	San Mateo Avenue
29	4B1/EB	Sand Slough Connector
36	4B2	Beaver Dam #5*
37	4B2	Beaver Dam #4*
38	4B2	Refuge Low Flow Crossing
39	4B2	Beaver Dam #3*
40	4B2	Beaver Dam #2*
41	4B2	Beaver Dam #1*
48	4B2/EB	Eastside Bypass Control Structure
49	4B2/MB	Mariposa Bypass Control Structure
51	4A	Dan McNamara Road
69	4B2/EB	Eastside Bypass Rock Weir
70	4B1/EB	Merced Refuge Weir #2
71	4B1/EB	Merced Refuge Weir #1

*Note: All five beaver dams were modeled using a single typical beaver dam scenario

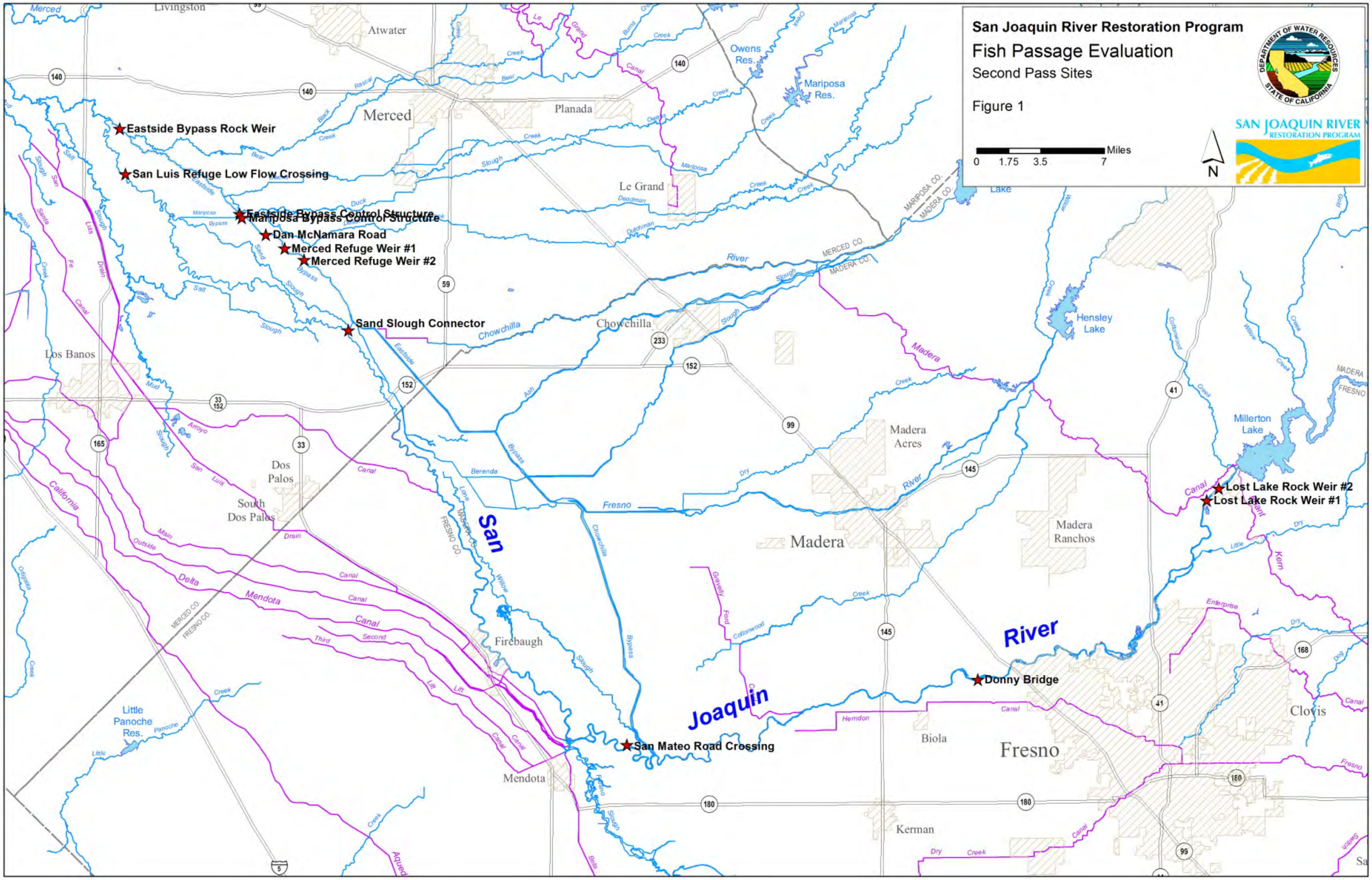


Figure 1. Second Pass Sites

This page was intentionally left blank

SECOND PASS EVALUATION CRITERIA

In evaluating fish passage for Task 2, criteria were identified based on guidelines developed by CDFG, NMFS, and others for adult salmonids. Due to the complexity of developing criteria and evaluating every structure for all fish species that may be present in the reach, adult Chinook salmon is the focus species for this evaluation. The second pass evaluates fish passage at all identified structures based on three main criteria: jump into the structure, depth in the structure, and velocity in the structure. Other factors including temperature, oxygen, straying, and predation can impact fish passage but these factors are outside the scope of this document.

Fish passage guidelines have been developed in California for anadromous salmonids primarily by the California Department of Fish and Game (CDFG) and the National Marine Fisheries Service (NMFS). CDFG 2010 California Salmonid Stream Habitat Restoration Manual (CDFG, 2010) emphasis is on salmon, steelhead, and trout; this manual is primarily intended to be used to assist in restoration efforts for those species in California. The Manual includes Part IX that has the NMFS criteria for fish passage in Appendix IX-B, Guidelines for Salmonid Passage at Stream Crossing (NMFS, 2010). The 2010 guidelines apply to all public and private roads, trails, and railroads within the range of anadromous salmonids in California. These guidelines establish passage criteria for structures that include culverts, bridges, and low flow crossings. The 2008 Anadromous Salmonid Passage Facility Design (NMFS, 2008) is referenced for criteria in the Hydraulic Design Method (Section 7.5) that were developed specifically for culverts. Although the second pass fish passage criteria focuses on the capabilities of adult Chinook salmon; the criteria considered the current draft SJRRP Native Fish Attributes Table[1] (Attribute Table), that was reviewed by the FMWG, dated October 2011 that is referenced for guidance and consistency with the Program. These criteria were developed based on a combination of the guidelines and those designated as SJRRP fish passage criteria as discussed in the following sections.

This plan will support the NMFS hydraulic criteria approach (NMFS, 2008) for evaluating fish passage conditions at each structure. The hydraulic criteria approach compares the hydraulic conditions in the structure with criteria that must be satisfied to ensure that adequate passage conditions exist. This evaluation will compare velocity, depth and jump to determine if conditions at a structure limit the ability of a fish to pass a structure.

The second pass criteria were developed for comparison to the hydraulic model results that include the minimum depth of flow, maximum velocities in the structure, and the ability to jump

[1] The native fish attributes table was compiled by the Reach 2B and 4B design teams for development of fish swimming and passage that assisted with decision making about specific design criteria for passage. This table was reviewed by the Fisheries Management Work Group and is draft and is subject to revision.

structural features to assess the ability of the salmon to pass the structure. The following sections discuss what factors were considered when developing each of the hydraulic criteria.

Depth

The minimum depth of flow through the structures, based on the SJRRP Attributes Table, should be at least 1.2 feet through the structures[2].

Velocity

The sustained speed of adult salmon is estimated to be at 10.8 feet per second (fps) with a burst speed of approximately 22.4 fps; these velocities were in the SJRRP Attribute Table and concur with published fish capabilities. These velocities were calculated from the United States Army Corps of Engineers (USACE) Fisheries Handbook (Bell, Fisheries Handbook of Engineering Requirements and Biological Criteria. Third., 1991) from a relationship shown on page 6.2, unless otherwise noted, based on the following: Cruising speed = 1/6 Vmax, Sustained swimming speed = 1/2 Vmax relative to Burst or Darting speed (Vmax). These speeds can be used to determine maximum flow velocities for passage at most structures with the exception of culverts. Flow velocities in culverts will be based on the maximum allowable average culvert velocity, which is dependent on the culvert length, as shown in Table 2 (CDFG, 2010) (NMFS, 2010).

Table 2. Maximum Allowable Average Culvert Velocity for Adult Chinook Salmon

Culvert Length (feet)	Max Average Velocity (fps)
< 60	6.0
60-100	5.0
100-200	4.0
200-300	3.0
>300	2.0

Jump

Adult Chinook salmon can jump a maximum height of 7 feet (Bjornn & Reiser, 1991), assuming that the fish jump at 80 degrees and have a short range of leap so the staging pool is nearby. To apply this capability in this evaluation, the jump height and jump length per structure is compared to a parabolic jump curve in Figure 2 based on a study conducted by Powers and Orsborn. (Powers & Orsborn, 1985). In addition, the curves assume the maximum burst speed for the fish at 22.4 fps which is consistent with the velocity criterion. The curves highlight the coefficient of fish condition (Cfc); these percentages reduce the jump depending on the condition of the fish by the percent of the maximum burst speed they are capable of swimming. The solid curve (Cfc = 1.00) is used for salmon fresh out of salt water or still a long distance from

[2] However, the NMFS and CDFG criteria to determine the minimum depth is based on 1.5 times the body height or 1 feet depth, whichever is greater.

spawning grounds. The dashed line (Cfc = 0.75) is for salmon in good condition that are in the river for a short time and are still migrating upstream. The published curves provided by Powers and Orsborn do not reflect the fish condition when close to the spawning grounds, when the fish are in poor condition (Cfc = 0.50). However, the curves for Cfc = 0.50 were developed from the Powers and Orsborn equations for this evaluation for use when applicable. Fish for the evaluation of jumping barriers include assessing both the good and poor condition curves for jump, but the final results present fish in good condition with the exception of Reach 1 that focus on fish in poor condition.

There are other factors that affect the swimming condition, including temperature, a reduction of swimming condition of 50 percent may occur as a result of adverse temperatures (Bell, 1991). In addition, oxygen levels and water quality can also affect the swimming speeds. This criterion does not consider the effect of environment on the adult Chinook salmon swimming condition, like temperature or oxygen levels that can further reduce the jumping capabilities.

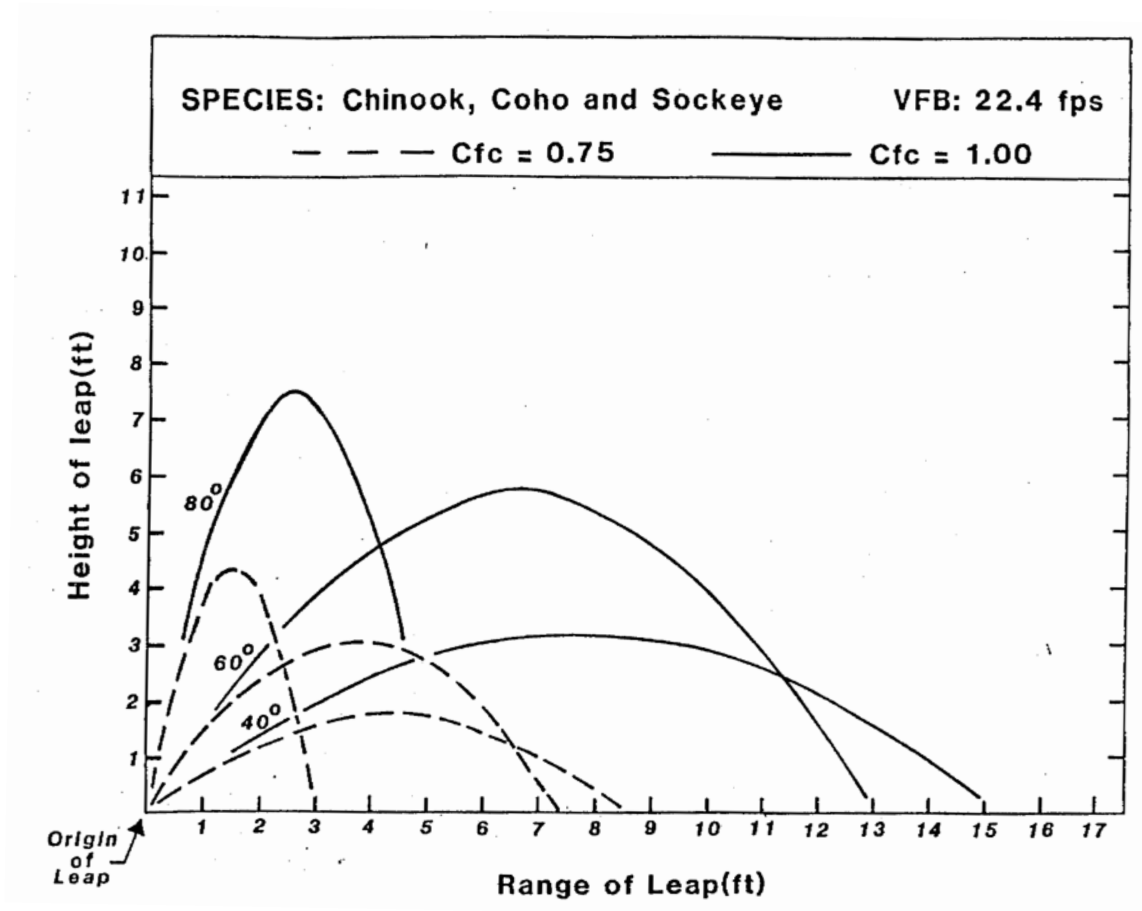


Figure 2. Leaping curves for Chinook, coho and sockeye salmon (Powers & Orsborn, 1985)

The NMFS design criteria state that a jump pool must be provided that is at least 1.5 times the jump height, or a minimum of two feet deep, whichever is greater (NMFS, 2008). In this analysis, the origin of leap was based on this criterion and is assumed not possible if this not achieved.

Figure 3 was used to determine the limiting velocity for passage between 10.8 fps and 22.4 fps swimming speeds though the structure based on the distance from the structures outlet to the inlet unless it is considered a culvert; see Table 2 for culvert velocities.

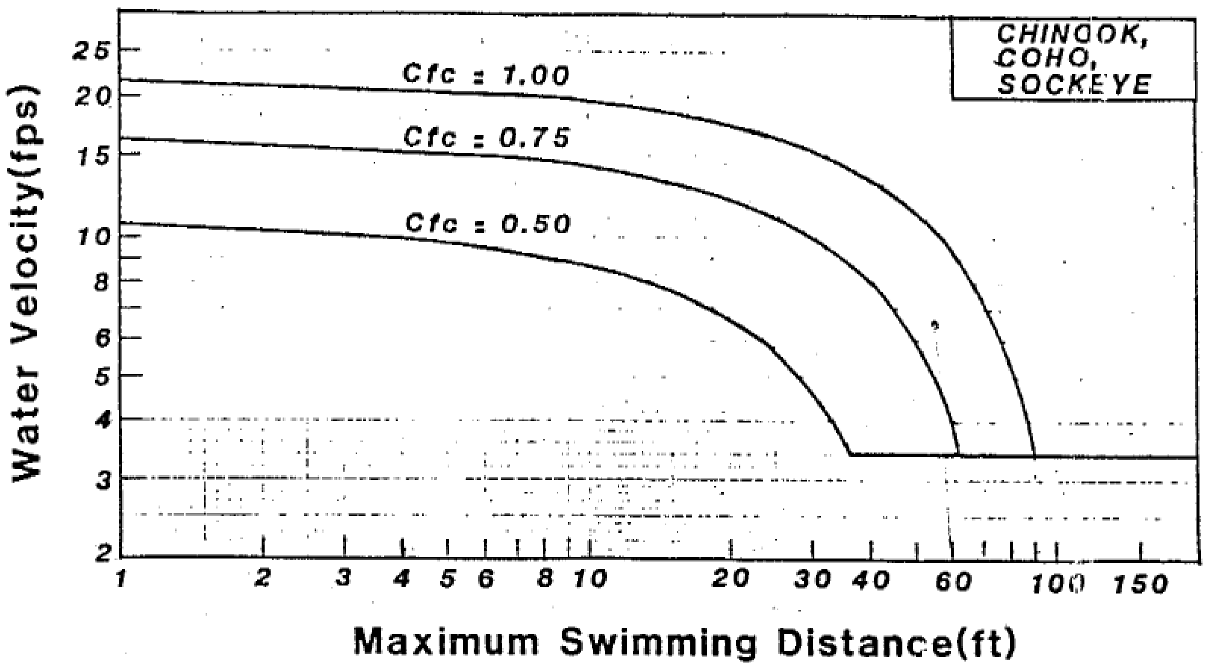


Figure 3. Maximum swimming distance for Chinook, coho and sockeye salmon (Powers & Orsborn, 1985)

Second Pass Criteria

The criteria for the second pass are listed in Table 3. The criteria identified by Task 2 are applied different than those used by engineers to design fish passage facilities and are only applicable for existing structures as a conservative approach to determine adult Chinook salmon passage.

Table 3. Task 2 Adult Chinook Salmon Criteria

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

The Task 2 evaluation compared these criteria to the hydraulic results to determine when there is potential for unimpaired passage. The results provide a range of flows when it is expected that there is potential for unimpaired passage for adult Chinook salmon at each structure.

Since the fish passage criteria is dependent on the type of structure; the passage criteria for each structure is detailed in Table 4. The maximum jump was derived from the Powers and Orsborn curves and is dependent on the minimum flow of 25 cfs as the maximum jump height to pass, since jump is varied depending on the flow. The minimum depth is based on the depth criterion. Maximum velocity is based on the velocity criterion and is dependent on how the structure functions as a culvert, crossing, or weir. A description of how each of the criteria per structure compares to the hydraulic results is discussed in the results section of this document.

Table 4. Fish Passage Criteria per Structure

Structure	Maximum Jump at 25 cfs (ft)[1]	Minimum Depth (ft)	Maximum Velocity (fps)
Lost Lake Rock Weir #1	1.5	1.2	10.8
Lost Lake Rock Weir #2	1.5	1.2	10.8
Donny Bridge	N/A	1.2	6
San Mateo Avenue Culvert	N/A	1.2	6
San Mateo Avenue Weir	N/A	1.2	3
Sand Slough Connector	N/A	1.2	6
Refuge Low Flow Crossing	N/A	1.2	8
Eastside Bypass Control Structure (Boards-Out) Outlet	3.3	1.2	5
Eastside Bypass Control Structure (Boards-In) Inlet	4.2	1.2	5
Mariposa Bypass Control Structure	1.8	1.2	6
Dan McNamara Road	3.3	1.2	6
Eastside Bypass Rock Weir	4.2	1.2	11
Merced Refuge Weir #1 (Boards-Out)	4.2	1.2	10.8
Merced Refuge Weir #1 (Boards-In)	3.3	1.2	10.8
Merced Refuge Weir #2 (Boards-Out)	4.2	1.2	10.8
Merced Refuge Weir #2 (Boards-In)	3.3	1.2	10.8
Typical Beaver Dam	4.2	1.2	10.8

[1] If jump is not present at the structure than it is designated with N/A (Not Applicable)

SECOND PASS DATA COLLECTION

A majority of the data collected during the second pass, is a combination of existing and new topographic data to simulate the actual current conditions when possible. Due to high and sometimes dangerous flow rates during the winter of 2010 and through the spring of 2011 access to the structures was limited. The simple criteria from the first pass were expanded to include the hydraulics considered and data collected from the second pass. Data collection during the second pass included the flow, velocities and depth at each structure location. This data allowed for the hydraulics at the site to be estimated by hydraulic models. Figures were developed from the models that were compared with the fish capabilities to determine the fish passage success.

Elevation Data

Elevation Data that was collected for Task 1 of the Fish Passage Evaluation was used when possible and included topographic data, design drawings from the state and counties, and structural details that were included in the hydraulic models. Structural or channel detail that was needed to fill data gaps or verify existing data, was collected by a DWR field survey crew. The specific elevation data that were utilized for each structure are included in Appendix B.

Topographic Data. Existing topographic data included the 1998/1999 Ayres Associates (Ayres Associates, 1998) (Ayres Associates, 1999), 2008 LiDAR (RBF Consulting, 2008), and supporting bathymetry from DWR, Reclamation and other sources. This reduced the amount of field data collection that was needed for the second pass.

The 1998/1999 Ayres Associates data survey area consists primarily of the mainstem of the San Joaquin River and the bypass system. The data was used for development of basin-wide hydraulic modeling by the US Army Corps of Engineers for the Sacramento and San Joaquin River Basins Comprehensive Study. The data was released as two foot contours using the National Geodetic Vertical Datum of 1929 (NGVD29). This data was updated, for most of the study area, with the 2008 LiDAR elevations or 2011 field topography.

The 2008 LiDAR data was collected in March-April of 2008. The vertical datum is North American Vertical Datum of 1988 (NAVD88). This data lacked elevations below the water surface if the channel bed was submerged during the orthophotography. Bathymetry data was used to supplement this information. Bathymetry, or measurement of underwater depth, was collected by various agencies during 1998/1999, 2010, and for Task 2 in 2011.

Topographic data collected to fill the data gaps or verify elevations during the second pass included elevation detail of the structure and channel to determine slopes, jumps, and hydraulic controls. This data was either collected by total station, survey grade GPS, or bathymetry collected during flow measurements with an Acoustic Doppler Current Profiler (ADCP). Topographic data was compared with previous surface data from the Ayres and LiDAR elevations to determine reasonableness. When topographic data was collected during this effort it superseded any existing topography in the model. Table 5 lists the dates and locations of structures that were surveyed to fill data gaps and verify elevations. A detail of the location of the data collected is presented in Appendix B.

Table 5. Location of Second Pass Topographic Surveys

Reach	Location	Survey Date
4B1/EB	Dan McNamara Road	09/28/2011
4B2/EB	Eastside Bypass Control	11/29/2011
4B2/MB	Mariposa Bypass Control	11/29/2011
4B2	Refuge Low Flow Crossing	11/17/2011
4B2/EB	Eastside Bypass Rock Weir	10/04/2011
4B1/EB	Merced Refuge Weir #1	01/18/2012
4B1/EB	Merced Refuge Weir #2	01/18/2012

Design Drawings. Structure data on the bypasses was supplemented with the original DWR design drawings that dated 1961 - 1965. If 'As Built' drawings were available these were preferred over design drawings to supplement structural data within the models, but not all structures had 'As Built' data.

Flow Data

Data needs for Task 2 included collection of a variety of discharges (flows) with corresponding velocity and water surface elevations (WSE) at each structure, if possible, and collecting data from the California Data Exchange Center (CDEC). Due to the preliminary nature of CDEC data, it was only used when no other data was available so CDEC stations that are applicable to Task 2 are listed in Table 6.

Table 6. CDEC Stations referenced for Task 2

CDEC Station	CDEC Description	Operator	Nearest Task 2 Structure
SJF	San Joaquin River below Friant	USGS	Lost Lake Weir #1 & #2
DNB	San Joaquin R at Donny Bridge	Reclamation	Donny Bridge
SJB	San Joaquin River below Bifurcation	Reclamation	San Joaquin River Control Structure
CBP	Chowchilla Bypass	San Luis Delta-Mendota Water Authority	Chowchilla Control Structure
SJN	San Joaquin R at San Mateo Rd nr Mendota	USGS	San Mateo

Discharge and Water Surface Elevations. Water surface profile surveys and discharges were coordinated with a current DWR data collection effort that has been collecting the same information at general locations along the SJR in the upper reaches since 2009 for the flow data needs at the structures for Task 2. Water surface profiles were obtained using a survey grade GPS (3D quality of 0.1 foot) to record the water surface elevations along the river. Discharge measurements were collected using an ADCP. Table 7 lists the flow data collected at each structure. Appendix B displays the locations of the discharge transects and water surface elevations that were collected per structure.

High flood flows that were present during this study, fall 2010 through spring 2011, limited the access to many locations to safely collect hydrologic data. DWR staff was able to collect intermediate flow data around 3,000 cfs in the late spring of 2011. These flows, at most structures, were typically out of the main channel and in the overbank. This data was able to supplement the interim flow data that was collected in 2010 which was used to calibrate the original one dimensional model on a reach basis. Low flows, less than 50 cfs, were not collected in the upper reaches and bypass system due to the absence of these flows in most of the reaches during the study.

Table 7. DWR Discharge and WSE Details

Reach	Location	Monitoring Date	Recorded Flow (cfs)
1A	Lost Lake Weir #1	05/12/2011	3,110
1A	Lost Lake Weir #2	05/13/2011	2,870
1B	Donny Bridge	05/19/2011	3,040
2B	San Mateo Avenue	05/19/2011	1,160
4B1/EB	Dan McNamara Road	05/10/2011	1,860
4B2/EB	Eastside Bypass Control Structure	05/23/2011	1,720
4B2/EB	Eastside Bypass Rock Weir	07/07/2011	1,840
4B2	Refuge Low Flow Crossing	05/24/2011	32.5
4B2	Beaver Dam #1 & #2	05/24/2011	41.0
4B2	Beaver Dam #4	07/07/2011	36.1

This page was intentionally left blank

HYDRAULIC MODELING ASSUMPTIONS

Hydraulic data are needed to evaluate fish passage of the structures under a variety of flow conditions, such as flow depth, velocity, and discharge. Hydraulic data was evaluated in relation to fish capabilities to determine Chinook salmon passage success. The software used to complete the hydraulic modeling was the Hydrologic Engineering Center's River Analysis System (HEC-RAS) version 4.1.0 developed by the USACE. The HEC-RAS model simulates one-dimensional flow that assumed steady gradually varied flow. The base model was originally developed by Tetra Tech, Inc. dba Mussetter Engineering Inc. (MEI) and modified for this evaluation based on data collected by Reclamation and DWR (Mussetter Engineering, Inc., 2008a) (Mussetter Engineering, Inc., 2008b). A HEC-RAS model was developed for each individual structure with the exception of the beaver dams. The beaver dams were modeled as a group using a single typical beaver dam structure.

The hydraulic assessment was completed in three phases including assessing existing base models, modifying the base models with structural and channel topography collected, and calibrating the models with water surface elevations and flow measurements collected at each structure. The updated models were then run over a range of flows to evaluate the fish passage. Data used for calibration is referenced in Appendix A. The hydraulic results are presented so that any fish species criteria can be compared to each hydraulic structure.

The hydraulic analysis of the structures was completed by the DWR-SCRO in coordination with the Reclamation and Tetra Tech. The hydraulic models were designed to assess each structure independently but with identical boundary conditions derived from the main model. The models were used to determine fish passage for a range of flows.

The original model was developed using contour maps of the river corridor based on subsidence-corrected 2-foot contour topographic mapping developed by Ayres Associates and bathymetry dated 1998/1999. The original model is in the NGVD29. In 2008, updated topography using LiDAR imagery was collected, and in 2010 updated bathymetry was collected. This data is in NAVD88. Tetra Tech has updated the topography of the base model for some of the SJRRP reaches and to varying degrees. The Reclamation has updated the topography for a portion of the Bypass Model from the Sand Slough Connector to the head of the Mariposa Bypass. Table 8 identifies each second pass location and whether or not the site specific model has been updated to reflect current conditions, and to what level.

Table 8. HEC-RAS Topography Status (Dec. 2011)

Description	Reach	LiDAR Update?	Bathymetry Update?
Lost Lake Rock Weir #1	Reach 1A	Yes	Yes
Lost Lake Rock Weir #2	Reach 1A	Yes	Yes
Donny Bridge	Reach 1B	Yes	Yes
San Mateo Avenue	Reach 2B	Yes	Yes
Beaver Dam #5	Reach 4B2	No	No
Beaver Dam #4	Reach 4B2	No	No
Beaver Dam #3	Reach 4B2	No	No
Beaver Dam #2	Reach 4B2	No	No
Beaver Dam #1	Reach 4B2	No	No
Sand Slough Connector	Eastside Bypass (Head of Reach 4B1)	Yes	Yes
Eastside Bypass Control Structure	Eastside Bypass	Yes	Yes
Dan McNamara Road	Eastside Bypass	Yes	Yes
Mariposa Bypass Control Structure	Mariposa Bypass	Yes	Yes
Eastside Bypass Rock Weir	Eastside Bypass (Near Bear Creek Confluence)	Yes	Yes
Refuge Low Flow Crossing	Reach 4B2	Yes	Yes
Merced Refuge Weir #1	Eastside Bypass	Yes	Yes
Merced Refuge Weir #2	Eastside Bypass	Yes	Yes

DWR individual model assumption adjustments for Task 2 hydraulic results are detailed per reach if they differ from the original model; additional data is provided in the result templates in Appendix A.

Reach 1A

Flows through Reach 1A were simulated using the HEC-RAS Reach 1A model developed by Tetra Tech, Inc. (Tetra Tech (dba Mussetter Engineering, Inc.), 2011b). Throughout the reach, many locations have sediment added to the channel bed for calibration purposes. Overall the reach performs well, but the Lost Lake Weir #2, could not be finalized. The structure will continue to be revised and updated when time permits. Lost Lake Weir #2 calibrated well to the high flows but was not able to capture the water surface elevations that are observed in the field for low flows over the left bank section of the weir. The left bank is the primary location that adult salmon would attempt to pass but the model results do not predict the water surface elevation, velocities or depths for this area accurately so the model results for this structure are not complete. Due to the complexity of the flow split and topography, a two dimensional model may be an alternative model that should be evaluated for reasonableness. Additional topographic data may also be needed.

Reach 1B
Flows through Reach 1B were simulated using the HEC-RAS Reach 1B model developed by Tetra Tech, Inc. (Tetra Tech (dba Mussetter Engineering, Inc.), 2010). The model could not accurately calculate velocities and depth for flows over 3,000 cfs at Donny Bridge due to the complexity of the flow passing through and over the bridge. Velocities based on the expertise of Tetra Tech and DWR at flows between 3,000 and 4,500 cfs are representing the average channel and not the flow through the bridge. HEC-RAS is noting that the cross sections at the bridge have been projected from the downstream cross section and the model is not computing answers inside the bridge. The flows in the model from 3,000 to 4,500 cfs are being modeled to go through the bridge deck, but in reality should be either going under or over the bridge deck. DWR and Tetra Tech, Inc. tried to correct the error but have not been able to determine a solution at print of the report. The graphs have been modified to omit the erroneous data. The model will continue to be refined.

Eastside Bypass Model
Flows through Eastside Bypass Bifurcation Structure were simulated using the HEC-RAS model developed by the Reclamation (Reclamation, 2011). The larger bypass model developed by MEI in 2007 assumed a rating curve that was originally based on the previous coordinate system. The rating curve was unable to calibrate reach wide with the 2011 flow monitoring data collected by DWR at the Eastside Bypass Bifurcation structure as well as nearby structures within the bypass. The final model calibrated well reach wide assuming normal depth for the water surface elevations from the 2011 flow monitoring data. It was decided that normal depth will be assumed for the reach until the rating curve is properly updated for use with the current topography and coordinate systems.

The model is run under two scenarios: Boards-in and Boards-out. Stops logs are found at Eastside Bypass Bifurcation Structure and both Merced Wildlife Refuge Weirs, hence two separate model simulations are needed to evaluate the effect of stops logs.

Reach 4B2
The reach has complex boundary conditions depending on if the Eastside Bypass, Bear Creek and Merced River have significant inflow. This area of the river is affected by backwater and this would affect how the structures within the reach would perform hydraulically. The typical beaver dam is a structure that due to its location would be influenced by backwater. The backwater would improve the passage at the structure by submerging the structure under several feet of water eliminating the need to jump. The model was calibrated with the known backwater but the model results assume that the most conservative flows would be those in critical years so no backwater was presented for the results.

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. This analysis did not consider operation at gated structures which can impede fish passage. 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 to guide future design decisions on future fish passage facilities. Calibration was not performed over a broad range of flows and results for very low flows and very high flows may not provide reasonable results. It is also recommended to conduct fish passage monitoring during the salmon reintroduction at those structures that may be partial barriers to make a final passage determination based on actual field data collected for a variety of flows.

Modeled Flow Range

The flow range that was input into the model was between 25 – 4,500 cfs for the San Joaquin River and 25 – 8,500 cfs for the bypasses. The result curves are presented up to 4,500 cfs since a majority of the passage that is impaired is for lower flows. The flow range is displaying the actual flow at the structure and does not correlate to Friant Releases.

Calibration Results

The structures were all calibrated to actual data collected during specific flows as listed in Table 7 in addition to calibration data collected by other agencies. The flow results provided are not related to Friant Dam releases and are only looking at local flows. Figure 4 in Appendix C displays the flows in Table 7 as they relate to Friant releases.

SECOND PASS EVALUATION RESULTS

The hydraulic models were used to compare each structure with the fish passage criteria in Table 4. The findings for each structure when compared to the criteria for jump, velocity and depth are summarized below and are presented in Table 9.

Lost Lake Weirs

The Lost Lake weirs are located within Lost Lake Park. Lost Lake Park is operated by Fresno County. The weirs are constructed of set in concrete boulders so the elevation of the top of the weirs is varied and includes sediment that has filled portions of the weirs. The sediment allowed vegetation to take hold so the average of the top of weir elevations were used to create a sediment fill[3] at each weir for the model.

Weir #1

Lost Lake Weir #1 looking upstream at left bank

This weir is located upstream of Weir #2. The average weir elevation in the model is 299.0 feet. The depth over the weir was calculated by subtracting the average weir elevation with the water surface elevation over the weir. There is flow over the weir at all flows but the depth over the weir does not reach 1.2 feet until flows are around 900 cfs. For flows under 900 cfs jump would be the primary method to pass. Depth for jumping is not sufficient until flows are above 100 cfs. The jump pool is just downstream the weir and a jumping height of 1.8 feet may be difficult for an adult Chinook salmon that is very close to its spawning grounds. Figure 1 did not include fish in poor condition (Cfc = 0.50) so the curves were developed and a jump of 80 degrees at the rock weir may be achieved with a maximum jump at 1.9 feet for a length of around one foot. There is a possibility that the fish will have problems passing with the height of the jump since the width of the weir is more than three feet and there are multiple rocks at varying depths. However, the model looks at the overall average weir height but the weir actually is varied in height so jump height is varied. Flow velocities are below 10.8 fps for all flows. Ultimately, the average jump height is within the criteria at 100 cfs. If the primary spawning grounds are going to be located upstream this structure, it is

[3] Sediment fill is used in hydraulic models to fill in gaps in the cross sectional elevations to average the elevation across the structure.

recommended that the structure be observed at flows from 100 cfs – 900 cfs to make sure fish passage is not an issue.

Weir #2

The average weir elevation in the model is 297 feet. There is flow over the weir at all flows but the depth over the weir does not reach 1.2 feet until flows are around 500 cfs. For flows less than 500 cfs jump would be the primary method to pass. The hydraulic one-dimensional model was not able to duplicate the complexity of the flow over the varied weir so the drop was not modeled. More data collection may be required to evaluate the structure.

Lost Lake Weir #2 looking downstream from left bank

Donny Bridge

The Bridge is located on the San Joaquin River downstream of Highway 99. It is not publicly accessible and use is limited. The bridge opening does not extend the width of the channel and causes flows to contract prior to flowing under the bridge. The capacity of the bridge opening is at around 3,000 cfs after which flows continue to hit the bridge deck and eventually overtop the bridge. Jump was not evaluated since the channel bed under the bridge is natural substrate at grade. Depth is basically the depth that is present in the channel upstream and downstream the bridge. Depth at 25 cfs exceeds 1.2 feet so depth under the structure is not impeding passage.

Donny Bridge looking downstream

However, velocities due to the constriction exceed criteria at some flows. A conservative approach to velocity is to assume the bridge is acting like a culvert so referencing Table 3 would limit the velocities at 6 fps for adult Chinook salmon. Flows above 3,000 cfs are considered pressure flow since they are forced under the Bridge deck until overtopped at flows over 4,500 cfs, but due to the modeling issues results for flows between 3,000 – 4,500 cfs are not valid. Unfortunately, the modeling issues were not able to be resolved so the graphs do not include information at the bridge for these flows. Until these flows can be studied in detail with actual field data collection the velocity curves are assumed to remain steady at the maximum velocity prior to being overtopped, so velocities over 2,500 cfs are assumed barriers for passage. Once the bridge is overtopped, the velocities should become passable under the bridge.

San Mateo Avenue

San Mateo is a low flow crossing that is publicly accessible. It is an earthen structure that spans the width of the channel with a culvert. The crossing was evaluated for passage at the culvert for flows up to 200 cfs. At flows that exceed 200 cfs the road is overtopped and acts like a weir.

San Mateo Avenue culvert looking downstream

The criteria for minimum depth of 1.2 feet is compared for the culvert and then as a weir when flows overtop the road. The culvert is imbedded so jump was not evaluated at the outlet since even the lowest flows would be at bed level. Minimum depth within the culvert is at 1.8 feet for 25 cfs; this exceeds 1.2 feet so depth does not exceed criteria within the culvert. Minimum depth over the road for flows from 200 – 700 cfs is less than 1.2 feet, but fish can pass in the culvert since it is fully submerged. Criteria for velocity is estimated based on Table 3 at 6 fps since the culvert length is less than 60 feet. Velocities of 6 fps within the culvert are not exceeded for any flows but are equal to 6 fps at the outlet for flows at 200 cfs. The maximum velocity over the weir is estimated from Figure 3 at just over 3 fps for the road length estimated at 44 feet wide. The cross sections just upstream and downstream the road average around 1 fps for all flows. Based on these criteria for passage, this structure does not exceed criteria at any passage flows.

Although San Mateo Avenue is deemed unimpeded when compared to the limiting passage criteria there is potential for stranding on the road at flows between 200 – 700 cfs. In addition, channel depth upstream at 25 cfs is less than one foot so Reach 2A may limit passage more than San Mateo Avenue.

Sand Slough Connector

The structure is located in Sand Slough just downstream the Reach 4B headgates. Since the headgates are not operational all flows from the San Joaquin River from Reach 4A flow through the Sand Slough Connector to the Eastside Bypass. The structure is basically a broad crested weir with a flume designed to have stop logs inserted at the inlet, but has not been observed with stop logs in place. The model assumes that the boards are out. According to the model, the weir is overtopped at flows just less than 200 cfs and the inlet is overtopped at flows above 400 cfs. The structure was evaluated as a culvert for flows under 400 cfs, because of the hardened bottom and flume sides. Flows over 400 cfs are basically weir flow, so burst speeds of 10.8 fps can be used to access the velocities at the weir when it is overtopped since the weir can be jumped or passed through the submerged inlet. Velocities of 6 fps are not exceeded for flows under 400 cfs at the inlet or the outlet.

Sand Slough Connector looking south

The depth of flow over the weir at 200 cfs is 0.2 feet; depth exceeds 1.2 feet at 600 cfs. The culvert inlet is at the channel elevation at the inlet and the outlet. Flows at 25 cfs have depth of 3.8 feet through the structure inlet and outlet. Depth for swimming is sufficient through the structure. Fish may jump the weir in lieu of swimming through the flume inlet so jump was assessed from flows of 200 cfs to 600 cfs. At flows over 600 cfs the fish can swim over the weir. The pool height needed for the jump is minimal so it is not impeding jumping at these flows. In addition, velocities do not exceed 10.8 fps.

Based on these assumptions the Sand Slough connector does not exceed criteria at any flows.

Refuge Low Flow Crossing

San Luis Wildlife Refuge low flow crossing looking east

The low flow crossing on the San Joaquin River is located within the San Luis Wildlife Refuge. It is maintained by the U.S. Fish and Wildlife Service. The crossing is used to access the East Bear Creek units. The crossing does not have any culverts and is constructed of mostly cobble. Vehicle crossing is limited to lower flows since it is almost always submerged. The width of the roadway top was measured around 14 feet. Since the structure is submerged most of the time, jump was not calculated but depth over the road should be at least 1.2 feet.

The depth is not achieved until flows reach about 50 cfs, so at 25 cfs the depth is less than 1.2 feet.

According to Figure 3, for a roadway width of 14 feet the velocities over the road should not exceed the burst speed of 8 fps. Velocities over the road are well below 8 fps. The crossing does not meet criteria for depth until flow reach 50 cfs.

Eastside Bypass Control Structure

The Eastside Bypass Control Structure is at the Mariposa Bypass Bifurcation structure and is located on the Eastside Bypass just upstream the Mariposa Bypass control structure. The structure was evaluated for passage for two scenarios that did not consider gate operations so gates are fully open. Full gate closure would cause this structure to become a fish barrier at all flows. The first scenario is the existing condition, which is assuming the stop logs are in place at the inlet (Boards-in). The second scenario is assuming the stop logs are removed (Boards-out). The structure becomes the controlling feature in this reach of the Eastside Bypass at the inlet for the boards-in scenario and at the outlet for the boards-out scenario.

Eastside Bypass Control Structure inlet looking east

For both evaluations, the initial staging pool is located about 30 feet downstream the sill and is 8 feet deep on average. Riprap has been placed downstream the sill in the channel for protection from scour and erosion. To account for the riprap the slope of the staging pool was compared with the distance to the minimum pool depth needed for the adult Chinook salmon to jump the sill based on the jump height per flow (WSE just downstream the sill subtracted by the WSE just upstream the sill). The parabolic jump curves for fish in good condition for the angles at 60 and 40 degrees were assumed to be the most conservative for evaluating jump. An angle of 80 degrees is not possible due to the riprap at the sill. Due to backwatering of the sill there are no minimum depth issues within the structure for both scenarios at all flows. For velocity within the structure, velocities of 5 fps are exceeded for 8,500 cfs so this will be the top end of the passage range. Velocities of 5 fps are exceeded at the baffles for flows between 900-1,000 cfs and flows above 5,500 cfs. Baffles at this structure are two feet deep by two feet wide and four feet in height with a spacing between the baffles of one foot that are located just upstream the outlet of the bay to dissipate the flows prior to exiting the culvert . These structures are not a solid feature and can be traversed at all flows if burst speed is assumed at 10.8 fps; assuming

10.8 fps at the baffles it does not exceed criteria for velocity. The baffles are overtopped between 1,000 cfs and 1,500 cfs.


Eastside Bypass Control Structure inlet looking upstream from inside bay

Scenario 1: Boards-in
Flows below 500 cfs exceeded the jump criterion at the sill due to the distance from the structure to achieve the minimum pool depth assuming fish in good condition and 700 cfs assuming fish in poor condition. However, if the curves for fish in excellent condition are used all flows are passable for jump at the sill. This is different for the inlet of the structure assuming boards-in. The hardened bottom of the structure does not provide a deep staging pool to jump the stop logs at the inlet. There is sufficient depth of flow just behind the boards for jump at 200 cfs but there is a hydraulic jump[4] at the boards that is greater than one foot for flows up to 1,500 cfs. Depth over the boards is less than 1.2 feet until 500 cfs. Table 3 was referenced to determine the maximum average velocity within the structure since the structure has a hardened bottom with multiple box culverts. The total structure length is 64.5 feet from the inlet to the outlet, so the maximum velocity criterion is 5 fps. Based on the curves in Appendix A pg 61, the velocity for the in bay curve does not exceed 5 fps at all flows. This velocity is not used for the curve at the sill or stop logs because technically they are acting as a weir and not a culvert. The limiting velocity at the sill and inlet is about 10.8 fps based on Figure 2 for the fish in good condition curve for one foot of length. Assuming the adult Chinook salmon are at maximum burst speed for the jump, the sill or inlet velocity does not exceed criteria.

The unimpeded passage flow range for gates fully open and some boards-in is based on the limiting flows for jump at the outlet. The structure exceeds criteria for jumping at the sill for flows under 700 cfs, but there is potential for it to be a behavioral barrier because of the hydraulic jump present that exceeds one foot at the inlet for flows under 1,500 cfs.

Scenario 2: Boards-out
The conditions at the sill for boards-out are the same as those for boards-in. The structure does not meet the jumping criterion for fish in good condition at the sill for flows under 500 cfs; 700 cfs for fish in poor condition.

[4] Hydraulic jump is a hydraulic term to describe the water surface as it is induced by downstream obstructions and a gradient change at the boards. Removal of the boards eliminates this hydraulic effect.

Based on Table 3 the velocity in the bay and inlet should not exceed 5 fps, since the structure is considered a culvert. Under these assumptions the inlet and bays do not exceed criteria for velocity until flows are at or exceed 8,500 cfs.

The unimpeded passage flow range for gates fully open and boards-out is based on the limiting flows for jump at the outlet. The structure exceeds the criterion for jumping at the sill for flows under 700 cfs, but unlike boards-in there is not really a potential for a behavioral barrier at the inlet since there is no longer a hydraulic jump present.

Mariposa Bypass Control Structure

The Mariposa Bypass control structure is at the head of the Mariposa Bypass just upstream the Eastside Bypass control structure. The structure was modeled assuming gates are closed and only the bays without gates have flow. Partial gate closure for the gated bays was not evaluated. Downstream the outlet is a 45 feet long concrete apron with a sill at the end. The top of the sill is at the same elevation as the channel bottom and has a cobble gabion for scour protection that begins just downstream the sill. Due to the concrete apron there is no staging pool, so jump is dependent on the depth of flow over the apron at the origin of the jump. The opening includes an ogee type spillway and has a 7.5 foot drop from the inlet to the outlet of the structure with no resting pool at the inlet.

Mariposa Bypass Control Structure at inlet looking south

The depth of flow at the inlet for flows above 900 cfs would meet criteria of 1.2 feet. The depth of the staging pool is not sufficient for jumping until flows that enter the structure are around 1,500 cfs. Due to the distance needed for the jump, around 9 feet, from the origin for a fish in good condition, jump would not be able to be completed based on the criteria. A fish fresh out of the ocean may be able to complete the jump. Not until flows exceed 2,500 cfs when the inlet elevation is equal to the elevation of the pool it is possible for a fish in good condition to complete a jump.

Since the bays are essentially culverts, referencing Table 3 flows should not exceed 6 fps. Velocities over the inlet exceed 6 fps for flows over 800 cfs and does not meet criteria within the culvert. At burst speed for the 9 feet, Figure 2, velocities should not exceed 9 fps if the most conservative culvert approach is ignored. It may be possible to pass briefly at 2,500 cfs but velocities for burst are exceeded at 3,000 cfs.

Based on this information Mariposa Bypass control structure exceeds criteria at all flows.

Dan McNamara Road

Dan McNamara Road is a low flow crossing within the Eastside Bypass near the Merced National Wildlife Refuge that is located upstream the Eastside Bypass bifurcation structures. Due to the proximity of the crossing to the bifurcation structures the hydraulics are affected by the boards-in at the Eastside Bypass and would be affected by gate closure. Both scenarios for boards-in and out with gates fully open were compared for fish passage to determine how changes at the Eastside Bypass Control Structure would change passage at Dan McNamara Road. The crossing is an earthen embankment with a gravel armored top. There is an incised channel at the culvert. The culvert is located in the center of the crossing with another culvert in the upper floodplain for an overflow channel that is silted in.

Dan McNamara Road looking north

According to the Eastside Bypass boards-in model the capacity of the culvert under the road is less than 20 cfs, so all flows overtop the road at 25 cfs. The culvert depth at full capacity is about 2 feet but velocities within the culvert exceed 6 fps at the outlet for flows between 25 and 50 cfs. Based on Table 3 the velocity in the culvert should not exceed 6 fps since the culvert length is less than 60 feet. For flows at 25 through 50 cfs the salmon would need to jump the road since the culvert exceeds criteria, but do not have sufficient depth just downstream the road for jumping until 100 cfs. The maximum depth over the road does not meet the 1.2 feet criteria for passage until 600 cfs. Flow velocity over the road, when compared to Figure 1, is within criteria for burst speed.

The Eastside Bypass boards-out model varies from the boards-in for flows above 1,500 cfs with minor to no changes to the model results for flows below 1,500 cfs. Fish passage criteria for this structure are exceeded for both scenarios at flows below 600 cfs for depth, so this structure may impede adult Chinook salmon at flows below 600 cfs.

Eastside Bypass Rock Weir

This structure is located within the Eastside Bypass near the confluence of the San Joaquin River. It is not a typical structural weir; it is composed of large rubble that is mostly concrete. At all flows the structure is partially submerged and becomes fully submerged at flows over 500 cfs. Due to unknown passage constraints, it was assumed that the structure exceeds criteria at flows below 500 cfs. The maximum height was estimated to be around 6.5 feet, based on the difference from the structures toe and maximum average height. The lowest point on the weir drops about 2 feet on average for a height of 5 feet, but there is rubble located just downstream this location so jump will be difficult since a deep staging pool is not in the area. There did not appear to be any staging pool so the pool depth will be estimated from the structures toe.


Eastside Bypass Rock Weir looking south at left bank

Using the minimum elevation to estimate jump when partially submerged, is less conservative, but due to the attraction flows at the lowest point in the weir; the lowest point is the most likely location where adult Chinook salmon will begin to jump. There is a hydraulic jump of over 1 foot at the weir until flows are above 1,000 cfs. It is estimated that adult Chinook salmon can complete a jump as low as 25 cfs assuming fish in good condition, but there is not enough depth to get past the width of the structure. The rock weir is about 30 feet wide at the toe of the structure and about 10 feet wide at the top, so the limiting criterion for passage is depth over the weir.

Depth over the weir was evaluated to determine if there is a potential for stranding and since there is no way to truly bypass the structure; stranding would be considered a barrier to upstream passage at this structure. Depth over the weir when partially submerged at 300 cfs at the lowest point is around 1.6 feet, but at 200 cfs depth is around 0.95 feet. There is potential for stranding due to insufficient depth at flows between 25 – 200 cfs.

To be conservative for this evaluation the maximum width of 30 feet was used to determine the criteria for velocity over the structure and based on the Figure 3 the velocity for 30 feet for fish in good condition is around 11 fps. Velocities are well below this for the structure. Due to depth over the weir passage criteria is exceeded until flows exceed 200 cfs.

Merced Refuge Weirs
The weirs are located on the Eastside Bypass in the Merced National Wildlife Refuge. The weirs are designed to have stop logs put in place to control head within the bypass to operate canals that feed the Refuge ponds. Since the structures have stop logs two scenarios were completed. The first scenario is the existing condition, which assumes the stop logs are removed (Boards-out) this simulates a culvert. The second scenario assumes the stop logs are in place at the inlet (Boards-in) this simulates a weir.

Scenario 1: Boards-Out

Weir #1
This structure is located downstream of Weir #2. The structure has concrete abutments on the banks with cobble armoring the banks and a cobble levee on the left bank. The cobble levee is overtopped before the weir is overtopped. The weir has a three foot wide metal grate for access to the metal I beams that are designed to accommodate the wood stop logs. There are two concrete pier walls that support the metal grate. There is a concrete apron on the bottom of the structure with a small concrete sill just downstream the structure that is submerged at all flows. There appears to be a higher sill at the inlet or stop logs that are in place that is about two feet higher than the concrete apron.

Merced Refuge Weir #1 looking west at left bank

The depth over the inlet is 1.2 feet when flows reach 500 cfs. The inlet can be jumped at 100 cfs mostly due to sufficient depth for jumping not due to the height of the jump, but with the many beams for the stop logs there is a risk of injury to the fish. The pool upstream is over four feet deep at 25 cfs. The weir is overtopped at flows above 3,000 cfs but the cobble bank is overtopped at 2,000 cfs. Depths over the cobble bank do not reach 1.2 feet until 3,000 cfs. The weir may not be passable at 3,000 cfs but the cobble bank is passable at 3,000 cfs. Velocities do not exceed cruising speed of 10.8 fps at all flows. Since the inlet can be jumped at 100 cfs, regardless of condition, fish should be able to pass at flows that exceed this flow.

Weir #2
This is a smaller structure that has concrete abutments on the banks with notched pier walls for the stop logs to slide into. The top of the weir has wooden planks that total two feet wide. The depth at 25 cfs is around four feet so depth is sufficient for all flows. Velocities remain below 3 fps for all flows. The weir is overtopped at flows above 350 cfs. Depth over the weir does not exceed 1.2 feet until flows are around 800 cfs, but fish should be able to pass through the structure at all flows unless stop logs are in place.

Scenario 2: Boards-In

Weir #1
The structure becomes the controlling feature in this reach of the Eastside Bypass at the inlet for

the boards-in scenario. The elevation of the stop logs was assumed to be 100.0 feet, which is the elevation just below the top of the supports, for the most conservative jump. The stop logs are inserted on the upstream side of the weir, so when fish jump the metal grate becomes an overhead barrier unless flows are high enough for the grate to be overtopped. With boards-in the jump is possible at 900 cfs, for fish in good condition, but with the overhanging metal grate the salmon will not be able to complete the jump. The weir is overtopped at 3,000 cfs which is the same as the boards-out scenario. At 3,000 cfs the weir can be bypassed on the left bank. It should be recommended that boards are out during salmon spawning since passage is drastically affected by the boards in place.

Weir #2

When the boards are in at Weir #1 this weir becomes ineffective and completely submerged. At 25 cfs the depth over the weir is around 2.5 feet. The downstream weir boards were removed to see how this would change the water surface elevations at the weir. The stop logs are on the downstream end of the structure so jump may be less hazardous for the salmon. Boards can be installed up to an elevation of 97.0 feet with the top of the deck at 97.65 feet. The deck is overtopped at 100 cfs but does not achieve a depth of 1.2 feet until 700 cfs. Jump is possible at all flows regardless of fish condition. Velocities are less than 6 fps, so the structure is passable at cruising speed or when jumping. To be conservative the weir exceeds criteria until flows exceed 700 cfs due to depth.

Merced Wildlife Refuge Weir #2 looking east at right bank

Typical Beaver Dam

A majority of the beaver dams on the San Joaquin River have been located within the San Luis Wildlife Refuge. Each beaver dam is unique in size and shape with varying heights and widths with some that appear abandoned and others that are well maintained. Eradication of beavers may not be the best option, since other restoration projects have not been successful in eradicating all the beavers. Removal of dams with an active beaver may not be a solution since beavers can reconstruct a dam overnight within 8 hours. The largest dam was used as the typical to determine if there are certain sizes of dams that may cause passage issues. The height of the dam downstream was measured at just over 4 feet, so 4 feet was the assumed modeling height. When backwatering is present in the Refuge the beaver dams are not really a problem since they are submerged by several feet of water. To evaluate the most conservative adult passage, the model was assumed with no downstream flows present in the Eastside Bypass, Bear Creek or Merced River, so no backwatering is present downstream of the dam.

At 4 feet height, the depth over the dam is 1.2 feet at 300 cfs. The pool depth is sufficient for jumping at 100 cfs but would be difficult or impossible at 25-50 cfs without a proper staging pool with a depth greater than 4 feet within 5 feet of the toe of the dam. All flows are passable due to jumping if there is a staging pool present. Depths upstream and downstream are sufficient at 25 cfs. Velocities are below 6 fps, so jumping or swimming over the dam is not above cruising speeds of 10.8 fps.

If dam heights exceed 4 feet from the downstream toe to the dam crest, dam removal or modification may be needed. At some locations that lack a staging pool, constructing a staging pool, dam removal, or modification may be needed to facilitate passage. If the beaver dam height is at or below 3 feet from the downstream toe to the dam crest than most low flows can be jumped without a staging pool.

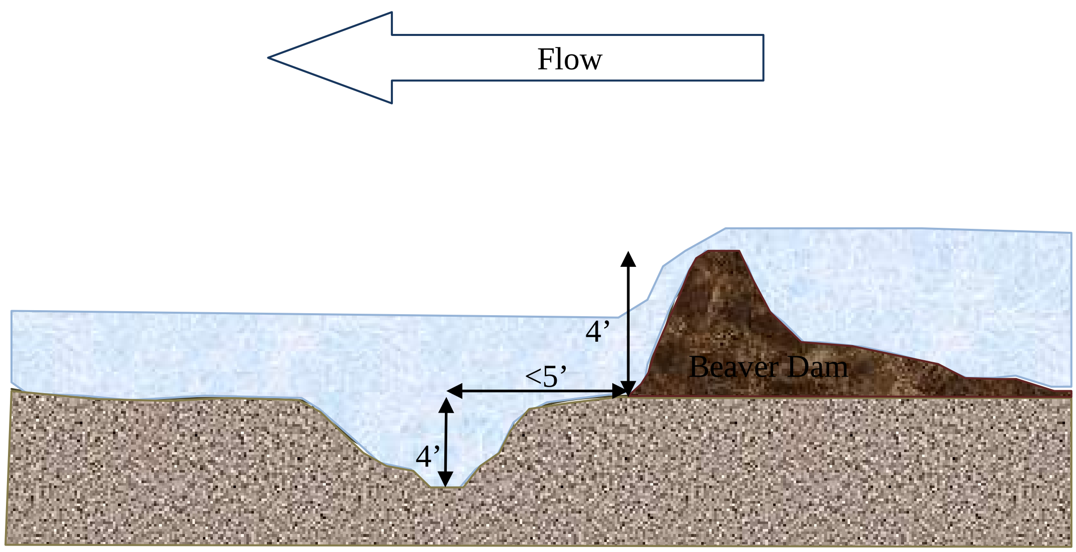


Figure 5. Recommended Beaver Dam Specifications

It is recommended to complete an annual survey of beaver dam locations, heights, and the presence of a staging pool (depth and distance). Modifications are needed if the dam exceeds 3 feet in height and a proper staging pool is not present. Staging pool depth should be about 4 feet below the dam toe elevation and within 5 feet from the toe of the dam. Figure 5 displays the conceptual drawing for the recommended beaver dam specifications.

Summary of Criteria Results per Structure

Table 9 displays the resulting unimpeded flow range for each structure to pass adult Chinook salmon. These flows are representing flows that are present at the structure and are not reporting actual flow releases at Friant Dam or those in the bypasses.

Table 9. Second Pass Evaluation Results

Structure	Unimpeded Passage Flow Range (cfs)[1]
Lost Lake Rock Weir #1	100 – 4,500
Lost Lake Rock Weir #2	Undetermined
Donny Bridge	25 – 2,500
San Mateo Avenue	Unimpeded
Sand Slough Connector	Unimpeded
Refuge Low Flow Crossing	50 – 4,500
Eastside Bypass Control Structure	500 – 8,500[2]
Mariposa Bypass Control Structure	Barrier
Dan McNamara Road	600 – 4,500
Eastside Bypass Rock Weir	200 – 8,500
Merced Refuge Weir #1 (Boards-Out)	100 – 4,500
Merced Refuge Weir #1 (Boards-In)	3,000 – 8,500
Merced Refuge Weir #2 (Boards-Out)	Unimpeded
Merced Refuge Weir #2 (Boards-In)	700 – 8,500
Typical Beaver Dam	Varies

[1]Flow range modeled for the San Joaquin River is 25-4,500 cfs and 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 are open, if gates are closed this is a total barrier at all flows

This page was intentionally left blank

CONCLUSIONS AND RECOMMENDATIONS

The analysis shows that there are potentially 11 structures (not counting Beaver Dams) that would be a partial or full barrier to adult Chinook salmon during some part of the restoration flow hydrograph. From those 11 there are three structures, assuming the Merced Refuge Weirs have boards-out, that are barriers during the spring and fall pulse flows for a critical high year, when it is expected that adult salmon will be migrating. Of those three structures, they would be barriers during normal and wet years. At summer base flows of 350 cfs for a normal dry year, six structures are barriers at the tail end of the spring run migration but are located within the Eastside Bypass. The Merced Refuge Weirs are barriers for the base flows and the upper weir is a barrier for all hydrographs if assuming boards are in. A majority of the structures that are barriers during the restoration flow hydrograph are located within the Eastside Bypass.

The results of this evaluation suggest that adult fall-run Chinook salmon would not be able to pass structures in Reach 4B or the Eastside Bypass unless improvements are completed to allow passage at the typical base flows of 350 cfs in Reach 1, but depths within the bypass channel should be investigated since they may not be sufficient to pass fish at these flows. Operations of flood control facilities need to be researched and modeled to ensure that typical operation changes would not impede passage. The Chowchilla Bypass model is currently being developed, so once it has been properly calibrated the structures that have been identified as partial barriers should be evaluated. Seepage and flow loses were not assumed in the current HEC-RAS model for this effort, so assumptions regarding flow routing and losses need to be refined and modeled. Monitoring is recommended for many of the structures that are deemed partial barriers. As decisions are made on routing paths and flows, the results of the Task 2 analysis will need to be reevaluated. Structures on the Chowchilla Bypass may need to be evaluated if it is a recommended pathway for migrating adult salmon. In addition, this study did not evaluate juveniles and resident fish and could include those in future studies.

Based on these findings, the following structures listed in Table 10 will be evaluated in Task 3 to develop passage alternatives. These structures were identified as partial or complete barriers for adult migration salmon. Some of these structures are already part of larger projects and are currently being assessed for designs to accommodate passage. A few structures on the list were also included since there was insufficient available information on the structure to determine if it was a barrier to migrating adult salmon.

Table 10. Recommended Task 3 Structures

Structure
Chowchilla Bypass Control Structure
San Joaquin River Control Structure
San Mateo Avenue
Mendota Dam
Sack Dam
San Joaquin River Reach 4B Headgates
Merced Refuge Weir #2
Merced Refuge Weir #1
Dan McNamara Road
Eastside Bypass Control Structure
Mariposa Bypass Control Structure
Mariposa Drop Structure
Eastside Bypass Rock Weir

Lost Lake Weir #2 may need to be modeled with a two-dimensional model and may need to have a complete topographic survey conducted this summer when flows are low. This structure is not recommended for Task 3, but DWR will continue to refine the model and if found a barrier will add the structure to Task 3.   Both Lost Lake weirs should be monitored during flows between 25-900 cfs to refine the models and confirm passage. Donny Bridge will also need to be further evaluated for flows over 2,500 cfs since velocities may exceed passage criteria. Future data collection and refinement of the model is necessary to determine the actual velocities at the bridge inlet when flows are contracting and are under pressure until the bridge is overtopped. Even though this structure is not recommended for Task 3, DWR will continue to refine the model and if found a barrier will add the structure to Task 3.

San Mateo Avenue will be included in Task 3 to identify improvements for flows between 200 cfs and 700 cfs to ensure passage. Typically the roadway is partially washed out with higher flows to a depth that would be 1.2 feet at 200 cfs so this may limit stranding on the roadway. Reach 3 has several known barriers at Sack Dam and Mendota Dam and are currently being studied for modification by Reclamation.

In the Eastside Bypass, passage criteria are exceeded at the Eastside Bypass Control Structure below 700 cfs and at the Eastside Rock Weir below 200 cfs. Further evaluation will also be necessary for the control structure when the gates are being operated to ensure depth and velocities do not exceed passage criteria. Dan McNamara Road may need a larger culvert or relocation of the road since stranding on the road is the greatest concern. The Merced Refuge Weirs when boards are in appears to impede passage during migration periods. The Eastside Bypass Rock Weir debris appears to be in place for maintaining a certain water surface elevation for operation of equipment, but exceeds criteria until 200 cfs. Task 3 can look at different alternatives from removal to replacing the weir with an engineered structure.

The Mariposa Bypass Control structure is exceeding criteria at all flows and the Reach 4B headgates are nonoperational. Beaver dams within the San Luis Wildlife Refuge should be surveyed annually for beaver dam locations, heights, and the presence of a staging pool (depth and distance). Modifications are needed if the dam exceeds 3 feet in height if a proper staging pool is not present. Staging pool depth should be about 4 feet below the dam toe elevation and within 5 feet from the toe of the dam.

It is recommended that Task 3 continue to evaluate many alternatives to resolve the passage problems at key structures to choose the most cost effective option for construction, operation, and maintenance. A thorough design through modeling will be completed to ensure changes to the structure do not impact other structures and create unforeseen passage impairments. Task 3 will develop channel depths at typical passage flows to determine if there is sufficient depth within the reaches of the river and bypass system just upstream and downstream the structures, if not completed by another agency. Additional data for assumed migration routing can be evaluated and presented to assist operators and management based on Friant releases, flood flows, and other conditions that are historically present in the system.

Improving passage at impaired structures is a critical step to successful reintroduction of salmon to the San Joaquin River. Additional work includes developing recommendations and identifying potential straying and standing issues through a separate evaluation. These recommendations should be combined to ensure the highest potential for passage success.

This page was intentionally left blank

REFERENCES

Ayres Associates. (1998). *Topographic and Bathymetric Surveys for the San Joaquin River from Friant Dam to Gravelly Ford (RM 267 to RM 229)*. Fresno, California: Prepared for Bureau of Reclamation.

Ayres Associates. (1999). Topographic and Hydrographic Surveying and Mapping for San Joaquin River, RM 40 to RM 230, Including Tributaries and Distributaries. Draft Report. *Topographic and Hydrographic Surveys for the Sacramento and San Joaquin Comprehensive Study*. California: Prepared for U.S. Army Corps of Engineers, Sacramento District.

Bell, M. (1990). *Fisheries Handbook of Engineering Requirements and Biological Criteria. Third.* Portland, Oregon: US Army Corps of Engineers, North Pacific Division.

Bell, M. (1991). *Fisheries Handbook of Engineering Requirements and Biological Criteria. Third.* Portland, Oregon: US Army Corps of Engineers, North Pacific Division.

Bjornn, T. a. (1991). Habitat Requirements of Salmonids in Streams, Chapter 4. *American Fisheries Society Special Publication, Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats* , 19:83-138.

Bjornn, T., & Reiser, D. W. (1991). Habitat Requirements of Salmonids in Streams, Chapter 4. *American Fisheries Society Special Publication, Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats*, 19:83-138.

CDFG. (1998, February). California Department of Fish and Game. *California Salmonid Stream Habitat Restoration Manual, Third Edition*. Inland Fisheries Division.

CDFG. (2010). California Department of Fish and Game. *California Salmonid Stream Habitat Restoration Manual, Fourth Edition*. Wildlife and Fisheries Division.

Mussetter Engineering, Inc. (2008b, August 7). Draft technical memorandum . *Development of San Joaquin River Unsteady-flow Model*. Fresno, California: Prepared for California Department of Water Resources.

Mussetter Engineering, Inc. (2008a, June 2). Draft technical memorandum. *San Joaquin HEC-RAS Model Documentation*. Fresno, California: Prepared for the California Department of Water Resources.

NMFS. (2010). Appendix IX-B, Guidelines for Salmonid Passage at Stream Crossings. In CDFG, *California Salmonid Stream Habitat Restoration Manual* (pp. IX-B-1 - IX-B-11). California Department of Fish and Game.

NMFS. (2001, September). National Marine Fisheries Service. *Guidelines for Salmonid Passage at Stream Crossings*. Santa Rosa, California: National Marine Fisheries Service, Southwest Region.

NMFS. (2008, February). National Marine Fisheries Service. *Anadromous Salmonid Passage Facility Design*. Portland, Oregon: NMFS, Northwest Region.

Powers, P. D., & Orsborn, J. F. (1985). *Analysis of Barriers to Upstream Fish Migration.* Pullman, Washington: Albrook Hydraulics Laboratory, Washington State University.

RBF Consulting. (2008). *Preliminary Aerial Photography taken from San Joaquin River LiDAR Surveys*. Prepared for the Department of Water Resources.

Reclamation. (2011, April 21). Draft Reach 4A Conveyance in the Vicinity of San Slough. *Technical Report No. SRH-2011-20*. Denver, Colorado.

SJRRP. (2010a, November). *Fisheries Management Plan*. San Joaquin River Restoration Program.

SJRRP. (2010b, November). *Final 2011 Agency Plan*. San Joaquin River Restoration Program.

SJRRP. (2011, July). Appendix B. *2011 Draft Annual Technical Report*.

SJRRP. (2010, November). San Joaquin River Restoration Program. *Fisheries Management Plan*.

Stuart, T. A. (1962). *The Leaping Behaviour of Salmon and Trout at Falls and Obstructions.* Department of Agriculture and Fisheries for Scotland, Freshwater Fisheries Laboratory, Pitlochry.

Taylor, R. N., & Love, M. (2010). California Salmonid Stream Habitat Restoration Manual. *Part IX, Fish Passage Evaluation at Stream Crossings*. California Department of Fish and Game.

Tetra Tech (dba Mussetter Engineering, Inc.). (2009a, June 19). Draft technical memorandum . *San Joaquin River HEC-RAS Steady-state Hydraulic Model Refinements*. Fresno, California: Prepared for California Dept. of Water Resources.

Tetra Tech (dba Mussetter Engineering, Inc.). (2009b, October 29). Draft technical memorandum. *San Joaquin River Reaches 2B, 3 and 4B1 HEC-RAS Steady-State Hydraulic Model LiDAR Updates*. Fresno, California: Prepared for California Dept. of Water Resources.

Tetra Tech (dba Mussetter Engineering, Inc.). (2010, August 30). Draft technical memorandum. *San Joaquin River Reaches 1B and 2A HEC-RAS Steady-State Hydraulic Model LiDAR Updates*. Fresno , California: Prepared for California Dept. of Water Resources.

Tetra Tech (dba Mussetter Engineering, Inc.). (2011a, February 28). Draft technical memorandum. *San Joaquin River Reach 4A HEC-RAS Steady-State Hydraulic Model LiDAR Updates*. Fresno, California: Prepared for California Dept. of Water Resources.

Tetra Tech (dba Mussetter Engineering, Inc.). (2011b, September 13). Draft technical memorandum. *San Joaquin River Reach 1A HEC-RAS Steady-State Hydraulic Model Geometry Updates*. Fresno, California: Prepared for California Dept. of Water Resources.

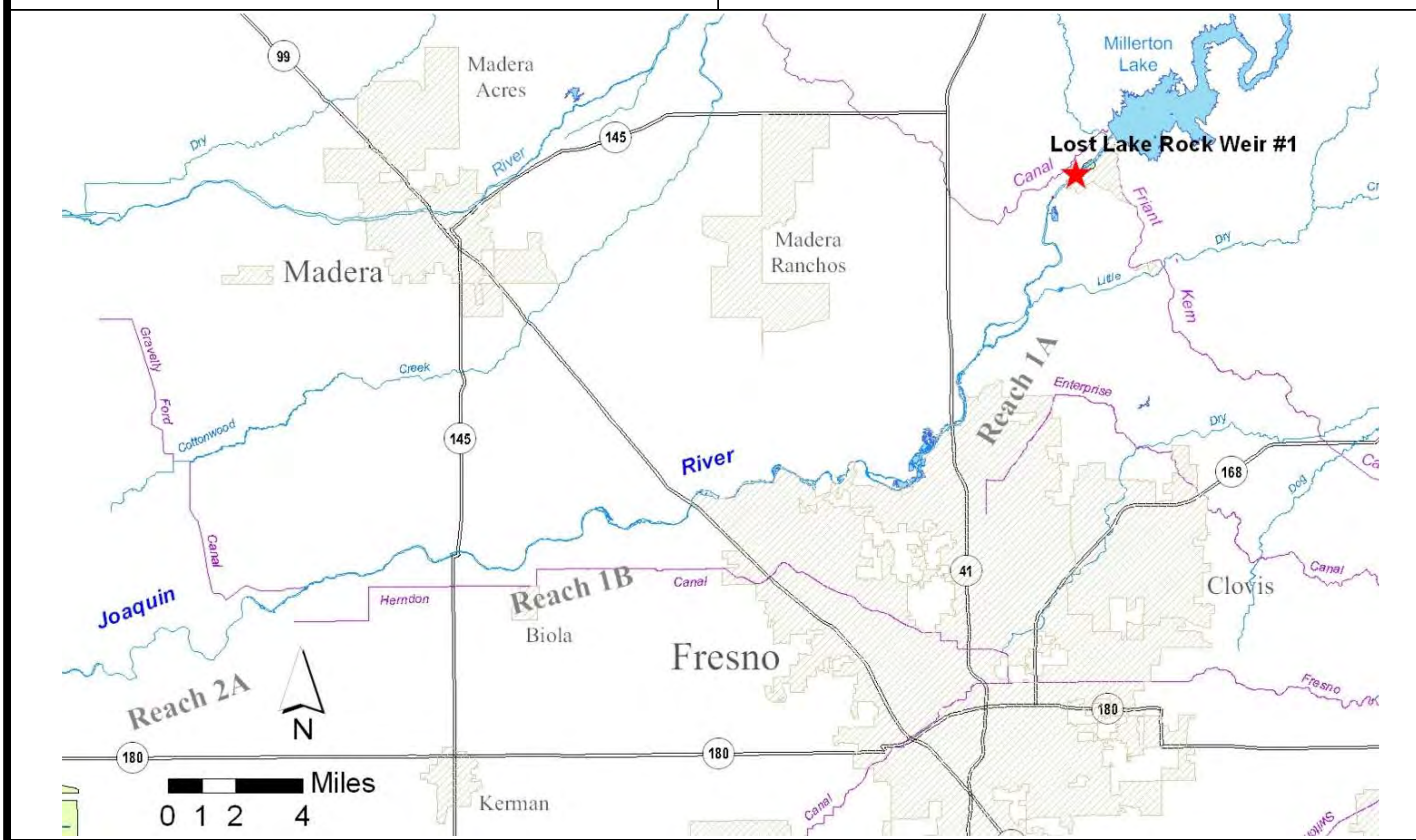
This page was intentionally left blank

APPENDIX A

Modeling Results

This page was intentionally left blank

BEARINGS			
Site Name[5]: Lost Lake Rock Weir #1	**I.D. Number[1]:** 4	**Reach:** 1A	
River Mile: 266	**Barrier Type[1]:** Rock Weir		**Rank[1]:** Gray



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

STRUCTURE DESCRIPTION

The rock weir is located in Lost Lake Park on the San Joaquin River near river mile 266. This site is publicly accessible through the Lost Lake Park campgrounds, a Fresno County operated facility, and is not accessible for day use visitors. The weir cannot be bypassed and extends the length of the active channel. The weir appears to be man made with large boulders placed into the channel. Large vegetation has taken root at the center of the weir (Photo 4_A). The weir width was measured at 50 feet with a length of 77 feet from the left bank to the vegetation (Photo 4_B). Total weir length is estimated at 115 feet. The water surface elevation upstream the weir was measured as 4.1 feet. The pool depth downstream the weir within five feet was measured as a water surface of 2.6 feet. The weir was submerged during the survey with only the tops of the boulders visible. There were rainbow trout seen upstream the weir.

The channel substrate is mostly bedrock with some boulders, cobble, and gravel. The channel is clean with the floodplain on the left bank maintained as a park setting with short grass, tall woody trees, campground areas, and parking. The right bank has mostly tall annual grasses, dense brush with tall woody trees.

<u>Photos:</u>

Photo 4_A. Rock weir looking upstream from downstream of the weir

Photo 4_B. Rock weir from upstream looking downstream from the weir

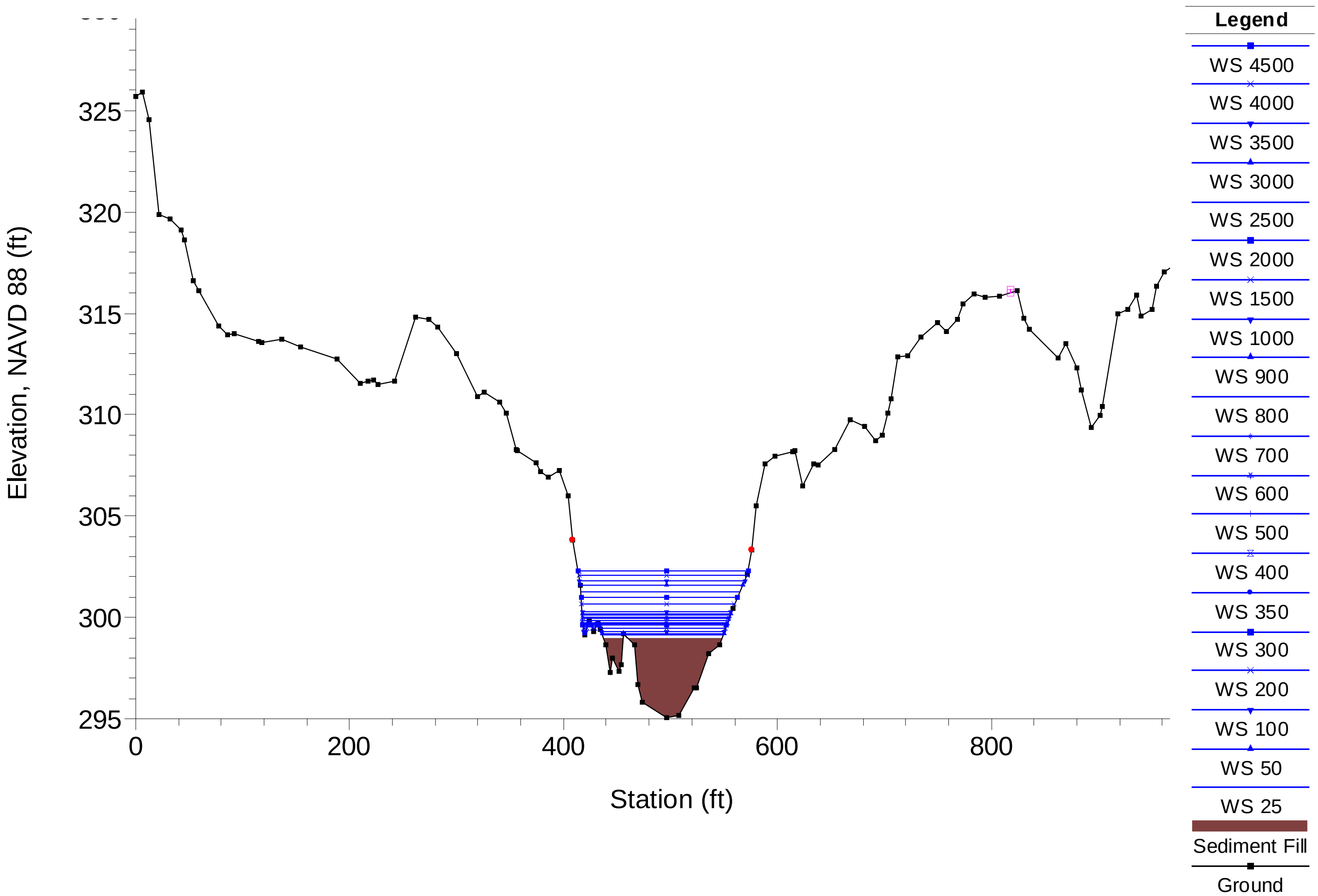
HEC-RAS MODEL SUMMARY TABLE

At Weir

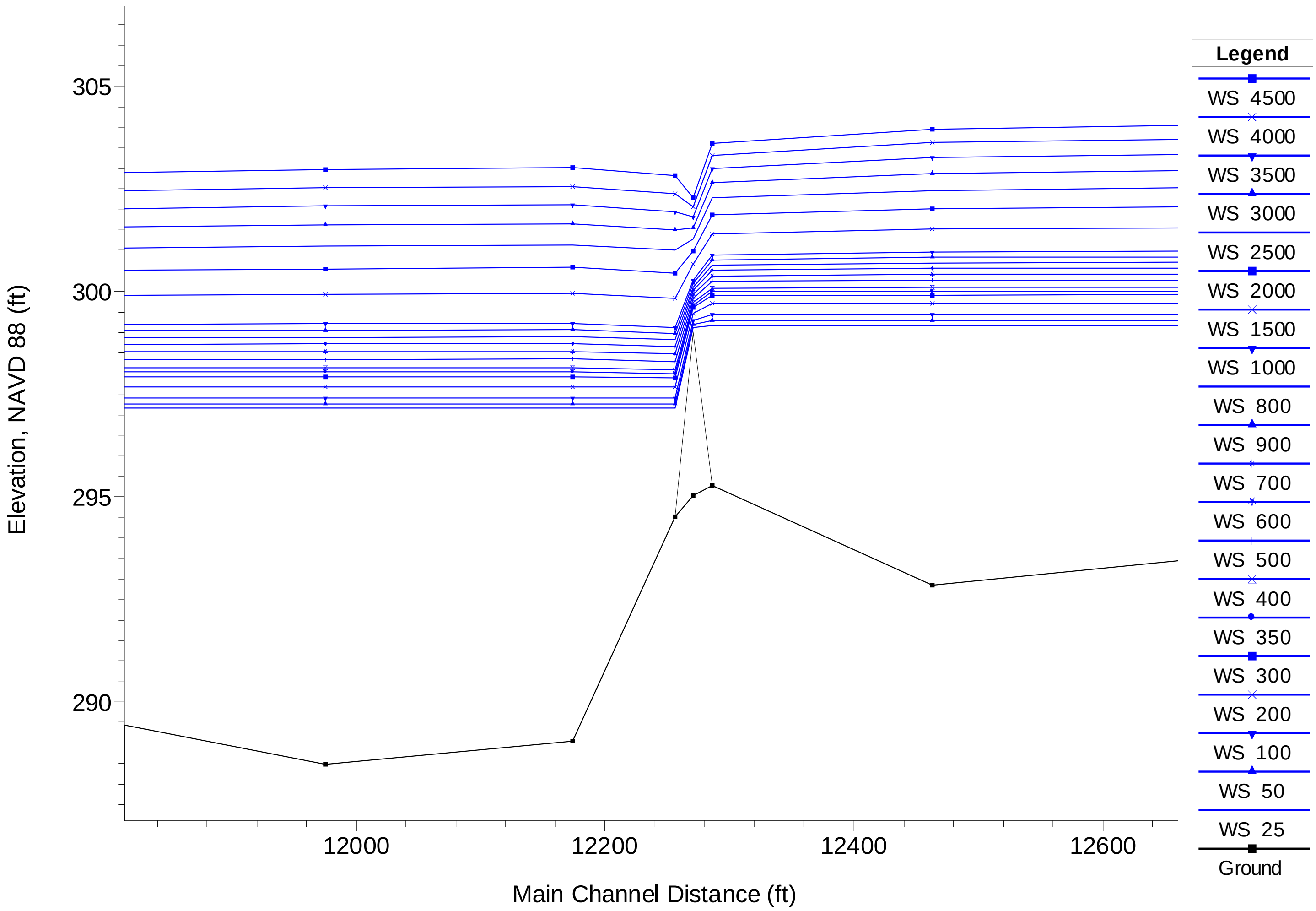
Flow	Maximum Depth	Channel Velocity	Maximum Water Surface Elevation Change
cfs	ft	fps	ft
25	0.1	1.9	2.0
50	0.2	2.4	2.0
100	0.3	3.0	2.0
200	0.5	3.7	2.0
300	0.6	4.2	2.0
350	0.7	4.4	2.0
400	0.7	4.6	2.0
500	0.8	5.0	1.9
600	0.9	5.2	1.9
700	1.0	5.5	1.9
800	1.1	5.7	1.8
900	1.2	6.0	1.8
1000	1.3	6.2	1.8
1500	1.7	7.0	1.6
2000	2.0	7.6	1.4
2500	2.3	8.2	1.3
3000	2.6	8.6	1.1
3500	2.8	9.0	1.1
4000	3.1	9.4	0.9
4500	3.3	9.7	0.8

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.

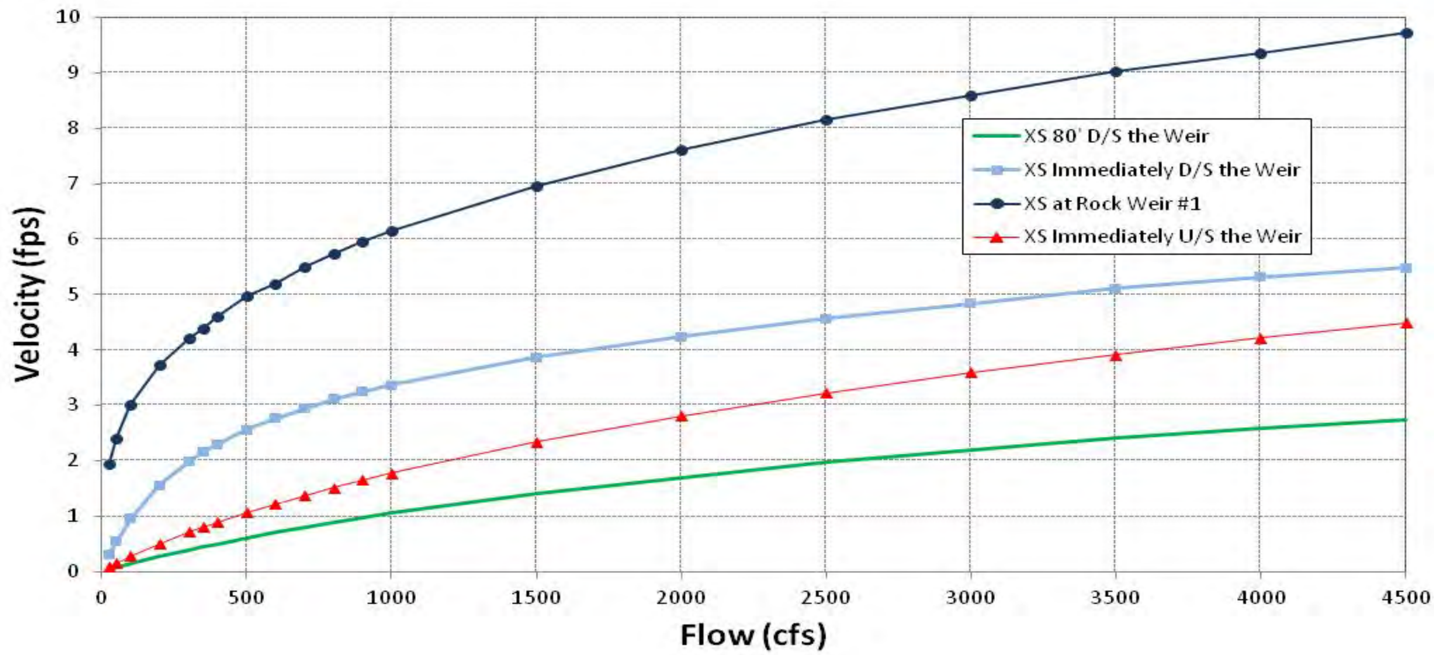
HEC-RAS MODEL STRUCTURE CROSS SECTION



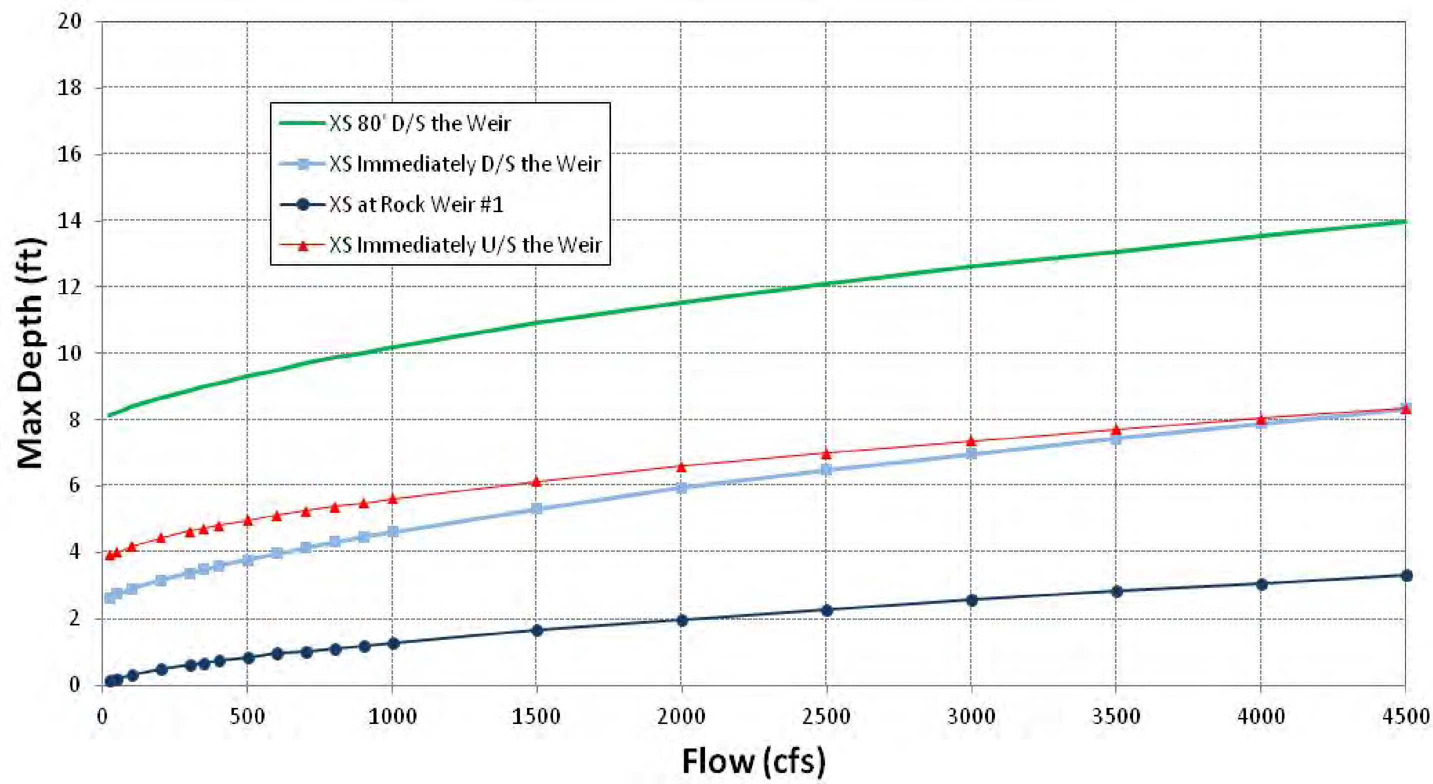
HEC-RAS MODEL BED AND WATER SURFACE PROFILE



HEC-RAS FLOW MODEL RESULTS



Velocity vs. Flow



Max Depth vs. Flow

HEC-RAS FLOW MODEL METADATA

TOPOGRAPHY	
Year:	2008
Creator/Source:	Towill Inc.
Type:	Photogrammetry
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)
BATHYMETRY	
Year:	2007/2008
Creator/Source:	DWR
Type:	ADCP/1998 Bathymetry
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)

Summary

- Model - Flows through the Lost Lake Rock Weir 1 were simulated using the HEC-RAS Reach 1A model developed by Tetra Tech, Inc. that was documented in the *San Joaquin River Reach 1A HEC-RAS Steady-State Hydraulic Model Geometry Updates* Technical Memorandum (September 13, 2011). Throughout the reach, many locations have sediment added to the channel bed for calibration purposes.
- Geometry - The model has updated topography and bathymetry to reflect current conditions, although some 1999 bathymetry was used to supplement updated bathymetry. Throughout the reach, many locations have sediment added to the channel bed for calibration purposes. Additional cross sections were placed upstream and downstream the weir to provide more information for fish passage analysis. New cross sections were cut from the Reach 1A surface provided by Tetra Tech, Inc. The structure has not been surveyed by DWR as part of the Task 2 efforts.
- Boundary Conditions – The rating curve for the Reach 1A model was developed by Tetra Tech using their latest Reach 1B model. The rating curve reflects the stage-discharge relationship at the downstream boundary condition.
- Calibration – The model was calibrated using the flow data collected by DWR on May 12, 2011, the flow was measured to be 3,110 cfs through the structure. The model water surface elevations were compared to the water surface elevations from the 2011 Task 2 flow monitoring data and were within +/- 0.5’.

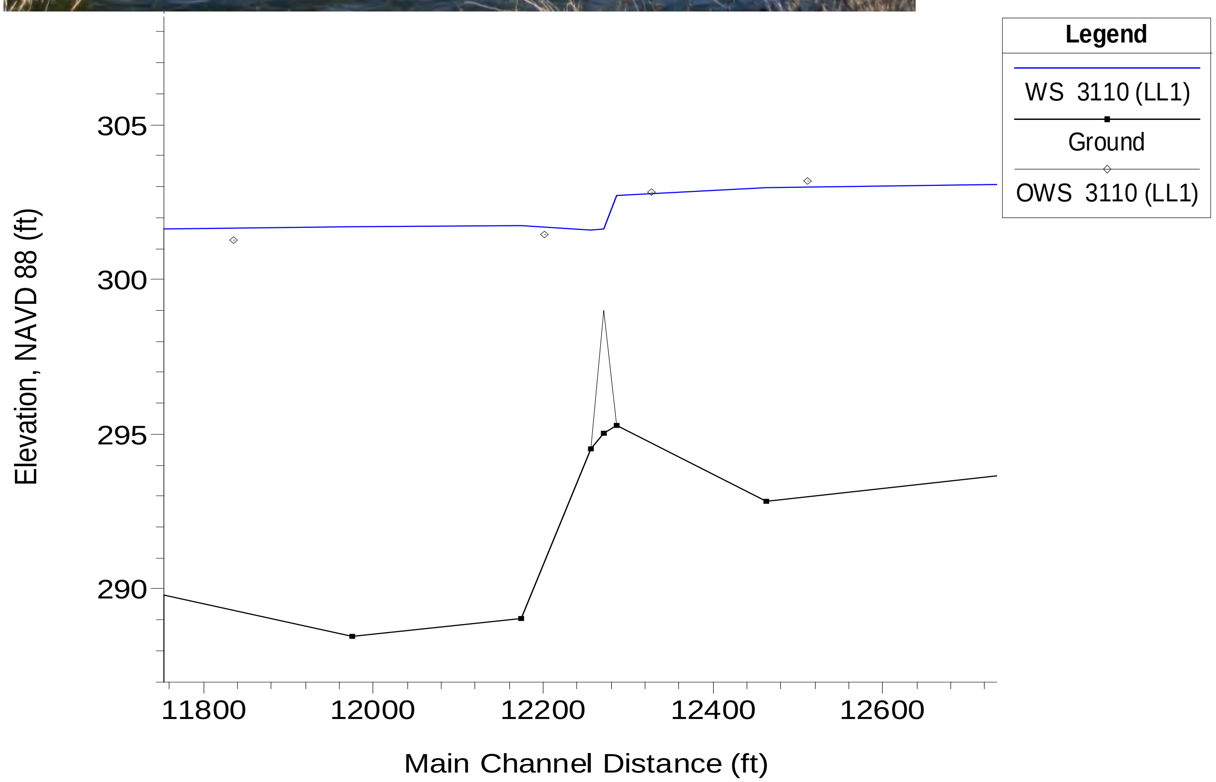
SAN JOAQUIN RIVER RESTORATION PROGRAM

TASK 2 EVALUATION RESULTS

LOST LAKE ROCK WEIR #1

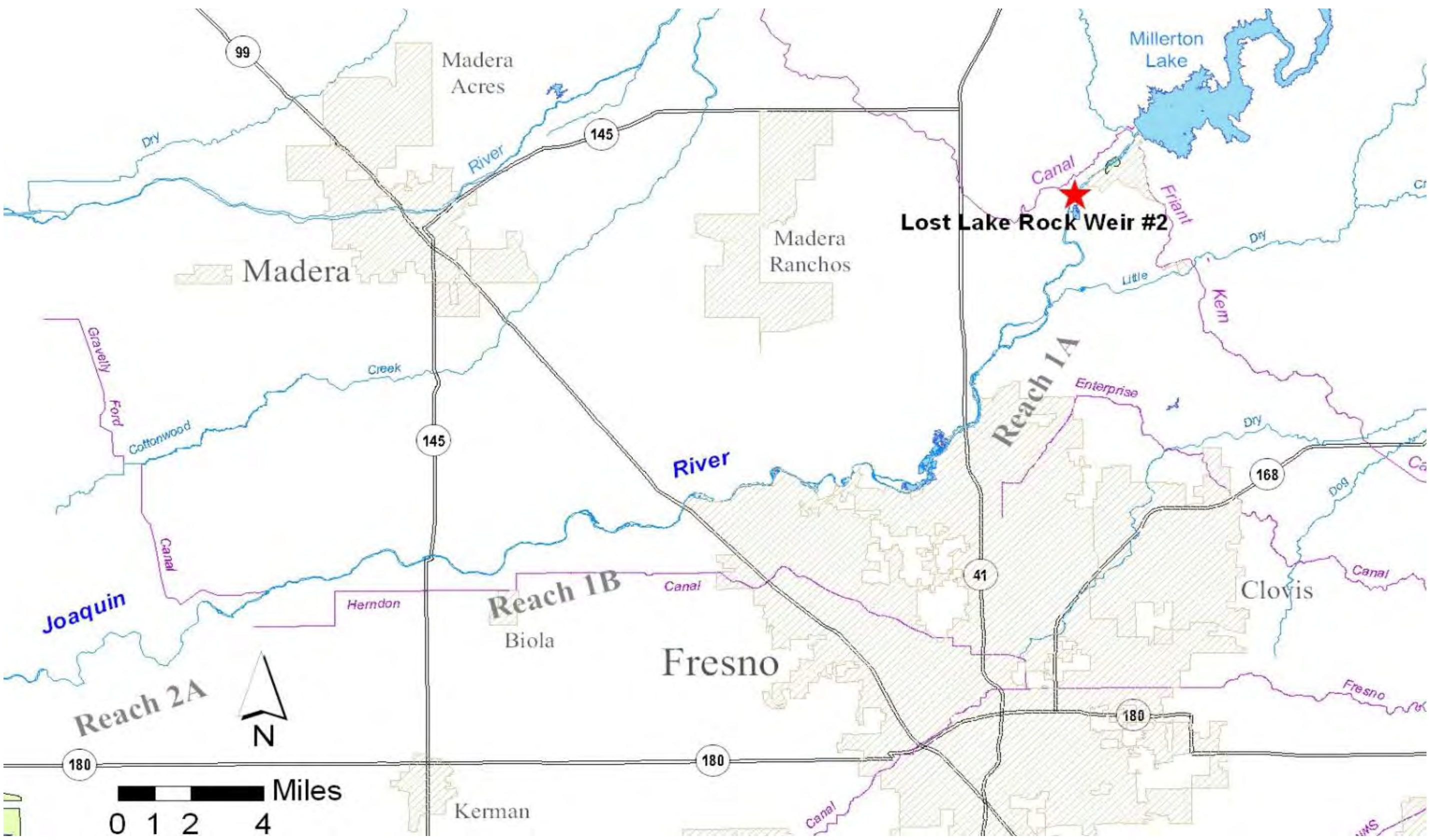
MODEL CALIBRATION

Date: May 12, 2011	**Flow (cfs):** 3,110	**Mean Velocity (ft/s):** 2.27



BEARINGS

Site Name[6]: Lost Lake Rock Weir 2	**I.D. Number[1]:** 5	**Reach:** 1A
River Mile: 265.0	**Barrier Type[1]:** Rock Weir	**Rank[1]:** Gray



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

STRUCTURE DESCRIPTION

There is a man made rock weir (Photo 5_A) at Lost Lake Park near river mile 265. This site is publicly accessible through Lost Lake Park, a Fresno County operated facility. The weir cannot be bypassed and extends the length of the active channel. Some of the rocks appear to be set in concrete and some large boulders are placed in the channel to create a backwater pool for the park. About 84 feet of the weir is clean and visible, but the remaining section has heavy vegetation that consists of large woody trees and heavy brush (Photos 5_B and 5_C). Total length is estimated at 425 feet. One of the parks attractions is fishing for rainbow trout that is planted by an upstream hatchery. The pool likely serves as a pond for this sport. Rainbow trout and Three Spine stickleback were seen upstream the weir.

About 225 feet downstream there is a rock weir that appears to be natural cascades with mostly bedrock (Photo 5_E). At low flows there is another drop to the main channel at the end of the falls (Photo 5_H) that at low flows would need to be jumped.

The channel substrate is mostly bedrock with some boulders, cobble, and gravel. The channel is clean with the floodplain on the left bank maintained as a park setting with short grass, tall woody trees, picnic areas, and parking. The right bank has mostly tall annual grasses with tall woody trees.

<u>Photos:</u>

Photo 5_A. Rock weir looking downstream

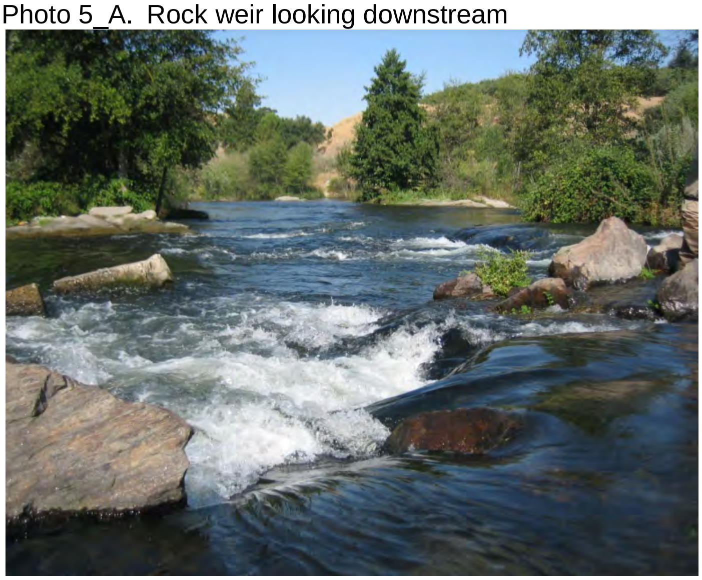


Photo 5_B. Rock weir from upstream looking downstream

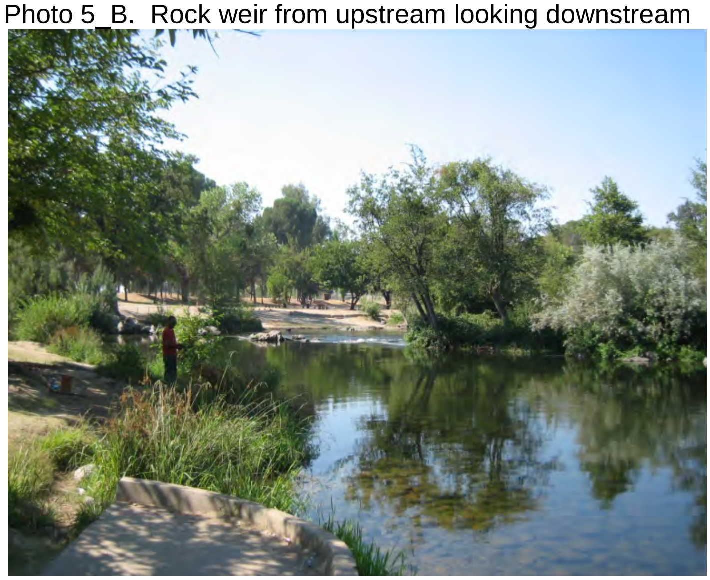


Photo 5_C. Rock weir vegetation from upstream looking downstream

Photo 5_D. Rock weir from downstream looking upstream

Photo 5_E. Cascades downstream of weir from downstream looking upstream

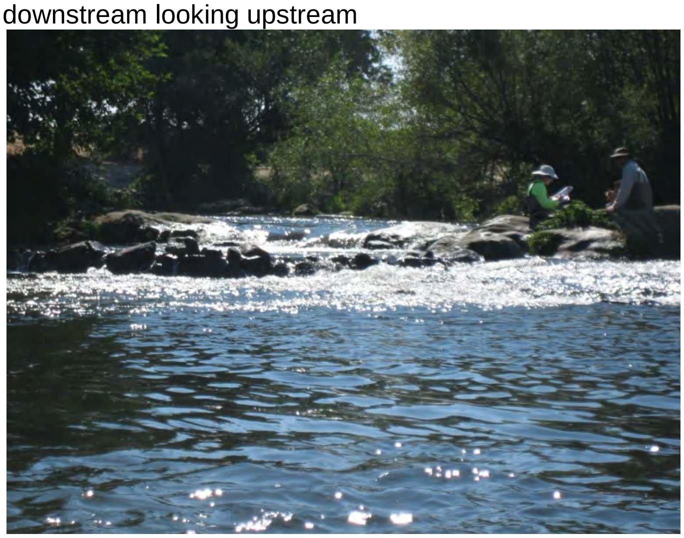


Photo 5_F. Channel downstream falls and weir

Photo 5_G. Channel upstream weir

Photo 5_H. Cascades downstream at 350 cfs

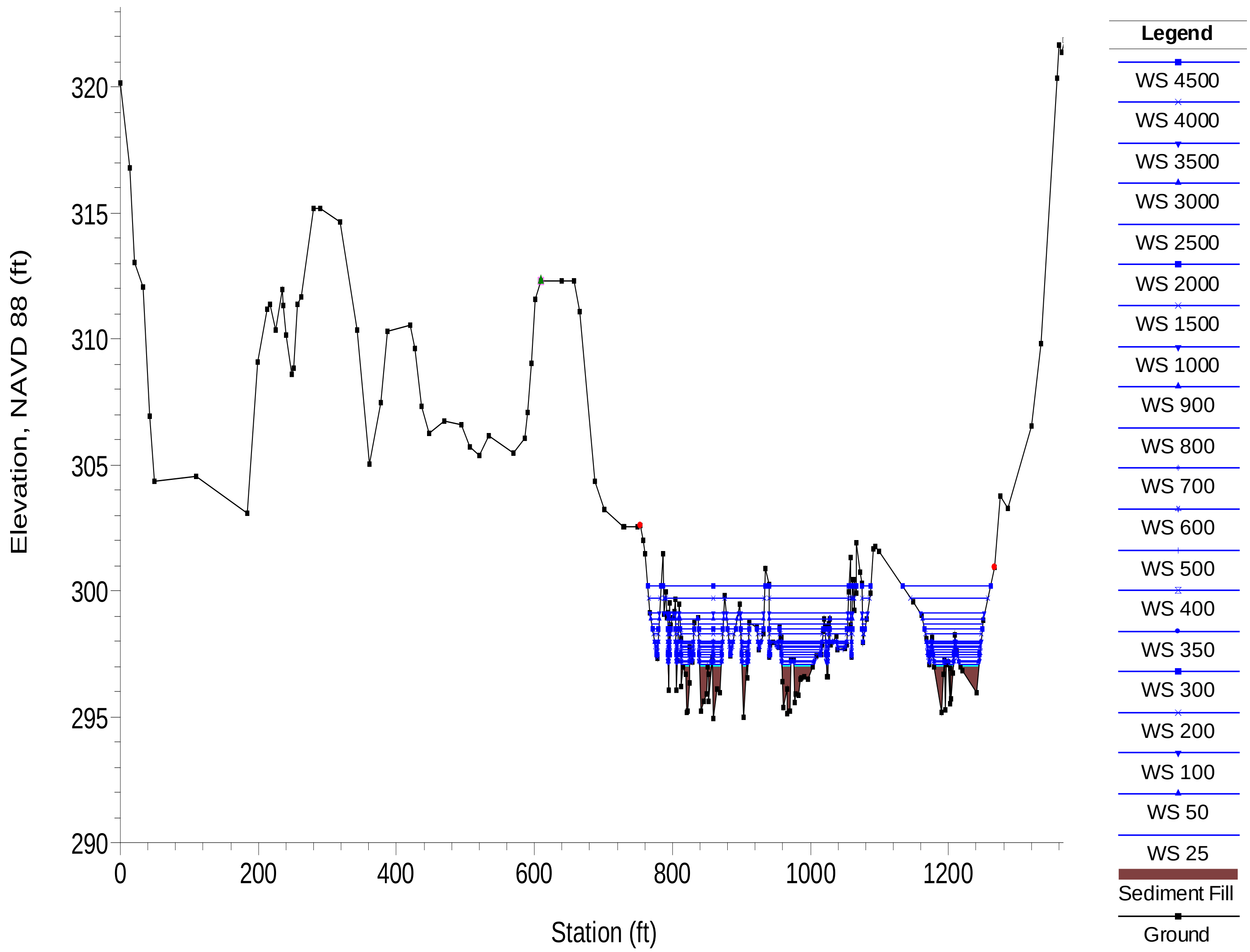
HEC-RAS MODEL SUMMARY TABLE

Results for flow over rock weir 2

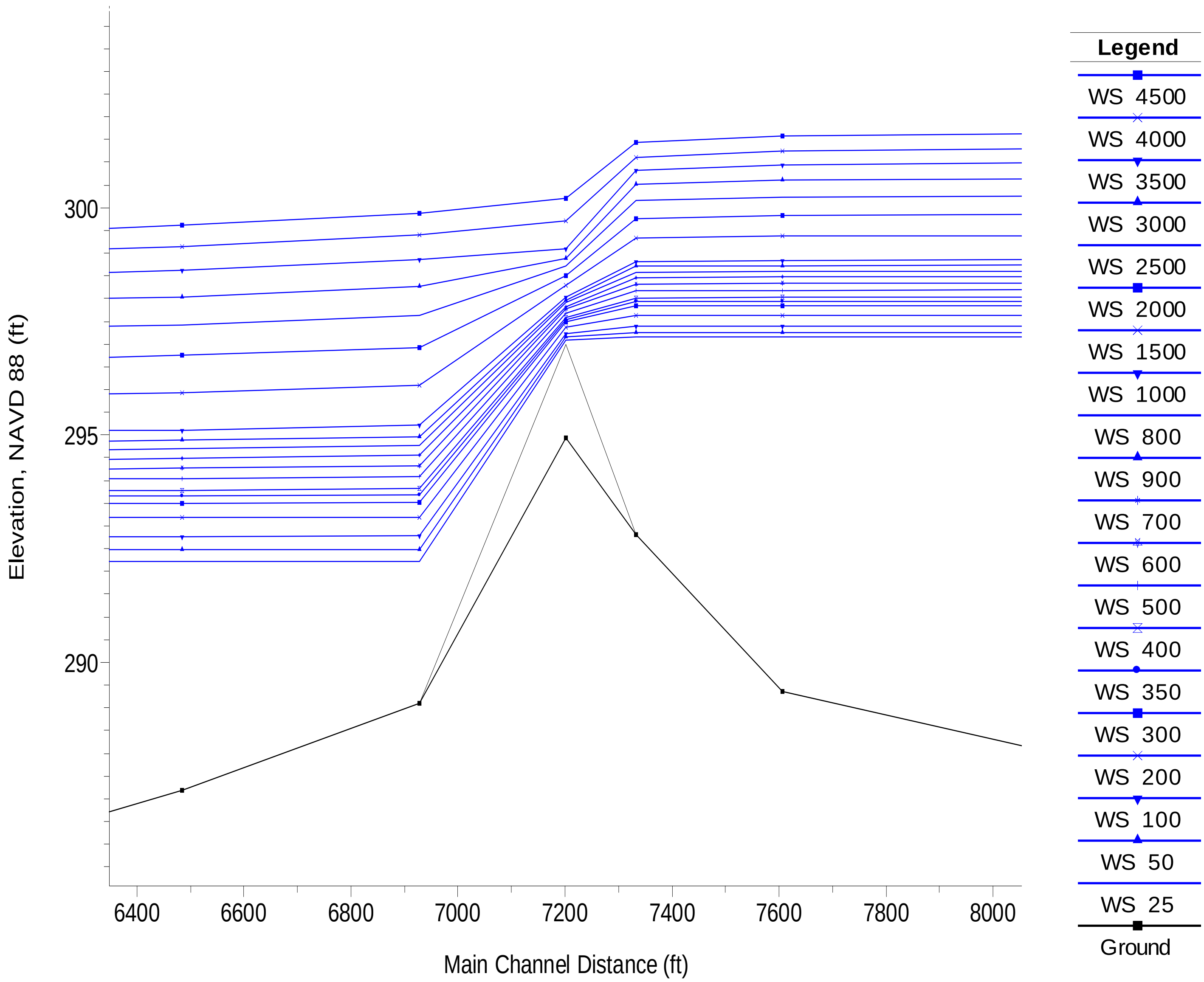
Flow	Maximum Depth	Channel Velocity	Maximum Water Surface Elevation Change
cfs	ft	fps	ft
25	0.1	1.8	4.9
50	0.2	2.1	4.8
100	0.2	2.7	4.6
200	0.4	3.3	4.4
300	0.5	3.7	4.3
350	0.5	3.9	4.2
400	0.6	4.1	4.2
500	0.7	4.2	4.1
600	0.8	4.4	4.0
700	0.8	4.6	3.9
800	0.9	4.7	3.8
900	1.0	4.9	3.7
1000	1.0	5.0	3.6
1500	1.3	5.6	3.2
2000	1.5	6.0	2.8
2500	1.7	6.3	2.5
3000	1.9	6.6	2.2
3500	2.1	6.6	1.9
4000	2.7	5.2	1.7
4500	3.2	4.6	1.5

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

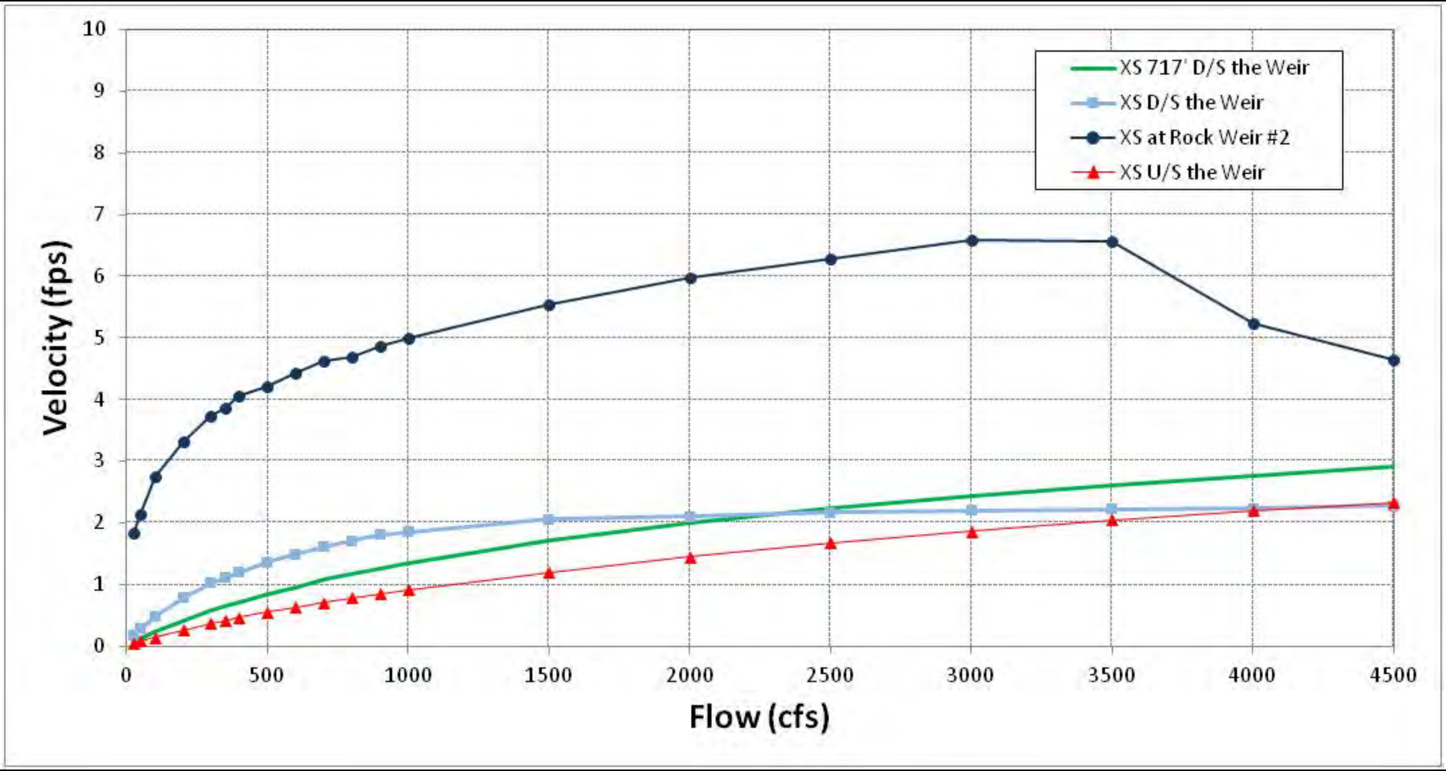
HEC-RAS MODEL CROSS SECTION AT ROCK WEIR 2



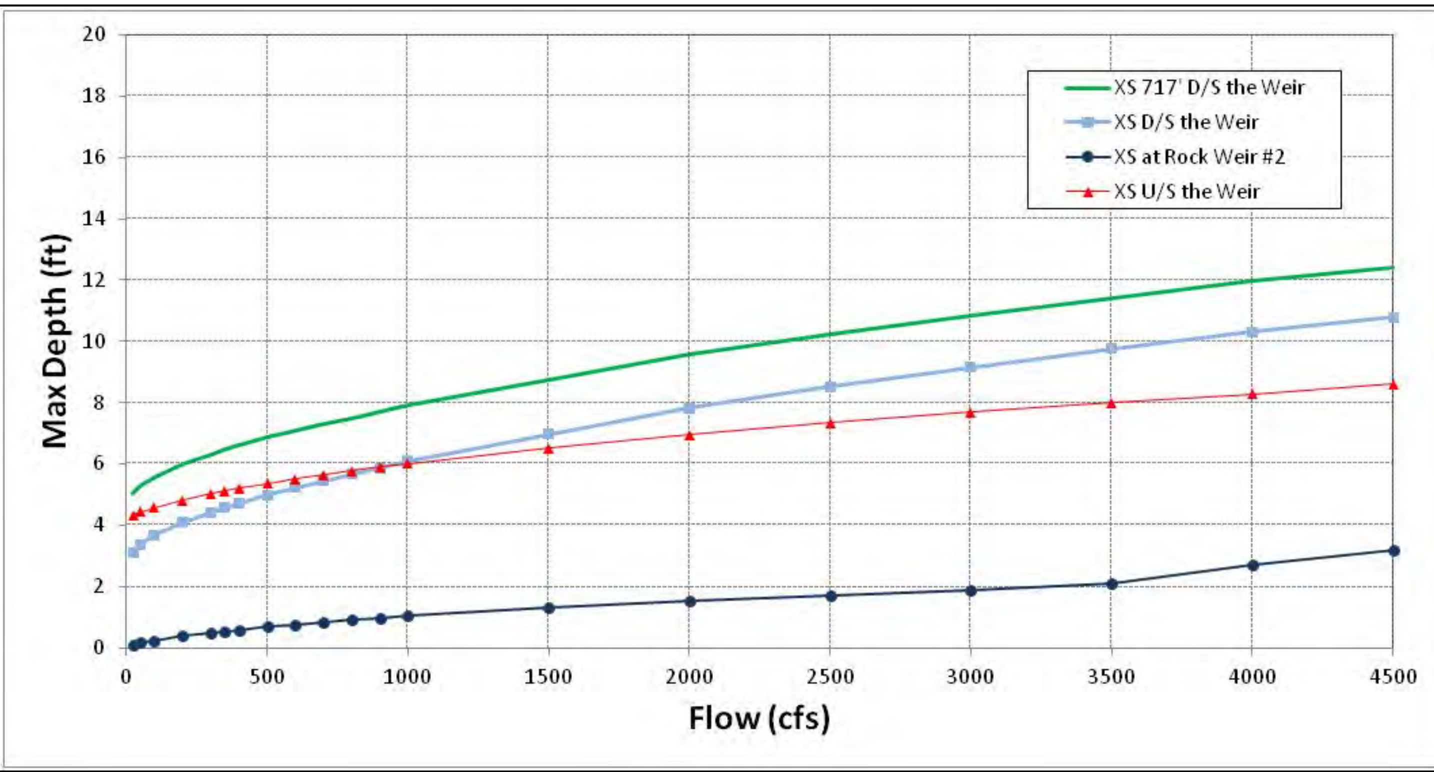
HEC-RAS MODEL BED AND WATER SURFACE PROFILE



HEC-RAS MODEL RESULTS



Velocity vs. Flow



Max Depth vs. Flow

HEC-RAS MODEL METADATA

TOPOGRAPHY	
Year:	2007
Creator/Source:	Towill Inc.
Type:	Photogrammetry
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)
BATHYMETRY	
Year:	2007/2008
Creator/Source:	DWR
Type:	ADCP/1998 Bathymetry
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)

Summary

- Model – Flows through the Lost Lake Rock Weir 2 were simulated using the HEC-RAS Reach 1A model developed by Tetra Tech, Inc. that was documented in the *San Joaquin River Reach 1A HEC-RAS Steady-State Hydraulic Model Geometry Updates* Technical Memorandum (September 13, 2011). Throughout the reach, many locations have sediment added to the channel bed for calibration purposes. This location is challenging to simulate with a 1-D model due to presence of multiple flow splits and hydraulic controls on irregular terrains.
- Geometry - The model has updated topography and bathymetry to reflect current conditions, although some 1999 bathymetry was used to supplement updated bathymetry. Throughout the reach, many locations have sediment fills for calibration purposes. The structure has not been surveyed by DWR as part of the Task 2 effort.
- Boundary Conditions – The rating curve for the Reach 1A model was developed by Tetra Tech using their latest Reach 1B model. The rating curve reflects the stage-discharge relationship at the downstream boundary condition.
- Calibration – The model was calibrated using the flow data collected by DWR on May 12, 2011, the flow was measured to be 2,870 cfs through the structure. To provide more information for fish passage analysis, additional cross sections were placed upstream and downstream the weir in two other separate refined models. However, the refined model did not capture the hydraulic details at lower flows than the original model. Hence, the original model was used to output hydraulic results. The water surface elevations were compared to the water surface elevations from the 2011 Task 2 flow monitoring data and were roughly within +/- 0.5'. A two dimensional model may be more suitable for determining depth and velocity at this structure.

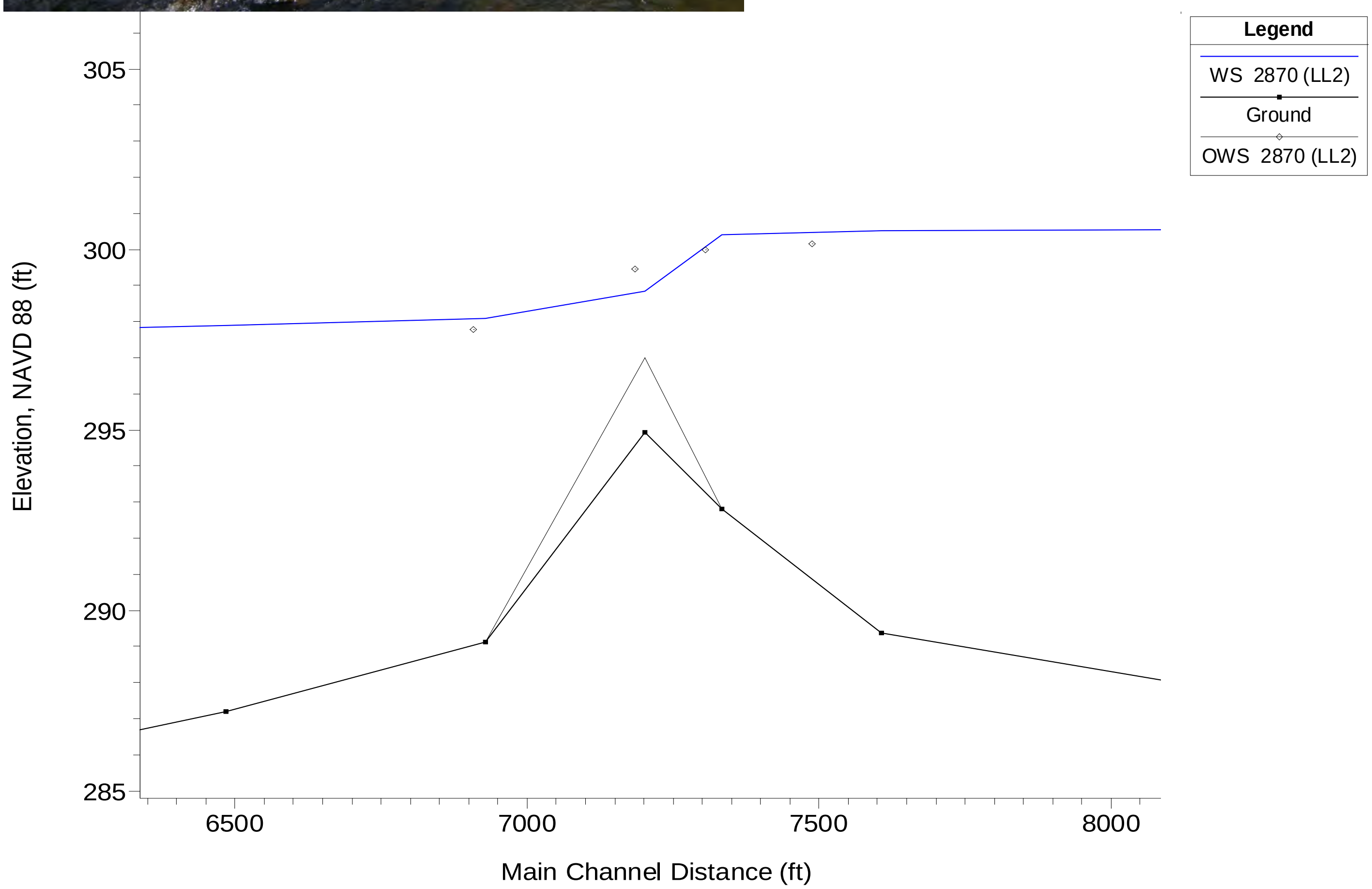
SAN JOAQUIN RIVER RESTORATION PROGRAM

TASK 2 EVALUATION RESULTS

LOST LAKE ROCK WEIR #2

MODEL CALIBRATION

Date: 5/12/2011	Flow (cfs): 2,870	Mean Velocity (ft/s): 1.59



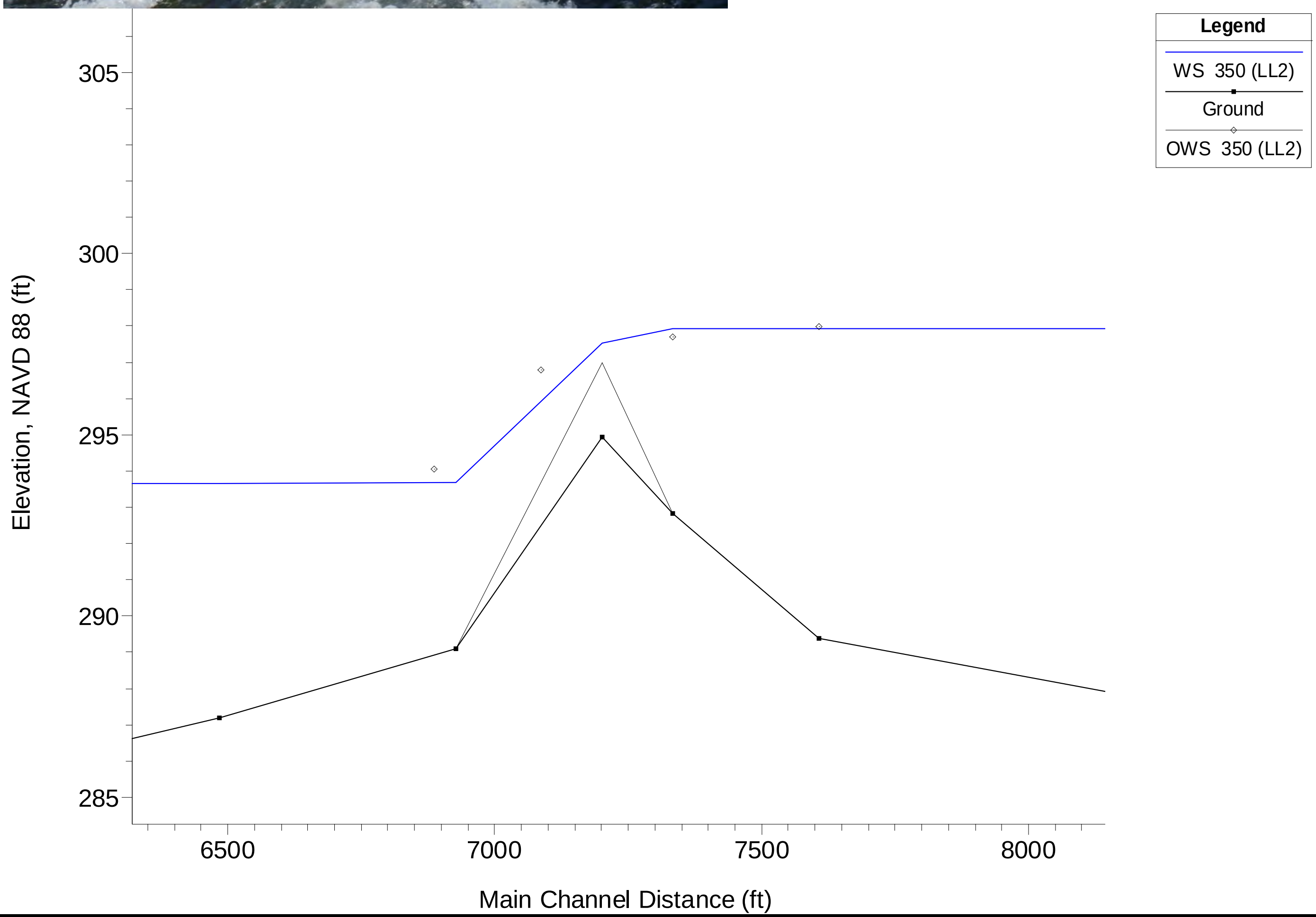
SAN JOAQUIN RIVER RESTORATION PROGRAM

TASK 2 EVALUATION RESULTS

LOST LAKE ROCK WEIR #2

MODEL CALIBRATION

Date: 2/9/2012	Flow (cfs): 350	Mean Velocity (ft/s):

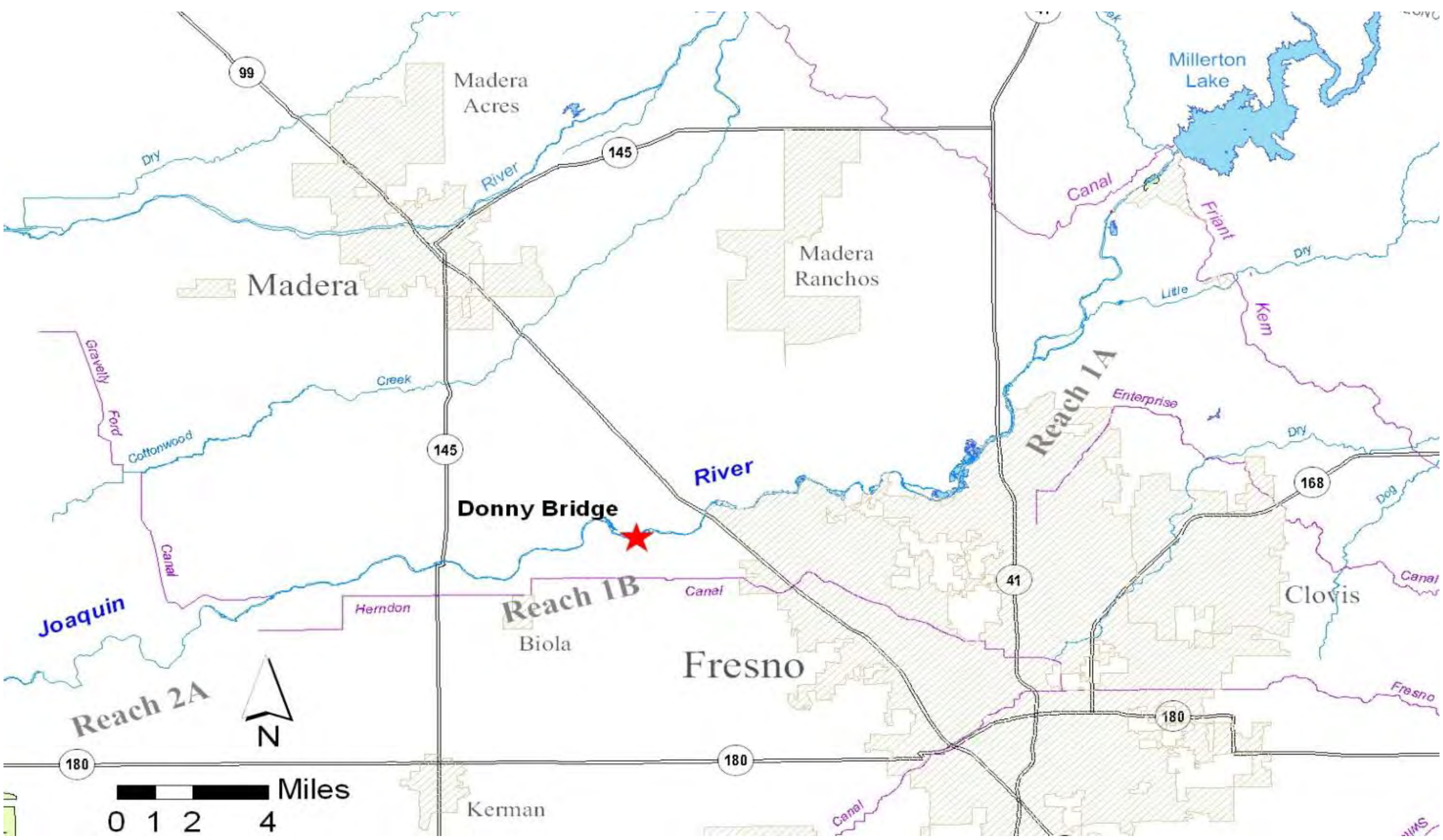


SAN JOAQUIN RIVER RESTORATION PROGRAM

TASK 2 EVALUATION RESULTS

DONNY BRIDGE

BEARINGS		
Site Name[7]: Donny Bridge	**I.D. Number[1]:** 17	**Reach:** 1B
River Mile: 240.7	**Barrier Type[1]:** Bridge	**Rank[1]:** Gray



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

STRUCTURE DESCRIPTION

Donny Bridge has private access and does not look like it is currently in use, but appears to be maintained for water data collection (Photo 17_A). The bridge was likely used for private equipment crossing. There is a concrete bridge deck with a metal truss and 12 inch diameter steel pipes for the piers. The bridge height was measured as 13.4 feet from the channel thalweg with a width of 16 feet and a span of about 52 feet. The total number of bridge piers is four and measured 17.1 feet apart.

The channel substrate is mostly sand with gravel and some cobble and boulders. The channel is clean with brush and large woody trees on the banks with tall annual grasses in the floodplain. The active channel width at the bridge measured as 37.5 feet. The channel upstream and downstream is much wider and was estimated at about 150 feet (Photo 17_B).

Photos:

Photo 17_A. Bridge looking downstream

Photo 17_B. Channel looking upstream

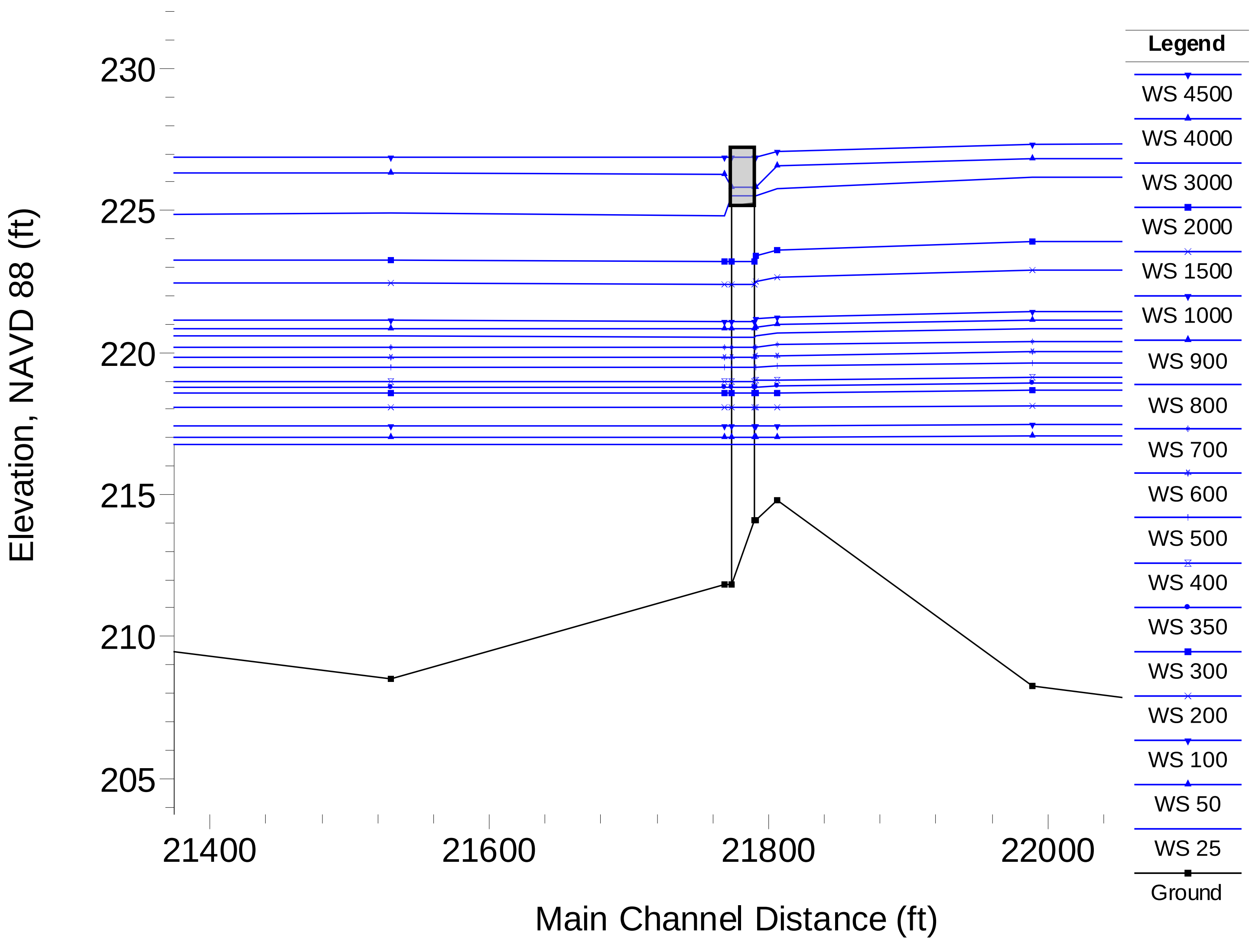
HEC-RAS MODEL SUMMARY TABLE

Donny Bridge Upstream Inlet

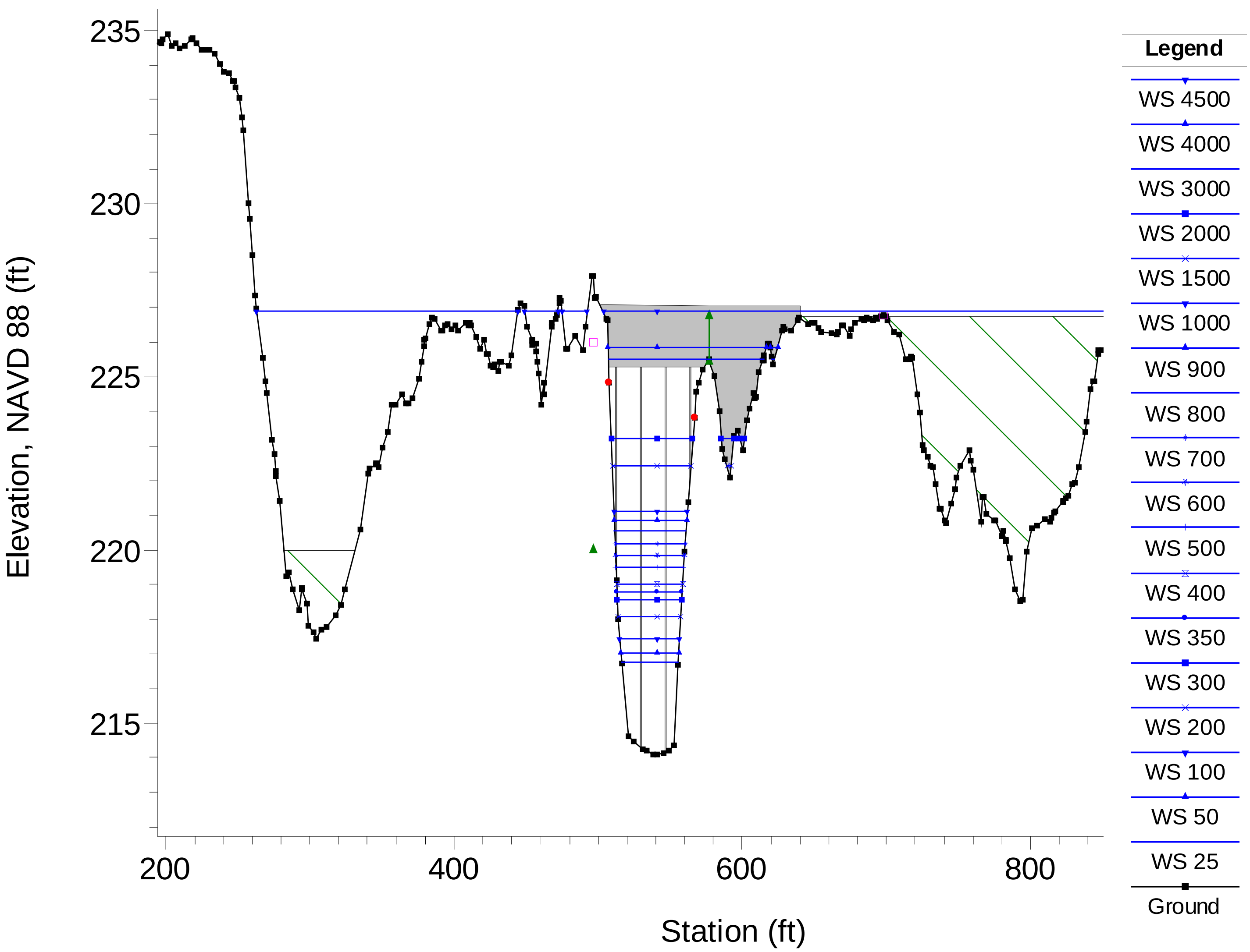
Flow	Maximum Depth	Channel Velocity	Maximum Water Surface Elevation Change
cfs	ft	fps	ft
25	2.7	0.3	0.0
50	2.9	0.5	0.0
100	3.3	0.9	0.0
200	4.0	1.5	0.0
300	4.5	1.9	0.0
350	4.7	2.1	0.0
400	4.9	2.3	0.0
500	5.4	2.6	0.1
600	5.7	2.8	0.1
700	6.1	3.1	0.1
800	6.5	3.3	0.1
900	6.8	3.5	0.1
1000	7.0	3.7	0.1
1500	8.3	4.5	0.3
2000	9.1	5.3	0.4
2500	10.0	6.0	0.5
3000	11.4	6.1	1.0
3500			
4000			
4500			

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

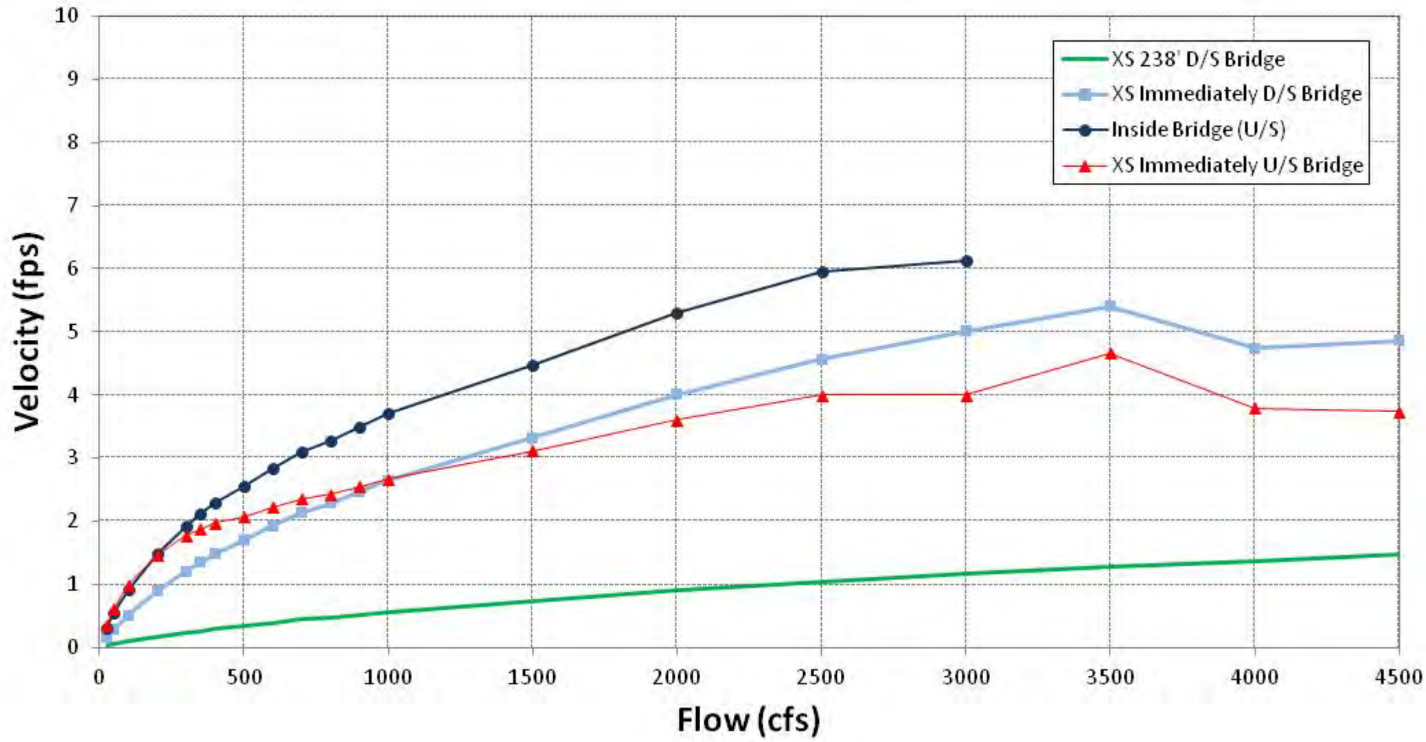
HEC-RAS MODEL STRUCTURE CROSS SECTION



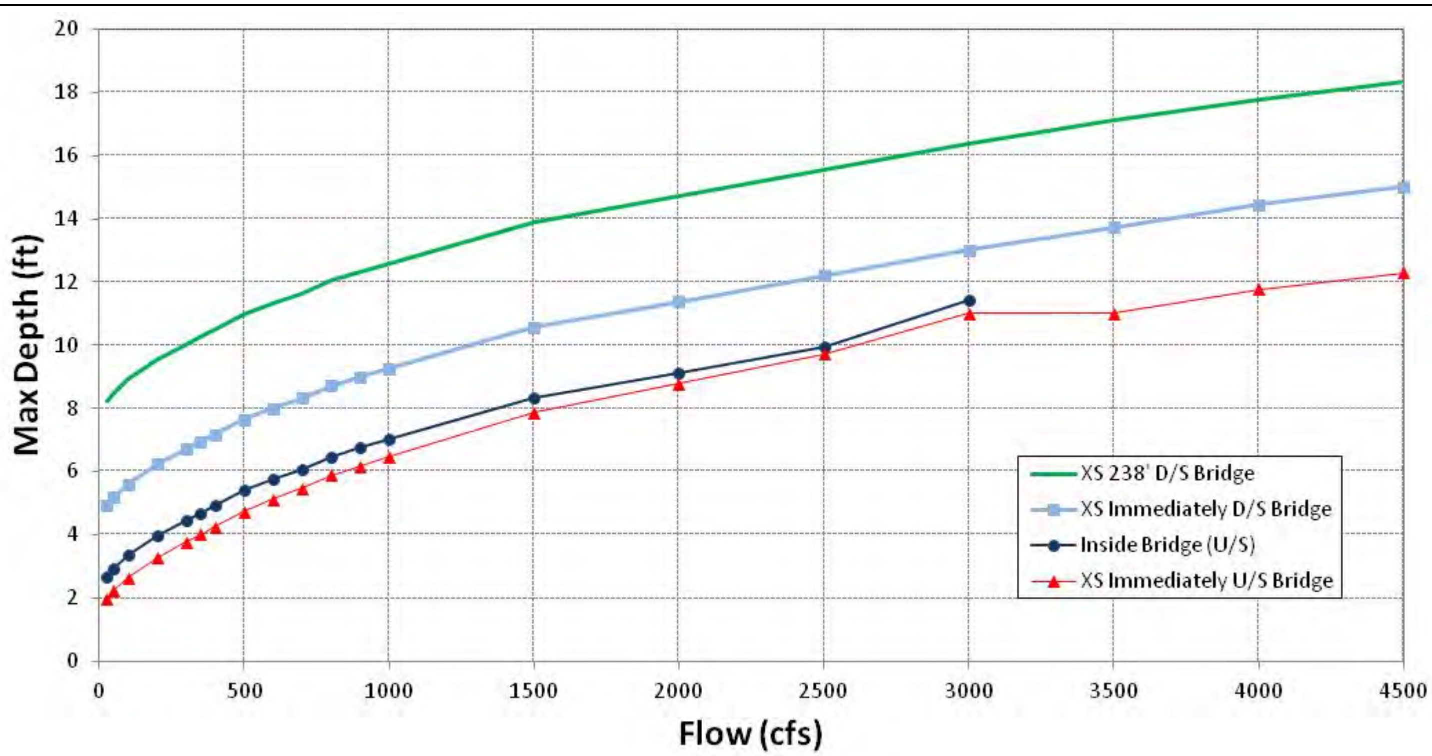
HEC-RAS MODEL BED AND WATER SURFACE PROFILE



HEC-RAS FLOW MODEL RESULTS



Velocity vs. Flow



Max Depth vs. Flow

HEC-RAS FLOW MODEL METADATA

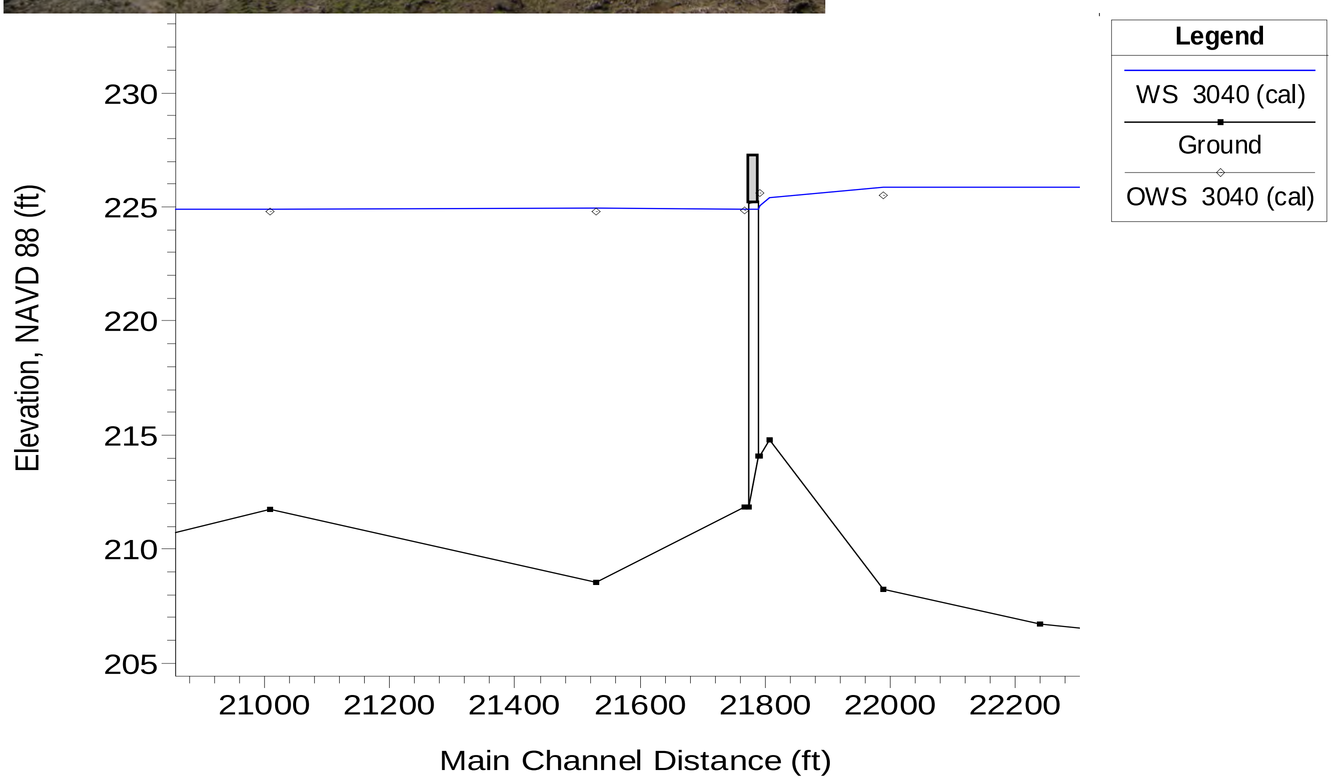
TOPOGRAPHY	
Year:	2008
Creator/Source:	Towill Inc.
Type:	LiDAR Topo
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)
BATHYMETRY	
Year:	2010
Creator/Source:	DWR
Type:	ADCP Bathymetry
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)

Summary

- Model - Flows through the Donny Bridge were simulated using the HEC-RAS Reach 2B model developed by Tetra Tech, Inc. that was documented in the *San Joaquin River Reaches 1B, 2A, 2B, 3 and 4B1 One-dimensional HEC-RAS Steady-State Hydraulic Model Bathymetry Updates* Technical Memorandum (January 31, 2012).
- Geometry - The model has updated topography and bathymetry to reflect current conditions. No additional changes were made to this model. The structure has not been surveyed by DWR as part of the Task 2 effort.
- Boundary Conditions – The rating curve for the model was developed by DWR using stage and discharge data collected near the downstream end of Reach 1B.
- Calibration – The model was calibrated using the flow data collected by DWR on May 19, 2011, the flow was measured to be 3040cfs through the structure. The model water surface elevations were compared to the water surface elevations from the 2011 Task 2 flow monitoring data and were within +/- 0.5’.

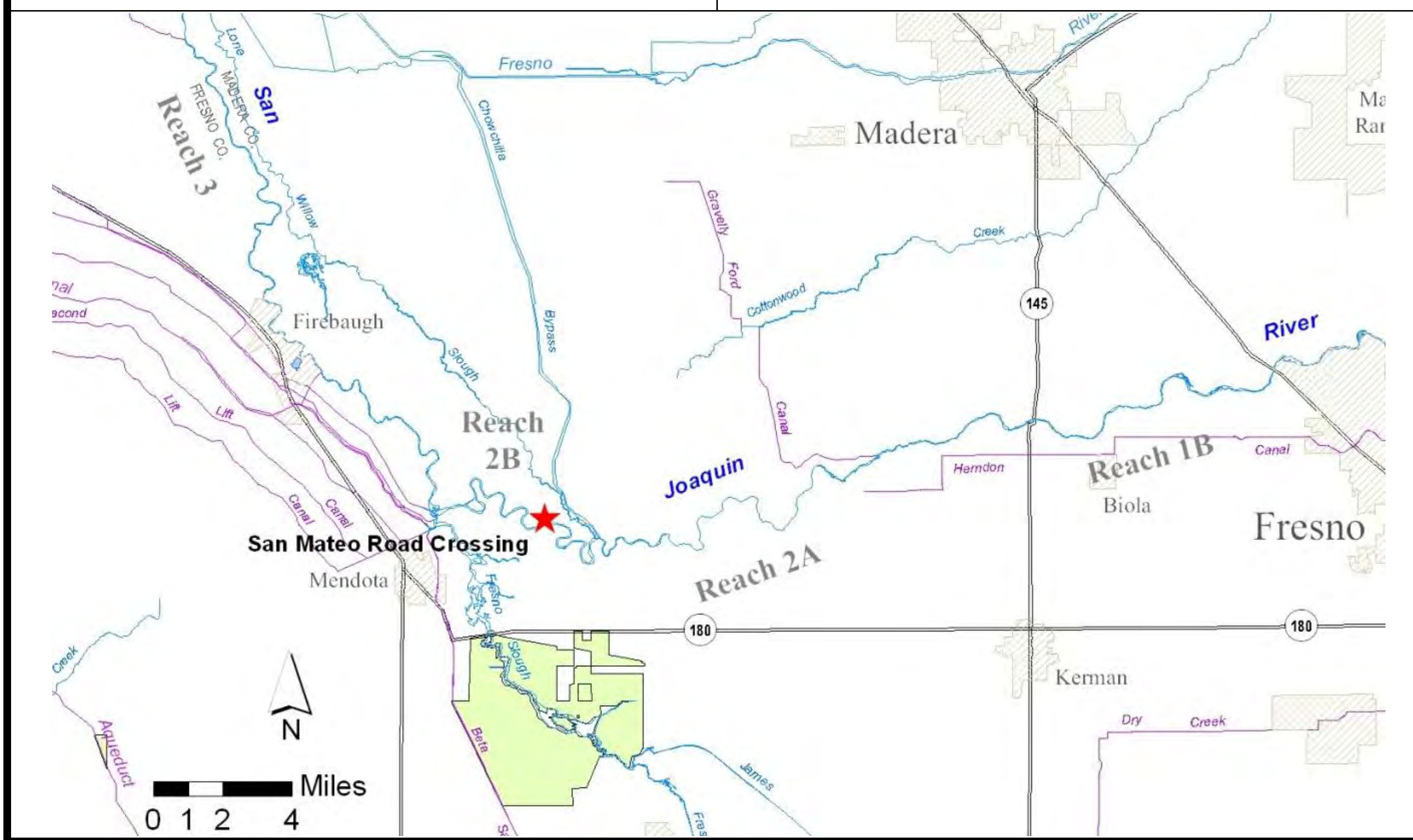
MODEL CALIBRATION

Date: May 19, 2011	**Flow (cfs):** 3,040	**Mean Velocity (ft/s):** 0.5



BEARINGS

Site Name[8]: San Mateo Avenue	**I.D. Number[1]:** 23	**Reach:** 2B
River Mile: 211.8	**Barrier Type[1]:** Low Flow Culvert Crossing	**Rank[1]:** Gray



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

STRUCTURE DESCRIPTION

San Mateo Avenue is an earthen low flow crossing with a culvert that is located on the San Joaquin River (Photo 23_A). During high flows the crossing is submerged, so the crossing geometry typically changes after high flows. It is unknown if and when road improvements are made after high flows. The upstream crossing slopes and culvert inlet are armored with old corrugate metal pipe that is filled with concrete and rebar (Photo 23_B and C). At this time, the pipes appear to be acting as bank protection for the crossing upstream.

The crossing has a 407 foot span and is 44 feet wide with an average height measured from upstream at 4.6 feet. The active channel width was measured as 230 feet downstream. The culvert is a 7.2 foot circular pipe constructed of riveted and welded structural plate with a projecting inlet/outlet configuration (Photo 23_D). The rustline was located at the current water surface elevation with a rustline height measured at 4.5 feet from the bottom of the culvert inlet. The culvert is partially embedded and has natural substrate with a depth of 1.7 feet at the outlet. There was no outlet drop and the outlet was aligned to the centerline of the channel downstream. The inlet alignment was at a near 90 degree angle with the centerline of the channel (Photo 23_E).

The river channel upstream is clean, except just upstream the culvert inlet there is trees in the channel. There is tall brush and large woody trees on the banks edge. The channel and the floodplain vegetation downstream are similar to upstream. The channel substrate is mostly sand.

<u>Photos:</u>

Photo 23_A. Crossing looking south

Photos 23_B. Culvert inlet

Photo 23_C. Culvert inlet looking upstream

Photo 23_D. Culvert outlet looking downstream

Photo 23_E. Channel, 90 angle, upstream inlet

Photo 23_F. Culvert inlet

Photo 23_G. The culvert outlet

Photo 23_H. The channel looking upstream

HEC-RAS MODEL SUMMARY TABLE

Results for flow within culvert

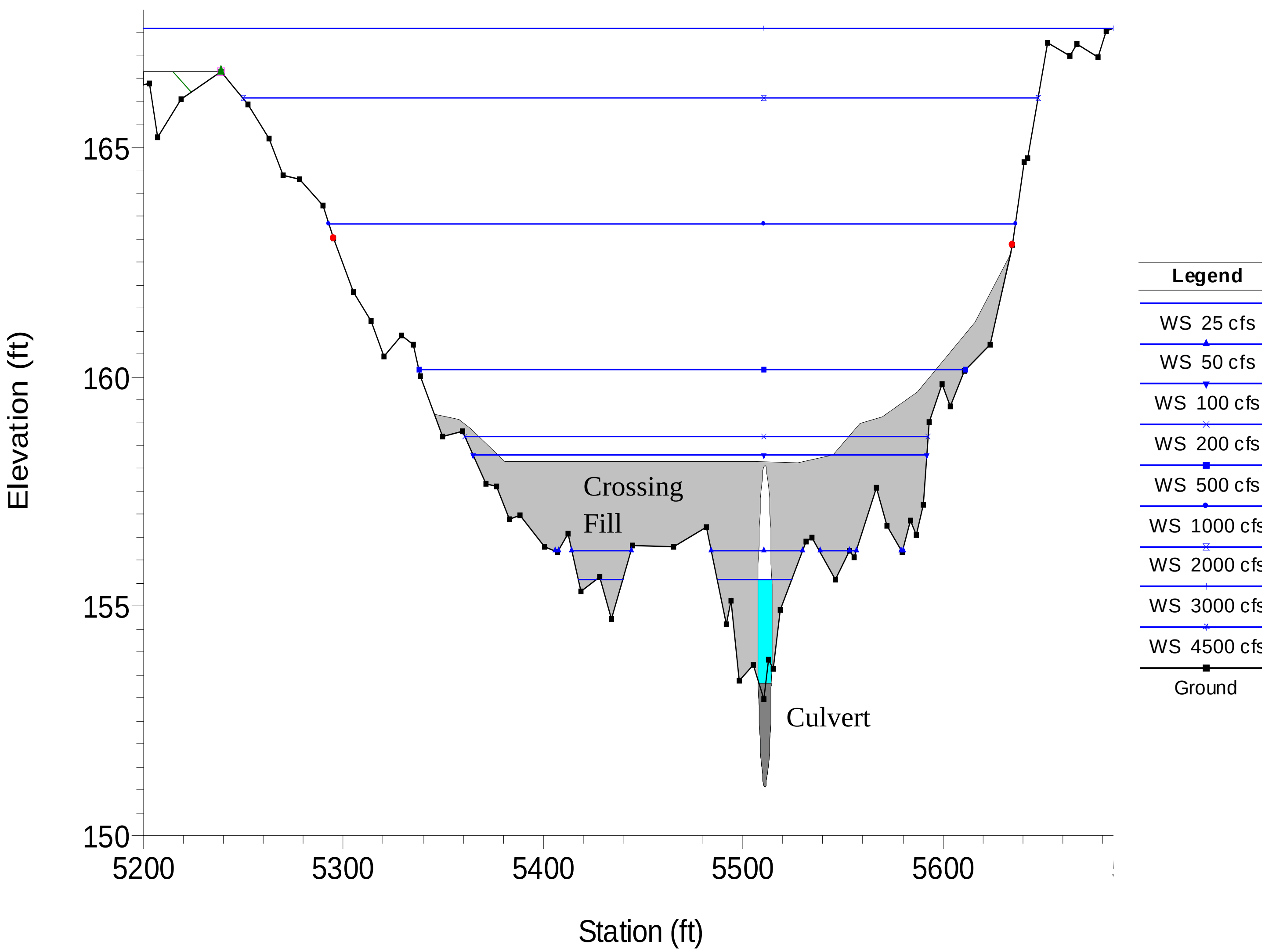
Flows	Culvert Maximum Depth		Culvert Velocity		Cross Section Velocity Just U/S Culvert	Maximum Water Surface Elevation Change
	Inlet	Outlet	Inlet	Outlet		
cfs	ft	ft	fps	fps	fps	ft
25	1.9	1.8	2.0	2.0	1.7	0.1
50	2.6	2.3	3.1	3.2	1.2	0.4
100	3.8	2.9	4.7	5.1	0.7	0.9

Results for flow over crossing (weir flow)

Flows	Weir Maximum Depth	Culvert Velocity		Cross Section Velocity Just U/S Culvert	Maximum Water Surface Elevation Change
		Inlet	Outlet		
cfs	ft	fps	fps	fps	ft
200	0.2	5.7	6.0	0.5	1.3
300	0.5	5.2	5.3	0.7	1.0
350	0.6	4.9	5.0	0.8	0.9
400	0.7	4.5	4.5	0.8	0.8
500	0.9	3.7	3.7	0.9	0.5
600	1.0	2.9	2.9	1.0	0.3
700	1.2	2.3	2.3	1.1	0.2
800	1.5	1.9	1.9	1.1	0.1
900	1.8	1.6	1.6	1.2	0.1
1000	2.0	1.0	1.0	1.2	0.0
1500	3.6	1.4	1.4	1.1	0.1
2000	5.3	1.4	1.4	1.0	0.1
2500	6.8	1.1	1.1	1.0	0.0
3000	8.0	0.8	0.8	1.0	0.0
3500	8.7	0.6	0.6	1.1	0.0
4000	9.1	0.6	0.6	1.2	0.0
4500	9.5	1.0	1.0	1.3	0.0

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

HEC-RAS MODEL STRUCTURE CROSS SECTION

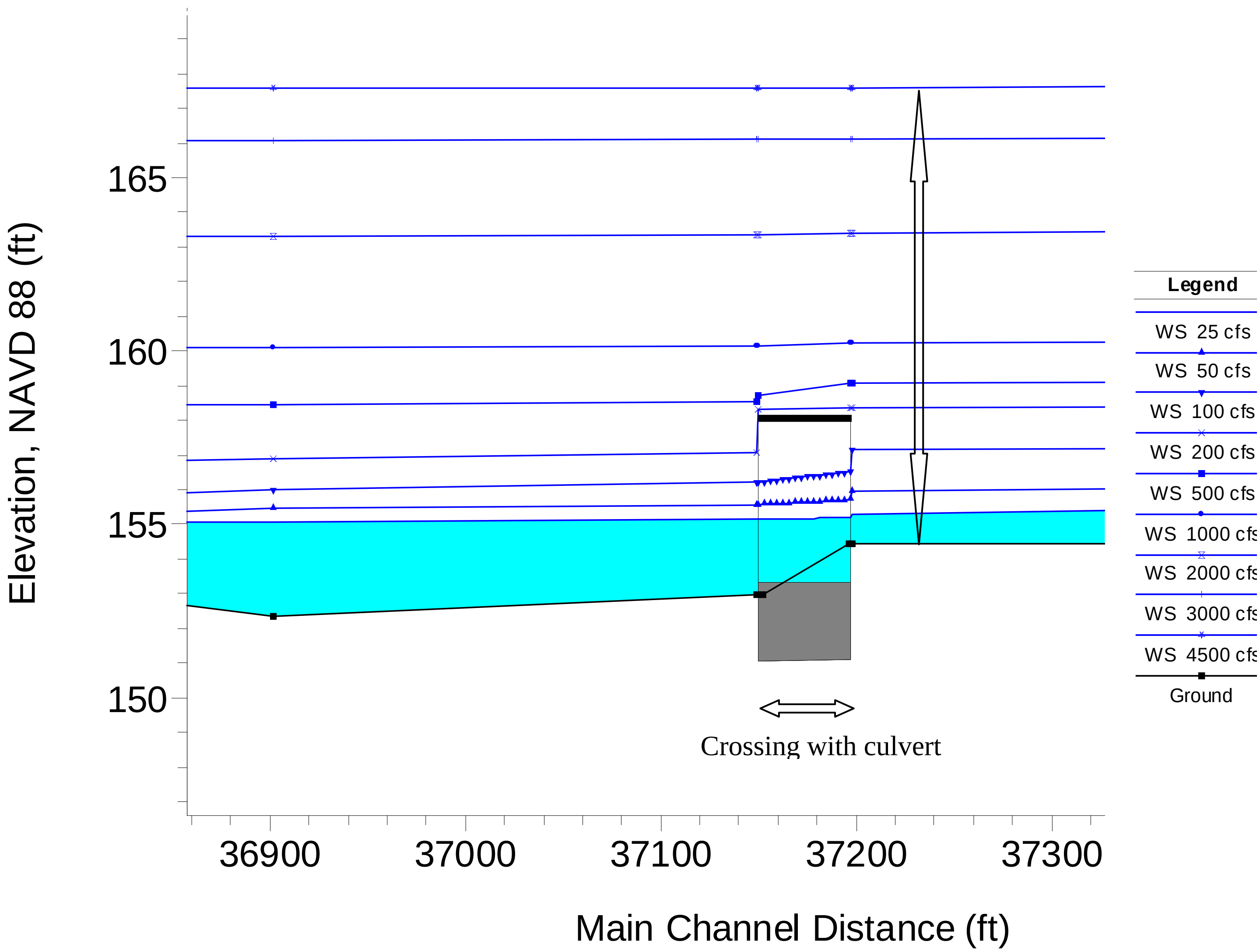


SAN JOAQUIN RIVER RESTORATION PROGRAM

TASK 2 EVALUATION RESULTS

SAN MATEO AVENUE

HEC-RAS MODEL BED AND WATER SURFACE PROFILE

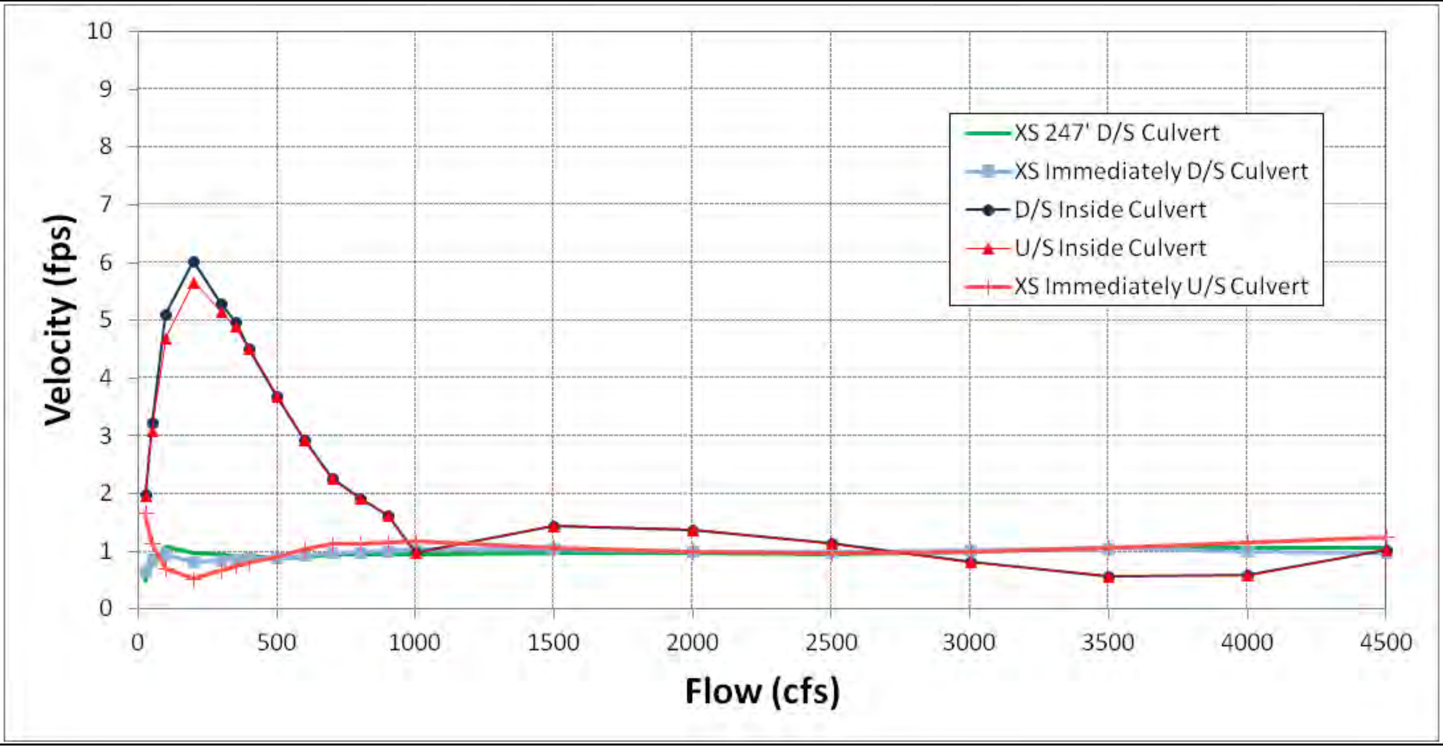


SAN JOAQUIN RIVER RESTORATION PROGRAM

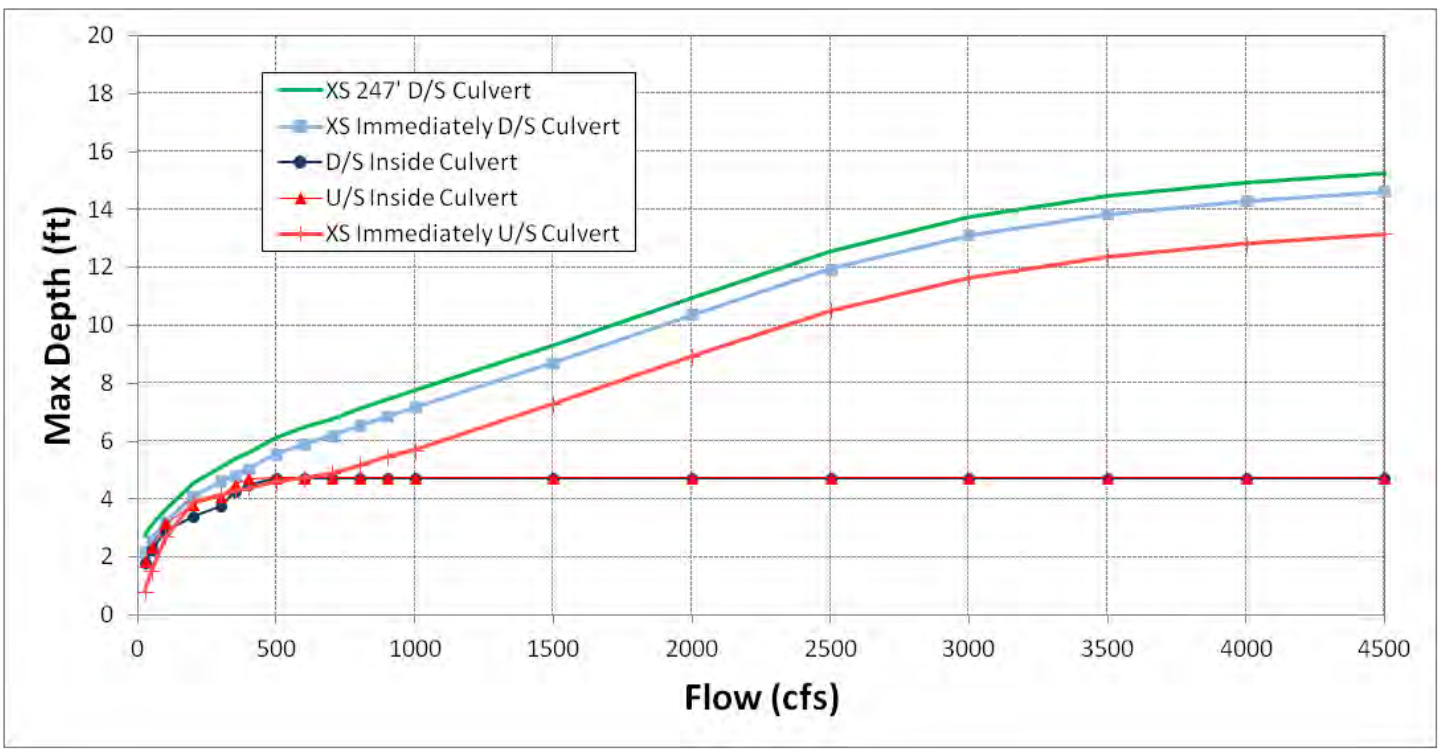
TASK 2 EVALUATION RESULTS

SAN MATEO AVENUE

HEC-RAS MODEL RESULTS



Velocity vs. Flow



Max Depth vs. Flow

HEC-RAS MODEL METADATA

TOPOGRAPHY	
Year:	2008
Creator/Source:	Towill Inc.
Type:	LiDAR Topo
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)
BATHYMETRY	
Year:	2009/2010
Creator/Source:	DWR/RECLAMATION
Type:	LiDAR Topo/ADCP Bathymetry
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)

Summary

- Model – Flows through San Mateo Avenue crossing were simulated using the HEC-RAS Reach 2B model developed by Tetra Tech, Inc. that was documented in the *San Joaquin River Reaches 1B, 2A, 2B, 3 and 4B1 One-dimensional HEC-RAS Steady-State Hydraulic Model Bathymetry Updates* Technical Memorandum (January 31, 2012).
- Geometry - No additional model details were incorporated into the model. . The structure has not been surveyed by DWR as part of the Task 2 efforts.
- Boundary Conditions – The boundary condition referenced a rating curve at the downstream end of Reach 2B that was developed from the existing model conditions within the Tetra Tech, Inc. HEC-RAS model for the entire project area. The rating curve reflects the stage-discharge relationship at the downstream boundary condition.
- Calibration – The model was calibrated using the flow data collected by DWR on May 19, 2011, the flow was measured to be 1,160 cfs through the structure. The model water surface elevations were compared to the water surface elevations from the 2011 Task 2 flow monitoring data and were within +/- 0.5’.

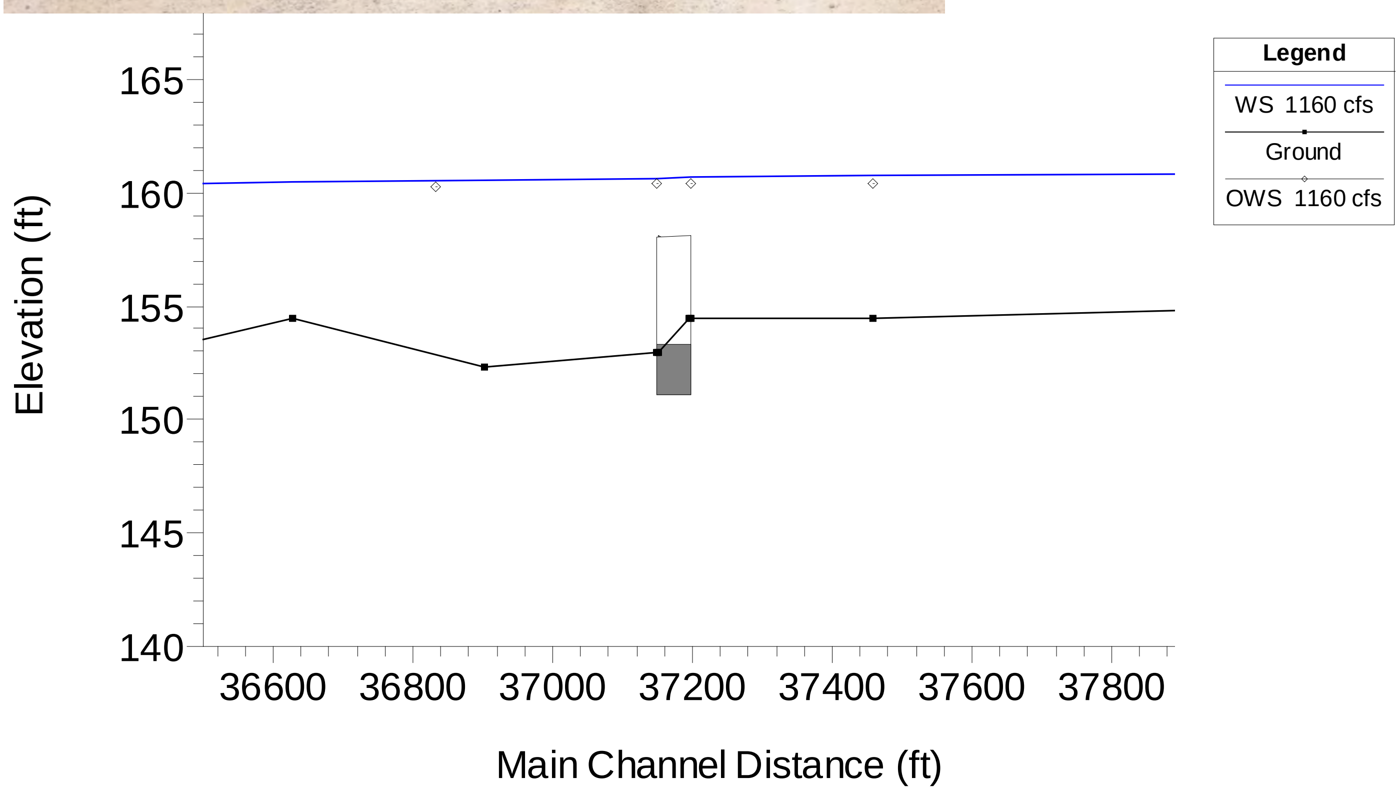
SAN JOAQUIN RIVER RESTORATION PROGRAM

TASK 2 EVALUATION RESULTS

SAN MATEO AVENUE

MODEL CALIBRATION

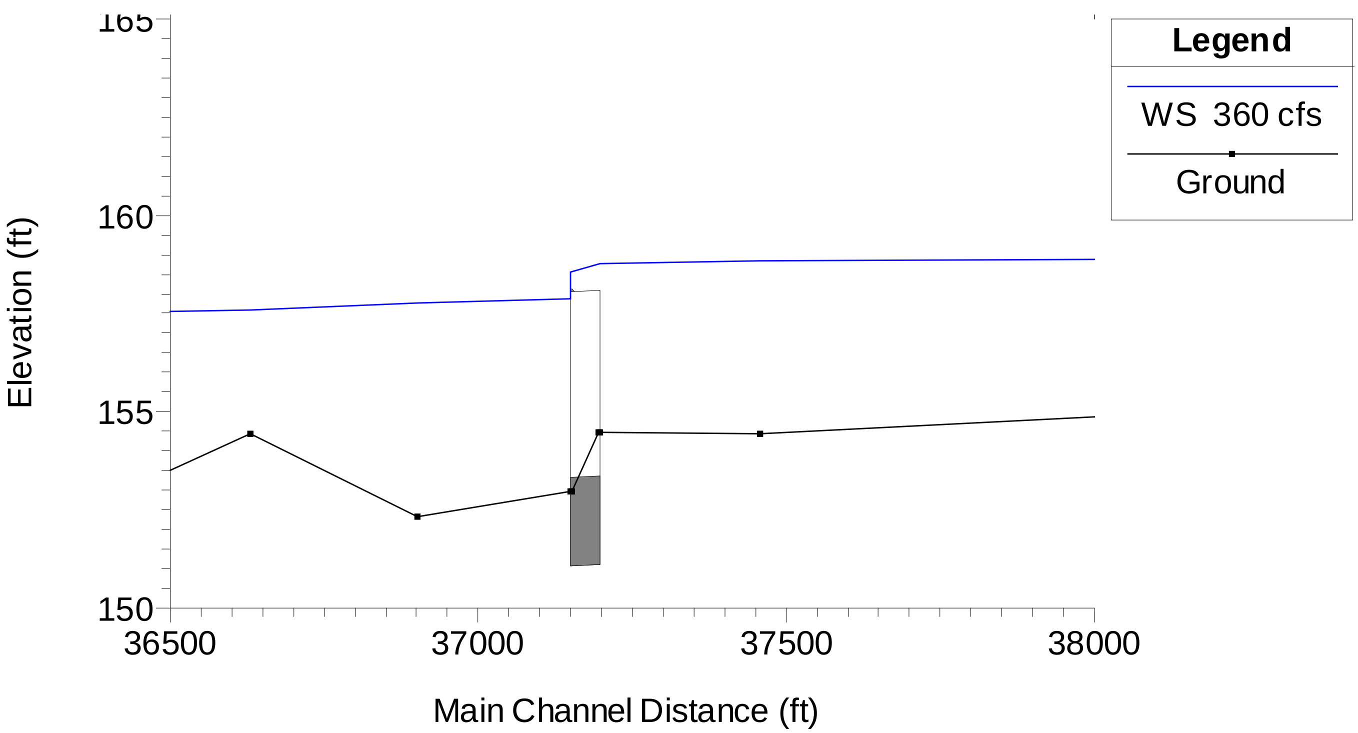
Date: May 19, 2011	**Flow (cfs):** 1,160	**Mean Velocity (ft/s):** 0.816



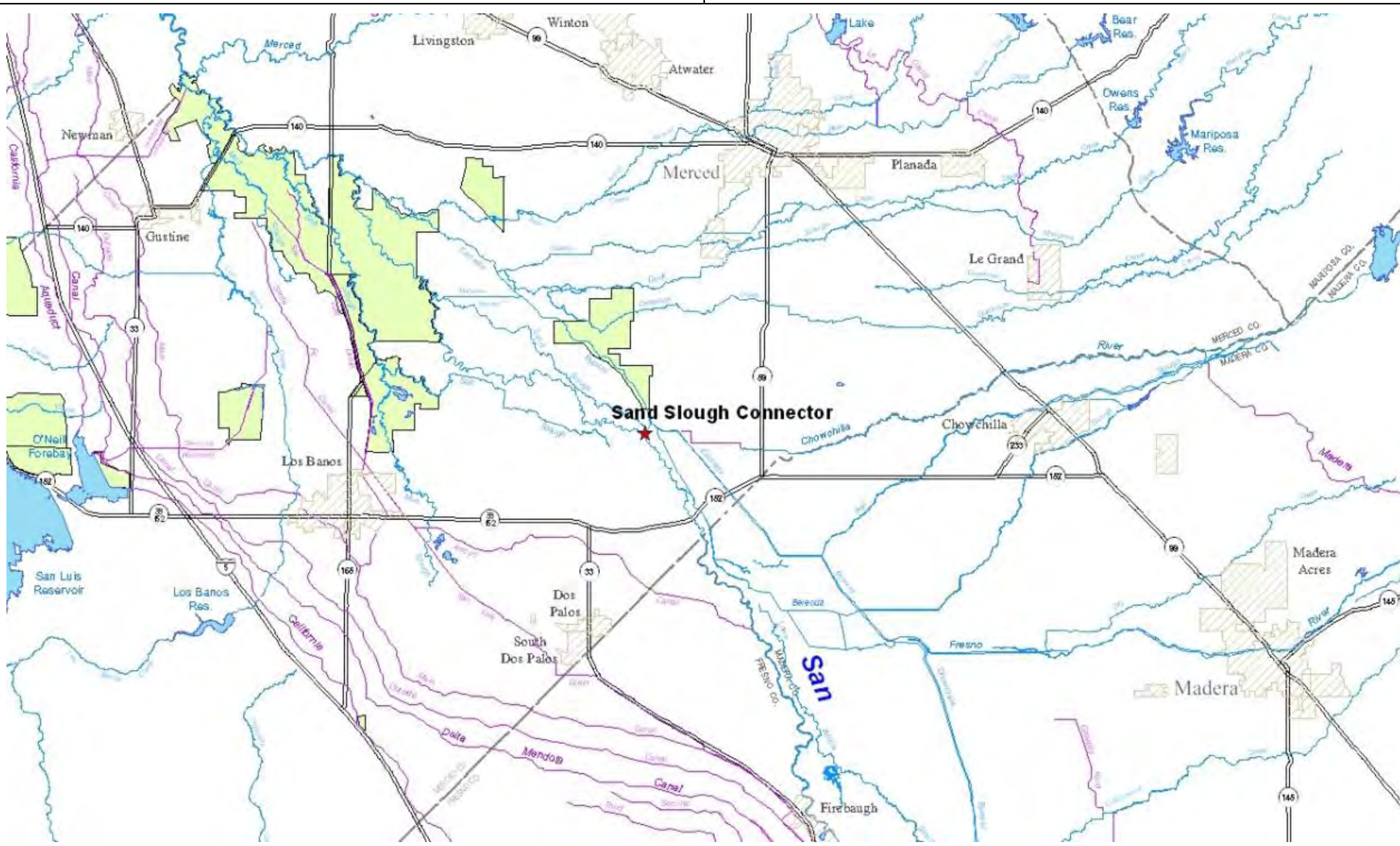
ADDITONAL SITE INSPECTIONS

Date: May 9, 2011	**Flow (cfs):** 360	**Mean Velocity (ft/s):** 2 -3 est.

Estimated 6 inches to 2 feet depth over road



BEARINGS				
Site Name[9]: Sand Slough Connector		**I.D. Number[1]:** 29	**Reach:** 4B1	
River Mile: 168.4	**Barrier Type[1]:** Diversion			**Rank[1]:** Gray



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

STRUCTURE DESCRIPTION

The Sand Slough Connector is located at the apex of the San Joaquin River and the Sand Slough near river mile 168.47 (Photo 29_A). The headgates to Reach 4B are located upstream on the right bank. The control structure is currently acting like a broad-crested weir with 6 rectangular openings each 5.1 x 5 feet (Photo 29_B). Each opening is designed for slide gates or stop logs that are manually dropped. At the time of the survey the openings were open. The structure has a cobble and concrete headwall that extends the structure to the right and left banks of the channel for a total length of 186 feet from bank to bank. The structure is about 2.5 feet wide and about 5.1 feet high.

There is a concrete flume downstream the weir openings that has a concrete apron, so the pool depth downstream is dependent on the amount of flow allowed to enter the structure. The flume is 48.5 feet long and about 15 feet wide at the narrowest part with a height of 4.7 feet. The end of the concrete apron is about 18 feet past the end of the flume, but is sloped down about three feet at the end of the flume and continues to slope down into the channel. The pool depth within three feet downstream had a water surface elevation of 3.3 feet.

The channel upstream had heavy weeds with tall annual grasses in the floodplain and vegetation growing in the openings of the weir (Photo 29_D). Downstream the channel had light weeds with tall annual grasses in the floodplain (Photo 29_E).

<u>Photos:</u>

Photo 29_A. Sand Slough Control Structure from the left bank

Photo 29_B. Sand Slough Control Structure openings looking upstream

Photo 29_C. Sand Slough Control Structure flume from right bank

Photo 29_D. Looking upstream from structure headwall

Photo 29_E. Looking downstream from flume

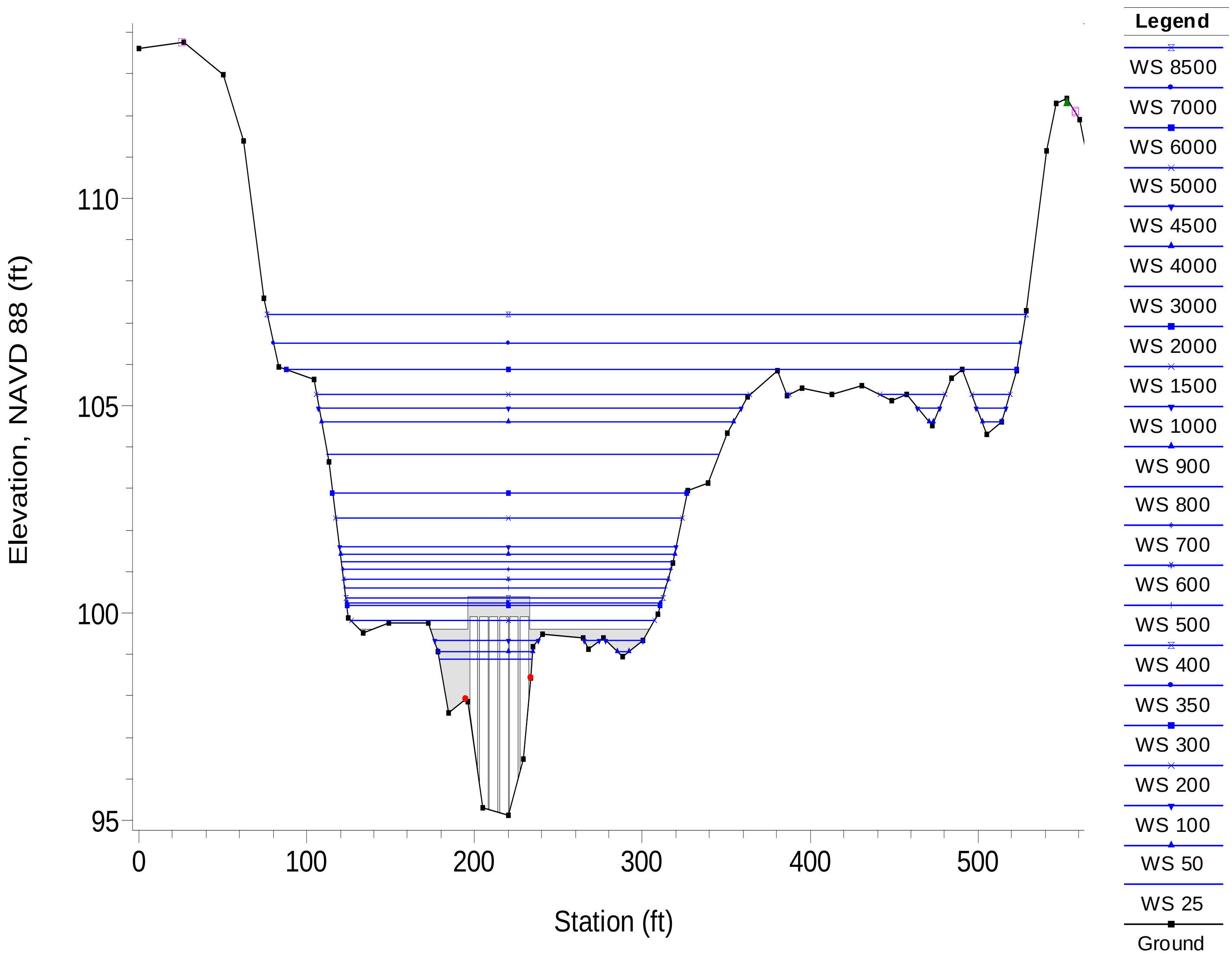
HEC-RAS MODEL SUMMARY TABLE

Results for flow through connector

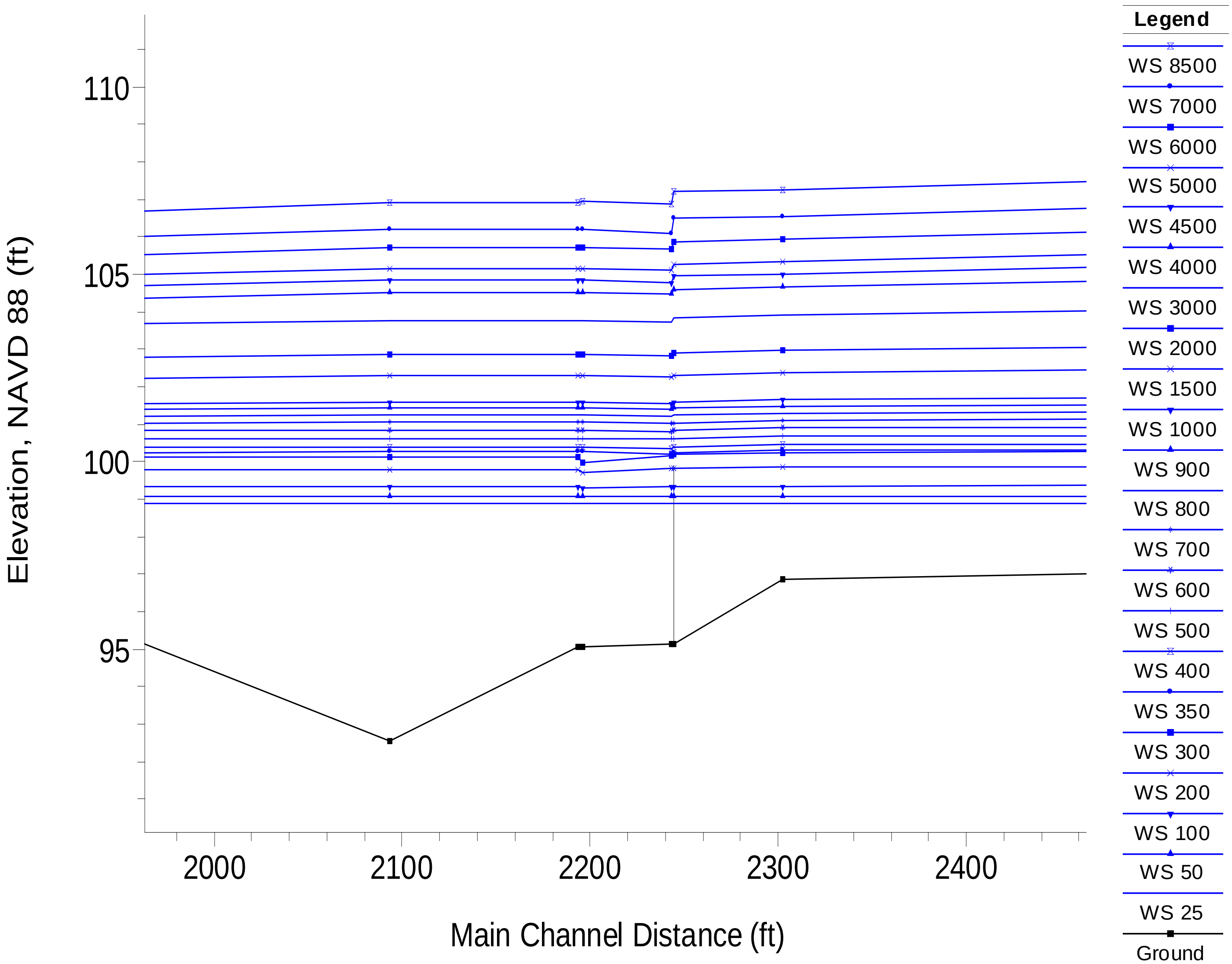
Flow	Maximum Depth	Channel Velocity	Maximum Water Surface Elevation Change
cfs	ft	fps	ft
25	3.8	0.3	0.0
50	3.9	0.5	0.0
100	4.2	1.0	0.0
200	4.7	1.6	0.0
300	5.1	2.0	0.1
350	5.1	2.3	0.1
400	5.2	2.4	0.1
500	5.5	2.3	0.1
600	5.7	2.3	0.1
700	5.9	2.4	0.1
800	6.1	2.4	0.1
900	6.3	2.4	0.1
1000	6.5	2.5	0.1
1500	7.2	2.6	0.1
2000	7.8	2.9	0.1
2500	8.3	3.1	0.2
3000	8.7	3.3	0.2
3500	9.1	3.4	0.2
4000	9.5	3.6	0.2
4500	9.8	3.8	0.2
5000	10.1	3.9	0.2
5500	10.5	4.1	0.3
6000	10.7	4.8	0.3
6500	11.1	4.7	0.4
7000	11.4	4.6	0.4
7500	11.6	4.6	0.4
8000	11.9	4.6	0.4
8500	12.1	4.6	0.4

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

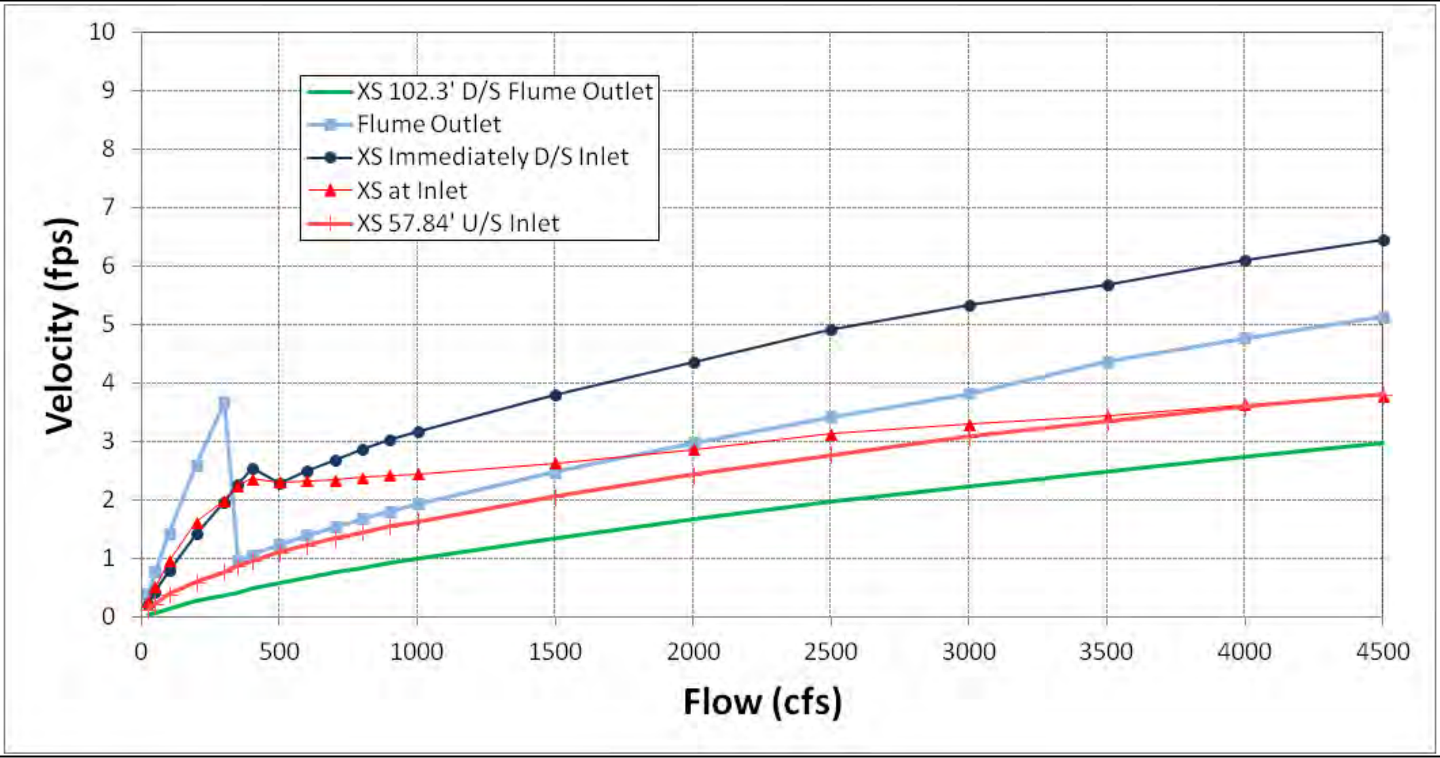
HEC-RAS MODEL CROSS SECTION AT CONNECTOR



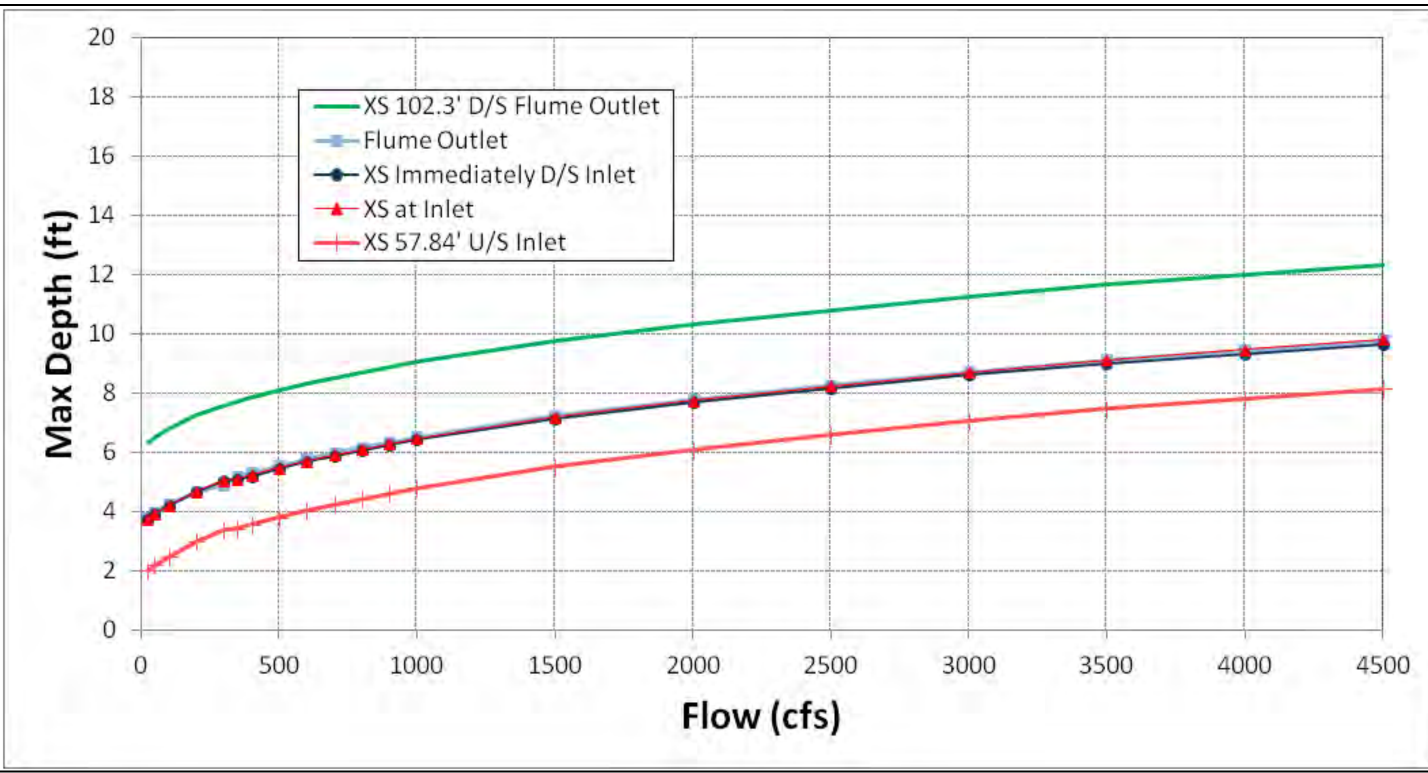
HEC-RAS MODEL BED AND WATER SURFACE PROFILE



HEC-RAS MODEL RESULTS



Velocity vs. Flow



Max Depth vs. Flow

HEC-RAS MODEL METADATA

TOPOGRAPHY	
Year:	2008
Creator/Source:	Towill Inc.
Type:	LiDAR Topo
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)
BATHYMETRY	
Year:	2010/2011
Creator/Source:	RECLAMATION
Type:	ADCP Bathymetry
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)

Summary

- Model - Flows through the structure were simulated using the HEC-RAS model developed by the US Bureau of Reclamation (RECLAMATION) and documented in *DRAFT Reach 4A Conveyance in the Vicinity of Sand Slough* Technical Report (April 21, 2011).
- Geometry - The model has updated topography and bathymetry to reflect current conditions. The structure dimensions are based on design drawings. The structure has not been surveyed by DWR as part of the Task 2 efforts.
- Boundary Conditions – The model assumes a normal depth for the downstream boundary condition at Lower Eastside Bypass, and no flows going into Mariposa Bypass.
- Calibration – The model was calibrated using the flow data collected by the RECLAMATION in January 17, 2011, the flow was assumed to be 1,200 cfs. The model water surface elevations were compared to the water surface elevations from the 2011 Task 2 flow monitoring data and were within +/- 0.5’.

SAN JOAQUIN RIVER RESTORATION PROGRAM

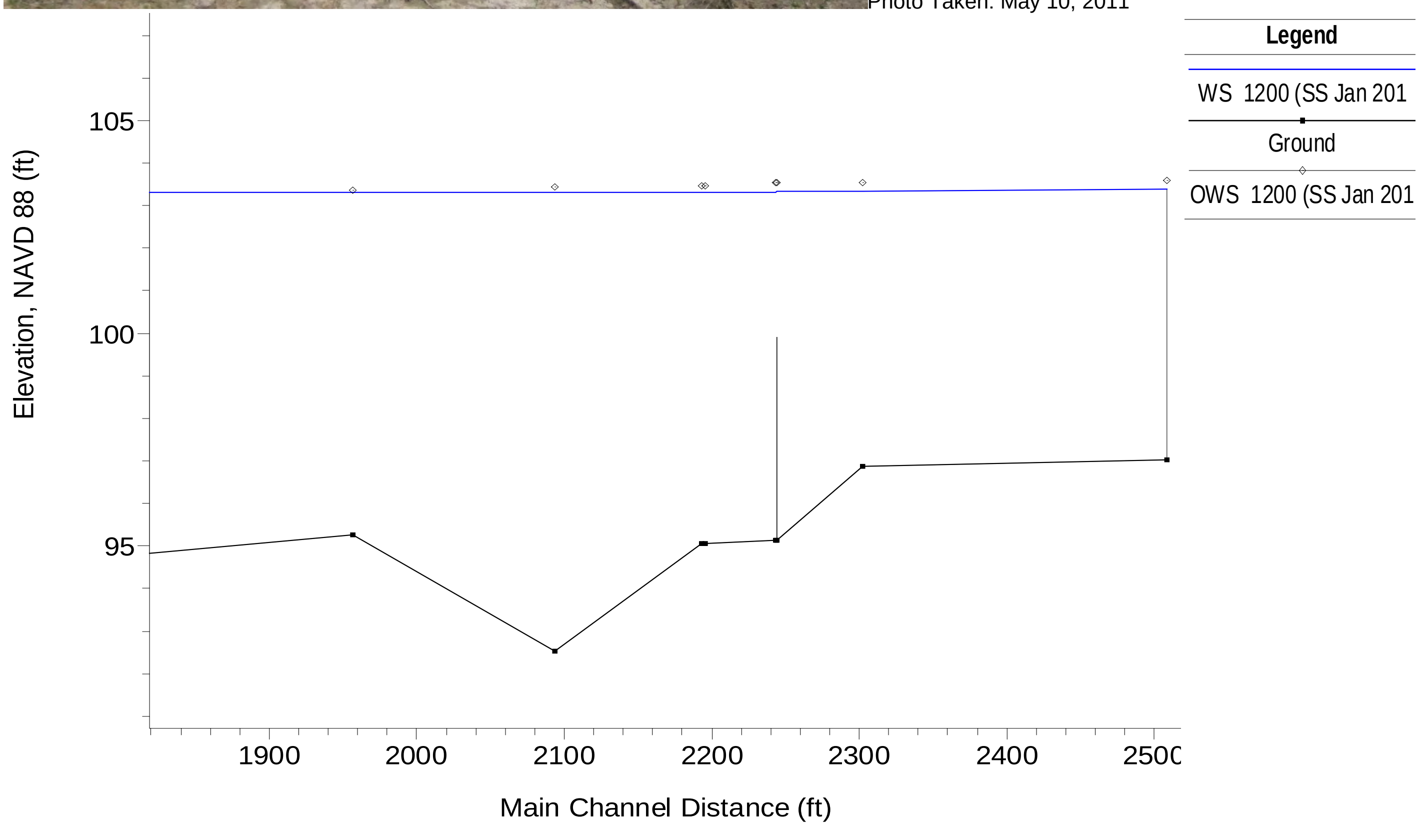
TASK 2 EVALUATION RESULTS

SAND SLOUGH CONNECTOR

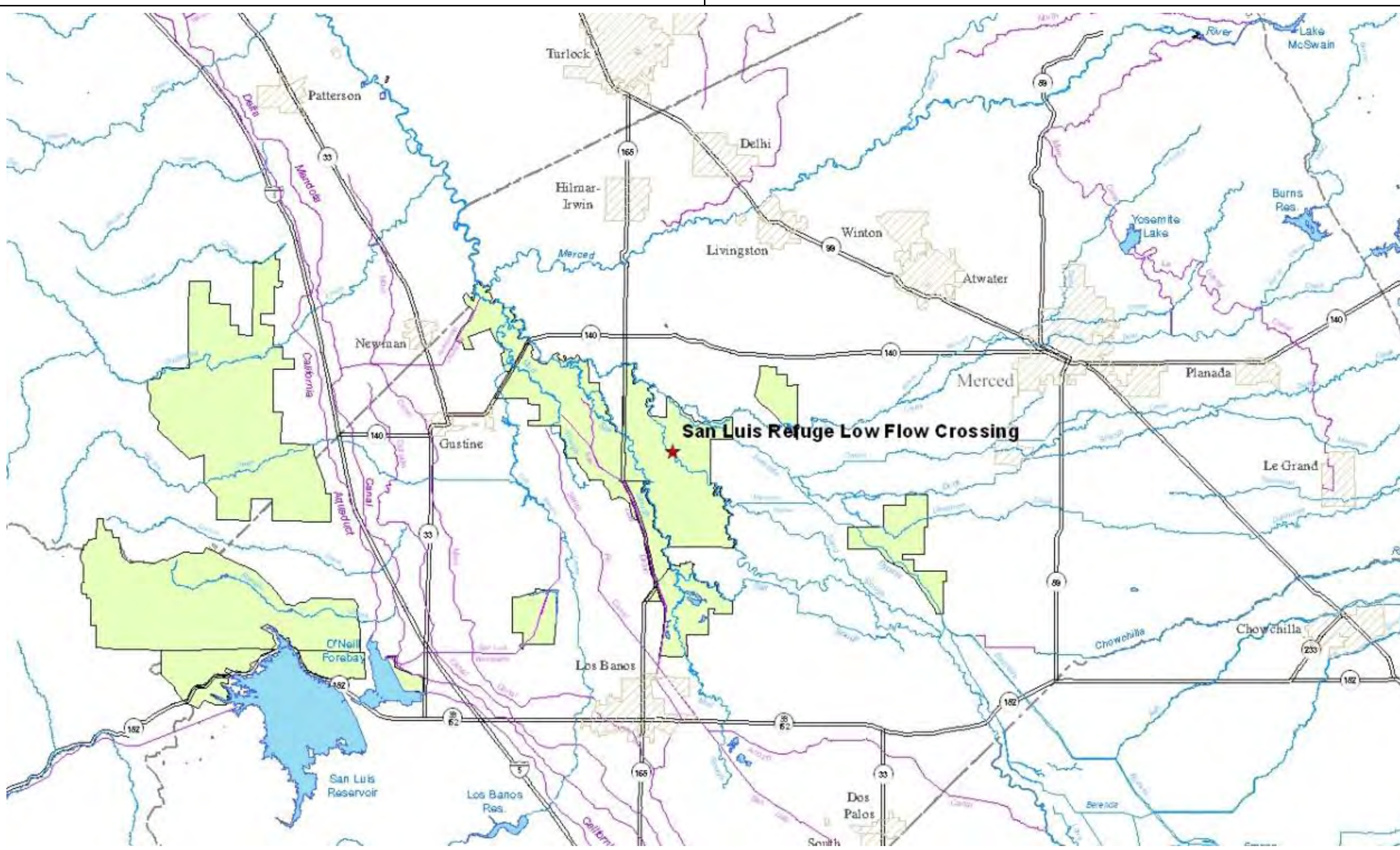
MODEL CALIBRATION

Date: January 17, 2011	**Flow (cfs):** 1,200	**Mean Velocity (ft/s):** 1.82

Photo Taken: May 10, 2011



BEARINGS				
Site Name[10]: SLWR Crossing		**I.D. Number[1]:** 38	**Reach:** 4B2	
River Mile: 143.2	**Barrier Type[1]:** Crossing			**Rank[1]:** Gray



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

STRUCTURE DESCRIPTION

There is a gravel armored low flow crossing (Photo 38_A) located on the San Joaquin River near river mile 143.2 within the San Luis Wildlife Refuge that is likely used to provide access to the eastern Bear Creek units. The gravel road appears to be well maintained. The road cannot be bypassed.

The channel upstream (Photo 38_B) is clean with some tall reeds on the left bank and tall woody trees on the banks located upstream and downstream the crossing. The reeds were choking the channel downstream and may be creating a fish barrier according to DFG (Photo 38_C) during the first pass but were cleared during the second pass. The crossing is about 138 feet from bank to bank and 24 feet wide. The crossing was submerged during the survey and no culverts were found. The active channel width was estimated at 73 feet.

The crossing is maintained so the elevations of the crossing should be periodically checked and updated in the model.

<u>Photos:</u>

Photo 38_A. Crossing from left bank

Photo 38_B. Channel looking upstream from road

Photo 38_C. Channel looking downstream at center line of channel

HEC-RAS MODEL SUMMARY TABLE

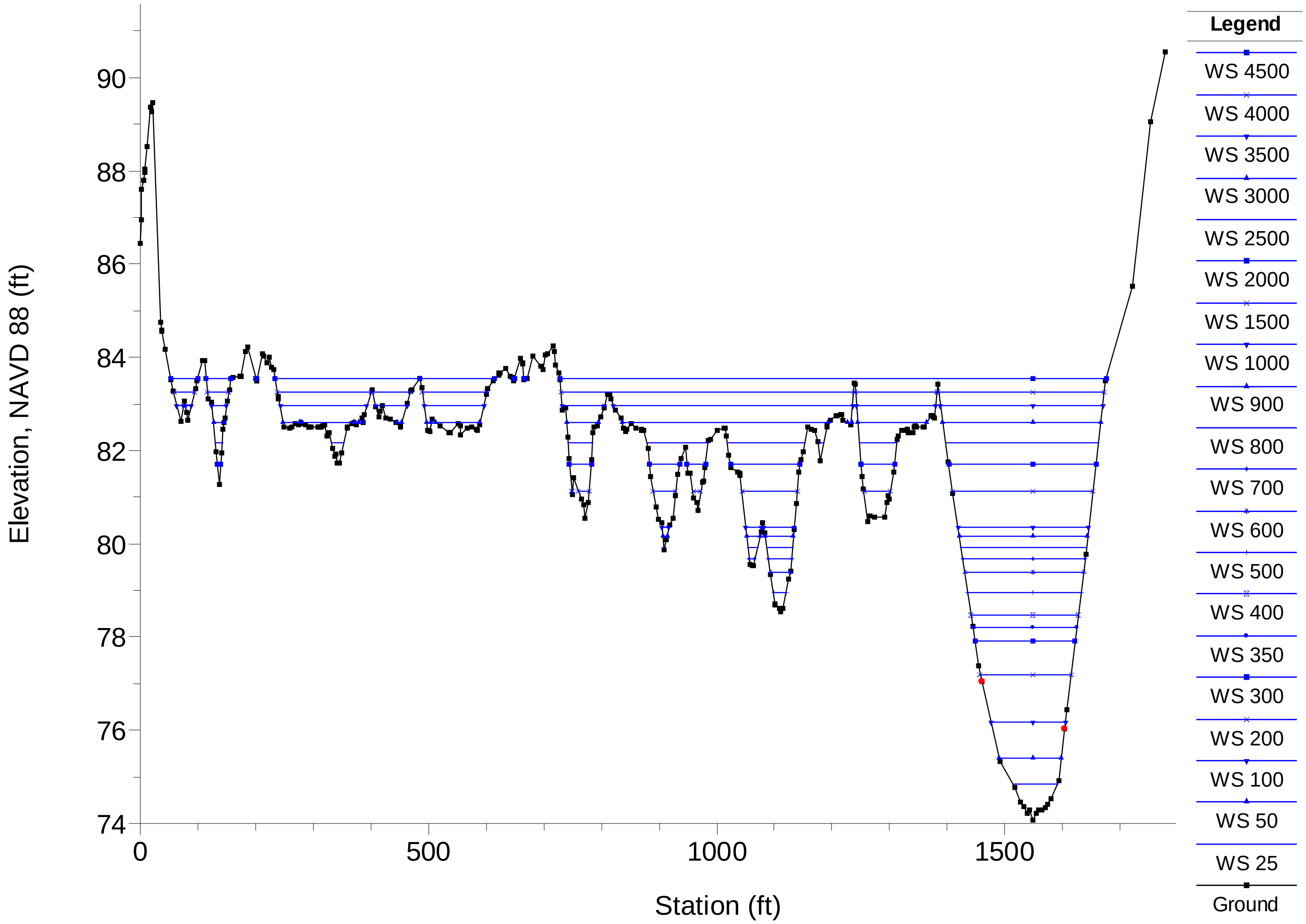
Results for flow over crossing

Flow	Maximum Depth	Channel Velocity	Maximum Water Surface Elevation Change
cfs	ft	fps	ft
25	0.8	0.8	0.0
50	1.3	0.6	0.0
100	2.1	0.6	0.0
200	3.1	0.6	0.0
300	3.8	0.7	0.0
350	4.1	0.8	0.0
400	4.4	0.8	0.0
500	4.9	0.9	0.0
600	5.3	0.9	0.0
700	5.6	1.0	0.0
800	5.9	1.1	0.0
900	6.1	1.1	0.0
1000	6.3	1.2	0.0
1500	7.1	1.5	0.0
2000	7.6	1.7	0.0
2500	8.1	1.9	0.0
3000	8.5	2.1	0.0
3500	8.9	2.3	0.0
4000	9.2	2.4	0.0
4500	9.5	2.4	0.0

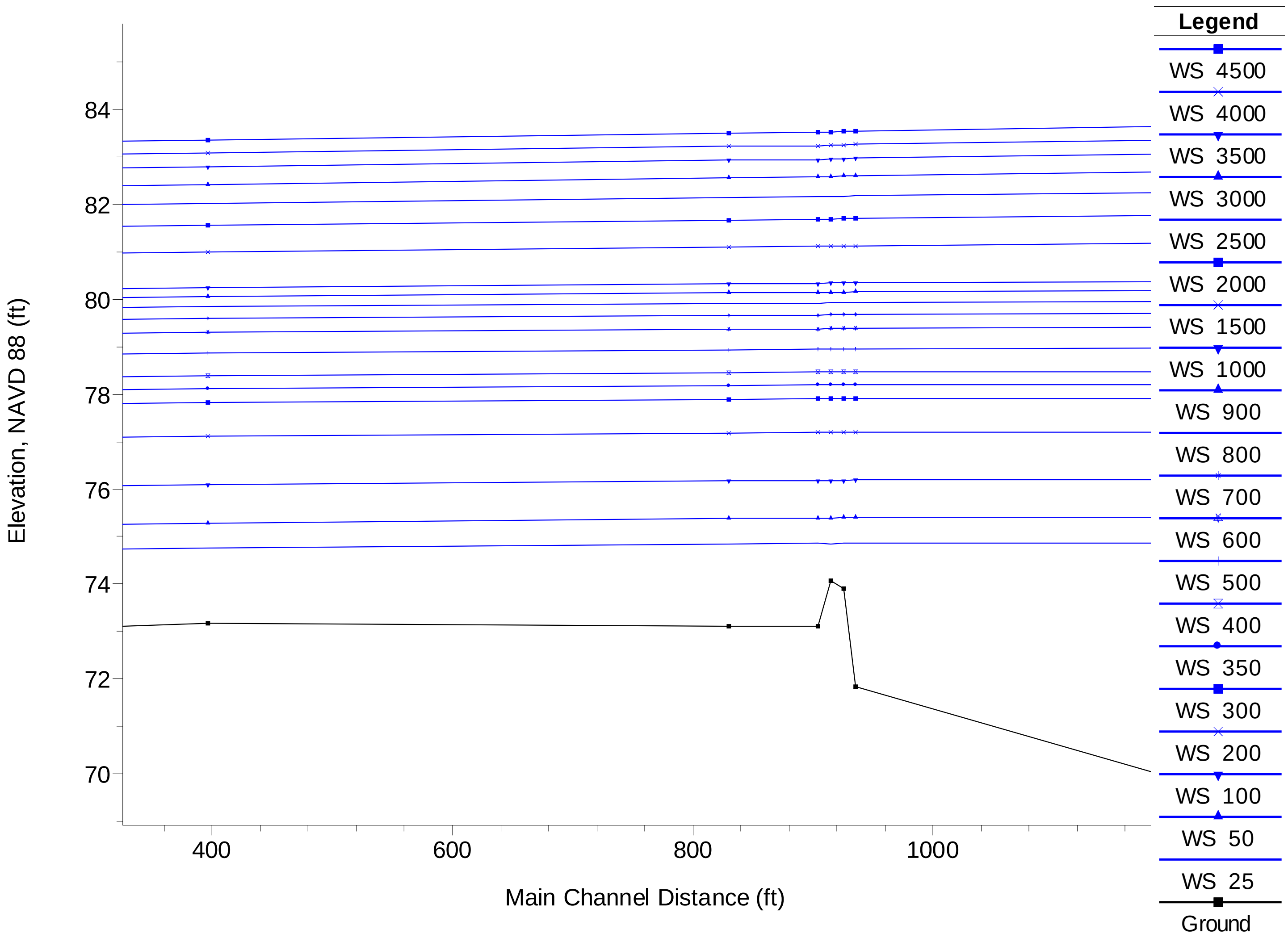
The maximum water surface elevation change was estimated based on the difference between the cross sections immediately upstream and downstream the weir.

SAN JOAQUIN RIVER RESTORATION PROGRAM
TASK 2 EVALUATION RESULTS
SAN LUIS WILDLIFE REFUGE CROSSING

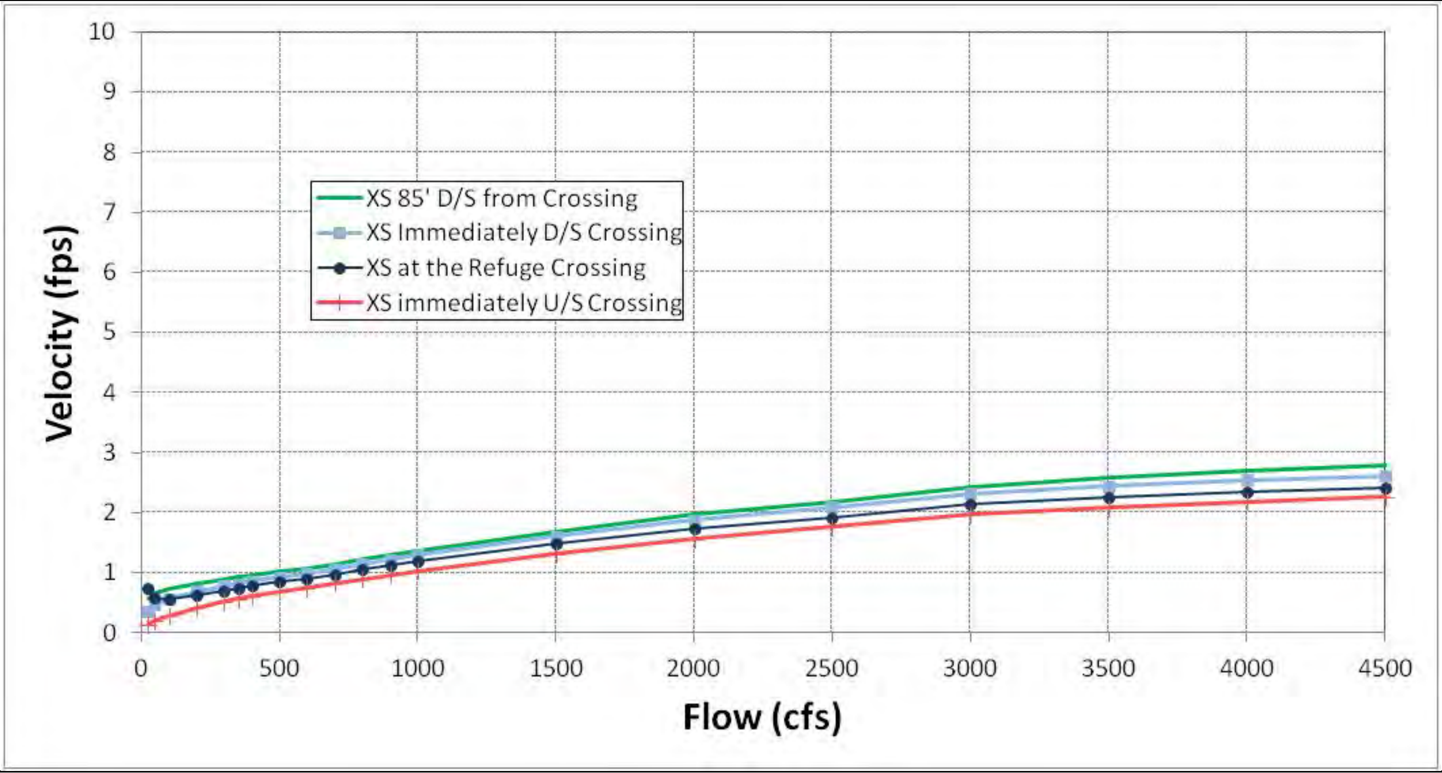
HEC-RAS MODEL CROSS SECTION AT CROSSING



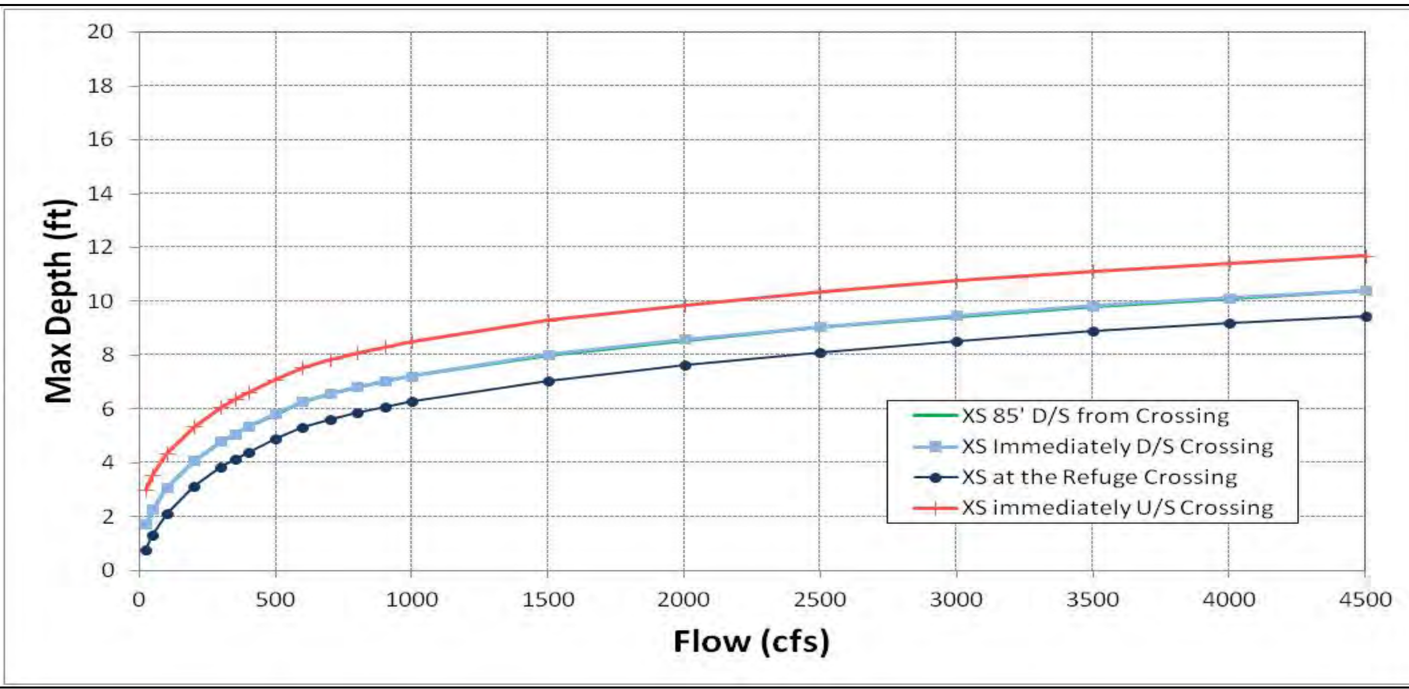
HEC-RAS MODEL BED AND WATER SURFACE PROFILE



HEC-RAS MODEL RESULTS



Velocity vs. Flow



Max Depth vs. Flow

HEC-RAS MODEL METADATA

TOPOGRAPHY	
Year:	2008
Creator/Source:	Towill Inc.
Type:	LiDAR Topo
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)
BATHYMETRY	
Year:	2011
Creator/Source:	DWR, Ayres Associates
Type:	ADCP/Surveyed Bathymetry
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)

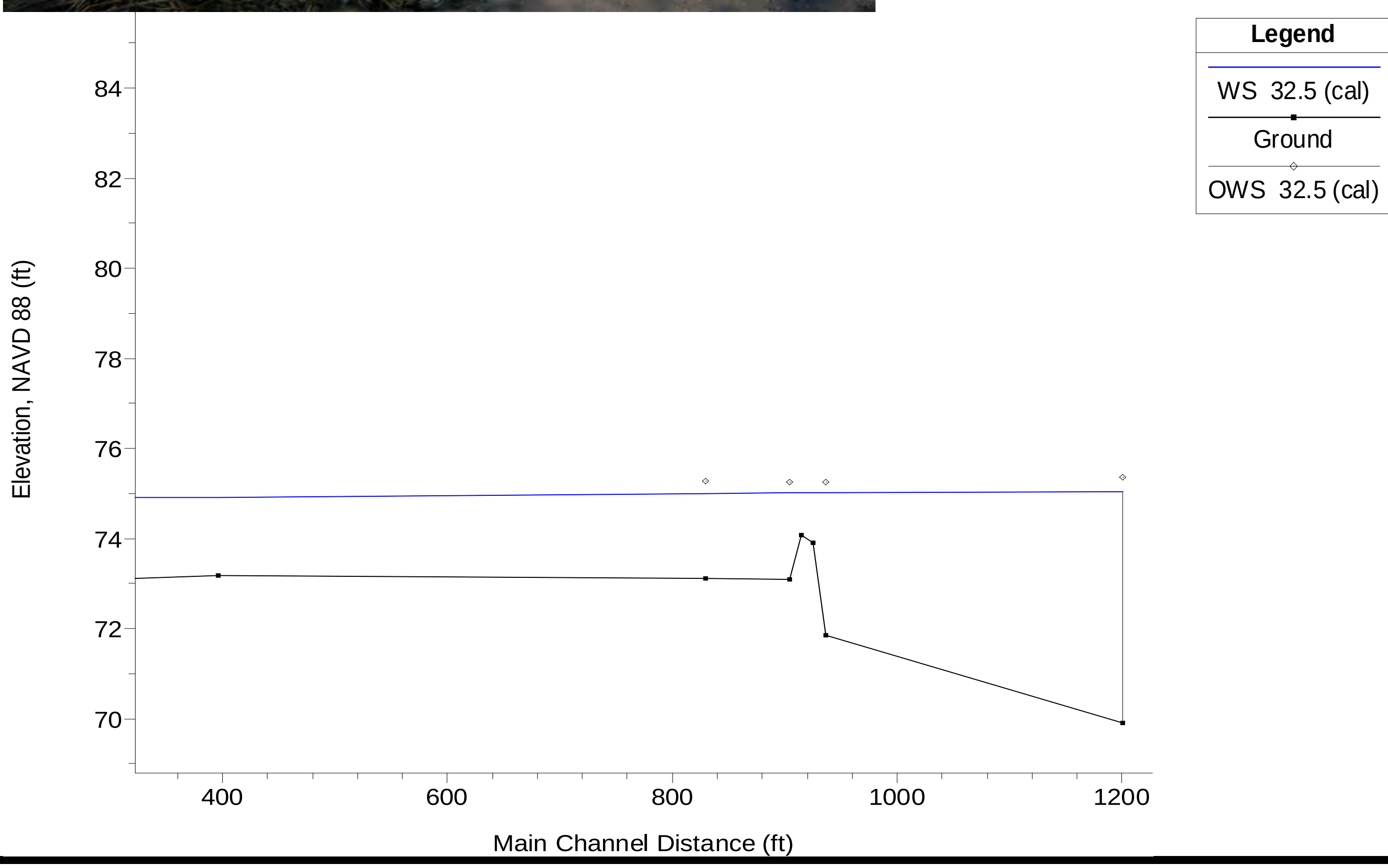
Summary

- Model – Flows through the San Luis Wildlife Refuge Crossing were simulated using a localized HEC-RAS model of the structure.
- Geometry - The model was developed by adding new cross sections at the structure using Task 2 topographic surveys, ADCP bathymetry, and 2008 LiDAR. Elevations at some channel cross sections were supplemented using the 1998/1999 Ayres Bathymetry (converted from NGVD 1929 to NAVD 1988).
- Boundary Conditions – The model assumes a normal depth for the downstream boundary condition.
- Calibration – The model was calibrated using the flow data collected by DWR on May 24, 2011, the flow was measured to be 32 cfs through the structure. The water surface elevations were compared to the water surface elevations from the 2011 Task 2 flow monitoring data and were within +/- 0.5'.

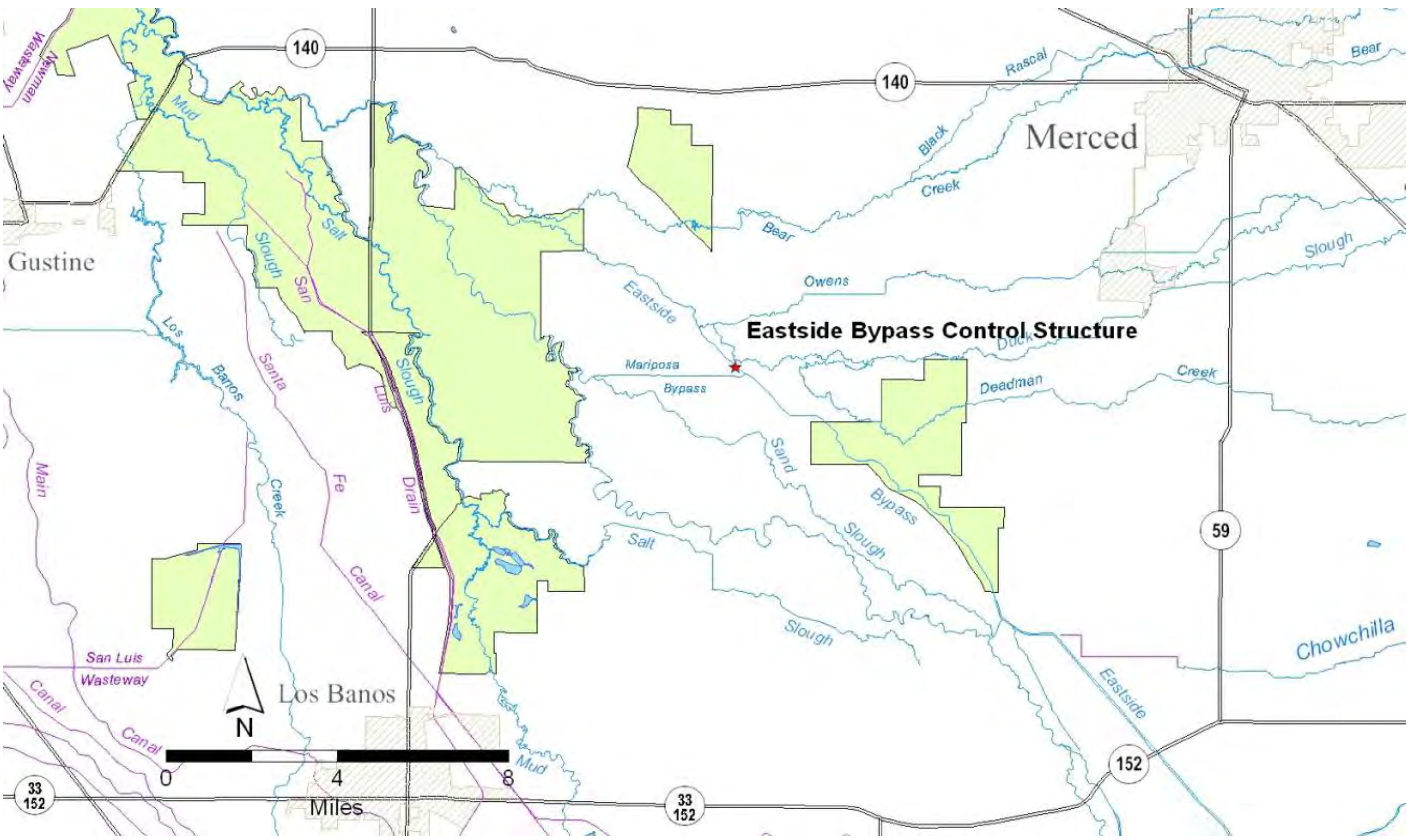
MODEL CALIBRATION

Date: May 24, 2011	**Flow (cfs):** 32.5	**Mean Velocity (ft/s):** 0.07

Just downstream crossing during flow monitoring



BEARINGS		
Site Name[11]: Eastside Bypass Control	**I.D. Number[1]:** 48	**Reach:** 4B2
River Mile:	**Barrier Type[1]:** Control Structure	**Rank[1]:** **Red**



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

STRUCTURE DESCRIPTION

The Eastside Bypass Control Structure is part of the bifurcation structure located at the apex of the Eastside Bypass and the Mariposa Bypass (Photo 48_A). The control structure was surveyed during Task 1 and Task 2, during both surveys the six radial gates were open with stop logs in place. This structure is very similar to the Chowchilla Bifurcation structure located on the San Joaquin River upstream.

There are a total of six gated bays opening that measure 19 feet in height and 20 feet wide. The structure height is about 21.5 feet and measures 130.3 feet in total length from the top deck. 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 45.5 feet in length with a 15 foot concrete apron downstream. There are six 2 x 2 x 4 foot concrete block diffusers (baffles) about 55 feet from the radial gate (Photo 48_B). The concrete apron has a short weir (sill) downstream that is about 2 feet tall and 1 foot wide.

There is a large pool just downstream the sill that is armored with rip rap to protect the concrete apron and weir from erosion (Photo 48_D). The rip rap protection extends about 30 feet downstream. The depth of the pool was not determined during Task 1 due to the depth exceeding what was able to be waded. Upstream there are stop logs in place that act like a weir at the inlet that averages 4 feet tall (Photo 48_C).

The channel upstream had short and tall annual grasses in the channel with tall annual grasses in the floodplain. The channel downstream had a large pool just downstream the structure and was clean with annual grasses in the channel downstream the pool. The channel substrate was mostly silt/clay.

Photos:

Photo 48_A. Structure, upstream looking downstream

Photo 48_B. Downstream looking upstream from end of bay

Photo 48_C. Weir upstream radial gate seal

48_D. Sill and rip rap at outlet

HEC-RAS MODEL SUMMARY TABLE

Eastside Bypass with Boards-In

Results for flows at sill

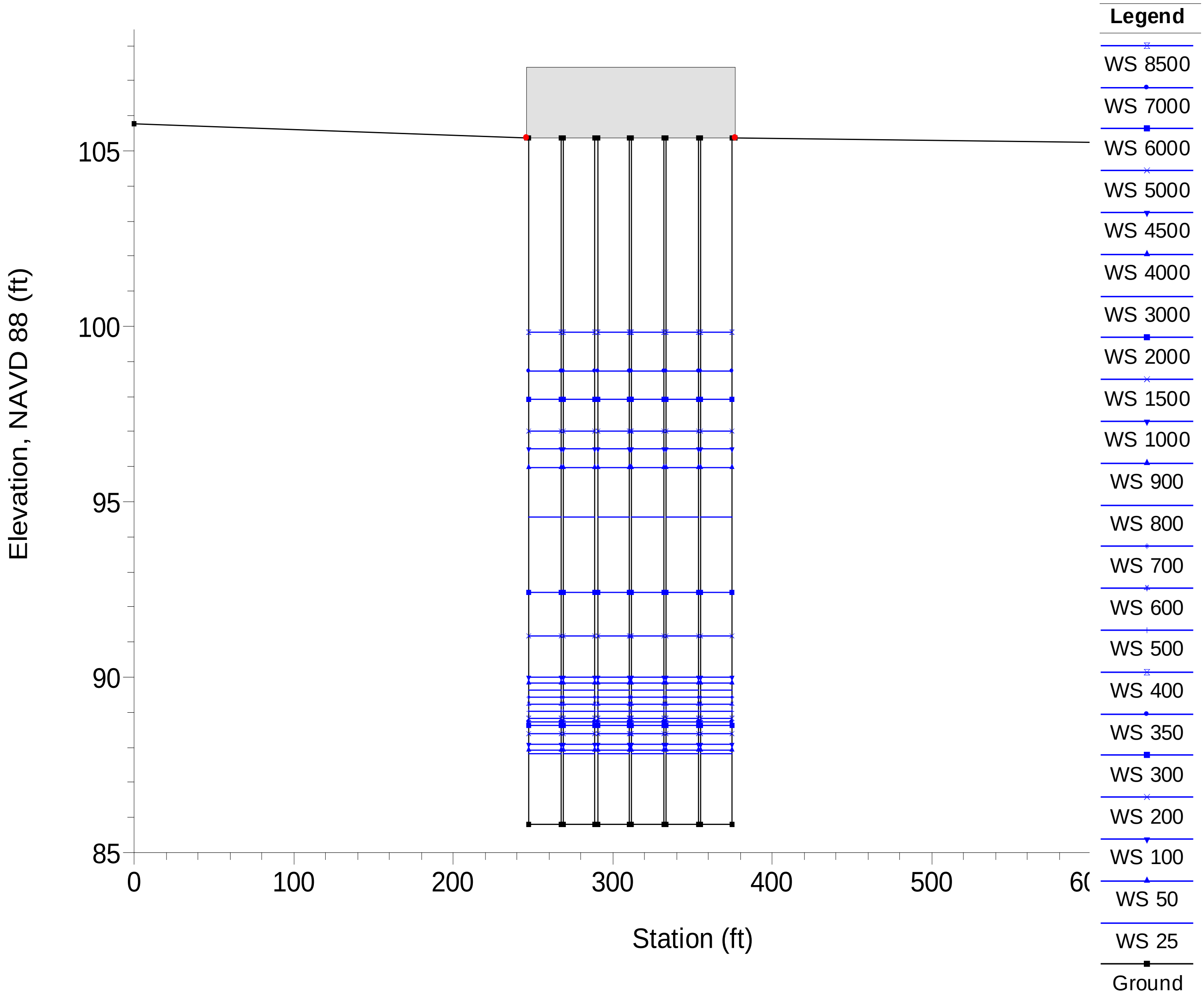
Flow	Maximum Depth	Channel Velocity	Maximum Water Surface Elevation Change
cfs	ft	fps	ft
25	0.1	1.9	1.9
50	0.2	2.3	2.0
100	0.3	2.9	2.0
200	0.4	3.7	2.1
300	0.6	4.2	2.2
350	0.6	4.4	2.2
400	0.7	4.6	2.3
500	0.8	5.0	2.3
600	0.9	5.3	1.8
700	1.0	5.6	1.4
800	1.1	5.8	0.9
900	1.1	6.1	0.6
1000	1.4	5.5	0.3
1500	3.1	3.7	0.1
2000	4.4	3.5	0.1
2500	5.7	3.4	0.1
3000	6.7	3.4	0.1
3500	7.5	3.6	0.1
4000	8.1	3.8	0.1
4500	8.6	4.0	0.1
5000	9.1	4.2	0.1
5500	9.5	4.4	0.1
6000	10.0	4.6	0.1
6500	10.4	4.8	0.1
7000	10.7	5.0	0.1
7500	11.1	5.2	0.1
8000	11.4	5.4	0.1
8500	11.8	5.5	0.1

Results for flows at Inlet (stop log)

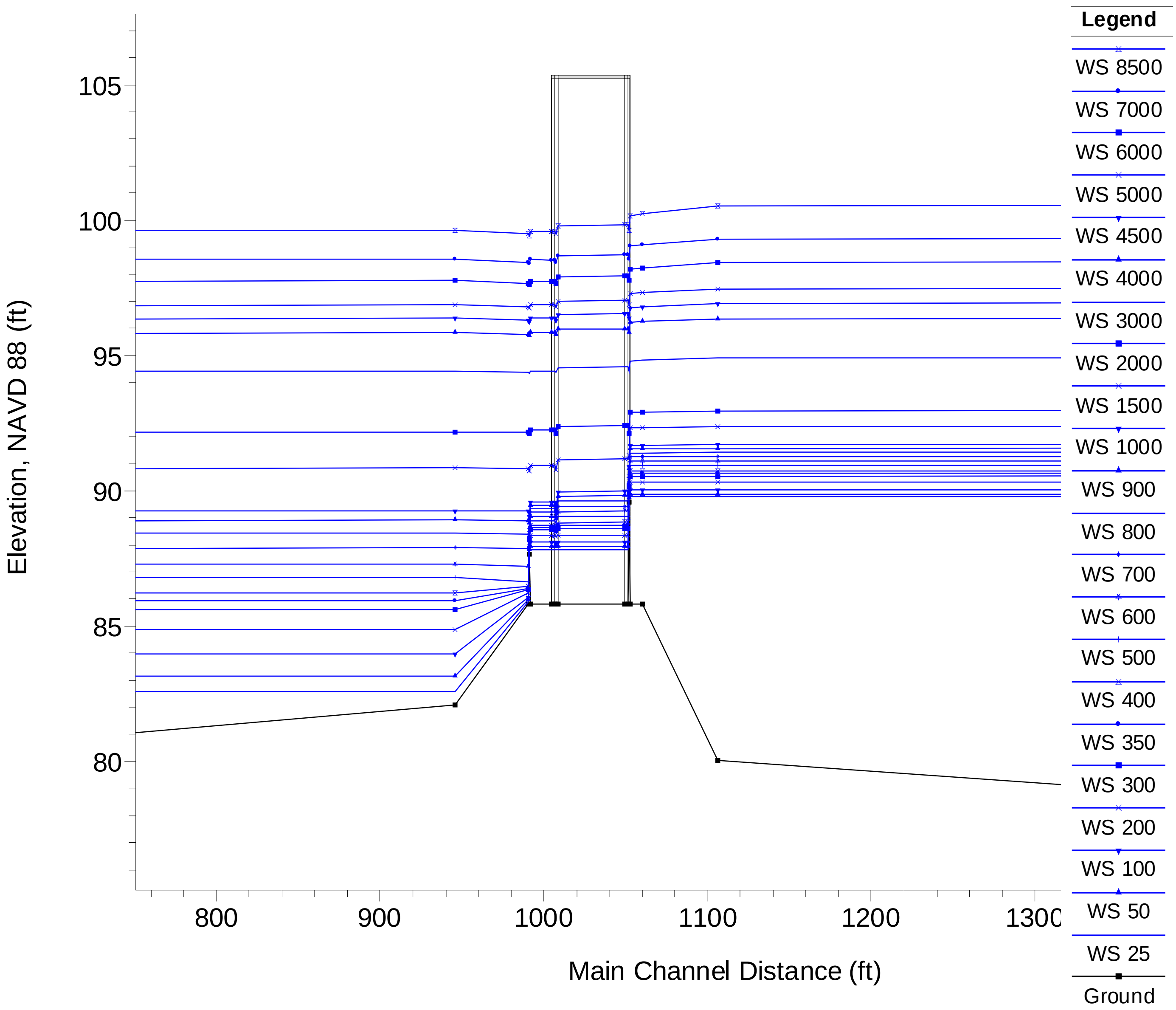
Flow	Maximum Depth	Channel Velocity	Maximum Water Surface Elevation Change
cfs	ft	fps	ft
25	0.1	1.9	1.9
50	0.2	2.4	1.9
100	0.3	3.0	2.0
200	0.4	3.8	1.9
300	0.6	4.3	1.9
350	0.6	4.6	1.9
400	0.7	4.8	1.9
500	0.8	5.1	1.9
600	0.9	5.4	1.9
700	1.0	5.7	1.8
800	1.1	6.0	1.8
900	1.2	6.2	1.8
1000	1.3	6.5	1.7
1500	1.7	7.4	1.2
2000	2.5	6.7	0.5
2500	3.8	5.6	0.3
3000	4.8	5.2	0.3
3500	5.6	5.2	0.2
4000	6.2	5.4	0.2
4500	6.8	5.6	0.2
5000	7.2	5.8	0.3
5500	7.7	6.0	0.3
6000	8.1	6.2	0.3
6500	8.5	6.4	0.3
7000	8.9	6.5	0.3
7500	9.3	6.7	0.3
8000	9.6	6.9	0.3
8500	10.0	7.1	0.3

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.

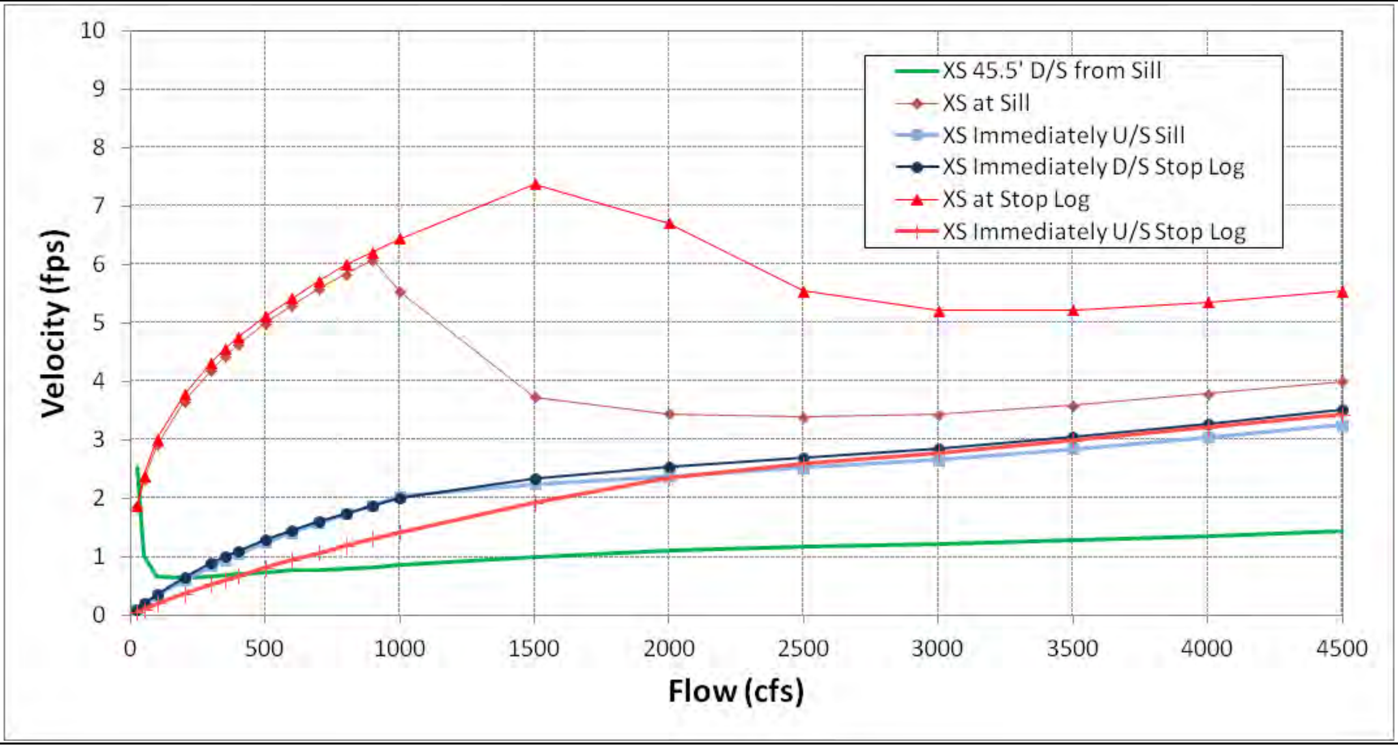
HEC-RAS MODEL STRUCTURE CROSS SECTION



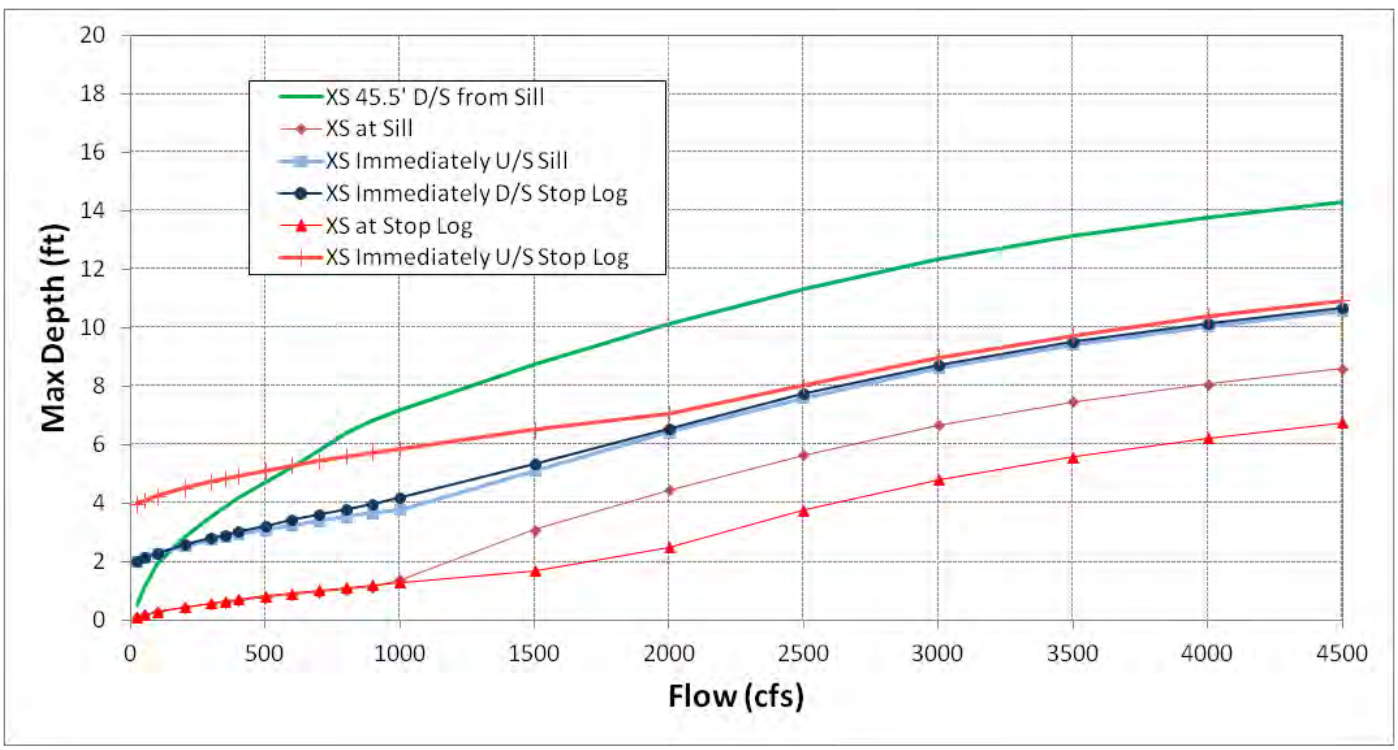
HEC-RAS MODEL BED AND WATER SURFACE PROFILE



HEC-RAS FLOW MODEL RESULTS BOARDS-IN

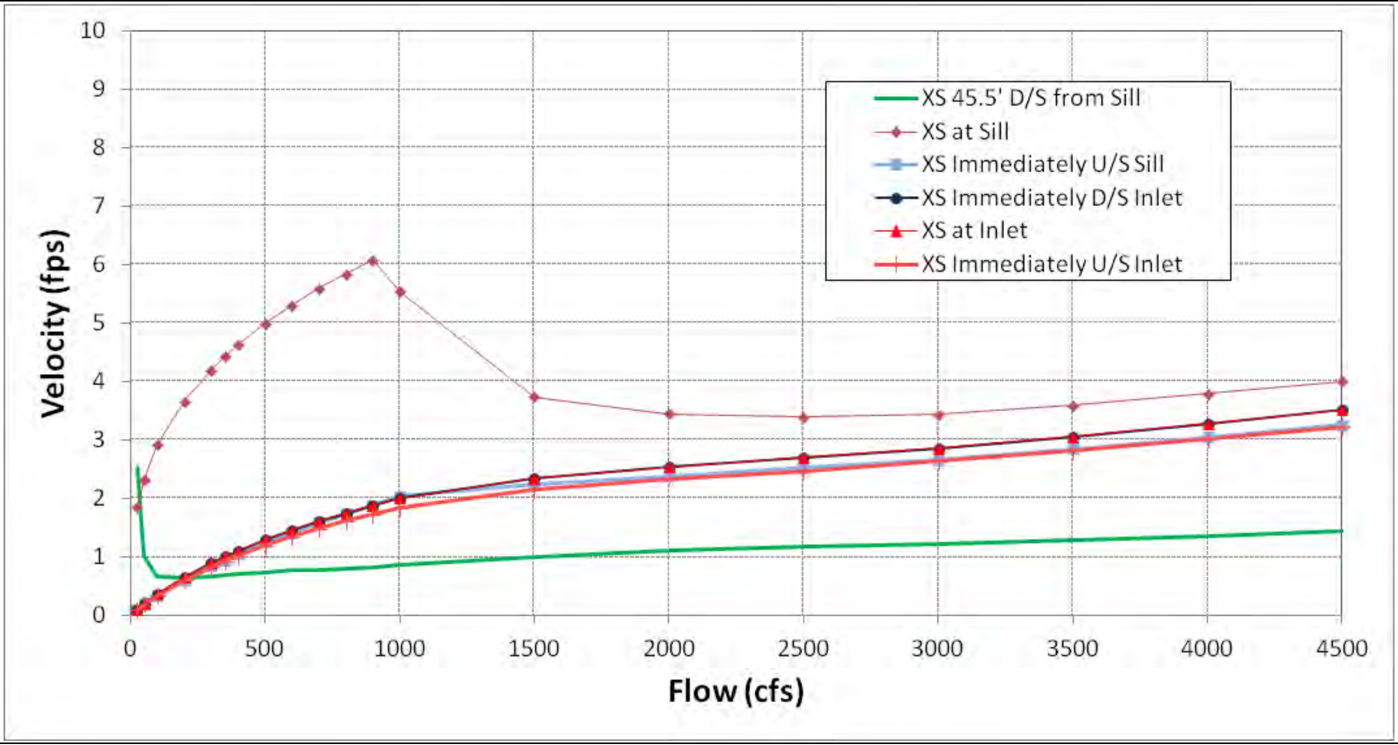


Velocity vs. Flow

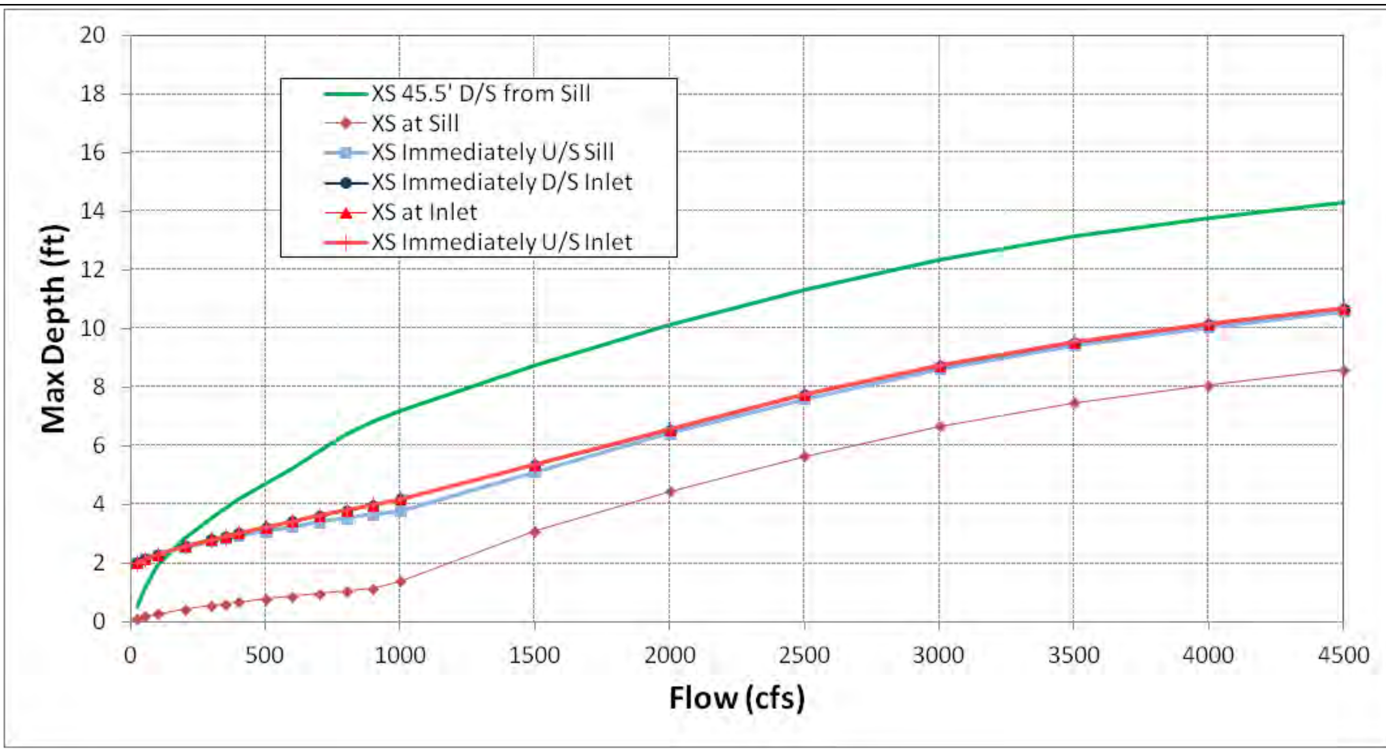


Max Depth vs. Flow

HEC-RAS FLOW MODEL RESULTS BOARDS-OUT



Velocity vs. Flow



Max Depth vs. Flow

HEC-RAS FLOW MODEL METADATA

TOPOGRAPHY	
Year:	2008
Creator/Source:	Towill Inc.
Type:	LiDAR Topo
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)
BATHYMETRY	
Year:	2010/2011
Creator/Source:	RECLAMATION
Type:	ADCP Bathymetry
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)

Summary

- Model - Flows through the Eastside Bypass Bifurcation Structure were simulated using the HEC-RAS model developed by the US Bureau of Reclamation (RECLAMATION) and documented in *DRAFT Reach 4A Conveyance in the Vicinity of Sand Slough* Technical Report (April 21, 2011). The model was run under two scenarios: Boards-in and Boards-out. Stop logs appear to be in place year round near the inlet of the structure, so it is considered Boards-in by default. Alternative model results with a Boards-out scenario were provided assuming stop logs not in place.
- Geometry - The model has updated topography and bathymetry to reflect current conditions. Structure elevations were based on the Task 2 topographic survey elevations.
- Boundary Conditions – The model assumes normal depth for the downstream boundary condition at Lower Eastside Bypass, and no flows going into Mariposa Bypass.
- Calibration – The model was calibrated using the flow data collected by DWR on May 23, 2011, the flow was measured to be 1,720 cfs through the structure. The model water surface elevations were compared to the water surface elevations from the 2011 Task 2 flow monitoring data and were within +/- 0.5’.

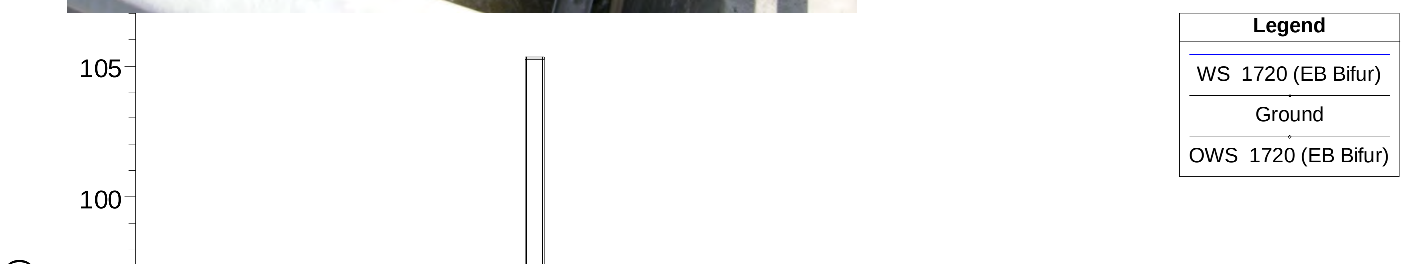
SAN JOAQUIN RIVER RESTORATION PROGRAM

TASK 2 EVALUATION RESULTS

EASTSIDE BYPASS CONTROL STRUCTURE

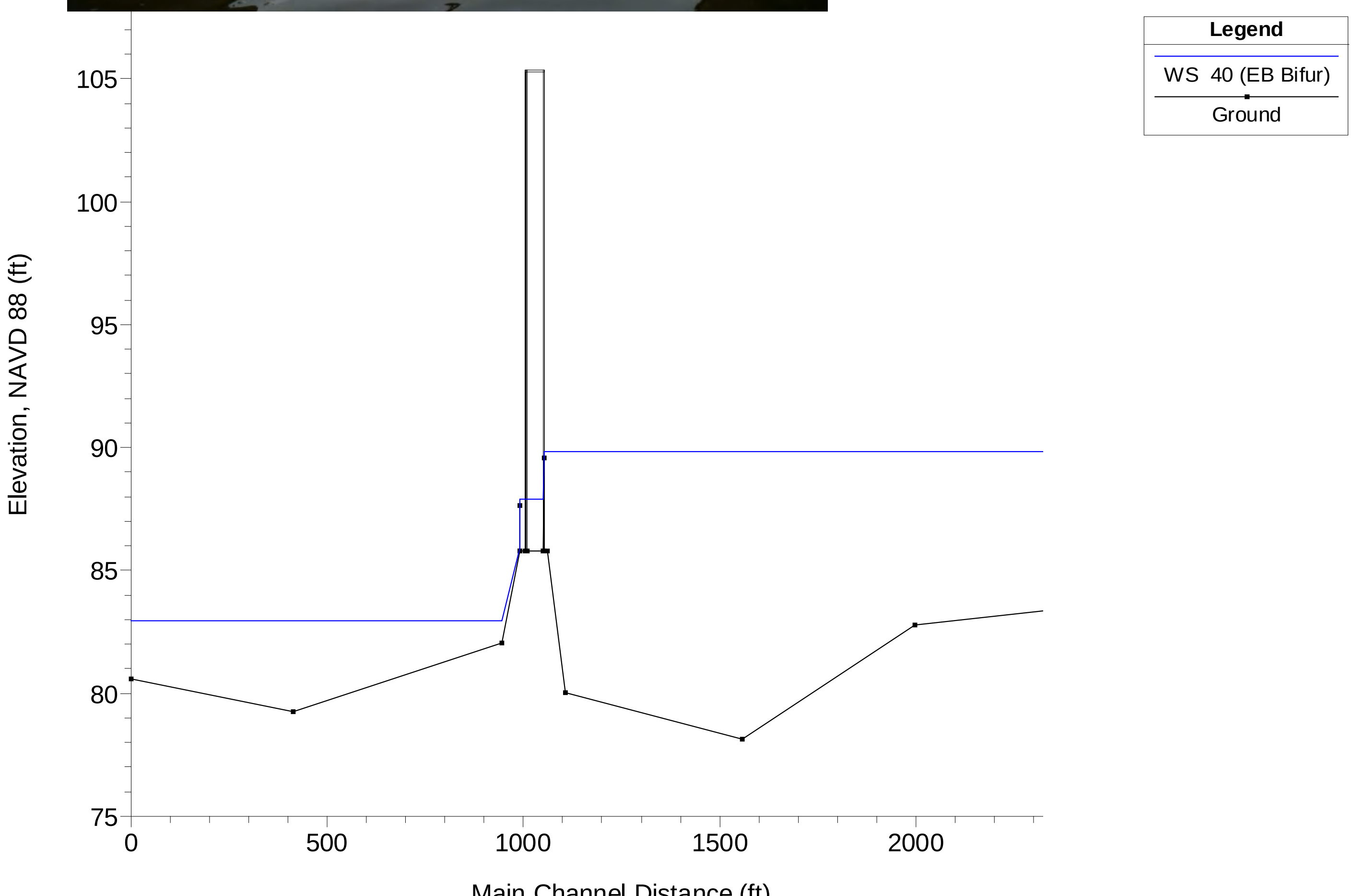
MODEL CALIBRATION

Date: May 23, 2011	**Flow (cfs):** 1,720	**Mean Velocity (ft/s):** 0.92



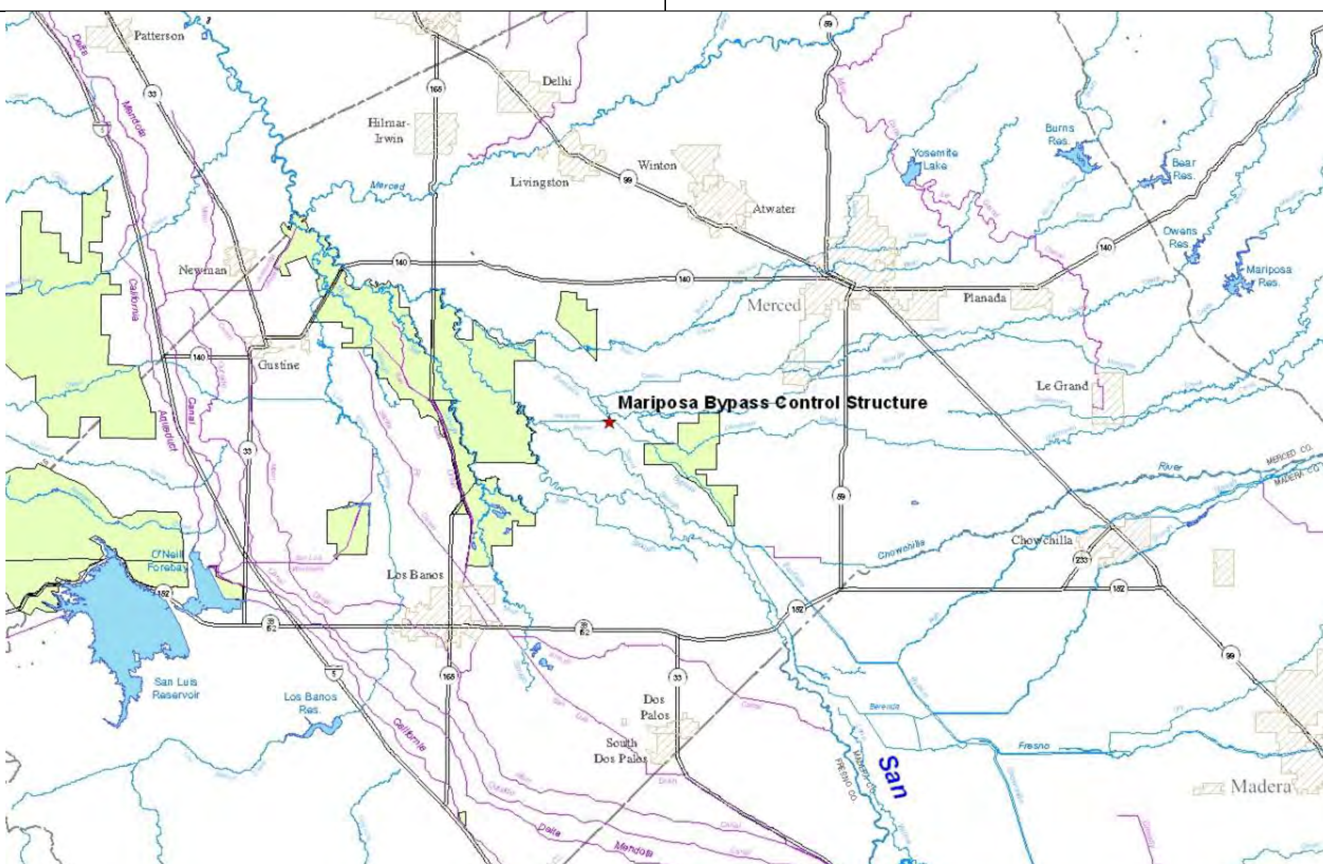
MODEL CALIBRATION

Date: November 29, 2011	**Flow (cfs):** 40 est.	**Mean Velocity (ft/s):**



BEARINGS

Site Name[12]: Mariposa Bypass Bifurcation	**I.D. Number[1]:** 49	**Reach:** 4B1	
River Mile: MB 3.36	**Barrier Type[1]:** Control		**Rank[1]:** **Red**



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

STRUCTURE DESCRIPTION

The bifurcation structure is located at the apex of the Eastside Bypass and the Mariposa Bypass (Photo 49_A). The Mariposa Bypass control structure has 14 bays with 8 radial gates that were partially open during the survey. The radial gates were located on each end of the structure, four at each end. Each bay opening is 10.5 feet in height and 20 feet wide. The structure height is about 20.6 feet, downstream, and measures 295.8 feet in total length from the top deck. The height of the outlet drop was surveyed over 7 feet. In addition, there is no staging pool just downstream because there is a hardened apron.

The structure has a maintenance road that crosses over the gate bay. The hoist motors are located at the top of each bay on the upstream end. There is a solid concrete headwall that extended to the north levee that had a gated culvert with a low flow channel. The bays have a roughly five foot drop with concrete diffusers that are 4.4 feet tall and 7.8 feet long (Photo 49_B). There is a concrete apron downstream for a distance of 45 feet to a short sill with a height of 2 feet and a width of about 1 foot (Photo 49_D). The concrete apron had a positive 30 degree angle to the weir.

The channel upstream has short and tall annual grasses in the channel with tall annual grasses in the floodplain. Just upstream the inlet broken concrete rip rap is in the stream bed of the right channel. A low flow channel entered a 36 inch culvert. The culvert outlet was located on the right bank wing-wall. The channel downstream had a large pool about 106 feet downstream the structure and was clean with annual grasses in the channel downstream the pool (Photo 49_C). The depth of the pool was reported by Reggie Hill to be 30 feet deep. Fish were observed jumping out of the pool. The channel substrate was mostly silt/clay.

<u>Photos:</u>

Photo 49_A. Structure upstream looking downstream

Photo 49_B. Ungated bay, downstream looking upstream

Photo 49_C. Structure, upstream looking downstream

Photo 49_D. Downstream sill

Photo 49_E. Gated bay, downstream looking upstream

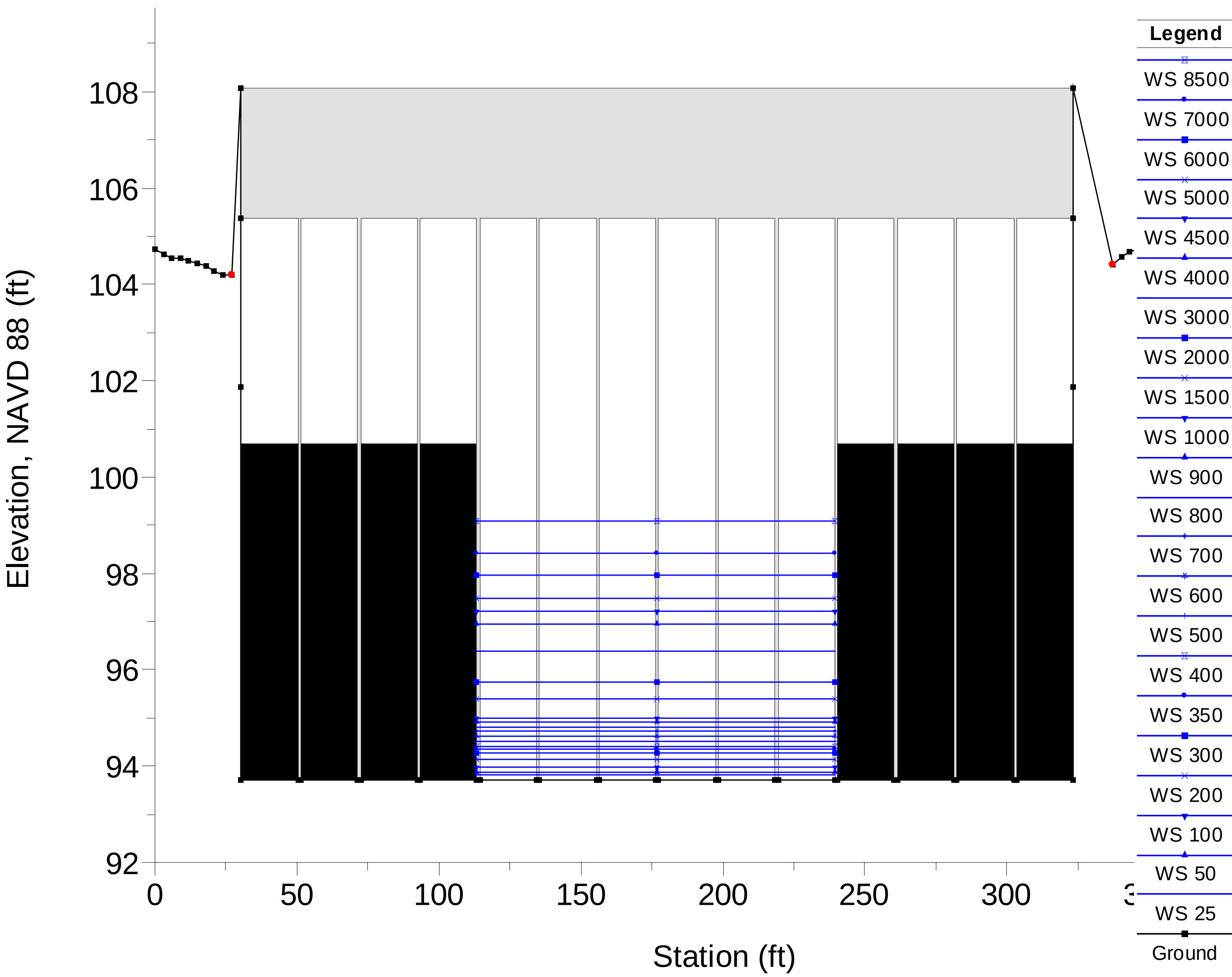
HEC-RAS MODEL SUMMARY TABLE

Results for flow at inlet

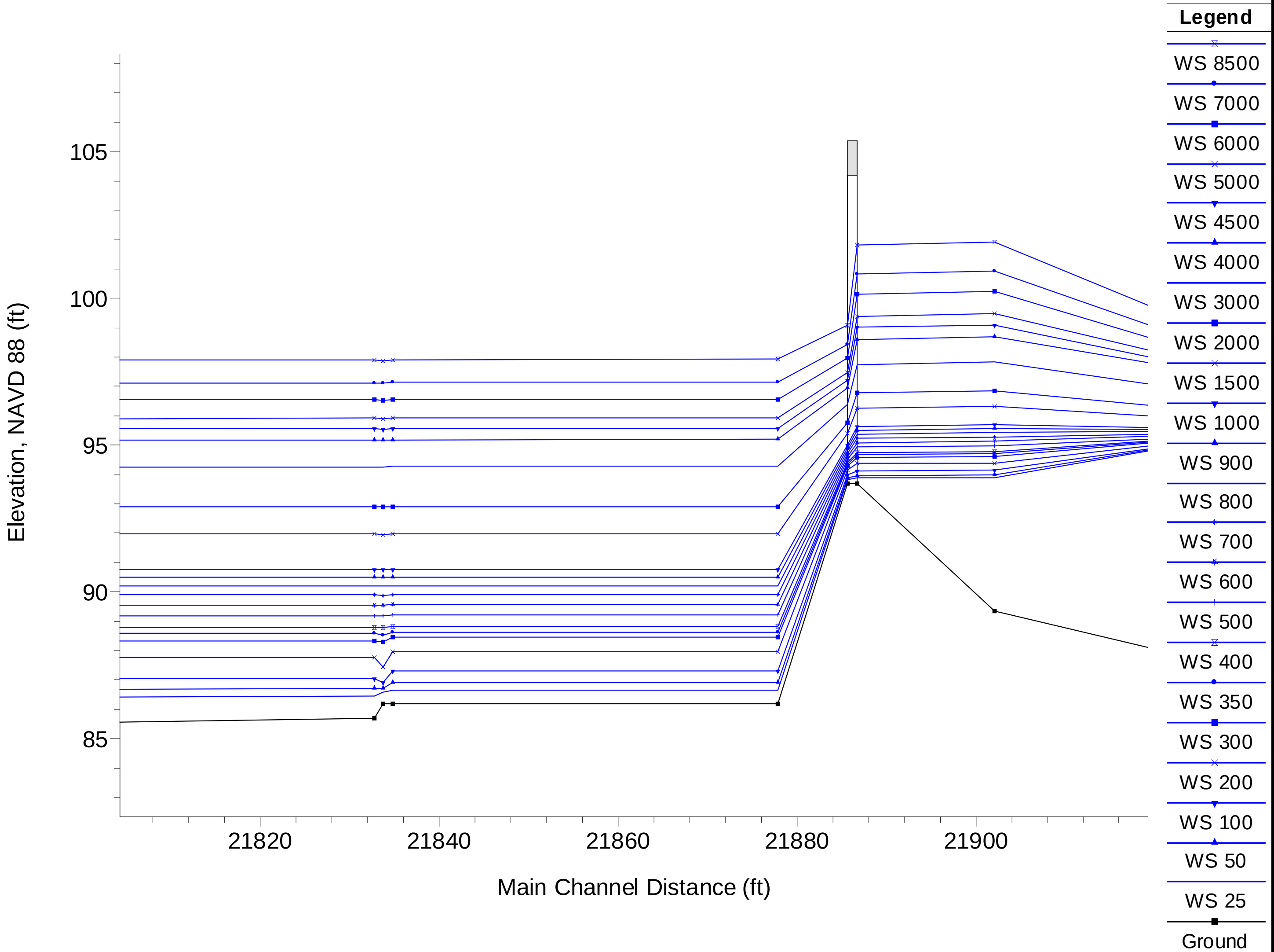
Flow	Maximum Depth	Channel Velocity	Maximum Water Surface Elevation Change
cfs	ft	fps	ft
25	0.1	2.0	7.2
50	0.2	2.4	7.1
100	0.3	3.0	6.8
200	0.4	3.8	6.4
300	0.6	4.3	6.1
350	0.6	4.5	6.1
400	0.7	4.7	5.9
500	0.8	5.1	5.7
600	0.9	5.5	5.5
700	1.0	5.7	5.3
800	1.1	6.0	5.2
900	1.2	6.2	5.0
1000	1.3	6.4	4.9
1500	1.7	7.4	4.3
2000	2.1	8.1	3.9
2500	2.4	8.7	3.6
3000	2.7	9.3	3.5
3500	3.0	9.8	3.4
4000	3.3	10.2	3.4
4500	3.5	10.6	3.4
5000	3.8	11.0	3.5
5500	4.0	11.4	3.5
6000	4.3	11.7	3.6
6500	4.5	12.0	3.6
7000	4.7	12.3	3.7
7500	5.0	12.6	3.7
8000	5.2	12.9	3.8
8500	5.4	13.2	3.9

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

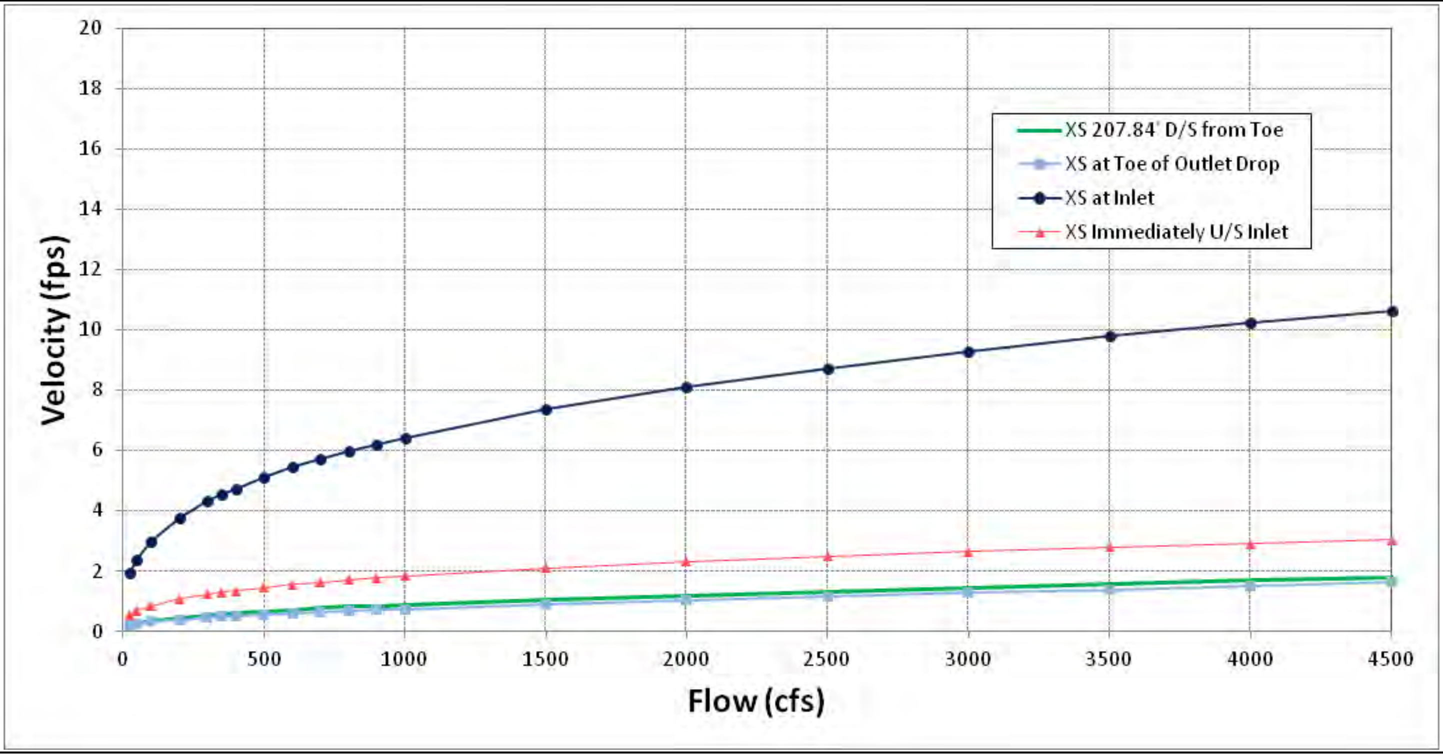
HEC-RAS MODEL CROSS SECTION AT BIFURCATION



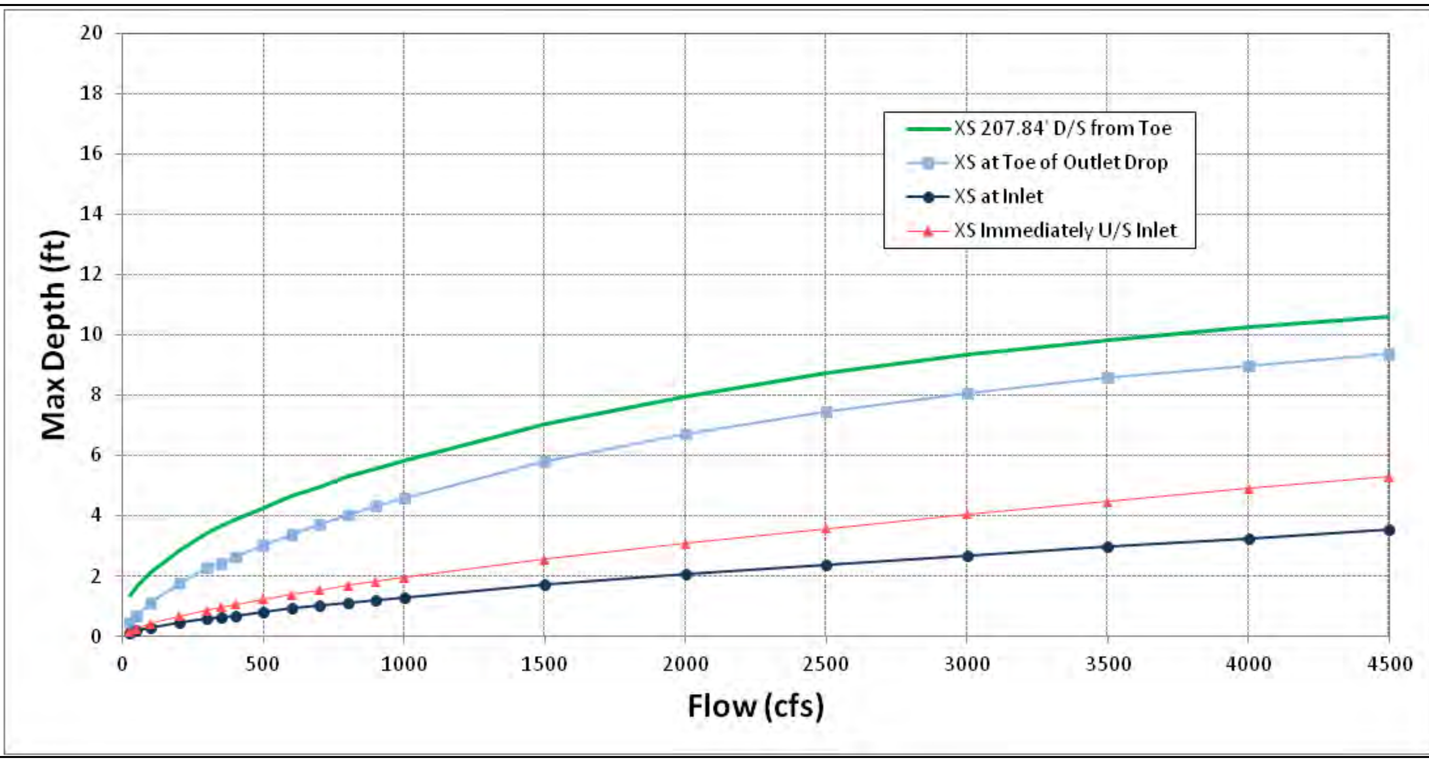
HEC-RAS MODEL BED AND WATER SURFACE PROFILE



HEC-RAS MODEL RESULTS



Velocity vs. Flow



Max Depth vs. Flow

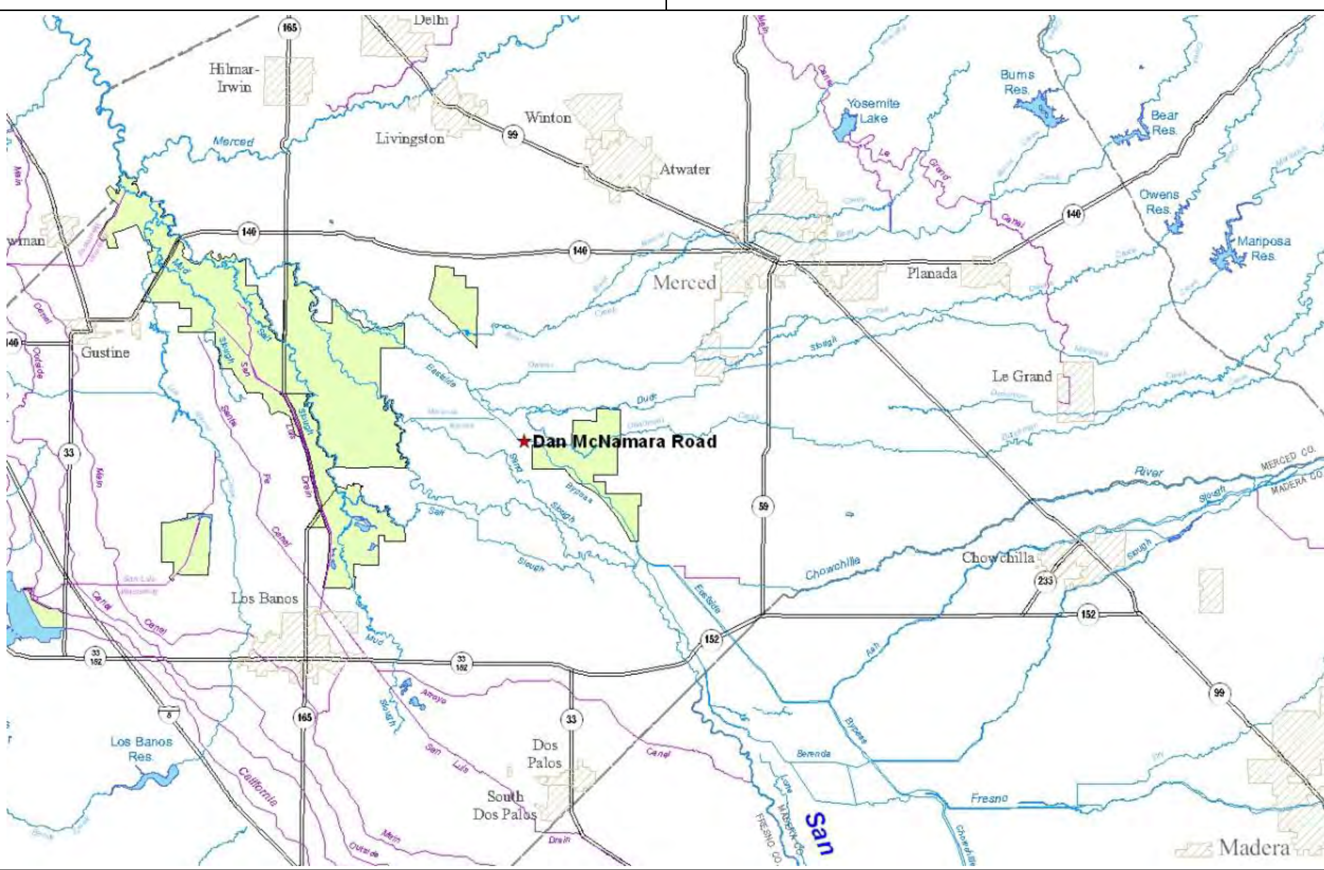
HEC-RAS MODEL METADATA

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

Summary

- Model - Flows through the Mariposa Bypass Control Structure were simulated using the HEC-RAS model developed by the US Bureau of Reclamation (RECLAMATION) and documented in *DRAFT Reach 4A Conveyance in the Vicinity of Sand Slough* Technical Report (April 21, 2011).
- Geometry - The model has updated topography and bathymetry to reflect current conditions. Structure elevations were based on the Task 2 topographic survey elevations. The structure has a total of 14 bays, 6 of which are located at the center and do not have gates. The model assumes that the bays with the gates are closed.
- Boundary Conditions – The downstream boundary condition for Mariposa Bypass Control Structure uses the rating curve from Reach 4B2 developed by RECLAMATION for their Sufficient Flow Study model.
- Calibration – The structure is not calibrated because no calibration flows could be collected.
- Flow Routing – Flows through Mariposa Bypass Control Structure are based on local flows that are routed through Mariposa Bypass from Eastside Bypass. The analyses performed assumed local flows that are actually flowing through the structure, and are not based on flood operations.

BEARINGS				
Site Name[13]: Dan McNamara Road		**I.D. Number[1]:** 51	**Reach:** 4A	
River Mile: EB 11.3	**Barrier Type[1]:** Crossing			**Rank[1]:** Gray



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

STRUCTURE DESCRIPTION

Dan McNamara Road is a cobble/gravel armored low flow crossing in the Eastside Bypass accessed from Sandy Mush Road (Photo 51_A). The road is publicly accessible, and at the time of the first pass survey the road was partially submerged. The road was not submerged during the second pass topography survey. The road width was measured at 50 feet with one culvert in the center of the channel. The crossing is an earthen embankment with a gravel armored top that averages about 1 foot height in the channel from the embankment toe to the top at the downstream. There is an incised channel at the culvert that has about 3 feet height at the culvert outlet. The bankfull channel width was measured at 175 feet. There was barbed wire fencing just upstream (Photo 51_B) and downstream of the crossing (Photo 51_C).

The culvert is a circular corrugated metal pipe that is located in the center of the crossing that measured 30 inches in diameter. The culvert length was measured at 50 feet with an inlet/outlet design with no apron. The culvert inlet and outlet is armored with cobble and concrete rip rap (Photo 51_D through F). There is another culvert in the upper floodplain for an overflow channel that is silted in (Photo 51 G).

Grazing is allowed in the channel upstream and downstream the crossing. Crayfish were observed in high numbers at the culvert during the second pass topographic survey.

<u>Photos:</u>

Photo 51_A. Dan McNamara Road when partially overtopped (Task 1)

Photo 51_B. Looking upstream from the crossing near the culvert inlet

Photo 51_C. Looking Downstream from the crossing at the culvert outlet.

Photo 51_D. Culvert outlet when road is submerged (Task 1)

Photo 51_E. Culvert inlet at flows less than 25 cfs

Photo 51_F. Culvert Outlet at flows less than 25 cfs

Photo 51_G. Culvert for overflow channel

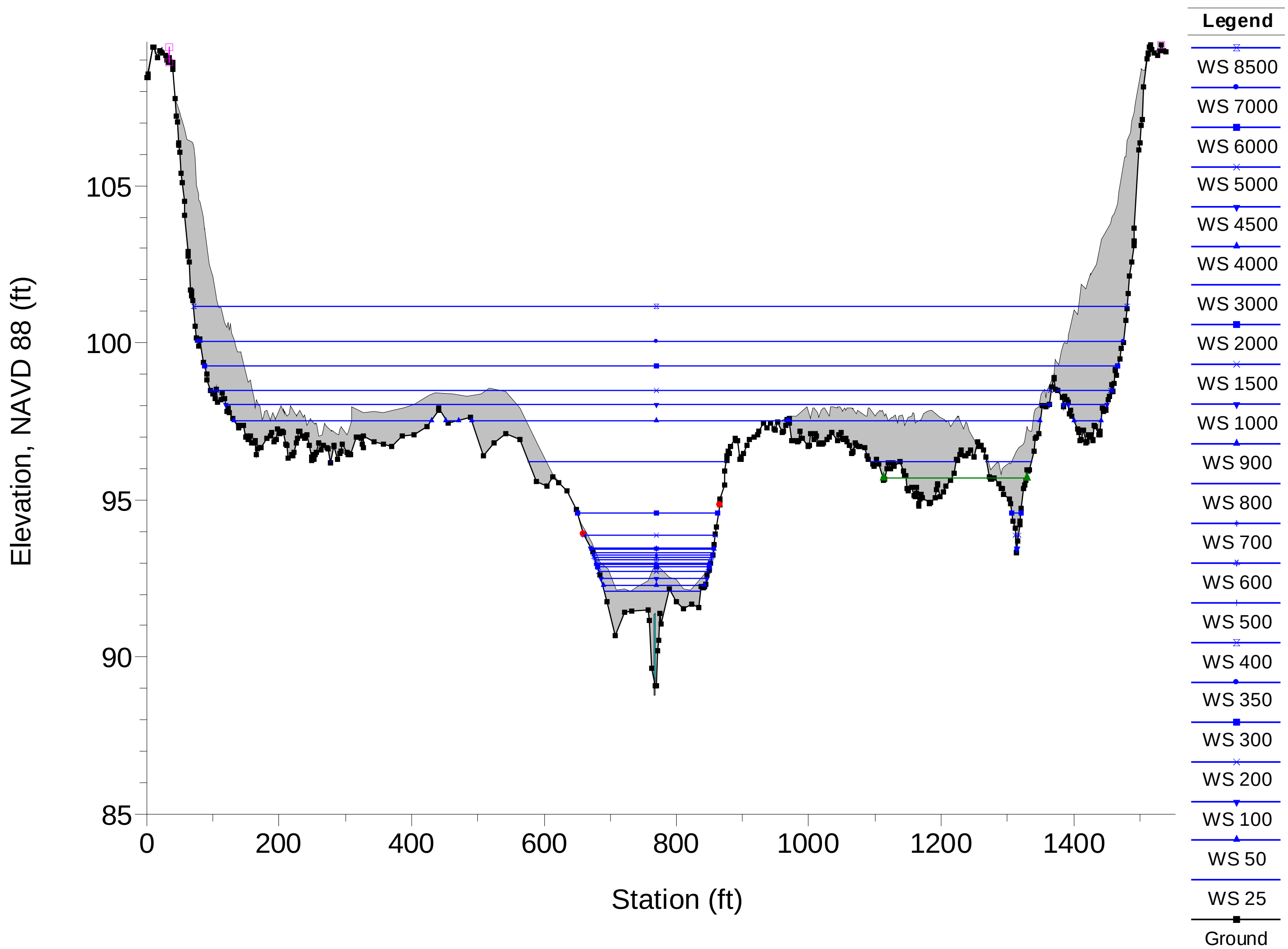
HEC-RAS MODEL SUMMARY TABLE

Results for Dan McNamara with boards-in at Eastside Bypass Control Structure (EB)

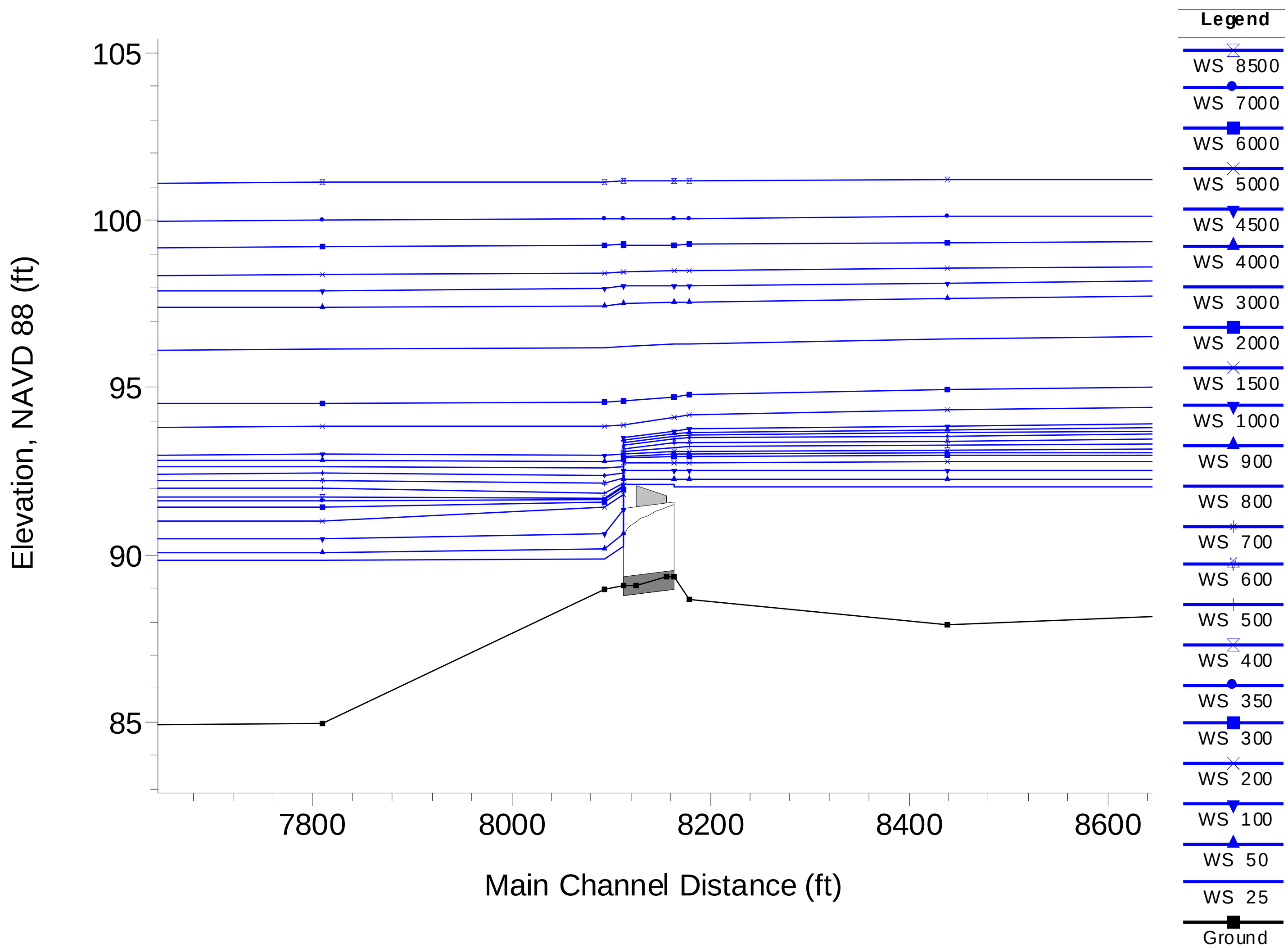
Flows	Weir Maximum Depth	Culvert Velocity		Cross Section Velocity Just U/S Culvert	Maximum Water Surface Elevation Change
		Inlet	Outlet		
cfs	ft	fps	fps	fps	ft
25	0.0	4.3	6.3	0.1	1.8
50	0.2	4.6	6.4	0.3	1.6
100	0.4	4.3	4.3	0.4	1.2
200	0.7	3.9	3.9	0.7	1.0
300	0.9	4.0	4.0	1.0	1.0
350	0.9	4.0	4.0	1.1	1.0
400	1.0	4.0	4.0	1.2	1.0
500	1.1	4.2	4.2	1.4	1.1
600	1.3	4.1	4.1	1.6	1.1
700	1.4	4.0	4.0	1.8	1.0
800	1.5	3.9	3.9	1.9	0.9
900	1.5	3.6	3.6	2.1	0.8
1000	1.7	3.5	3.5	2.2	0.7
1500	2.1	2.0	2.0	2.9	0.3
2000	2.6	1.4	1.4	3.1	0.1
2500	3.4	1.1	1.1	3.1	0.1
3000	4.2	1.1	1.1	3.0	0.1
3500	4.9	1.0	1.0	3.0	0.0
4000	5.4	0.2	0.2	2.9	0.0
4500	5.9	0.8	0.8	2.8	0.0
5000	6.4	0.7	0.7	2.6	0.0
5500	6.8	0.7	0.7	2.5	0.0
6000	7.2	0.6	0.6	2.5	0.0
6500	7.6	0.6	0.6	2.4	0.0
7000	7.9	0.6	0.6	2.3	0.0
7500	8.3	0.6	0.6	2.3	0.0
8000	8.7	0.6	0.6	2.2	0.0
8500	9.0	0.6	0.6	2.2	0.0

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

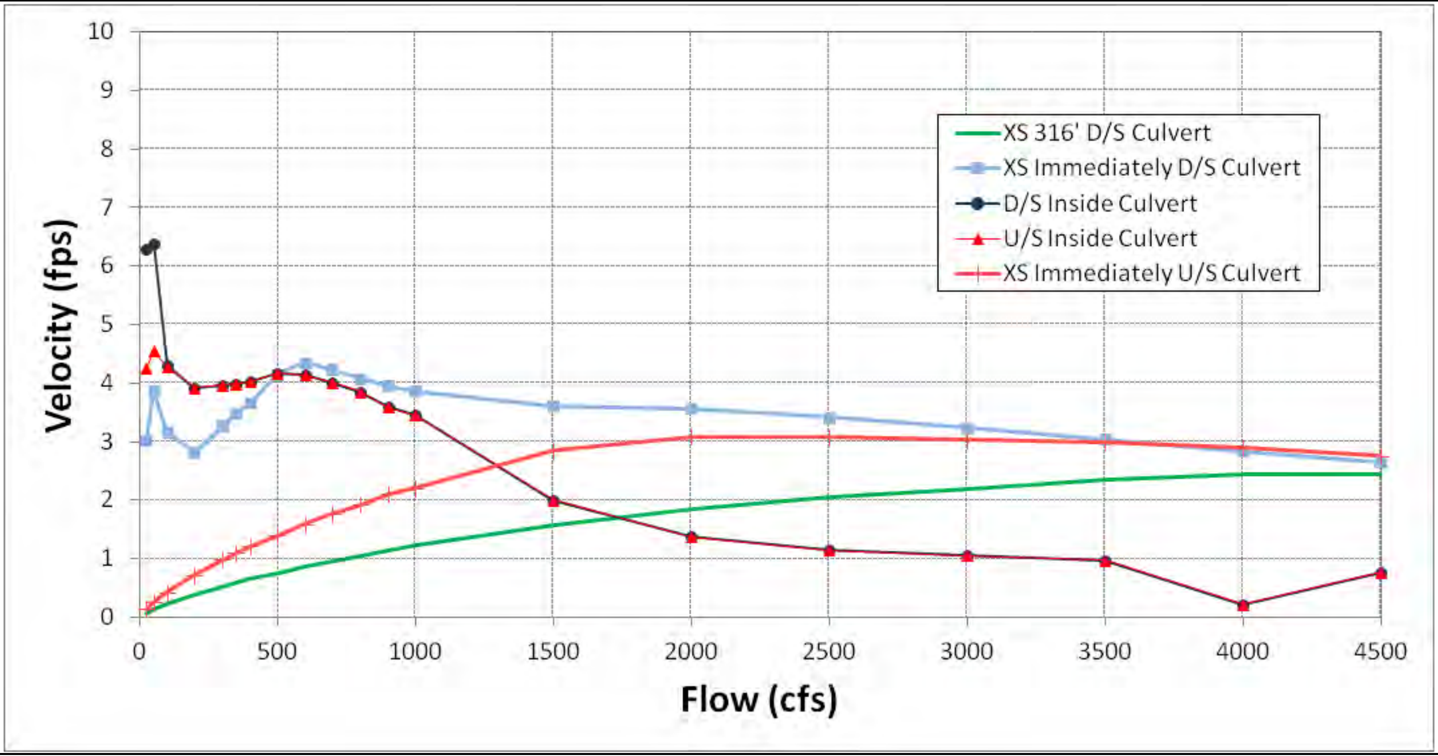
HEC-RAS MODEL CROSS SECTION AT CROSSING



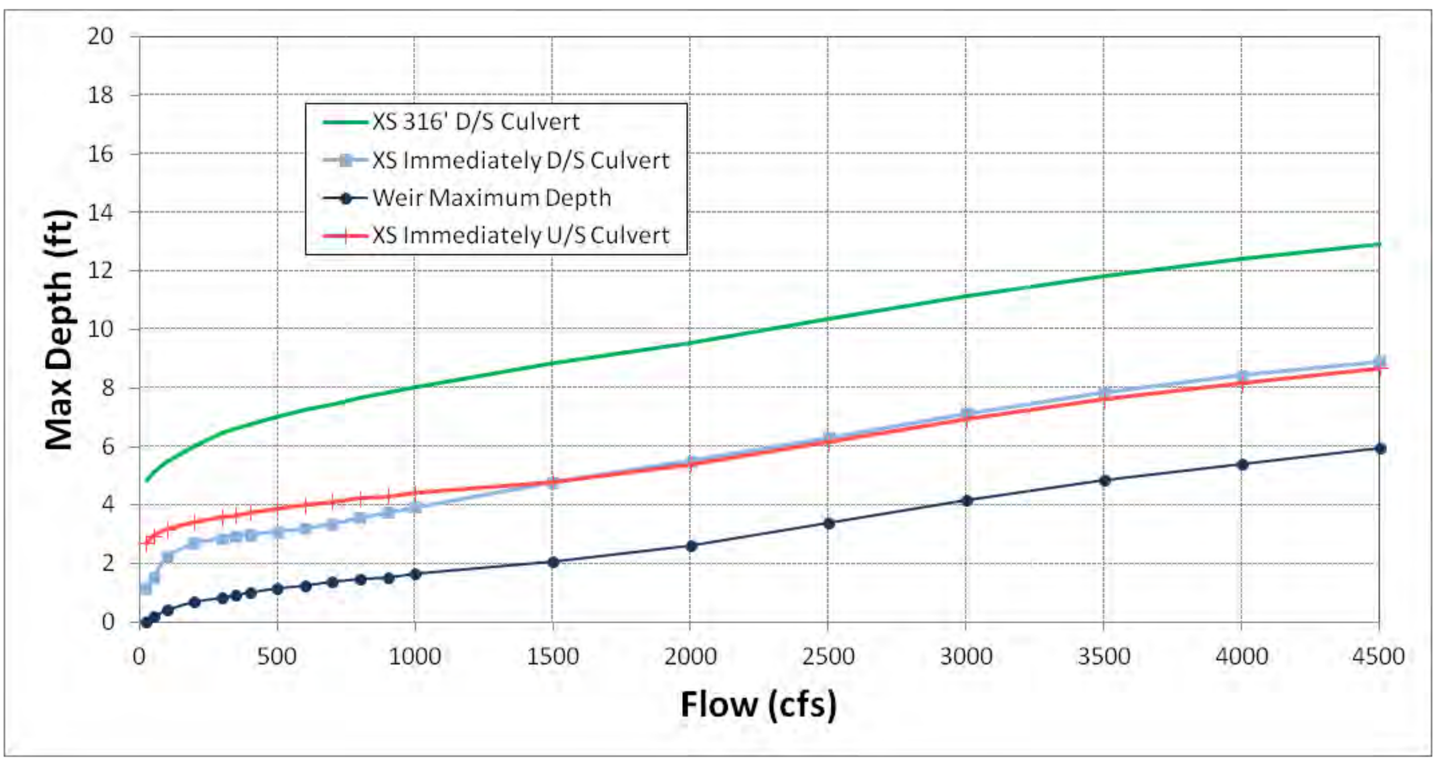
HEC-RAS MODEL BED AND WATER SURFACE PROFILE



HEC-RAS MODEL RESULTS (EB BOARDS-IN)

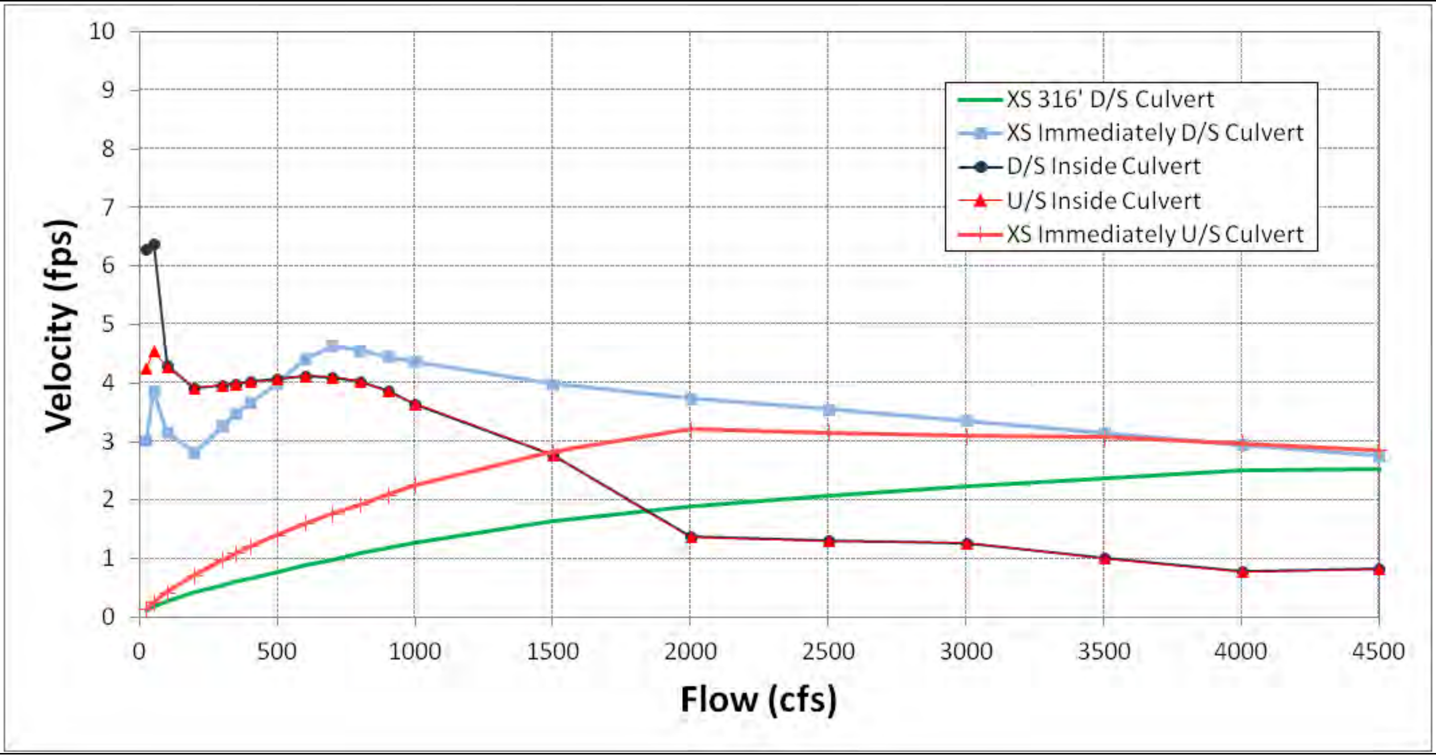


Velocity vs. Flow

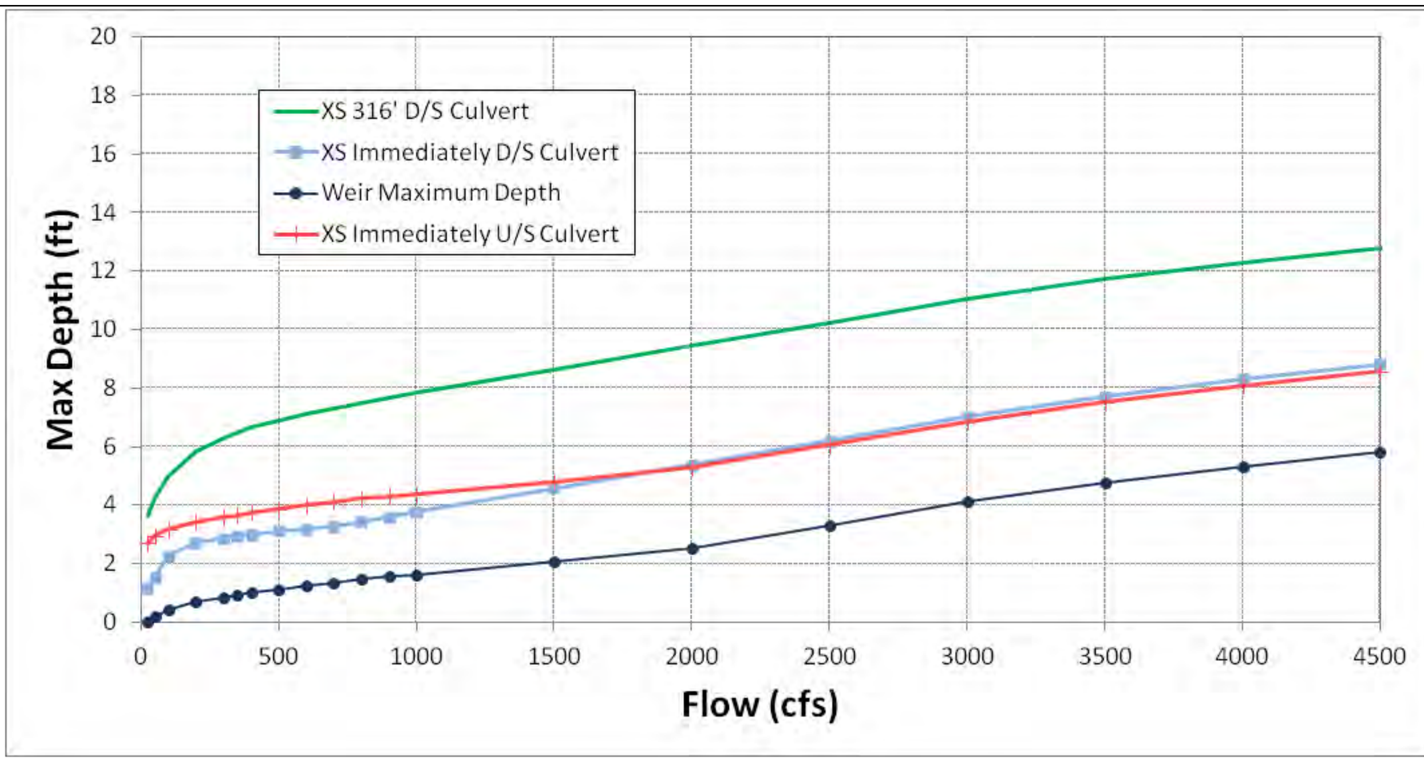


Max Depth vs. Flow

HEC-RAS MODEL RESULTS (EB BOARDS-OUT)



Velocity vs. Flow



Max Depth vs. Flow

HEC-RAS MODEL METADATA

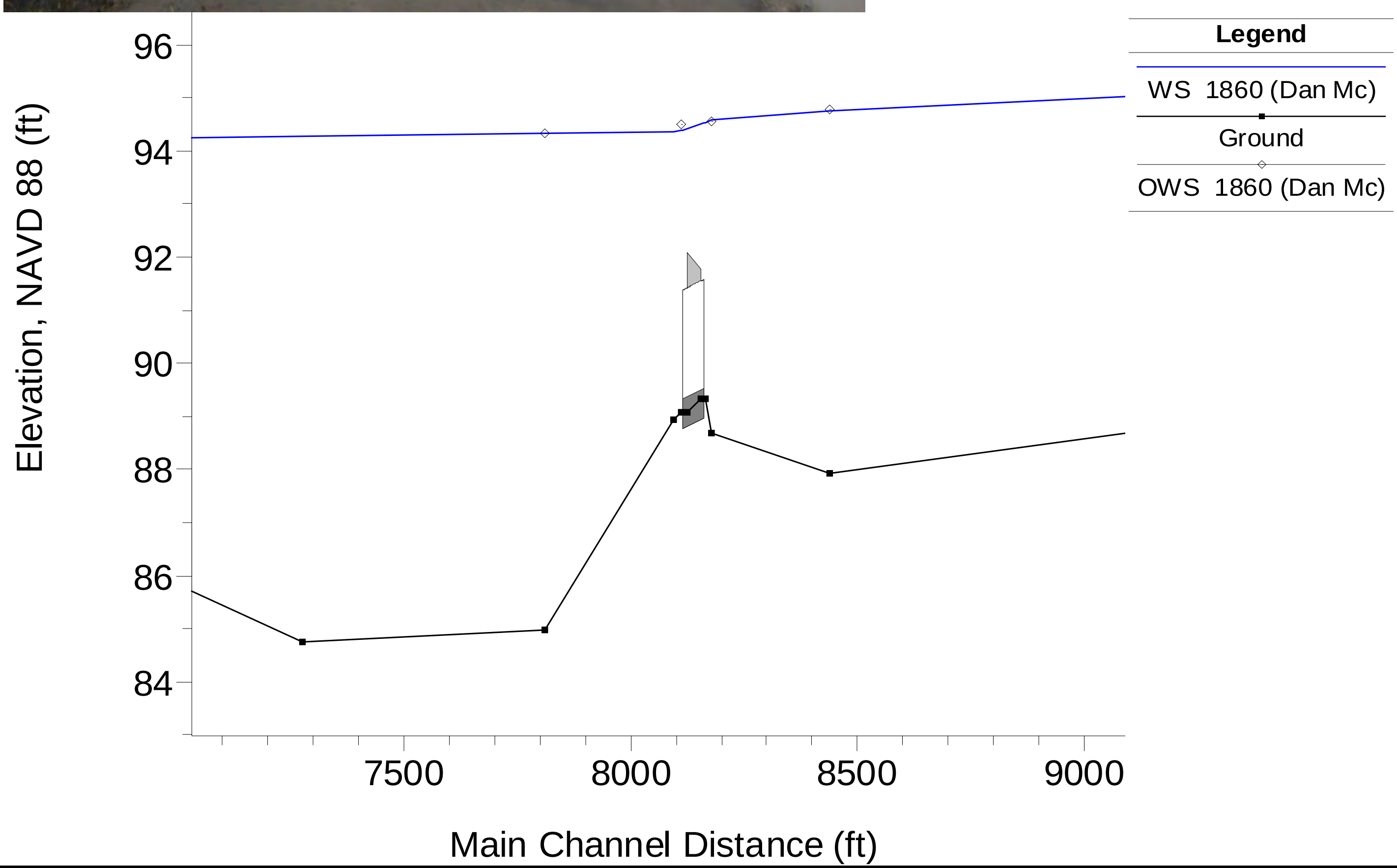
TOPOGRAPHY	
Year:	2008
Creator/Source:	Towill Inc.
Type:	LiDAR Topo
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)
BATHYMETRY	
Year:	2010/2011
Creator/Source:	DWR/RECLAMATION
Type:	ADCP Bathymetry
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)

Summary

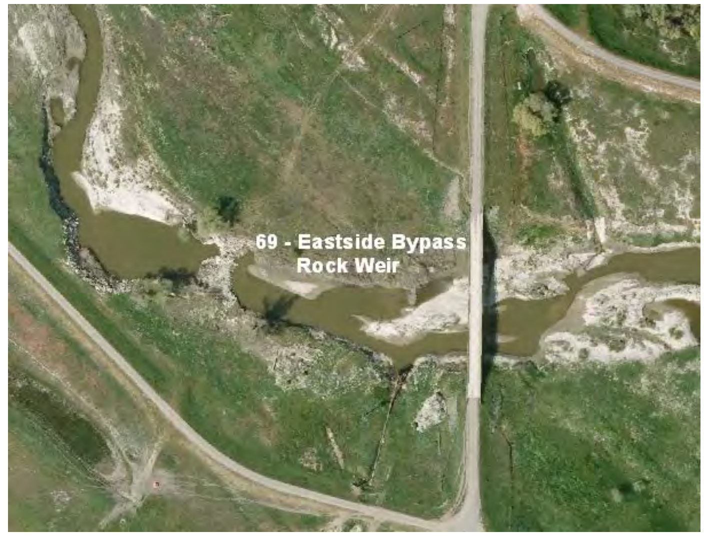
- Model - Flows through the structure were simulated using the HEC-RAS model developed by the US Bureau of Reclamation (RECLAMATION) and documented in *DRAFT Reach 4A Conveyance in the Vicinity of Sand Slough* Technical Report (April 21, 2011). The model was run under two scenarios: Boards-in and Boards-out at Eastside Bypass Bifurcation Structure to account for the extent of backwater effect.
- Geometry - The model has updated topography and bathymetry to reflect current conditions. The culvert and road crossing data were collected by DWR during Task 2 topographic survey and were incorporated into the model.
- Boundary Conditions – The model assumes a normal depth for the downstream boundary condition at Lower Eastside Bypass.
- Calibration – The model was calibrated using the flow data collected by DWR on May 19, 2011, the flow was measured to be 1,860 cfs through the structure. The model water surface elevations were compared to the water surface elevations from the 2011 Task 2 flow monitoring data and were within +/- 0.5'.

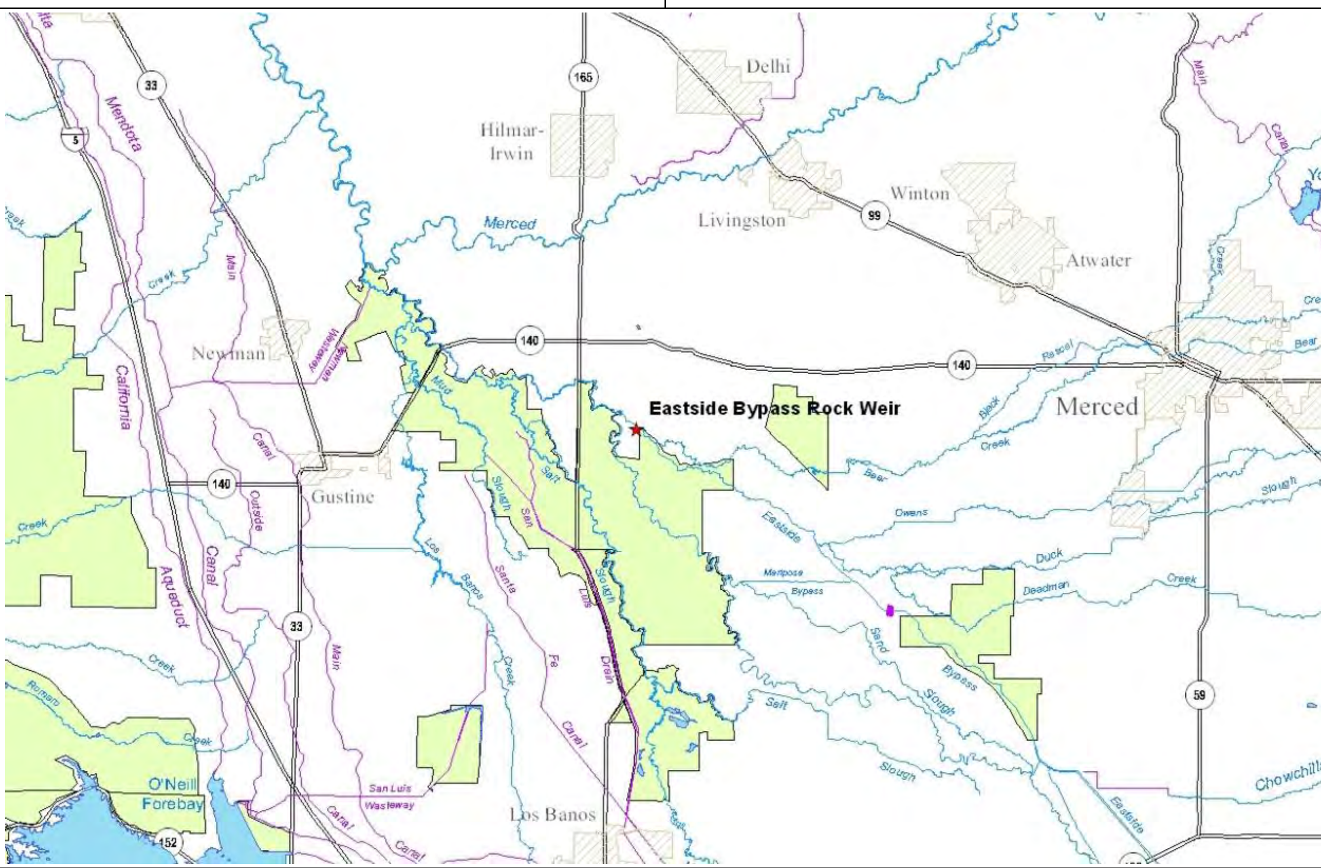
MODEL CALIBRATION

Date: May 19, 2011	**Flow (cfs):** 1,860	**Mean Velocity (ft/s):** 2.29



BEARINGS			
Site Name[14]: Eastside Bypass Rock Weir	**I.D. Number[1]:** 69	**Reach:** 4B2	
River Mile:	**Barrier Type[1]:** Weir		**Rank[1]:** Gray





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

STRUCTURE DESCRIPTION

The weir is located on private property within the Eastside Bypass near the San Luis Wildlife Refuge. The rock weir is mostly constructed of large concrete debris with some rebar and asphalt. The weir appears to be acting as a grade control structure to provide back water for a pump upstream. The weir was estimated during Task 1 to have a minimum four foot drop with a length of 40 feet and span of 90 feet. During the Task 2 topographic survey the weir height varied between 4 and 8 feet. The weir cannot be bypassed and is located within the main channel of the Eastside Bypass.

Photos:

Photo 69_A. Rock weir from downstream looking upstream

Photo 69_B. Rock weir from upstream looking downstream

HEC-RAS MODEL SUMMARY TABLE

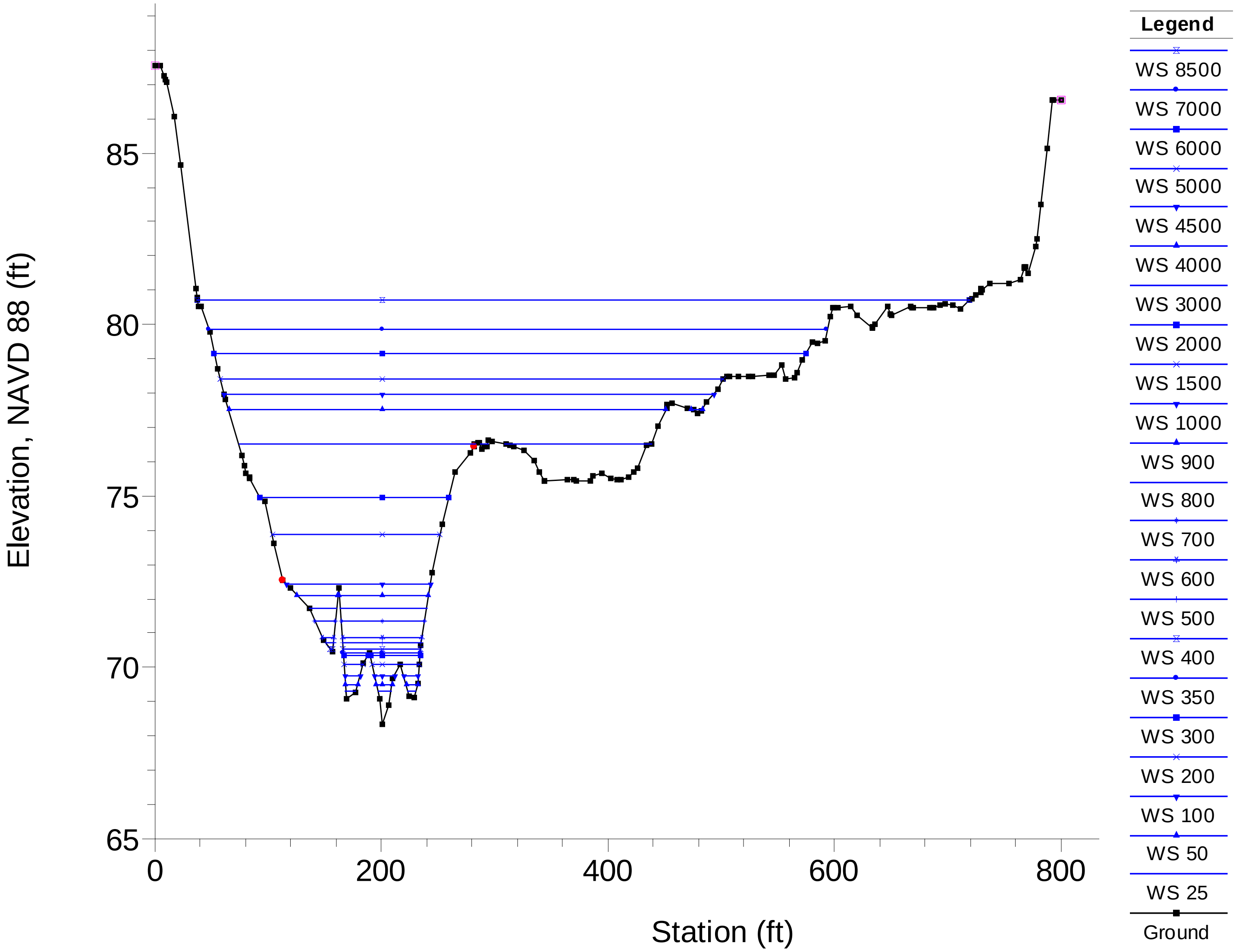
Results for flow over weir

Flow	Maximum Depth	Channel Velocity	Maximum Water Surface Elevation Change
cfs	ft	fps	ft
25	1.0	3.1	3.6
50	1.2	3.6	3.6
100	1.4	4.2	3.3
200	1.8	4.8	2.6
300	2.0	5.3	2.4
350	2.1	5.5	2.2
400	2.2	5.7	2.1
500	2.4	6.0	1.9
600	2.5	6.2	1.7
700	3.0	5.1	1.5
800	3.4	4.6	1.3
900	3.7	4.2	1.1
1000	4.1	4.0	0.9
1500	5.5	3.3	0.4
2000	6.6	3.3	0.3
2500	7.6	3.1	0.2
3000	8.2	3.2	0.2
3500	8.7	3.1	0.2
4000	9.2	3.1	0.2
4500	9.6	3.1	0.2
5000	10.1	3.0	0.2
5500	10.5	3.0	0.2
6000	10.8	3.0	0.2
6500	11.2	3.0	0.2
7000	11.5	3.0	0.1
7500	11.8	2.9	0.2
8000	12.1	2.9	0.2
8500	12.4	3.1	0.2

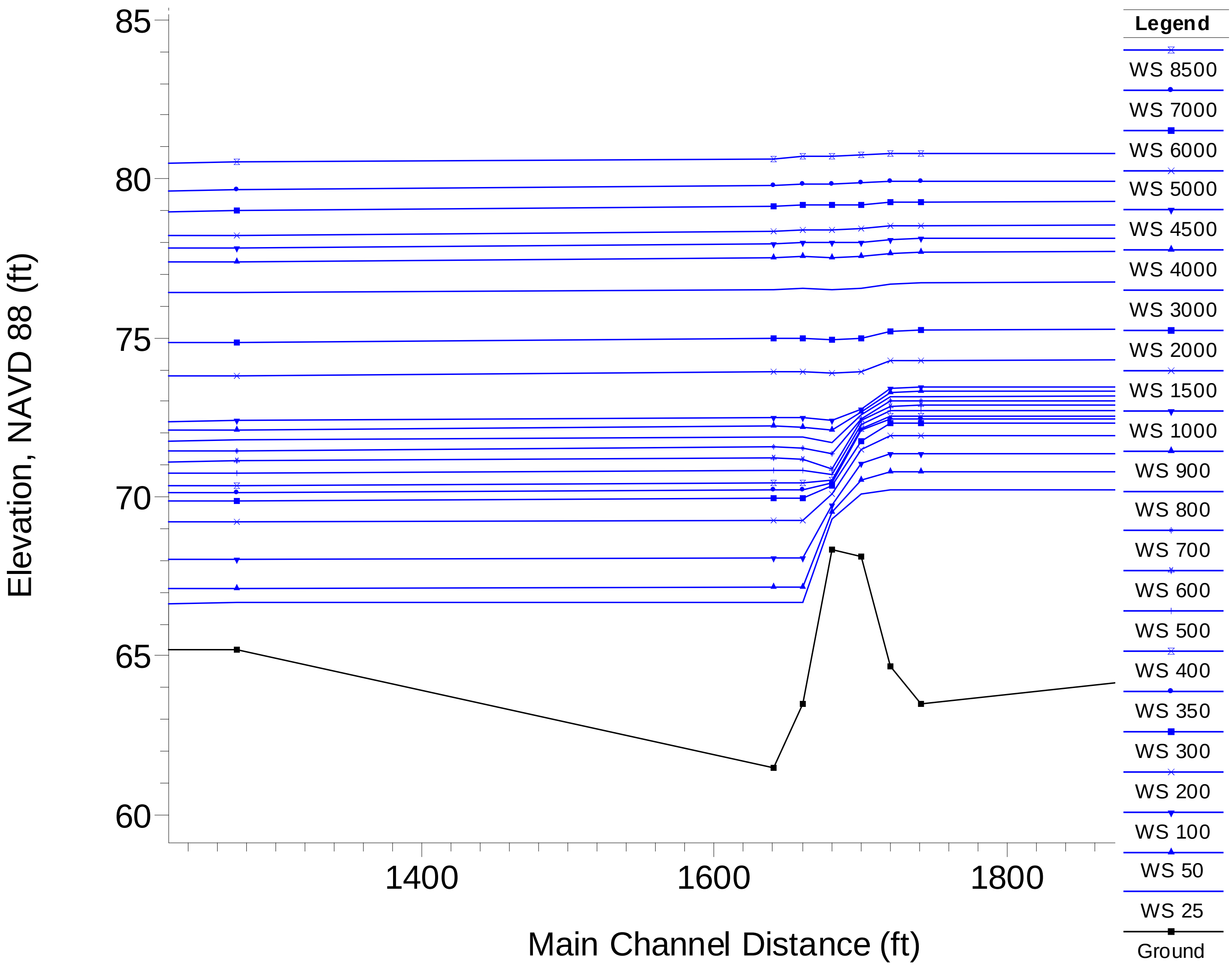
The maximum water surface elevation change was estimated based on the difference between the cross sections immediately upstream and downstream the weir.

SAN JOAQUIN RIVER RESTORATION PROGRAM
TASK 2 EVALUATION RESULTS
EASTSIDE BYPASS ROCK WEIR

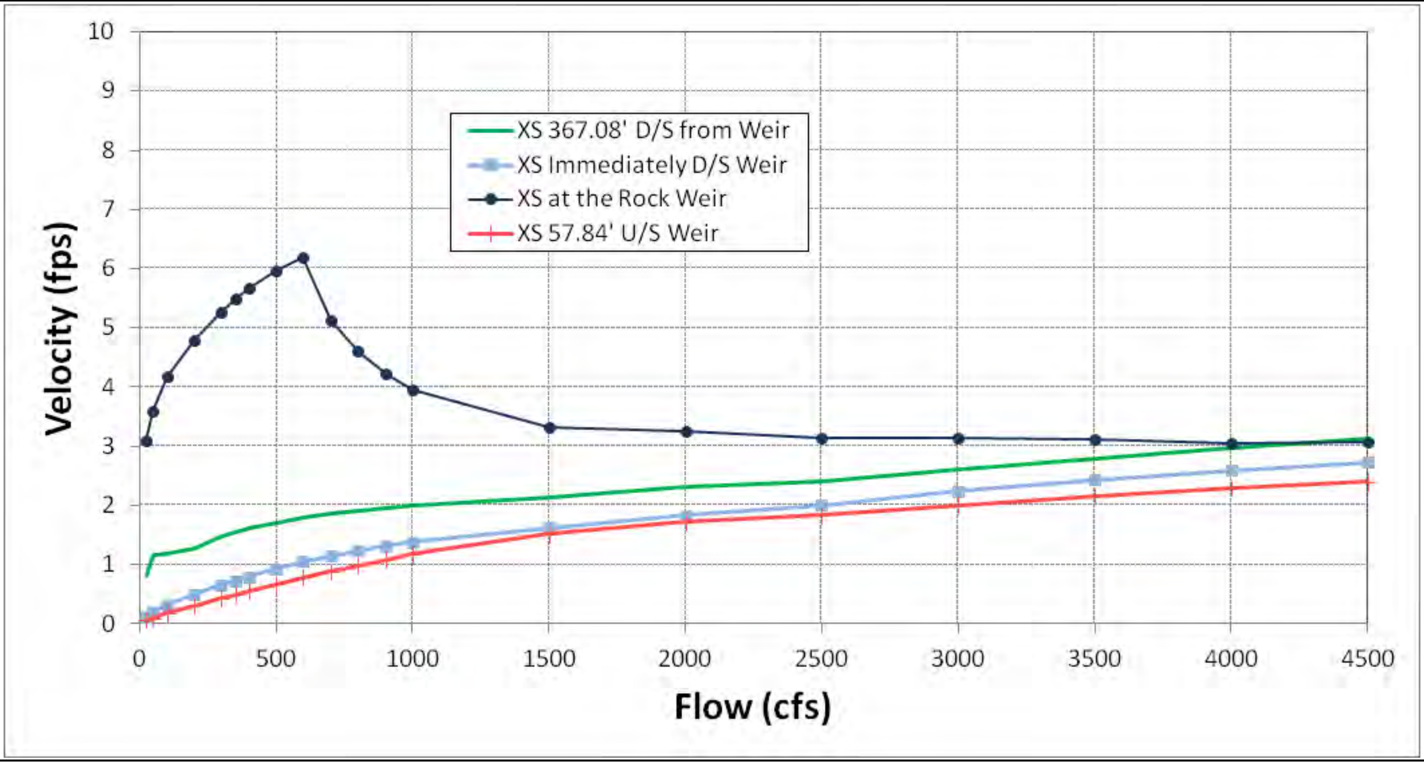
HEC-RAS MODEL CROSS SECTION AT WEIR



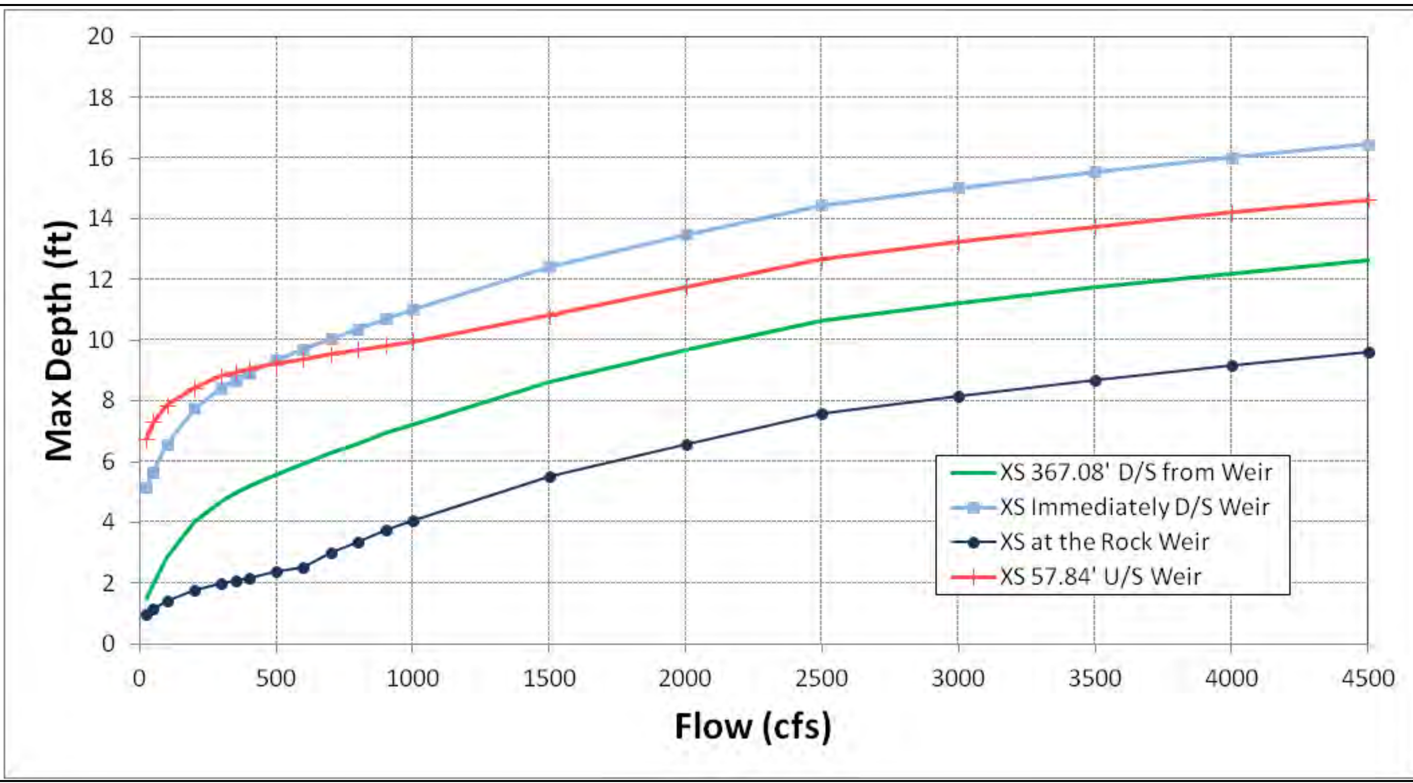
HEC-RAS MODEL BED AND WATER SURFACE PROFILE



HEC-RAS MODEL RESULTS



Velocity vs. Flow



Max Depth vs. Flow

HEC-RAS MODEL METADATA

TOPOGRAPHY	
Year:	2008
Creator/Source:	Towill Inc.
Type:	LiDAR Topo
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)
BATHYMETRY	
Year:	2011
Creator/Source:	DWR, Ayres Associates
Type:	ADCP/Surveyed Bathymetry
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)

Summary

- Model - Flows through the Eastside Bypass Rock Weir were simulated using a localized HEC-RAS model of the structure.
- Geometry - The model was developed by adding new cross sections at the structure using Task 2 topographic surveys, ADCP bathymetry, and 2008 LiDAR. Elevations at some channel cross sections were supplemented using the 1998/1999 Ayres Bathymetry (converted from NGVD 1929 to NAVD 1988).
- Boundary Conditions – The model assumes a normal depth for the downstream boundary condition.
- Calibration – The model was calibrated using the flow data collected by DWR on July 7, 2011, the flow was measured to be 1,840 cfs through the structure. The model water surface elevations were compared to the water surface elevations from the 2011 Task 2 flow monitoring data and were within +/- 0.5'.

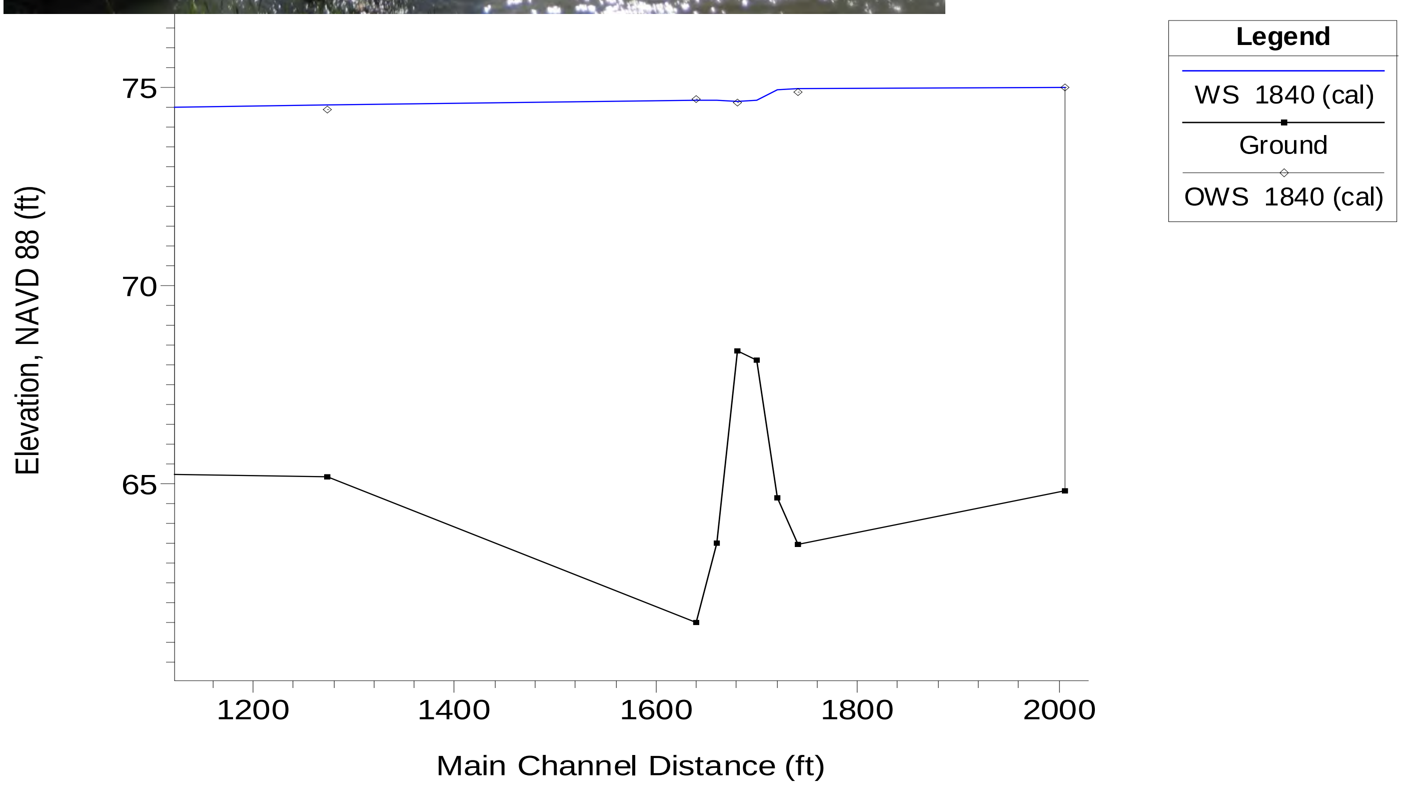
SAN JOAQUIN RIVER RESTORATION PROGRAM

TASK 2 EVALUATION RESULTS

EASTSIDE BYPASS ROCK WEIR

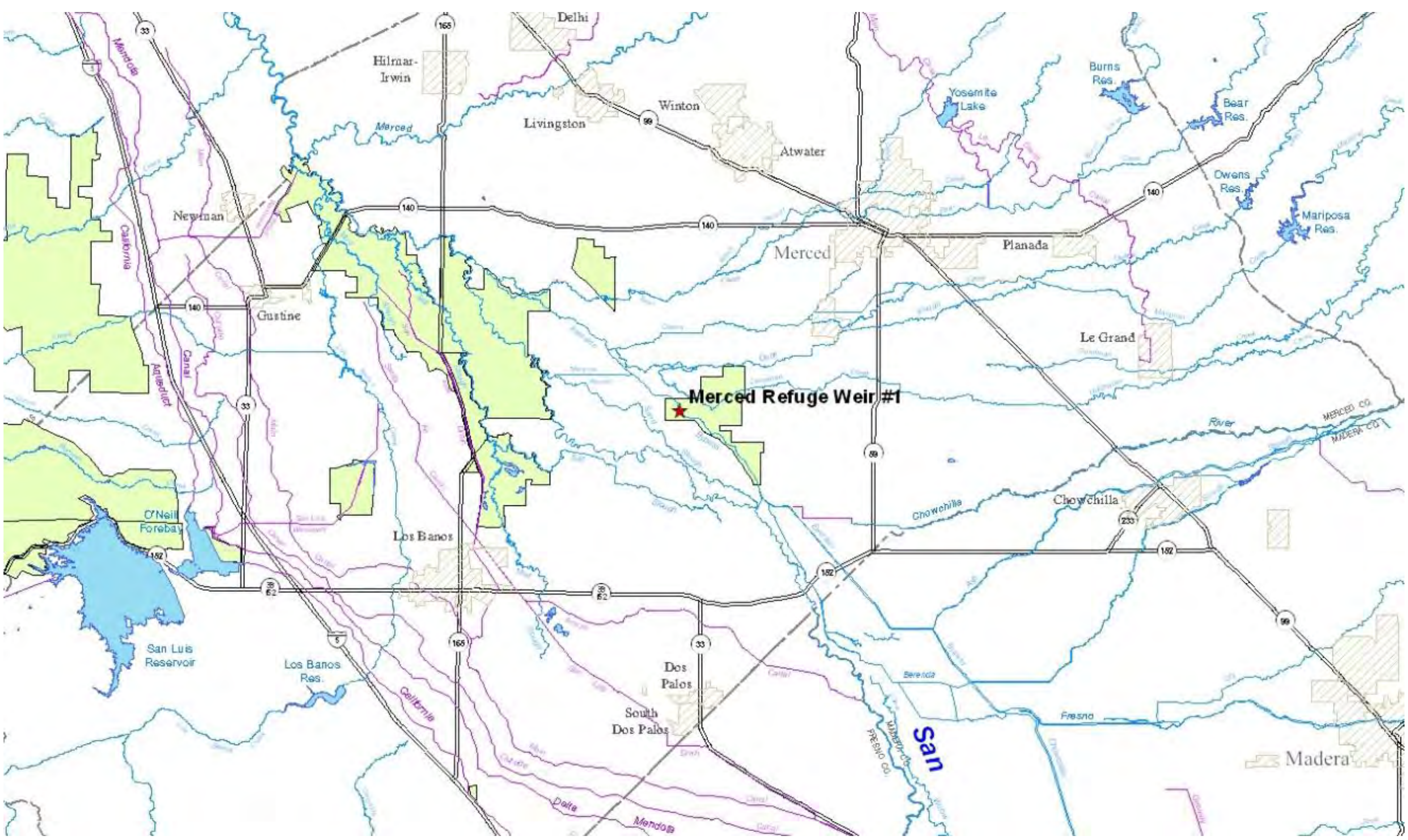
MODEL CALIBRATION

Date: July 7, 2011	**Flow (cfs):** 1,840	**Mean Velocity (ft/s):** 1.82



BEARINGS

Site Name[15]: Merced Refuge Weir #1	**I.D. Number[1]:** 71	**Reach:** EB	
River Mile:	**Barrier Type[1]:** Weir		**Rank[1]:**



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

STRUCTURE DESCRIPTION

The Merced Refuge Weir is located in the Eastside Bypass within the Merced National Wildlife Refuge (Photo 70_A). The weir is used to divert flows from the Eastside Bypass to the Refuge. In order to divert flows boards (stop logs) are installed to raise the water surface elevations in the pool upstream the weir (Photo 70_C). The weir total height is about 6.5 feet and is capped by a metal grate for access while installing the stop logs. The stop logs are located on the upstream side of the weir and are able to be installed up to an elevation of 100.0 feet or a height of 6 feet. The weir has 14 bays that average a width of 4.5 feet. There is a concrete apron for a distance of about 6 feet that has a short 1 foot tall 10 inches wide sill at the outlet of the apron. The weir has a hardened cobble levee on the left bank and right bank (Photo 70_B).

Photos:

Photo 70_A. Weir, upstream looking downstream

Photo 70_B. Upstream looking downstream from cobble levee

Photo 70_C. Metal grate catwalk with stop logs

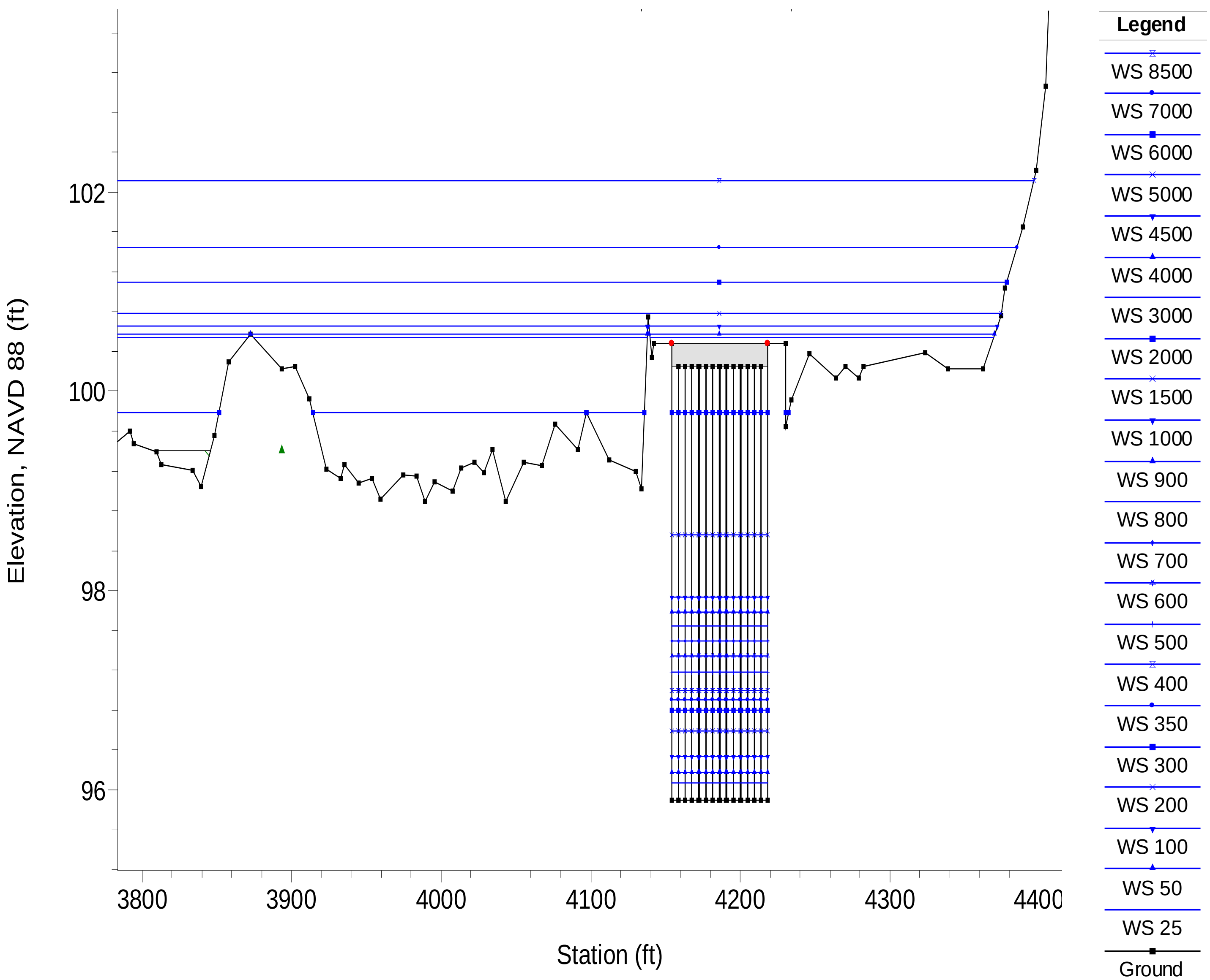
HEC-RAS MODEL SUMMARY TABLE

Merced Refuge Weir Boards Out (Default)

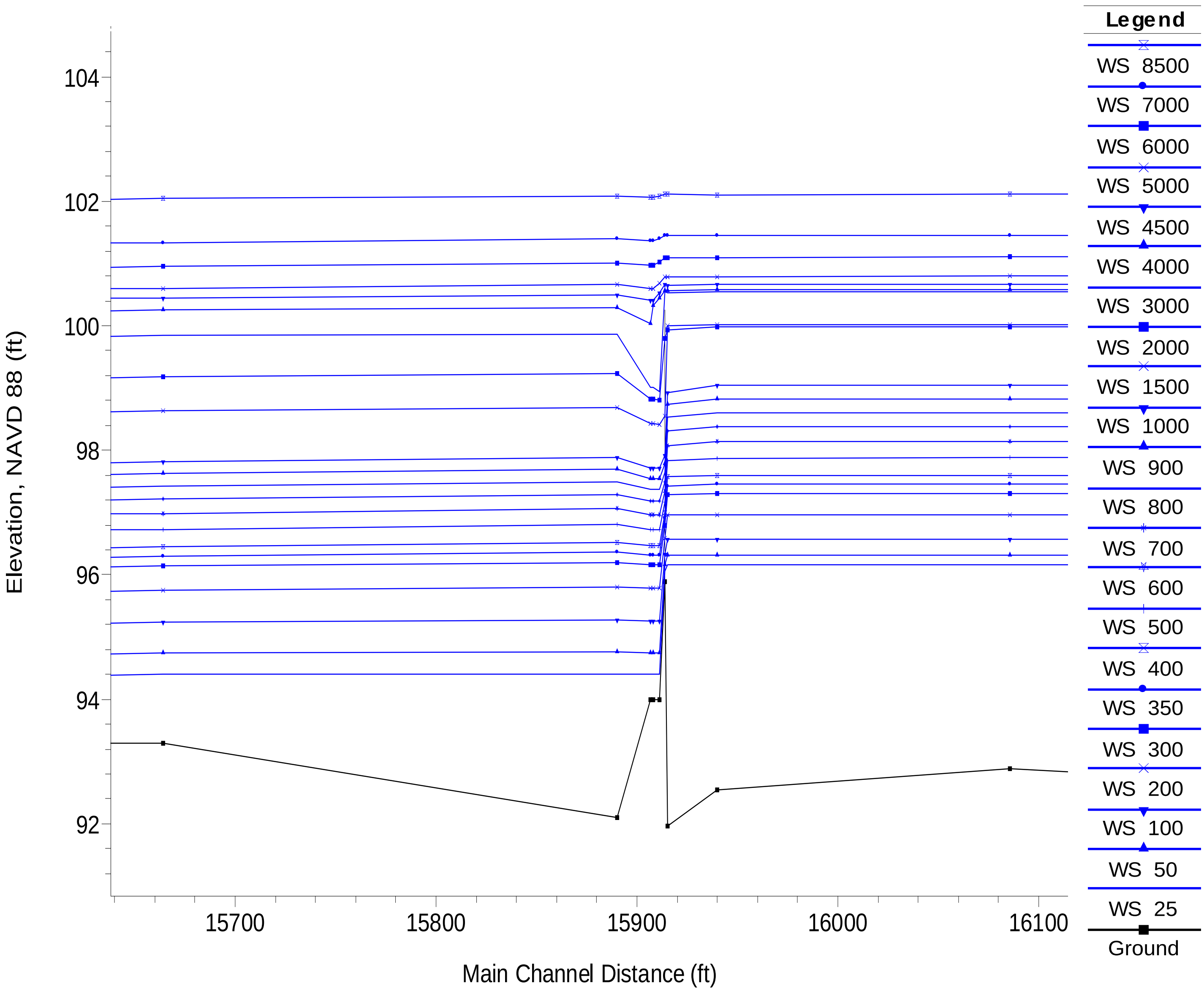
Flow	Maximum Depth	Channel Velocity	Maximum Water Surface Elevation Change
cfs	ft	fps	ft
25	0.2	0.2	1.8
50	0.3	0.3	1.6
100	0.4	0.4	1.3
200	0.7	0.7	1.2
300	0.9	0.9	1.1
350	1.0	1.0	1.1
400	1.1	1.1	1.1
500	1.3	1.3	1.1
600	1.5	1.5	1.1
700	1.6	1.6	1.1
800	1.8	1.8	1.2
900	1.9	1.9	1.2
1000	2.0	2.0	1.2
1500	2.7	2.7	1.6
2000	3.9	3.9	1.1
2500	4.1	4.1	1.0
3000	4.2	4.7	1.6
4000	4.2	4.7	0.1
4500	4.3	4.8	0.1
5000	4.5	4.9	0.1
5500	4.6	5.1	0.1
6000	4.8	5.2	0.1
6500	4.9	5.4	0.1
7000	5.1	5.6	0.0
7500	5.3	5.8	0.0
8000	5.5	6.0	0.0
8500	5.8	6.2	0.0

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.

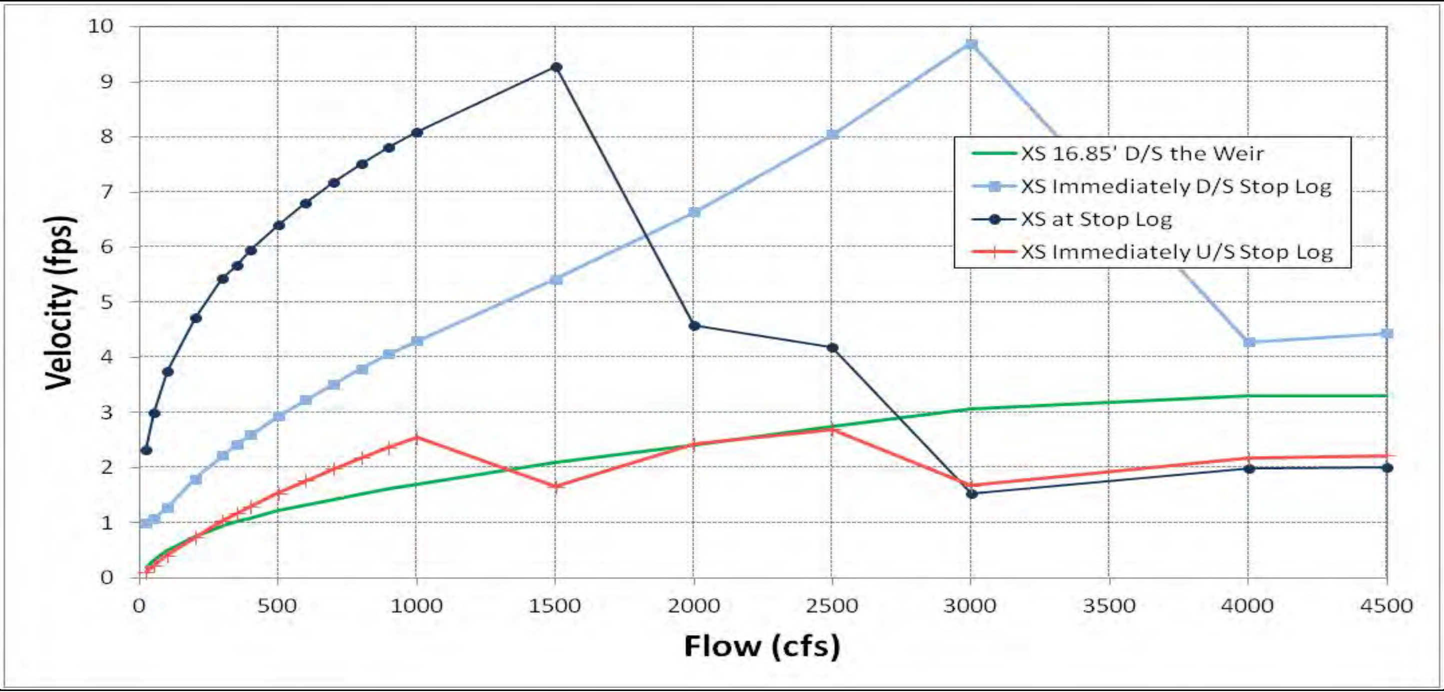
HEC-RAS MODEL STRUCTURE CROSS SECTION



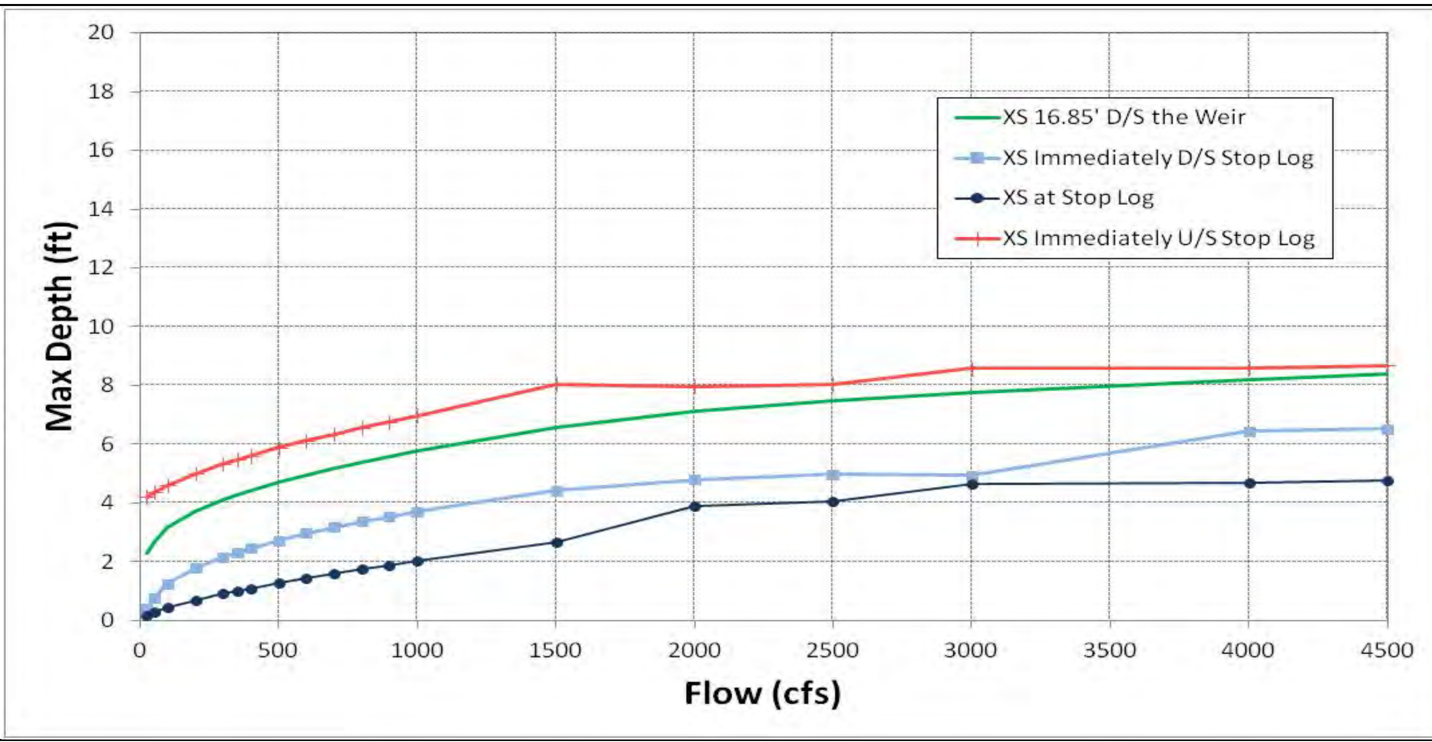
HEC-RAS MODEL BED AND WATER SURFACE PROFILE



HEC-RAS FLOW MODEL RESULTS BOARDS OUT (DEFAULT)

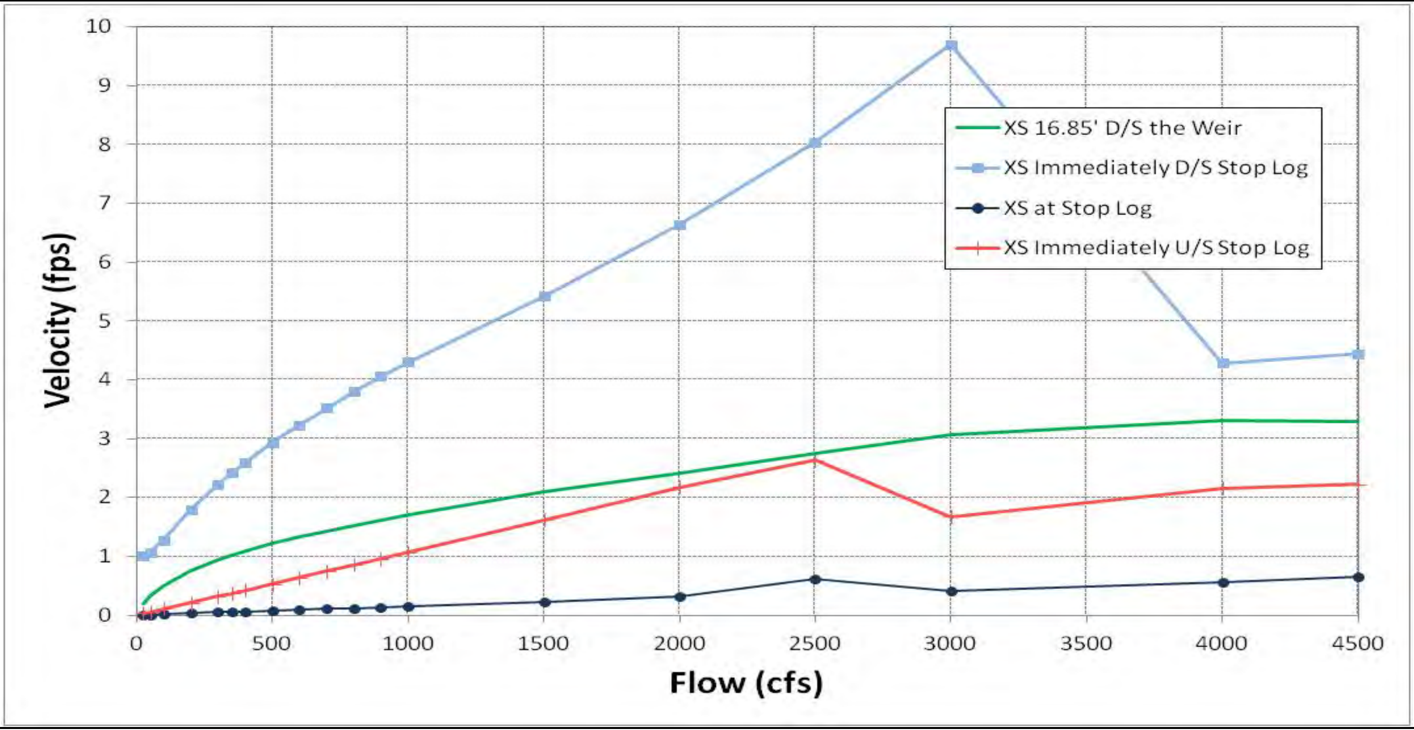


Velocity vs. Flow

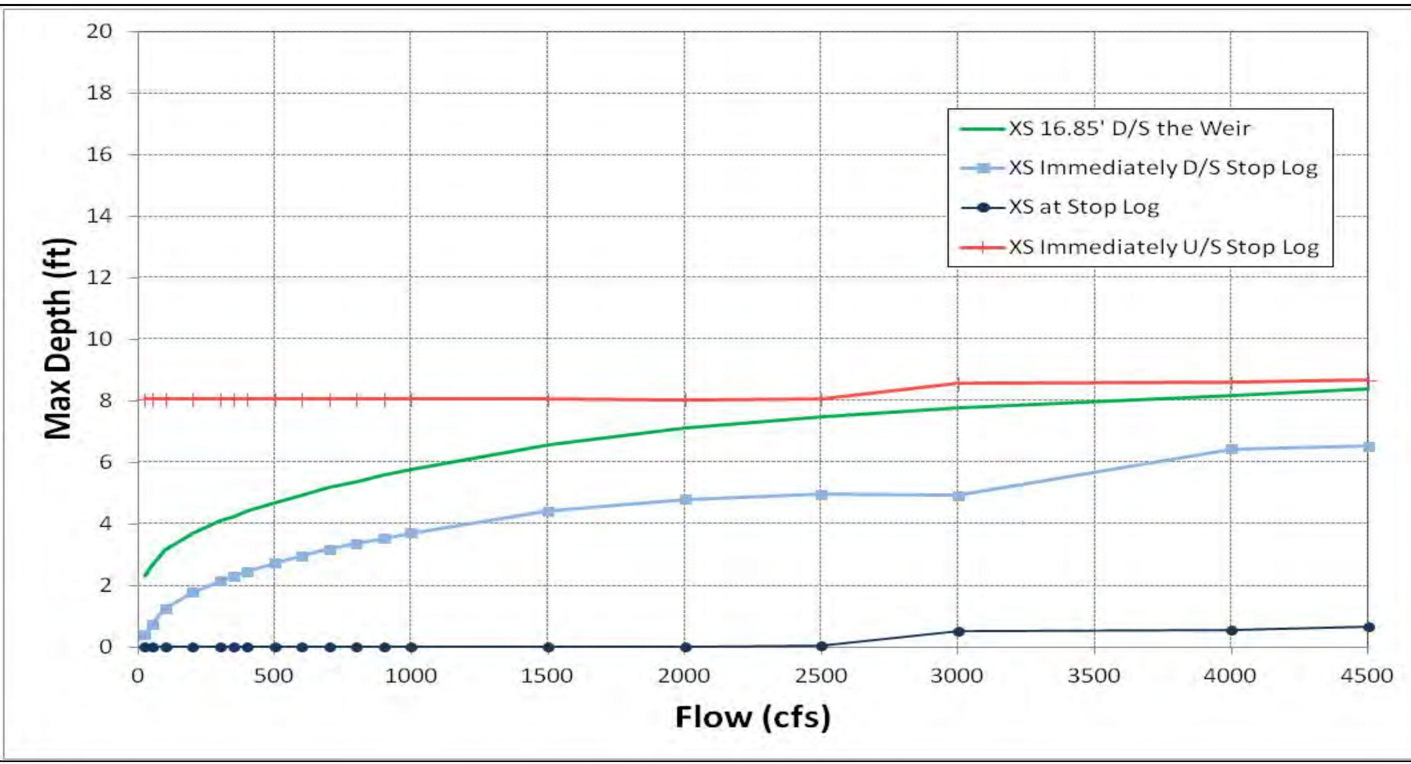


Max Depth vs. Flow

HEC-RAS FLOW MODEL RESULTS BOARDS-IN



Velocity vs. Flow



Max Depth vs. Flow

HEC-RAS FLOW MODEL METADATA

TOPOGRAPHY	
Year:	2008
Creator/Source:	Towill Inc.
Type:	LiDAR Topo
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)
BATHYMETRY	
Year:	2010/2011
Creator/Source:	RECLAMATION
Type:	ADCP Bathymetry
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)

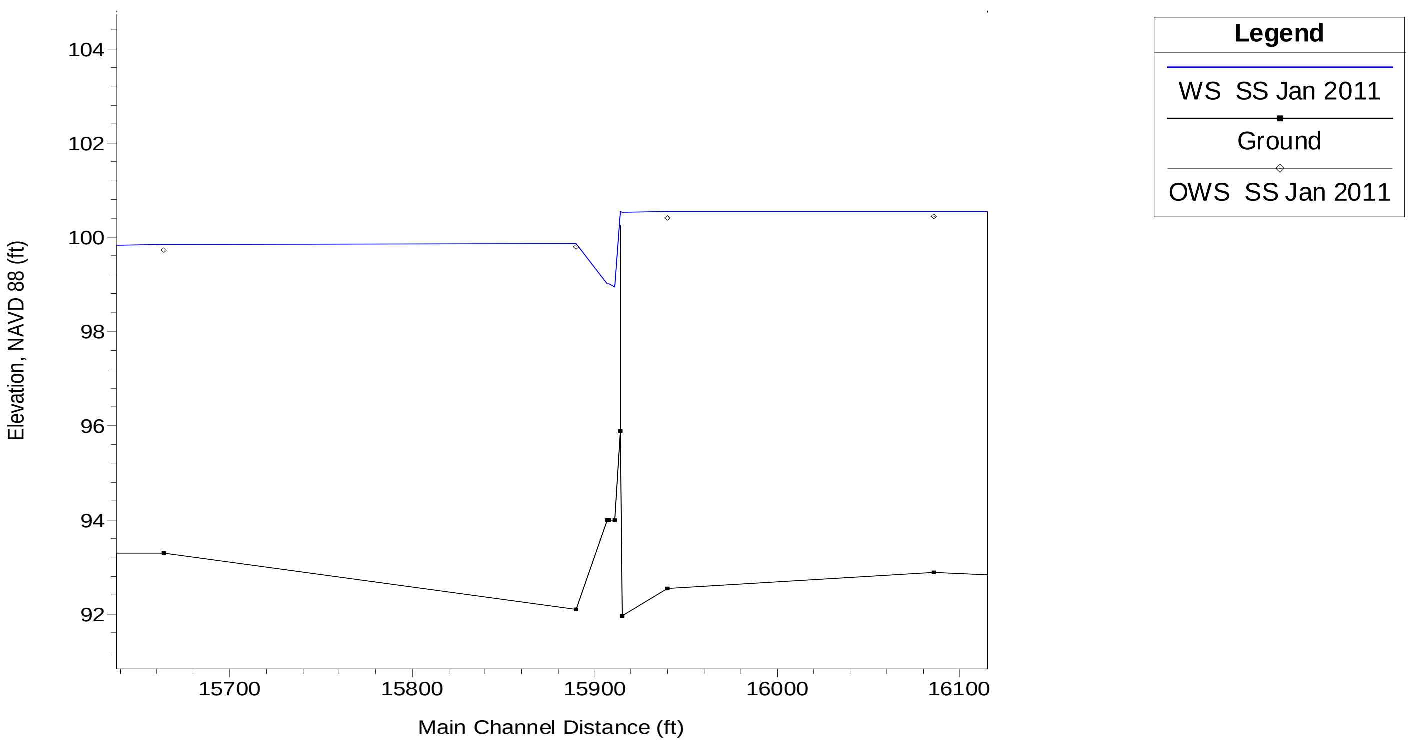
Summary

- Model - Flows through the Merced Refuge Weir #1 were simulated using the HEC-RAS model developed by the US Bureau of Reclamation (RECLAMATION) and documented in *DRAFT Reach 4A Conveyance in the Vicinity of Sand Slough* Technical Report (April 21, 2011). The model was run under two scenarios: Boards-out and Boards-in. Stop logs were not in place during surveys, so it is considered Boards-out by default. An alternative Boards-out scenario was also run assuming stop logs in place at the maximum possible height.
- Geometry - The model has updated topography and bathymetry to reflect current conditions. Structure elevations were based on the Task 2 topographic survey elevations.
- Boundary Conditions – The model assumes a normal depth for the downstream boundary condition at Lower Eastside Bypass, and no flows going into Mariposa Bypass.
- Calibration – The model was calibrated using the flow data collected by the RECLAMATION in January 17, 2011, the flow was assumed to be 3,000 cfs. The model water surface elevations were compared to the water surface elevations from the 2011 Task 2 flow monitoring data and were within +/- 0.5'.

MODEL CALIBRATION

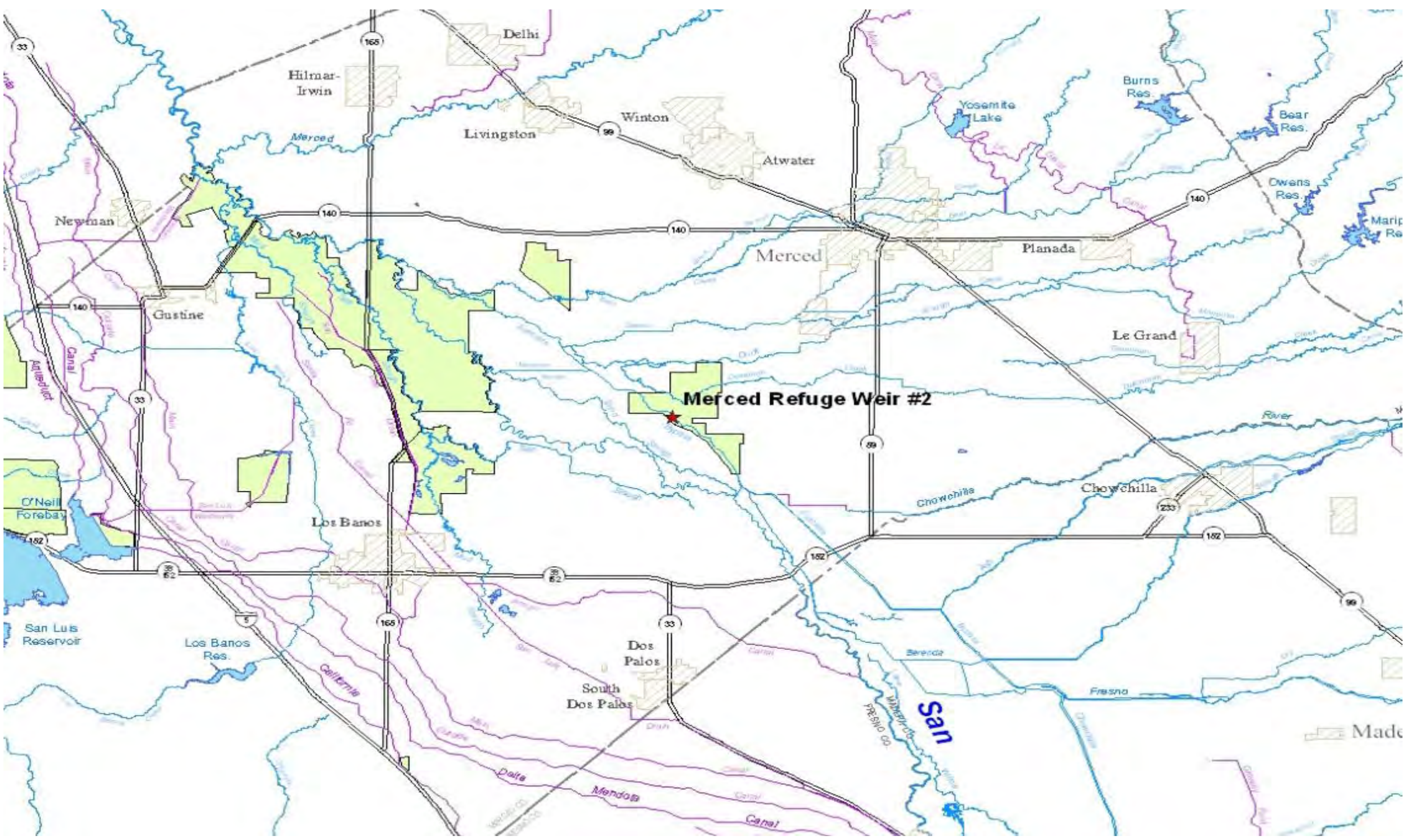
Date: January 17, 2011	Flow (cfs): 3,000	Mean Velocity (ft/s):

No photo available



BEARINGS

Site Name[16]: Merced Refuge Weir #2	**I.D. Number[1]:** 70	**Reach:** EB
River Mile:	**Barrier Type[1]:** Diversion	**Rank[1]:**



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

STRUCTURE DESCRIPTION

The Merced Refuge Weir is located in the Eastside Bypass within the Merced National Wildlife Refuge (Photo 71_A). The weir is used to divert flows from the Eastside Bypass to the Refuge. In order to divert flows boards (stop logs) are installed to raise the water surface elevations in the pool upstream the weir. The weir total height is about 6 feet and is capped by wooden planks for access while installing the stop logs. The stop logs are located on the upstream side of the weir and are able to be installed up to an elevation of about 97.0 feet or a height of 5.5 feet. The weir has 12 bays that average a width of 4 feet. There is a concrete apron for a distance of about 4 feet but more could be buried under sediment. The weir has concrete abutments that tie into the banks of the channel (Photo 71_B).

This structure is typically backwatered by Weir #1 located downstream.

Photos:

Photo 71_A. Weir, downstream looking upstream

Photo 71_B. Abutment

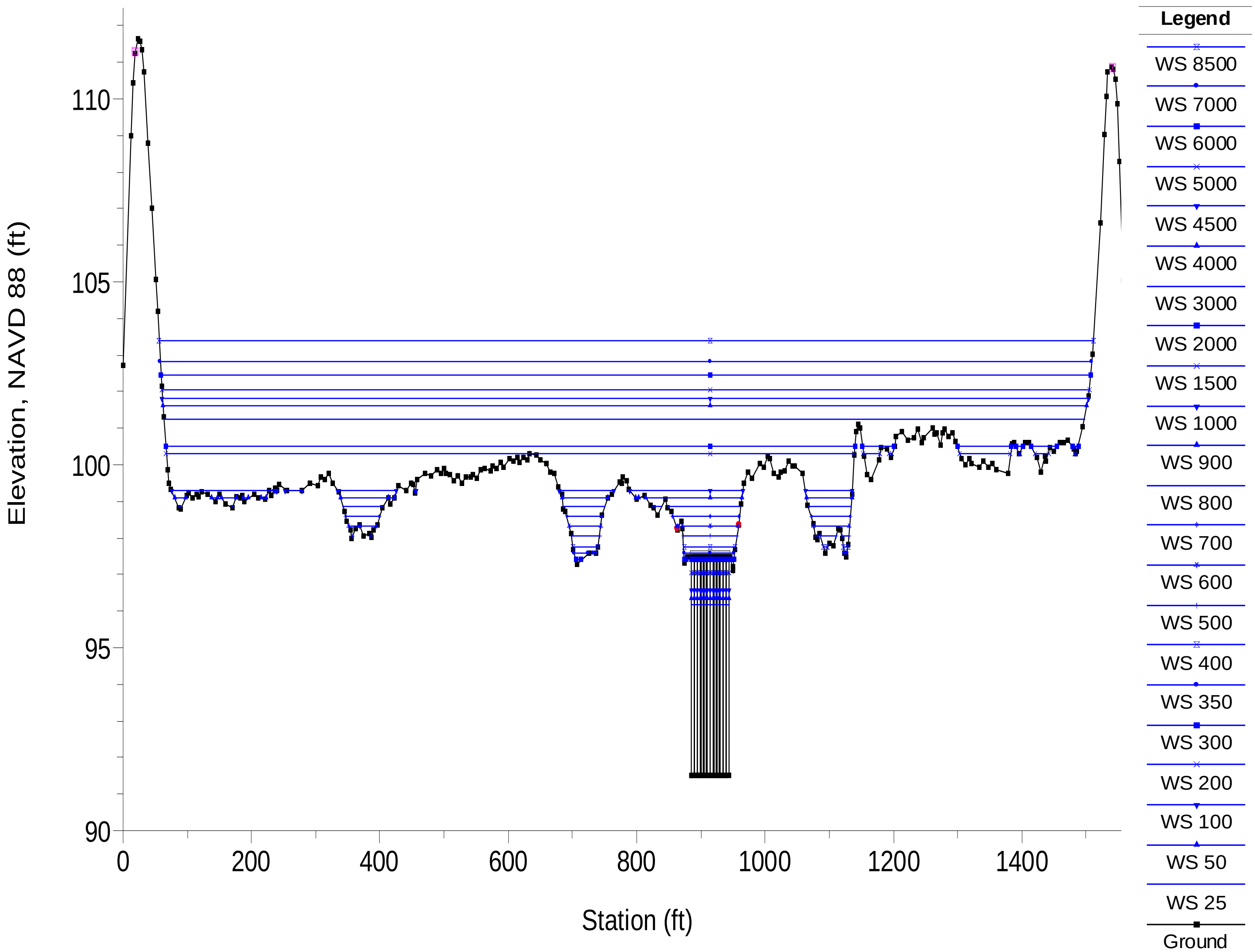
HEC-RAS MODEL SUMMARY TABLE

Boards Out by Default at Stop Log

Flow	Maximum Depth	Channel Velocity	Maximum Water Surface Elevation Change
cfs	ft	fps	ft
25	4.0	0.1	0.0
50	4.1	0.3	0.0
100	4.4	0.5	0.0
200	4.8	0.9	0.0
300	5.2	1.2	0.0
350	5.4	1.3	0.0
400	5.6	1.5	0.0
500	5.9	1.6	0.0
600	6.1	1.8	0.0
700	6.4	1.9	0.0
800	6.7	2.0	0.0
900	6.9	2.0	0.0
1000	7.1	2.1	0.0
1500	8.1	2.0	0.0
2000	8.3	2.4	0.0
2500	8.9	2.2	0.0
3000	9.0	2.5	0.0
3500	9.5	2.4	0.0
4000	9.4	2.8	0.0
4500	9.6	2.9	0.0
5000	9.8	2.9	0.0
5500	10.0	3.0	0.0
6000	10.2	3.0	0.0
6500	10.4	3.1	0.0
7000	10.6	3.1	0.0
7500	10.8	3.1	0.0
8000	11.0	3.1	0.0
8500	11.2	3.2	0.0

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

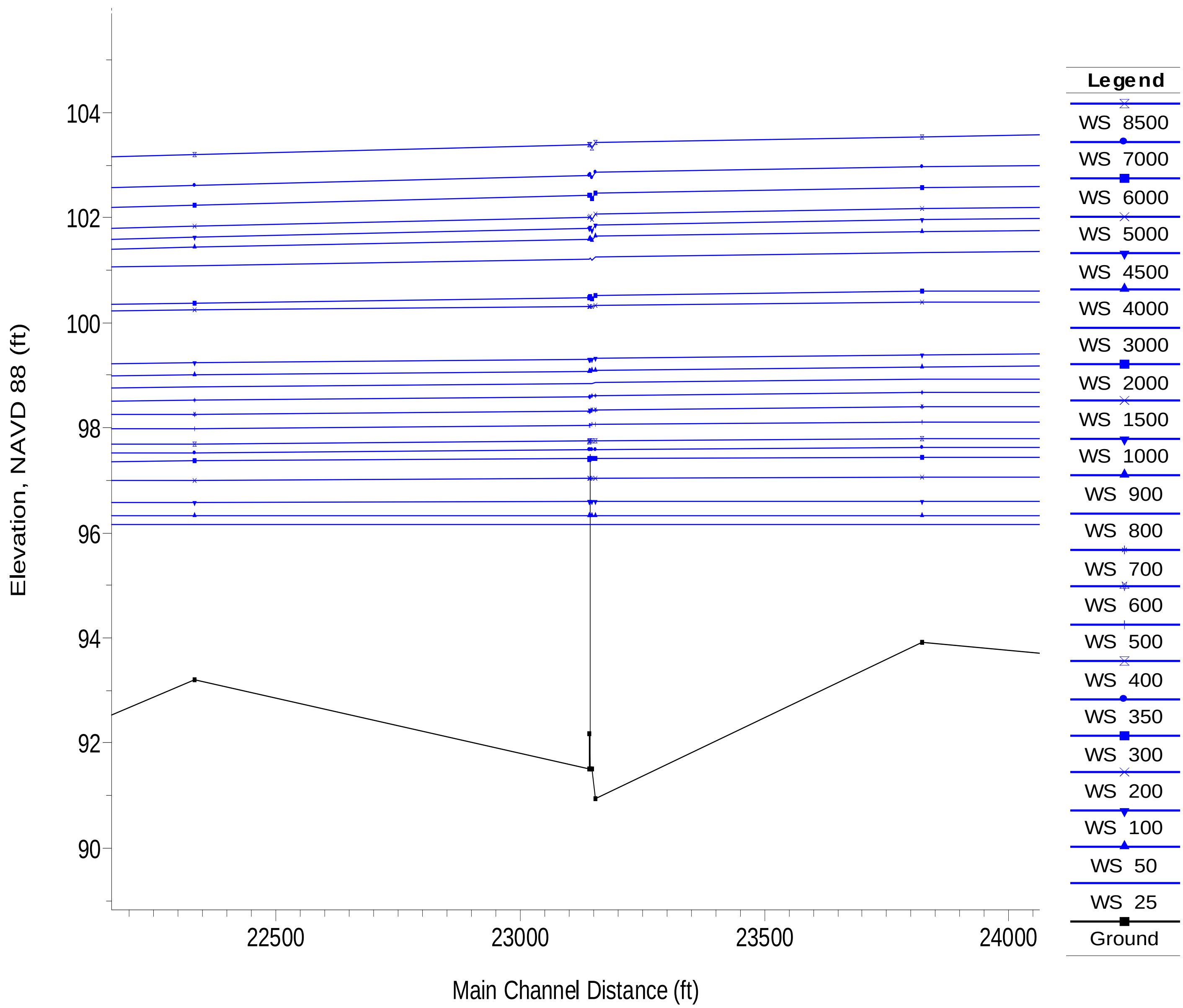


SAN JOAQUIN RIVER RESTORATION PROGRAM

TASK 2 EVALUATION RESULTS

MERCED WILDLIFE REFUGE WEIR #2

HEC-RAS MODEL BED AND WATER SURFACE PROFILE

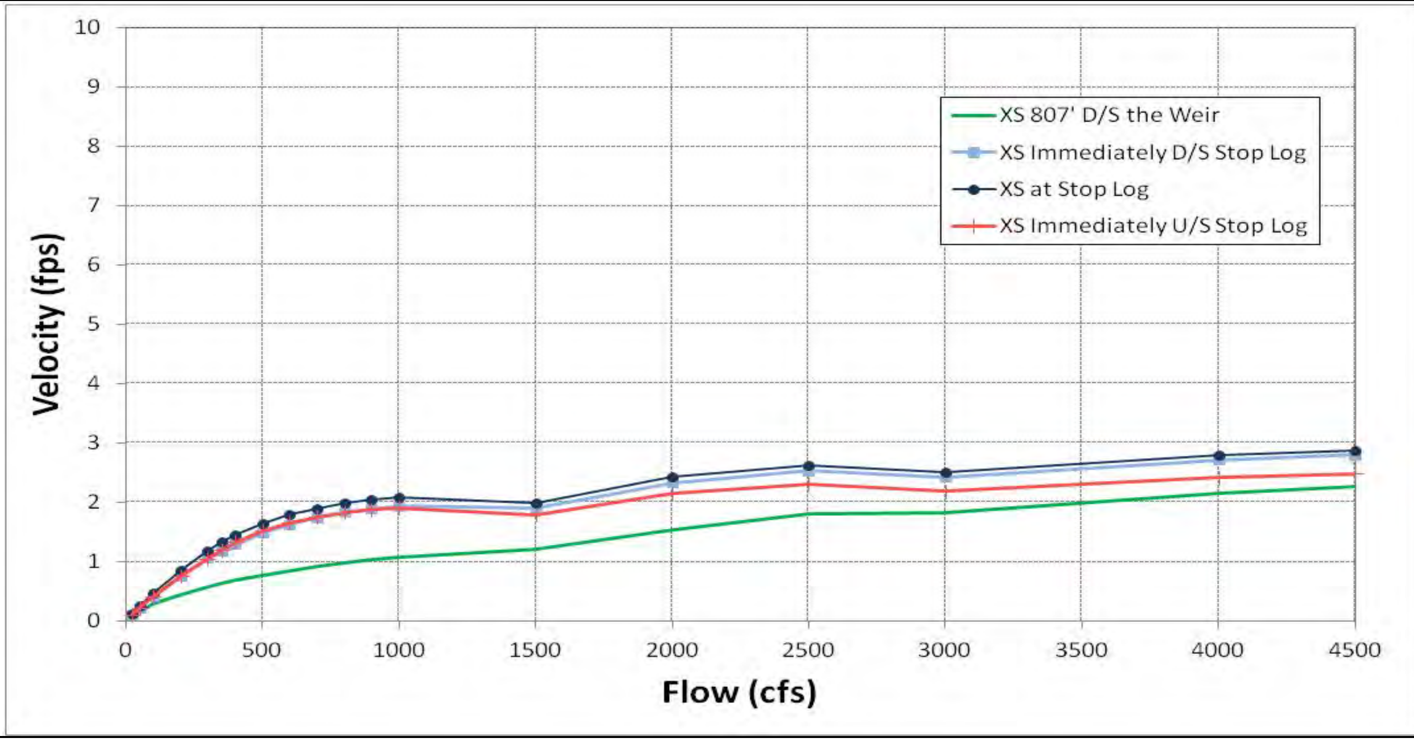


SAN JOAQUIN RIVER RESTORATION PROGRAM

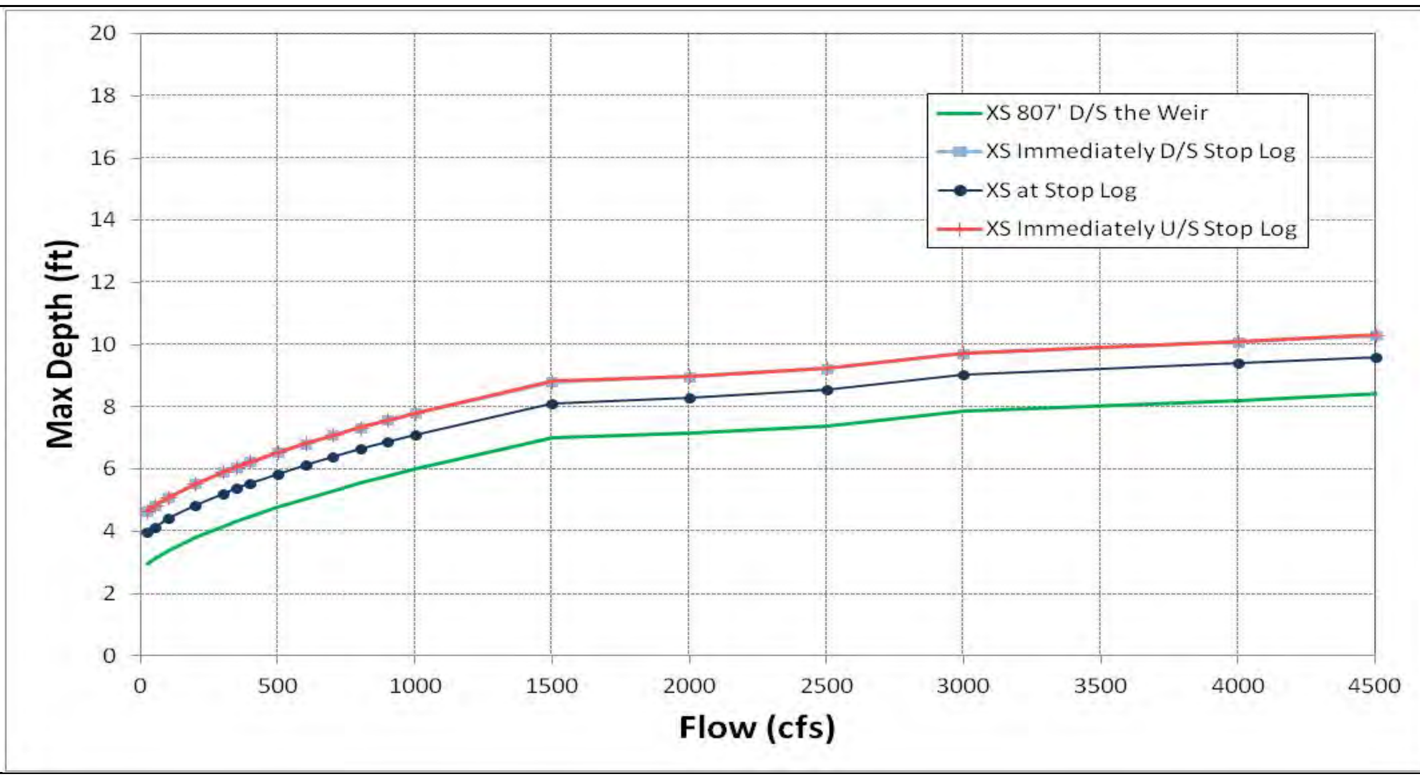
TASK 2 EVALUATION RESULTS

MERCED WILDLIFE REFUGE WEIR #2

HEC-RAS FLOW MODEL RESULTS BOARDS OUT (BY DEFAULT)

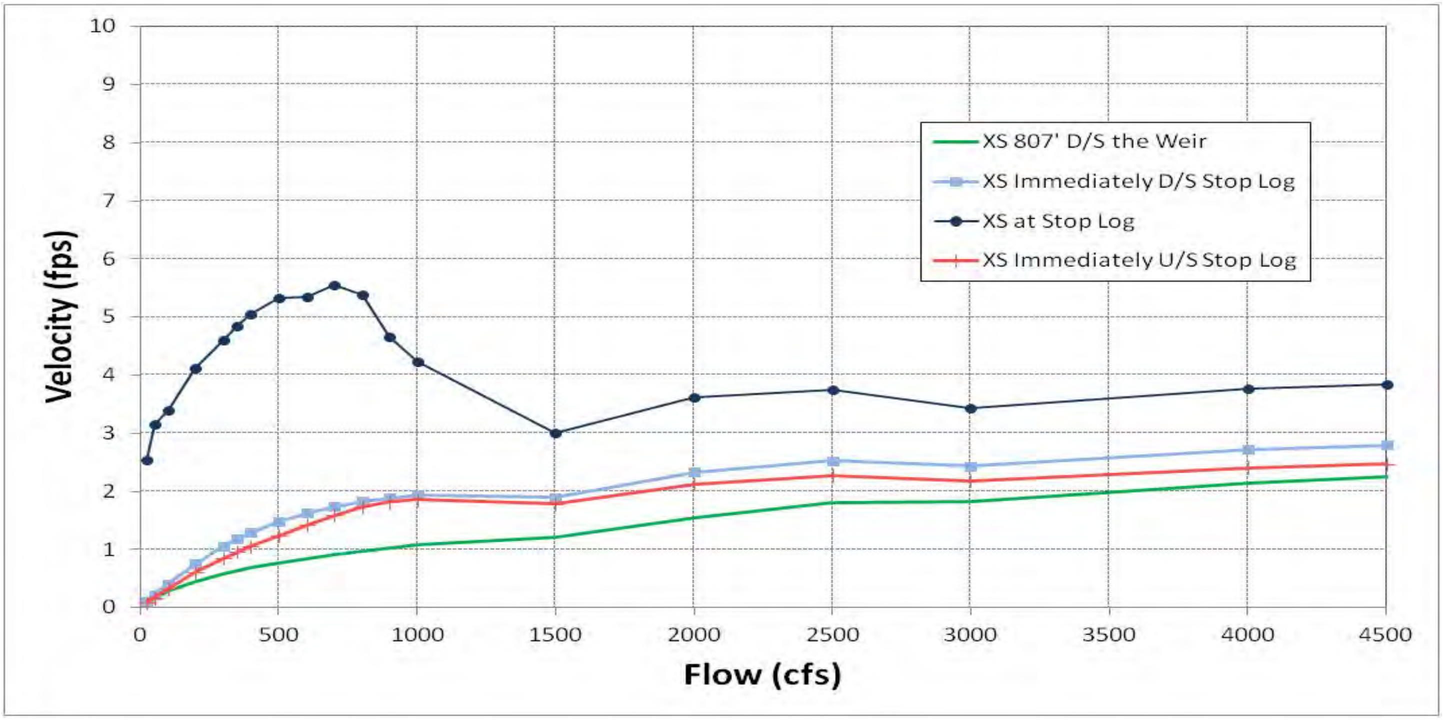


Velocity vs. Flow

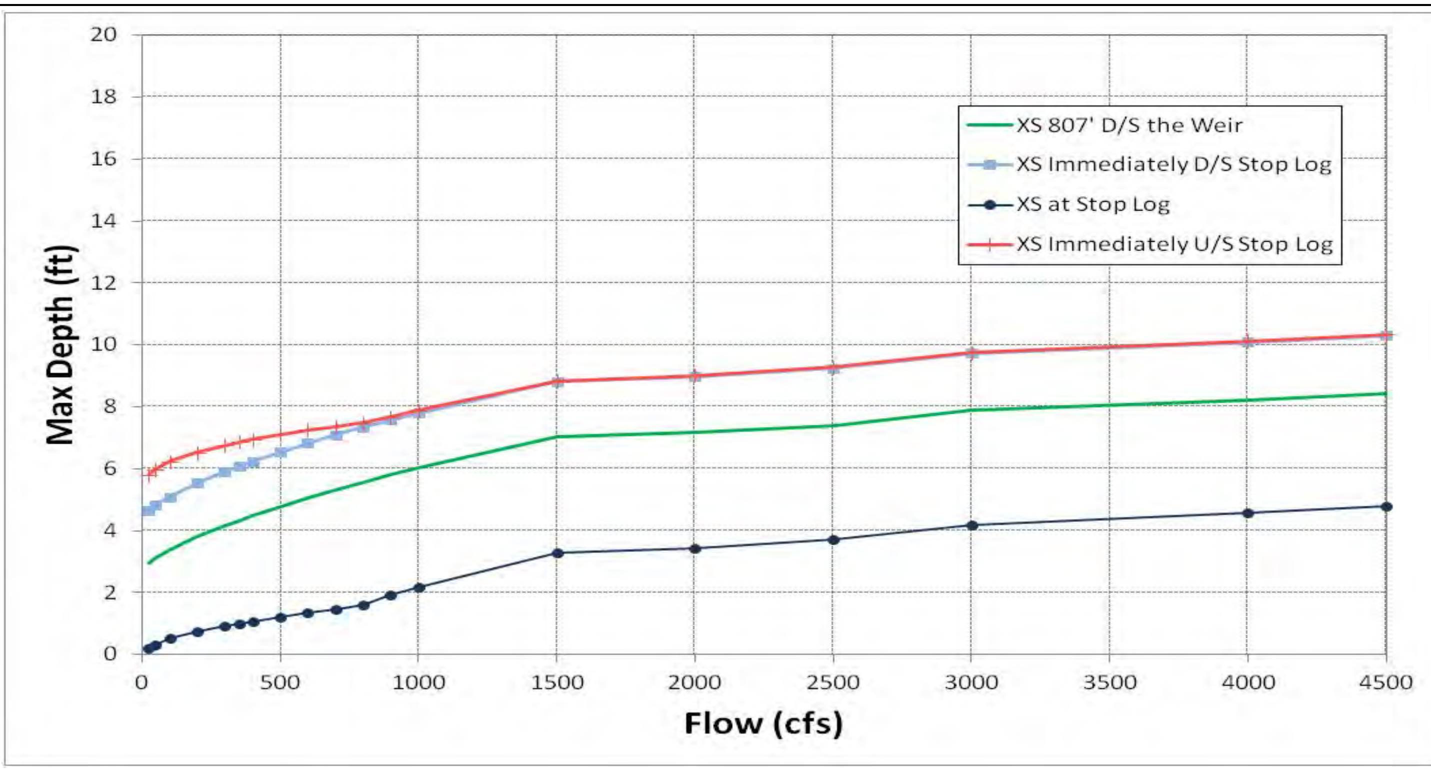


Max Depth vs. Flow

HEC-RAS FLOW MODEL RESULTS BOARDS IN



Velocity vs. Flow



Max Depth vs. Flow

HEC-RAS FLOW MODEL METADATA

TOPOGRAPHY	
Year:	2008
Creator/Source:	Towill Inc.
Type:	LiDAR Topo
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)
BATHYMETRY	
Year:	2010/2011
Creator/Source:	RECLAMATION
Type:	ADCP Bathymetry
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)

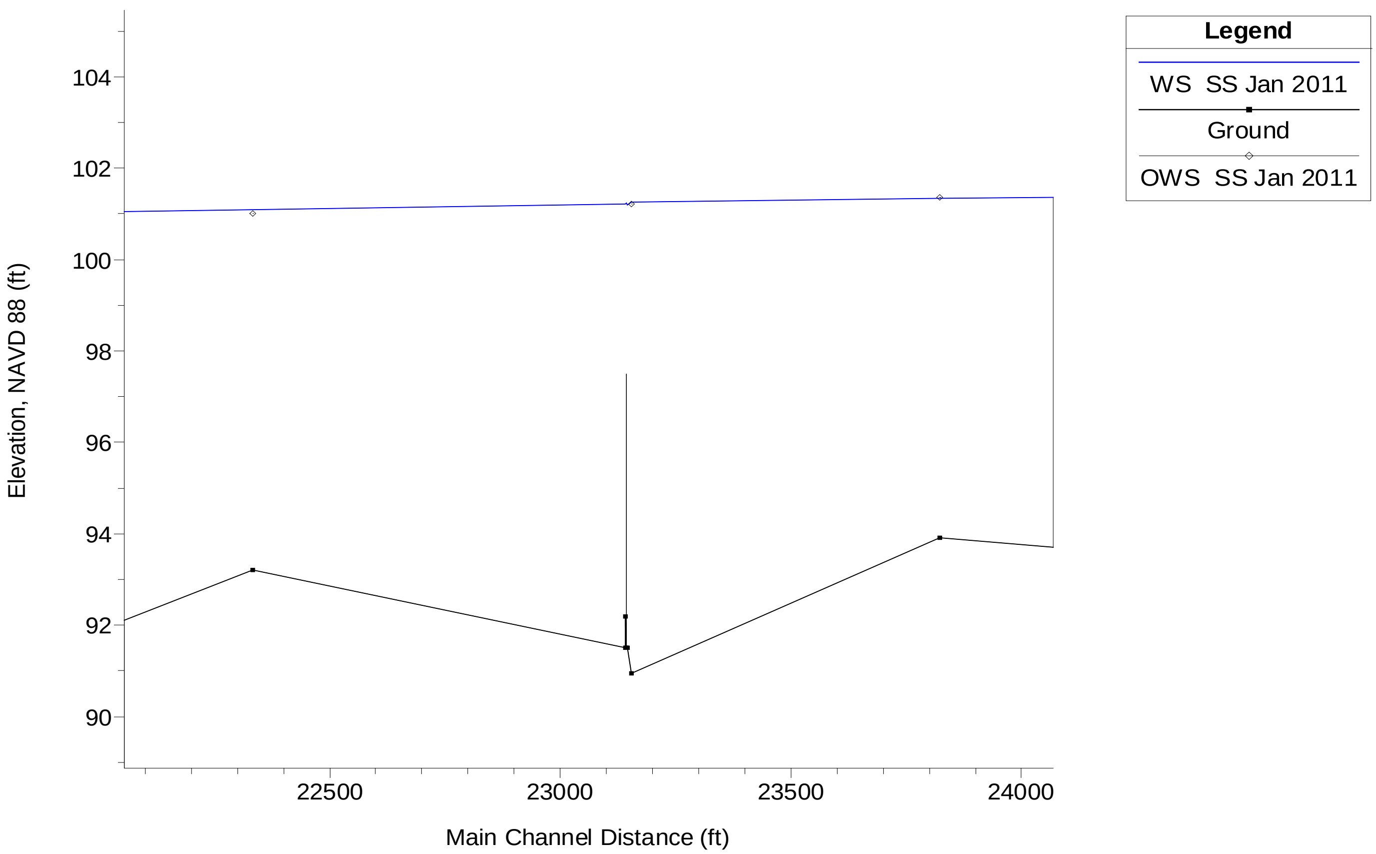
Summary

- Model - Flows through the Merced Wildlife Refuge Weir #2 were simulated using the HEC-RAS model developed by the US Bureau of Reclamation (RECLAMATION) and documented in *DRAFT Reach 4A Conveyance in the Vicinity of Sand Slough* Technical Report (April 21, 2011). The model was run under two scenarios: Boards-out and Boards-in. Stop logs were not in place during surveys, so it is considered Boards-out by default. An alternative Boards-in scenario was also run assuming stop logs in place at the maximum possible height.
- Geometry - The model has updated topography and bathymetry to reflect current conditions. Structure elevations were based on the Task 2 topographic survey elevations.
- Boundary Conditions – The model assumes a normal depth for the downstream boundary condition at Lower Eastside Bypass, and no flows going into Mariposa Bypass.
- Calibration – The model was calibrated using the flow data collected by the RECLAMATION in January 17, 2011, the flow was assumed to be 3,000 cfs. The model water surface elevations were compared to the water surface elevations from the 2011 Task 2 flow monitoring data and were within +/- 0.5'.

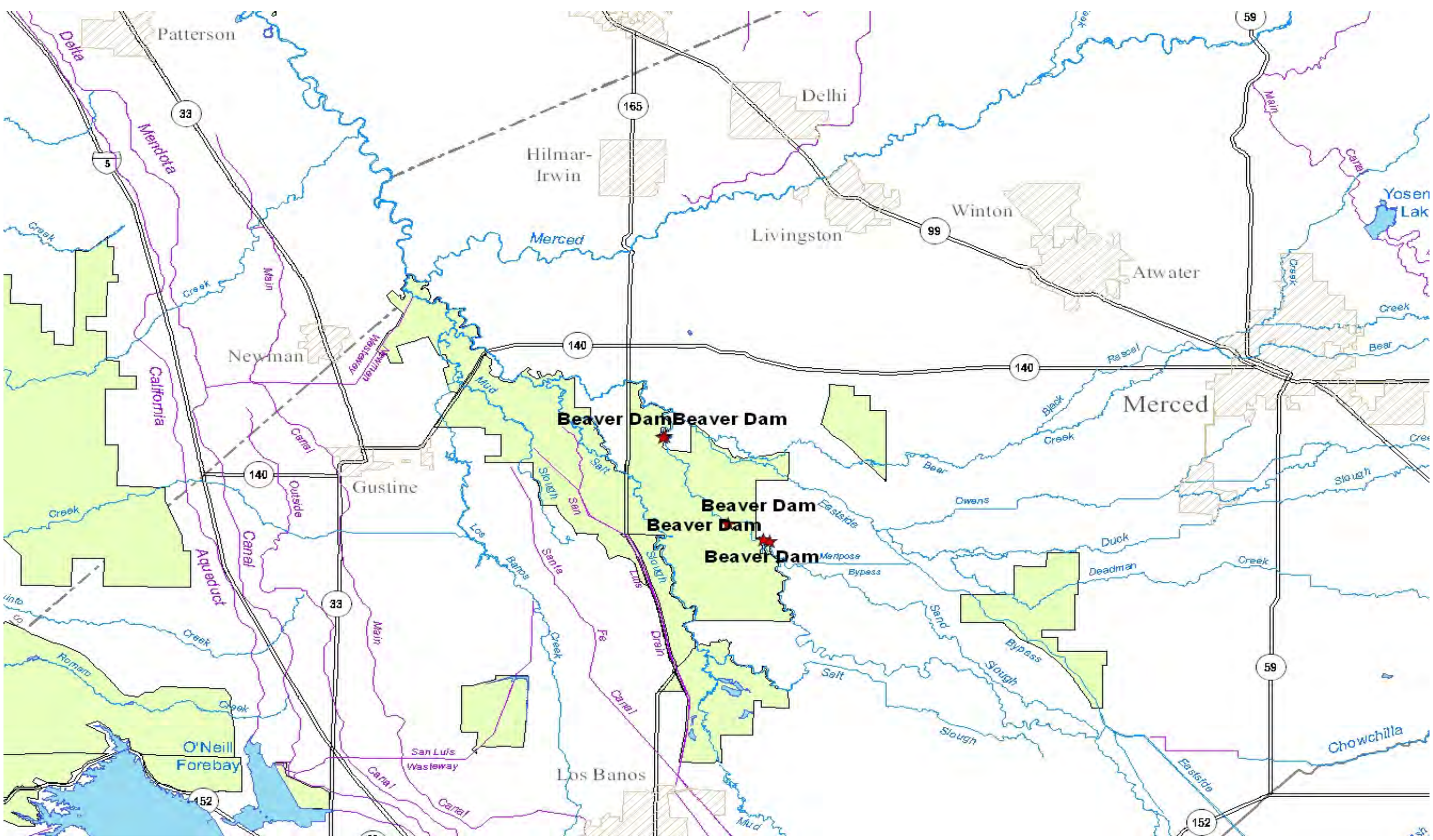
MODEL CALIBRATION

Date: January 17, 2011	**Flow (cfs):** 3,000	**Mean Velocity (ft/s):**

No photo available



BEARINGS			
Site Name[17]: Beaver Dam		**I.D. Number[1]:** 41	**Reach:** 4B2
River Mile: 137.7	**Barrier Type[1]:** Natural		**Rank[1]:** Gray



---

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

STRUCTURE DESCRIPTION

The beaver dam is located on the San Joaquin River near river mile 137.7 in the San Luis National Wildlife Refuge. The dam is constructed of large woody tree branches that have been placed in the channel (Photo 41_A). The dam has been there for some time, it was seen in the 2007 aerial photos. Refuge staff was not sure of its age. There are several Beaver Dams upstream, so this structure was chosen to be the typical construction.

The channel downstream (Photo 41_B) was clean but shallow in some areas. A small staging pool on the right bank was present adjacent to a sand bar in the center of the channel. Upstream the channel was clean with a large pool from the backwatering created by the beaver dam (Photo 41_C). The backwatering goes up the channel for some distance. The channel banks have large woody trees and tall annual grasses with scatter large woody trees in the floodplain. The staging pool location on the right bank may not be practical since there are some overhanging tree limbs upstream the beaver dam that may impede safe passage. Small minnows were observed just downstream and upstream. Unidentified larger fish were observed downstream and upstream of the dam. One was downstream near a large woody tree limb that was in the channel and two were observed upstream in the pool. The channel bottom majority is silt/clay/sand.

The distance between the terminal points of the woody debris and the channel banks is about 46 feet. The bankfull channel width is about 34 feet. The bottom of the dam base is about 11 feet wide. The water surface elevation is three feet just behind the dam and the dam height was estimated at 3.4 feet upstream and 4.3 feet downstream, this creates a 1.1 foot drop to the channel bed. There was a two foot drop in water surface elevation from the upstream pool to the downstream water surface elevation. There was a small staging pool downstream measuring about 30 feet from the pool tail to the top of the dam. The staging pool was estimated to be about 10 feet deep in the center, but could not be verified since this is too deep to wade.

<u>Photos:</u>

Photo 41_A. Beaver Dam from downstream looking upstream

Photo 41_B. Looking downstream from sand bar

Photo 41_C. Upstream pool from left bank

HEC-RAS MODEL SUMMARY TABLE

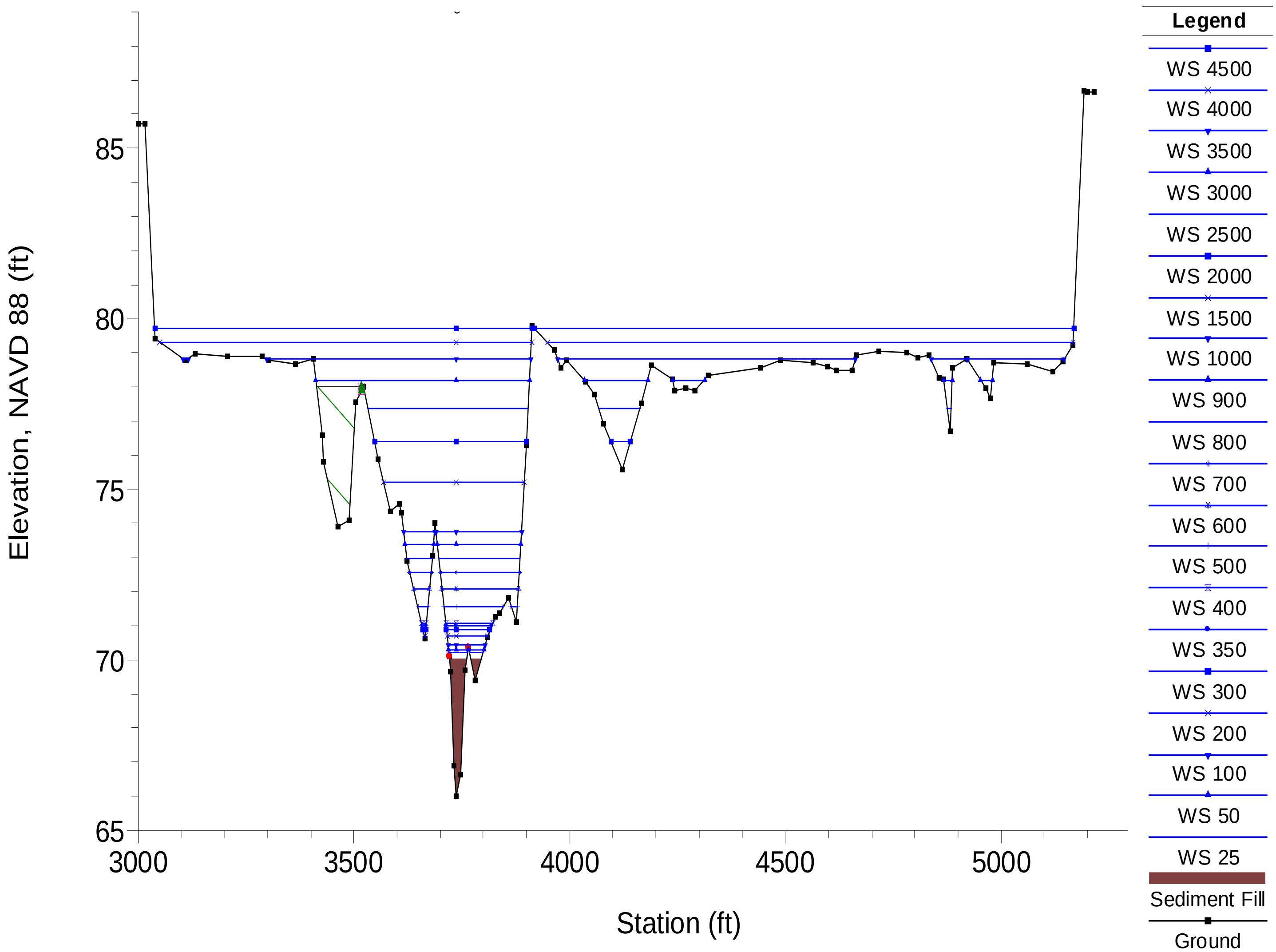
Results for flow over Beaver Dam

Flow	Maximum Depth	Channel Velocity	Maximum Water Surface Elevation Change
cfs	ft	fps	ft
25	0.2	2.6	2.5
50	0.3	3.2	2.2
100	0.4	4.0	1.8
200	0.7	5.0	1.2
300	0.9	5.6	0.8
350	1.0	5.9	0.6
400	1.1	6.1	0.4
500	1.5	5.0	0.1
600	2.1	3.9	0.1
700	2.5	3.3	0.0
800	3.0	3.0	0.0
900	3.4	2.8	0.0
1000	3.7	2.7	0.0
1500	5.2	2.6	0.0
2000	6.4	2.5	0.0
2500	7.4	2.5	0.0
3000	8.2	2.7	0.0
3500	8.8	2.9	0.0
4000	9.3	2.9	0.0
4500	9.7	2.7	0.0

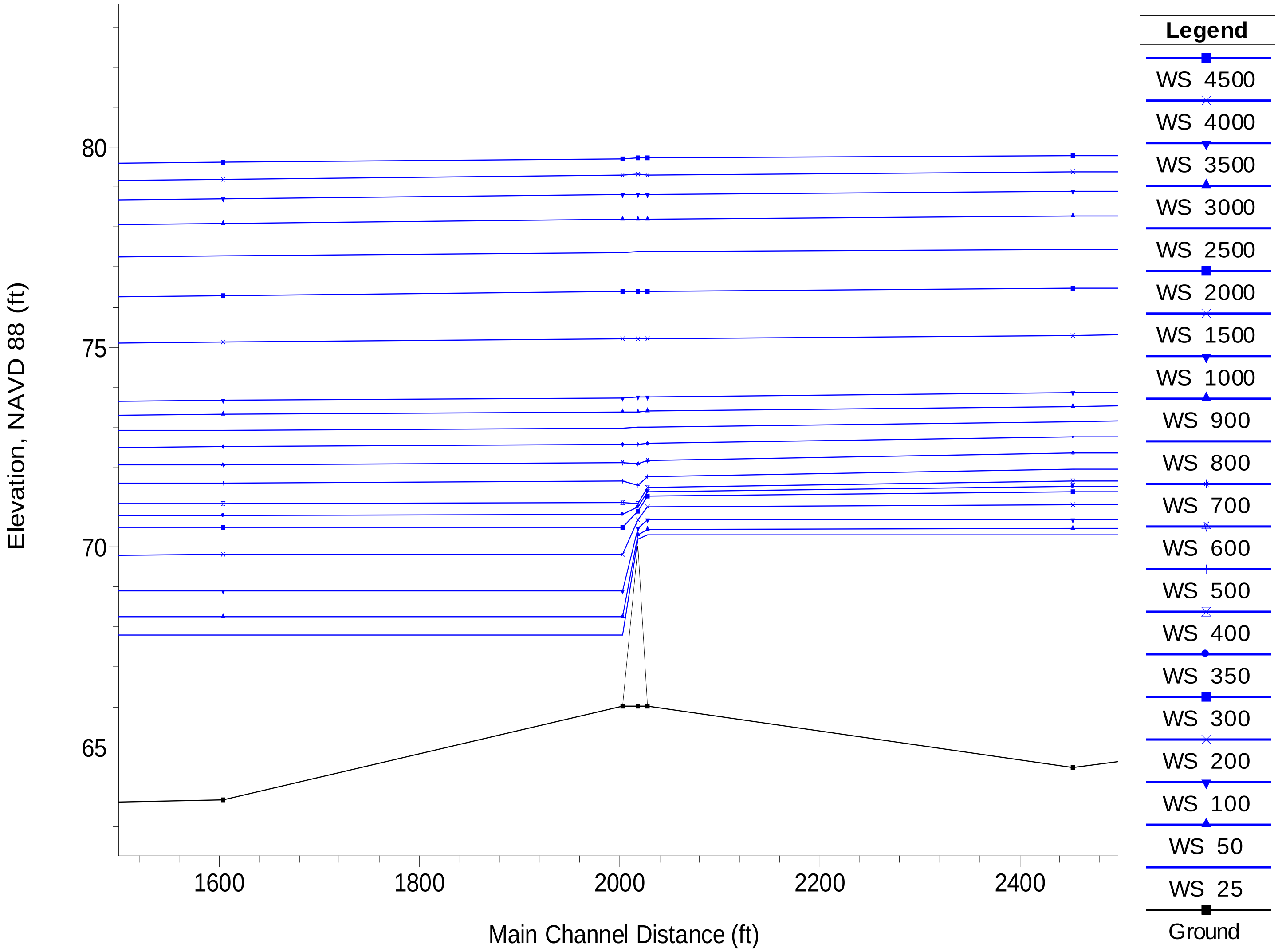
The maximum water surface elevation change was estimated based on the difference between the cross sections immediately upstream and downstream the weir.

SAN JOAQUIN RIVER RESTORATION PROGRAM
TASK 2 EVALUATION RESULTS
TYPICAL BEAVER DAM

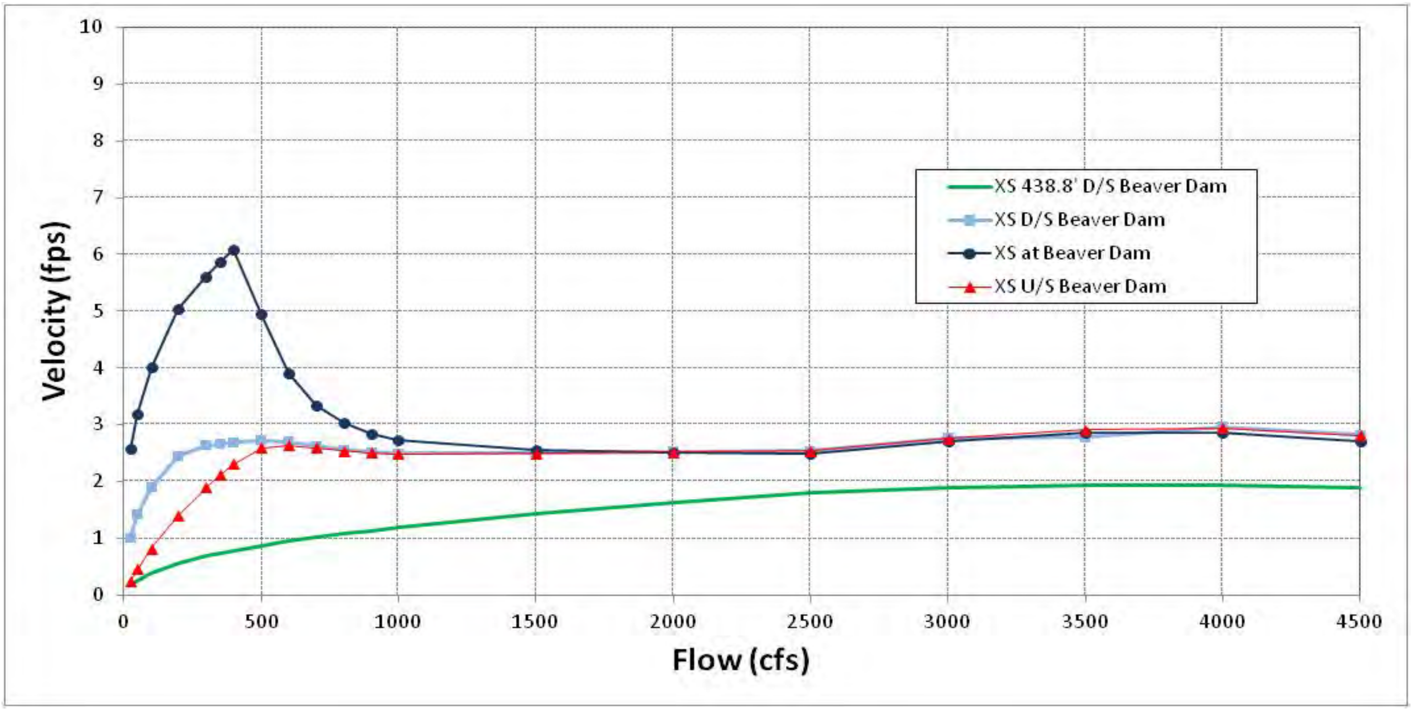
HEC-RAS MODEL CROSS SECTION AT BEAVER DAM



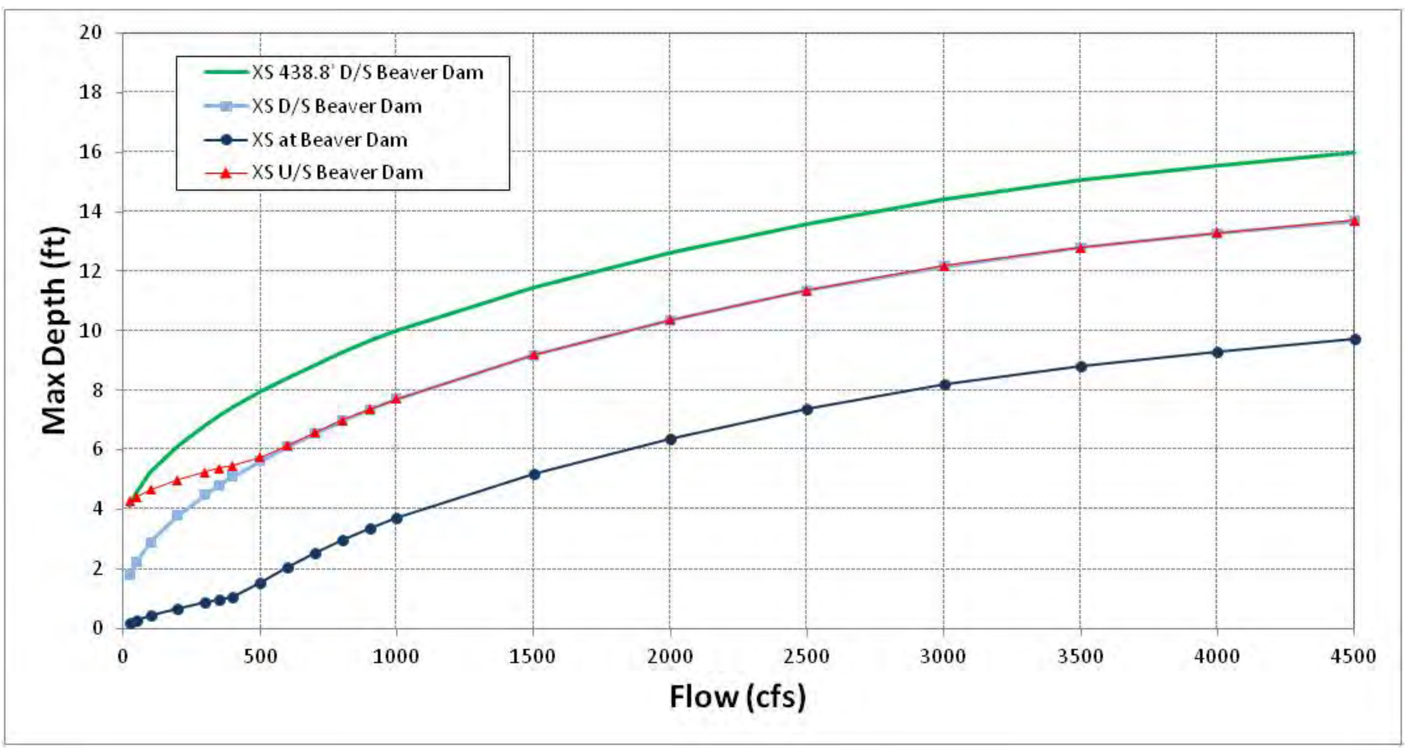
HEC-RAS MODEL BED AND WATER SURFACE PROFILE



HEC-RAS MODEL RESULTS



Velocity vs. Flow



Max Depth vs. Flow

HEC-RAS MODEL METADATA

TOPOGRAPHY	
Year:	1998/1999
Creator/Source:	Ayres Associates
Type:	Photogrammetry
Vertical:	NGVD29 (adjusted to NAVD 1988)
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)
BATHYMETRY	
Year:	1998/1999
Creator/Source:	Ayres Associates
Type:	Photogrammetry
Vertical:	NAVD 1988
Horizontal:	NAD83 State Plane CA Zone III FIPS (ft)

Summary

- Model – To provide the general hydraulics of flow through a Beaver Dam, a hydraulic model of an existing beaver dam was completed. This example can be used to provide general assessments of fish passage at other beaver dams.
- Geometry - The model was developed using a stand-alone HEC-RAS model localized for the structure by incorporating cross sections from the Tetra Tech dba MEI 2007 all-reach model (NGVD 1929). The vertical elevation data for the imported cross sections were adjusted by 2.4' to match that of NAVD 1988. The actual beaver dam structure was not surveyed, but its height relative to river bed was estimated based on Task 1 observations. Sediment fill was used in the model to simulate the observed height.
- Boundary Conditions –To calibrate the model, a boundary condition was developed to account for the downstream backwater effect from Reach 5. The range of flows evaluated for passage uses a different rating curve that assumes no backwater effect from Reach 5 downstream (same flows in Reach 4B2 and 5). Both rating curves were developed using the MEI 2007 all-reach model and then converted from NGVD 1929 to NAVD1988.
- Calibration – The model was calibrated using the flow data collected by DWR on May 24, 2011, the flow was measured to be 41 cfs through the structure with backwater effect. The water surface elevations were compared to the water surface elevations from the 2011 Task 2 flow monitoring data and were within +/- 0.5'.

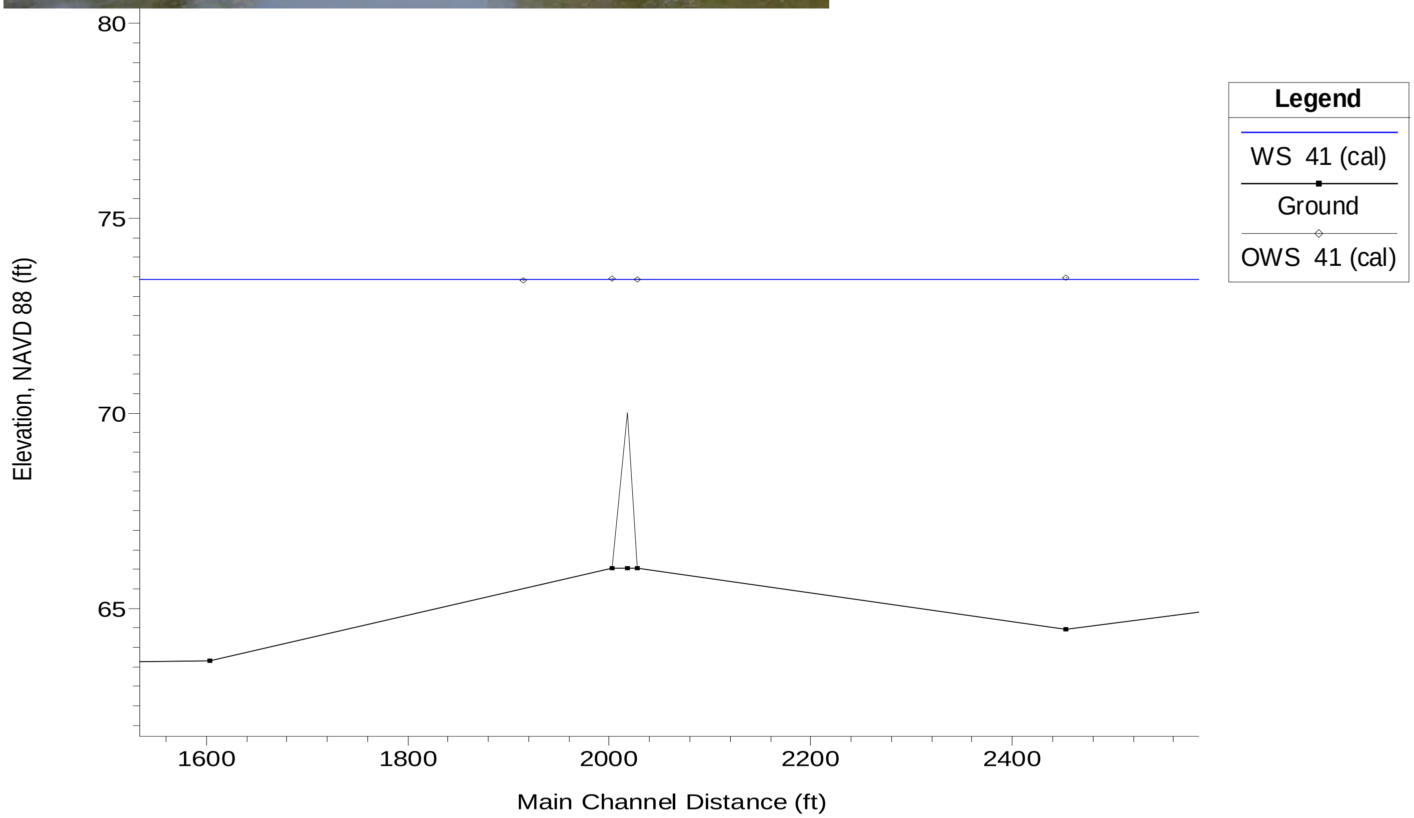
SAN JOAQUIN RIVER RESTORATION PROGRAM

TASK 2 EVALUATION RESULTS

TYPICAL BEAVER DAM

MODEL CALIBRATION

Date: 5/24/2011	**Flow (cfs):** 41	**Mean Velocity (ft/s):** 0.070



This page was intentionally left blank

APPENDIX B

Data Collection

This page was intentionally left blank

SAN JOAQUIN RIVER RESTORATION PROGRAM

TASK 2 DATA COLLECTION

LOST LAKE ROCK WEIR #1

SAN JOAQUIN RIVER RESTORATION PROGRAM

MONITORING DATA

Site Name[18]**:** Lost Lake Rock Weir #1	**I.D. Number**[1]**:** 4	**Reach:** 1A	**River Mile:** 266
Date: May 12, 2011	**Flow:** 3,110 cfs	**Average Velocity:** 2.27 ft/s	

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

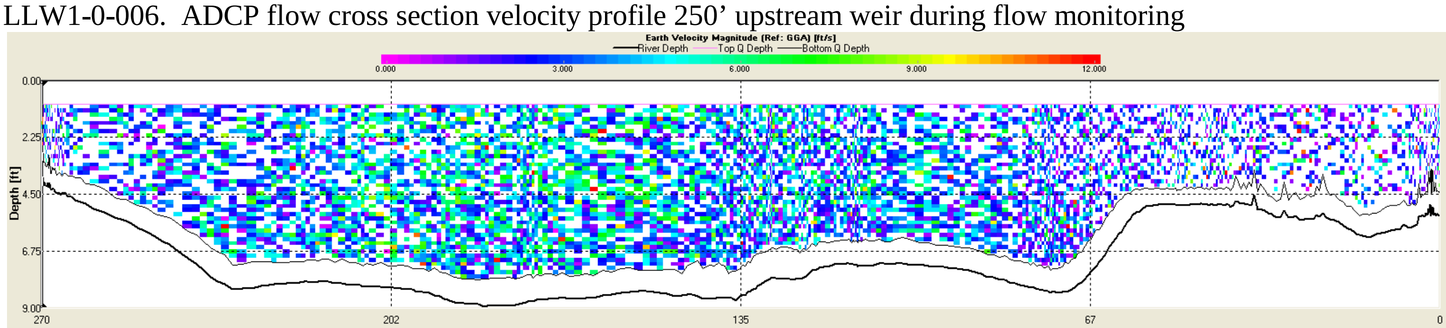
SECOND PASS DESCRIPTION

Lost Lake Rock Weir #1 had water surface elevations (WSE), flow and velocity data collected on May 12, 2011 by DWR with an ADCP and GPS. Flows were surveyed about 250 feet upstream the weir. The weir was submerged during the flow monitoring. DWR used an ADCP to collect flow, velocity, and depth data as displayed in the previous map. Water Surface Elevations (WSE) were collected during the time of the monitoring by GPS. The WSE are approximate elevations and may vary due to the soil conditions and access. The flow and WSE data was used to calibrate the one dimension HEC-RAS model for Task 2. Additional data that has been reviewed and processed was reviewed for calibration reasonableness included CDEC flow data for flow in the San Joaquin River below Friant Dam.

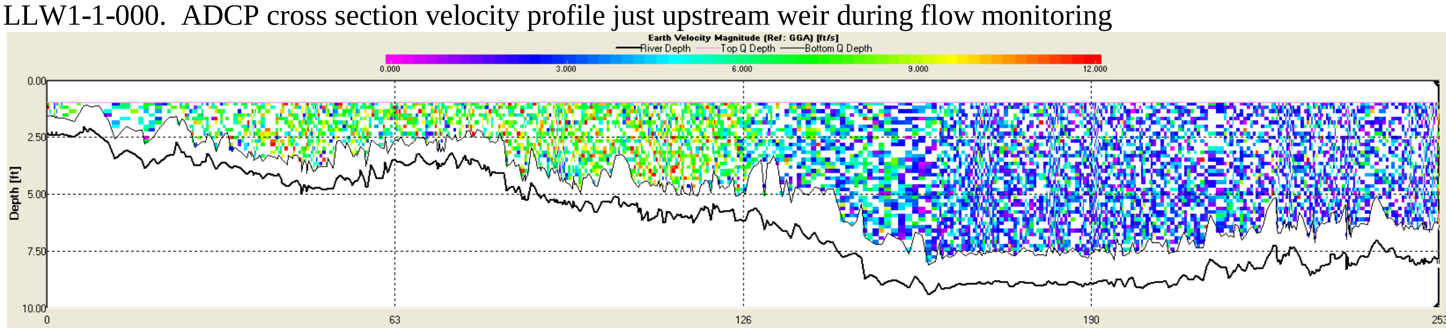
An ADCP flow cross sectional velocity profile, LLW1-0-006, from one of the flow measurements about 250' upstream the weir is provided to display a three dimensional view of the velocities. The highest velocities are located within the main channel that is located between the left bank and the center of the channel. The cross section velocity for the section just upstream the weir shows the two-dimensional variation in the velocity that was not captured by the one-dimensional model. The left bank displays higher velocities than the right bank. The average velocity for this section is around 4.26 fps.

Data Cross Section:

LLW1-0-006. ADCP flow cross section velocity profile 250' upstream weir during flow monitoring



LLW1-1-000. ADCP cross section velocity profile just upstream weir during flow monitoring



SAN JOAQUIN RIVER RESTORATION PROGRAM
TASK 2 DATA COLLECTION
LOST LAKE ROCK WEIR #2

MONITORING DATA			
Site Name[19]: Lost Lake Rock Weir 2	**I.D. Number[1]:** 5	**Reach:** 1A	**River Mile:** 265
Date: May 13, 2011	**Flow:** 2,870 cfs	**Average Velocity:** 1.59 ft/s	

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

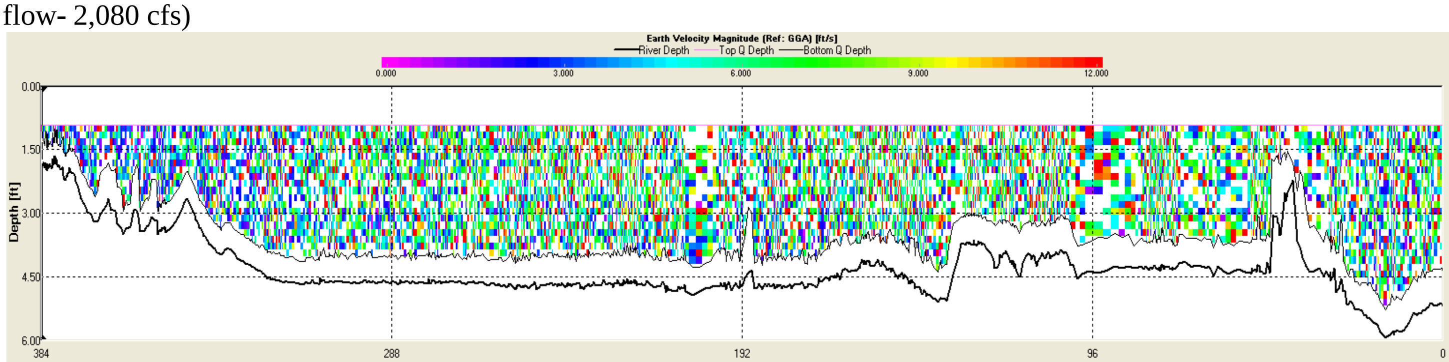
SECOND PASS DESCRIPTION

Lost Lake Rock Weir #2 had water surface elevations (WSE), flow and velocity data collected on May 13, 2011 by DWR with an ADCP and GPS. DWR used an ADCP to collect flow, velocity, and depth data as displayed in the previous map. Flows were surveyed about 150 feet upstream the weir that was estimated at 2,870 cfs and about 75 feet upstream the weir that was estimated at about 2,080 cfs. The difference in flow, 790 cfs, was to estimate a split flow over the weir. The weir was submerged during the flow monitoring. Water Surface Elevations were collected during the time of the monitoring by GPS. The WSEs are approximate elevations and may vary due to the soil conditions and access. The flow and WSE data was used to calibrate the one dimension HEC-RAS model for Task 2. Additional data that has been reviewed and processed for calibration reasonableness included CDEC flow data for flow in the San Joaquin River below Friant Dam.

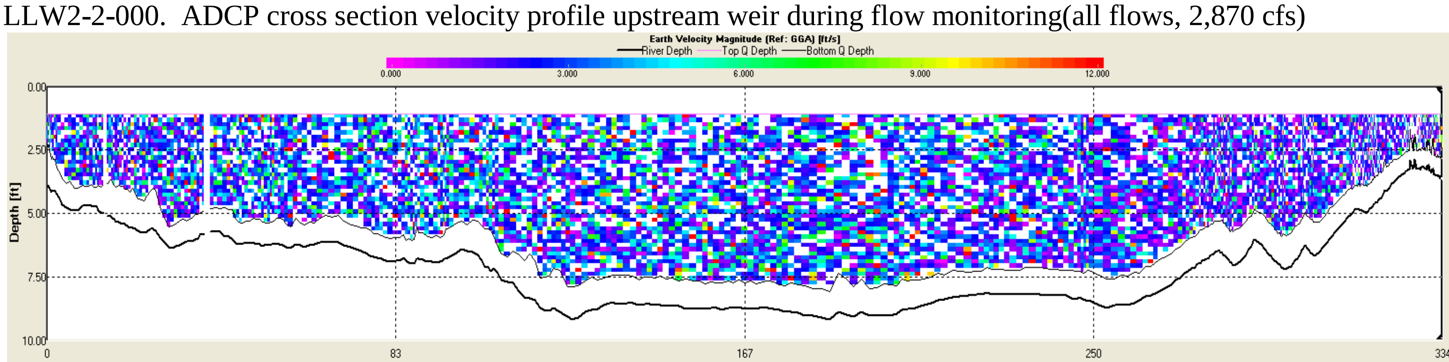
An ADCP cross sectional velocity profile, LLW2-0-006, from one of the flow measurements upstream the weir is provided to display a three dimensional view of the velocities. The highest velocities are located within the main channel that is located between the left bank and the center of the channel. The velocity profile, LLW2-2-000 after the flow split displays an increase of velocity in the channel. The velocity profile, LLW2-0-006, for just upstream the weir averaged 4.58 fps.

<u>Data Cross Section:</u>

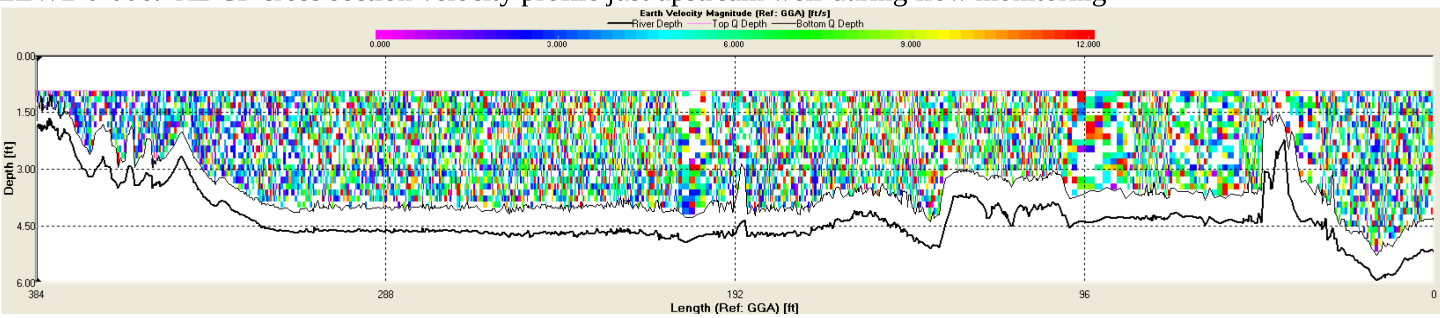
LLW2-0-006. ADCP cross section velocity profile just upstream main weir during flow monitoring(not including split flow- 2,080 cfs)



LLW2-2-000. ADCP cross section velocity profile upstream weir during flow monitoring(all flows, 2,870 cfs)



LLW2-0-006. ADCP cross section velocity profile just upstream weir during flow monitoring



MONITORING DATA			
Site Name[20]: Donny Bridge	**I.D. Number[1]:** 17	**Reach:** 1B	**River Mile:** 265
Date: May 19, 2011	**Flow:** 3,040 cfs		**Average Velocity:** 0.502 ft/s

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

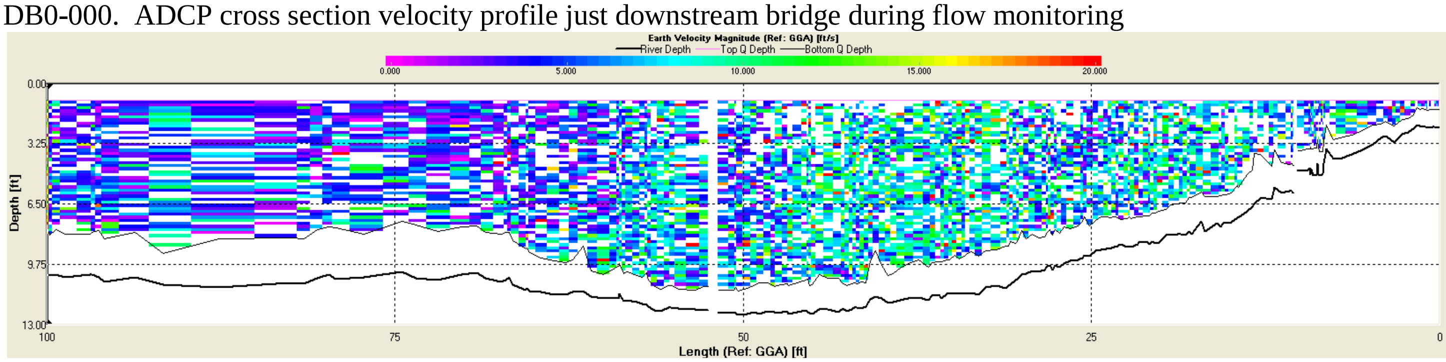
SECOND PASS DESCRIPTION

Donny Bridge had water surface elevations (WSE), flow and velocity data collected on May 19, 2011 by DWR with an ADCP and GPS. DWR used an ADCP to collect flow, velocity, and depth data as displayed in the previous map. Flows were surveyed about 575 feet upstream the bridge that was estimated at 3,040 cfs. Water Surface Elevations were collected during the time of the monitoring by GPS. The WSEs are approximate elevations and may vary due to the soil conditions and access. The flow and WSE data was used to calibrate the one dimension HEC-RAS model for Task 2. Additional data that has been reviewed and processed for calibration reasonableness included CDEC gage data for Donny Bridge. The final gage data was requested from the gage operator, RECLAMATION, that was estimated at 2,554 cfs (final data supersedes CDEC data). The final RECLAMATION flow rating curve data that was provided exceeded the actual gage rating curve.

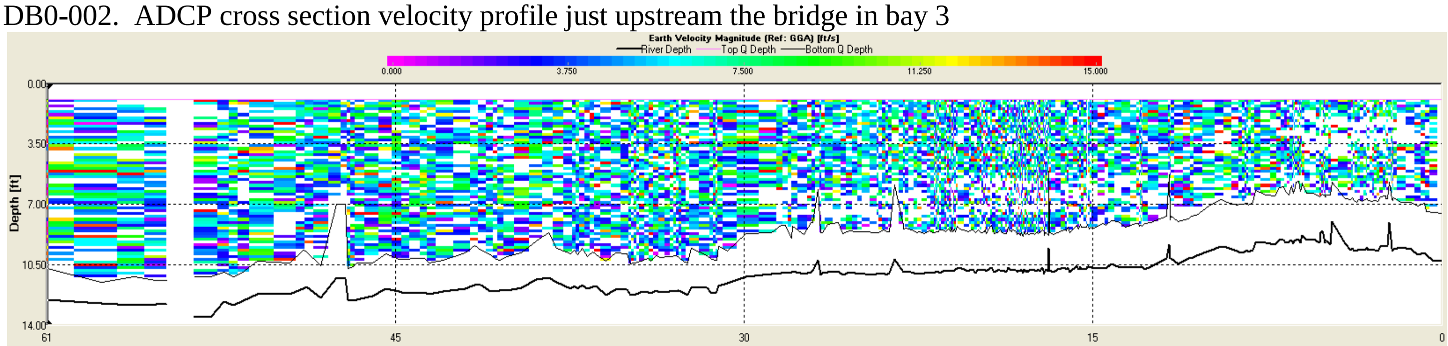
An ADCP cross sectional velocity profile from one of the flow measurements upstream the weir is provided to display a three dimensional view of the velocities. The highest velocities are located just upstream and downstream the bridge with average velocities around 5.0 ft/s. The velocity profile at the flow measurement upstream the bridge had significantly lower velocities.

<u>Data Cross Section:</u>

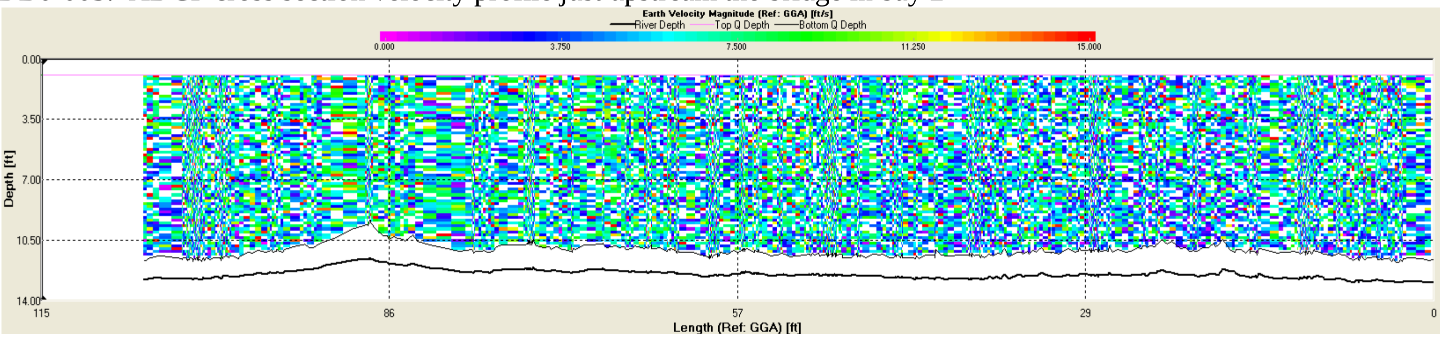
DB0-000. ADCP cross section velocity profile just downstream bridge during flow monitoring



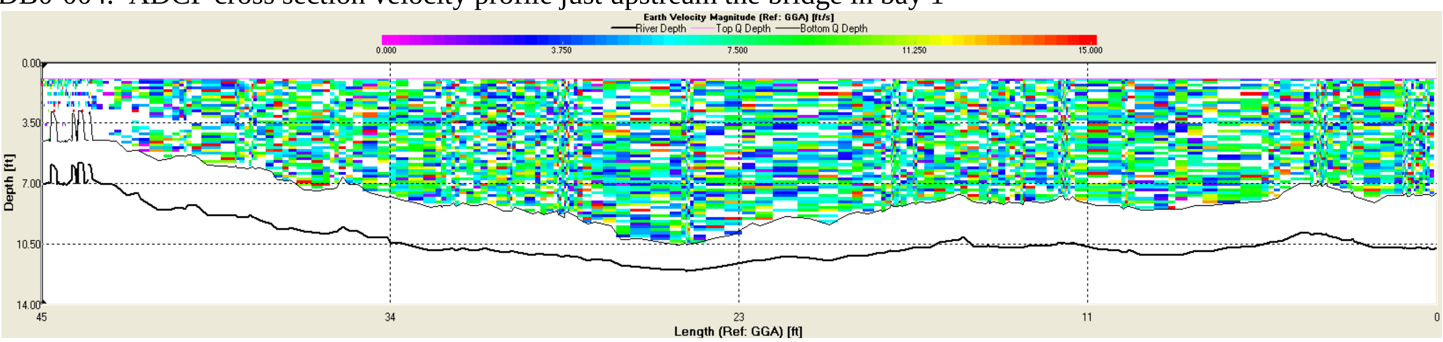
DB0-002. ADCP cross section velocity profile just upstream the bridge in bay 3



DB0-003. ADCP cross section velocity profile just upstream the bridge in bay 2



DB0-004. ADCP cross section velocity profile just upstream the bridge in bay 1



MONITORING DATA			
Site Name[21]: San Mateo Avenue	**I.D. Number[1]:** 23	**Reach:** 2B	**River Mile:** 211.8
Date: May 19, 2011	**Flow:** 1,160 cfs	**Mean Velocity:** 0.816 ft/s	

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

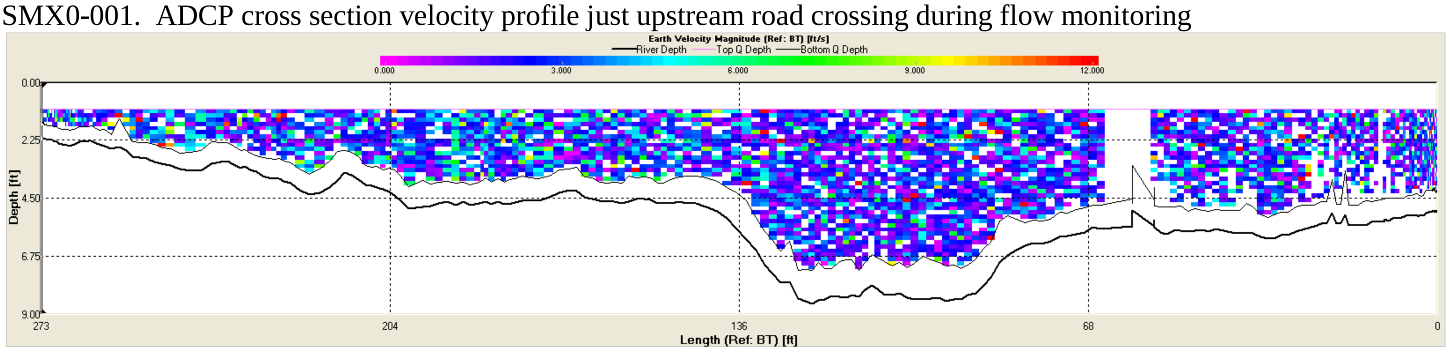
SECOND PASS DESCRIPTION

San Mateo Avenue had water surface elevations (WSE), flow and velocity data collected on May 19, 2011 by DWR with an ADCP and GPS. Flows were surveyed about 20 feet upstream the road. The road was submerged during the flow monitoring. DWR used an ADCP to collect flow, velocity, and depth data for the cross sections displayed in the previous map. Water Surface Elevations (WSE) were collected during the time of the monitoring by GPS. The WSE are approximate elevations and may vary due to the soil conditions and access. The flow and velocity data was used to calibrate the one dimension HEC-RAS model for Task 2. Additional data that has been reviewed and processed was reviewed for calibration reasonableness included the CDEC gage on the San Joaquin River at San Mateo Road near Mendota.

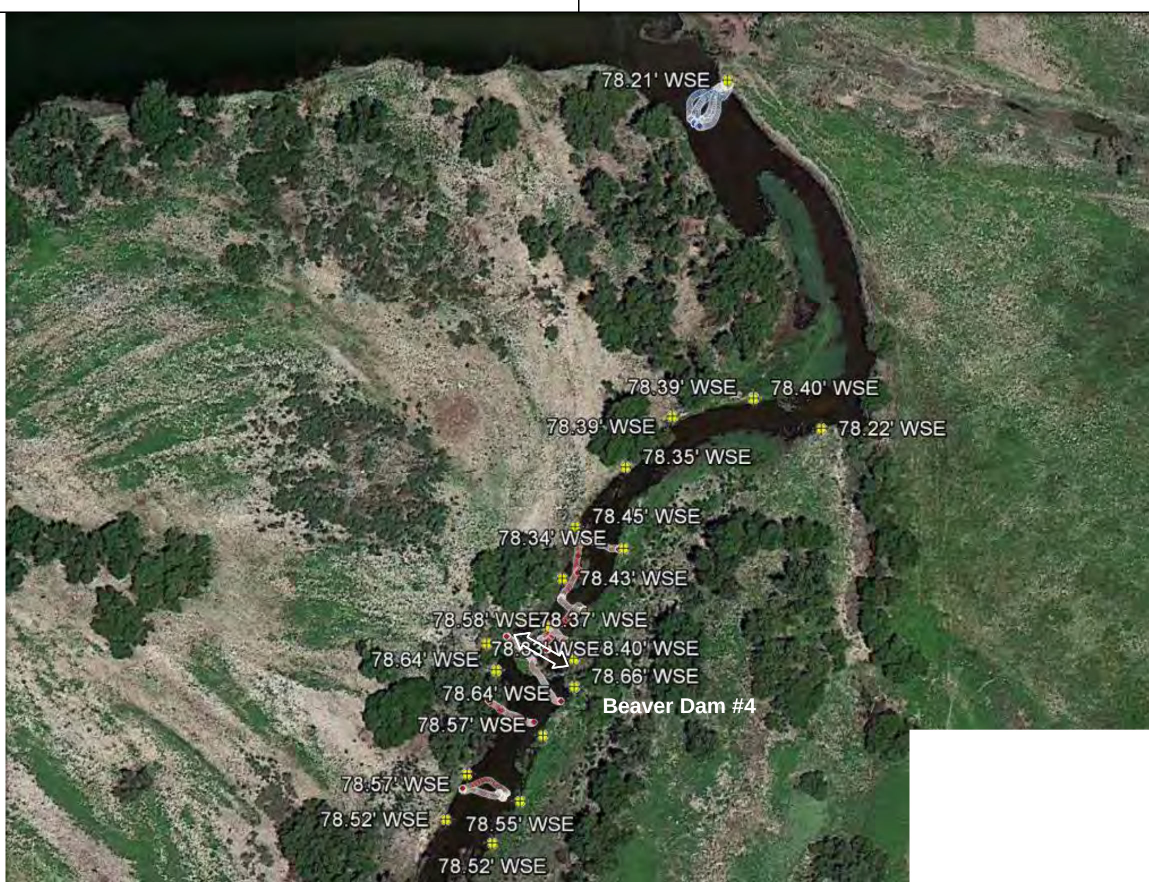
An ADCP cross sectional velocity profile from one of the flow measurements upstream the weir is provided to display a three dimensional view of the velocities.

<u>Data Cross Section:</u>

SMX0-001. ADCP cross section velocity profile just upstream road crossing during flow monitoring



MONITORING DATA			
Site Name[22]: Beaver Dam 4	**I.D. Number[1]:** 37	**Reach:** 4B	**River Mile:** 145
Date: July 7, 2011	**Flow:** 36.1 cfs	**Average Velocity:** 0.358 ft/s	



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

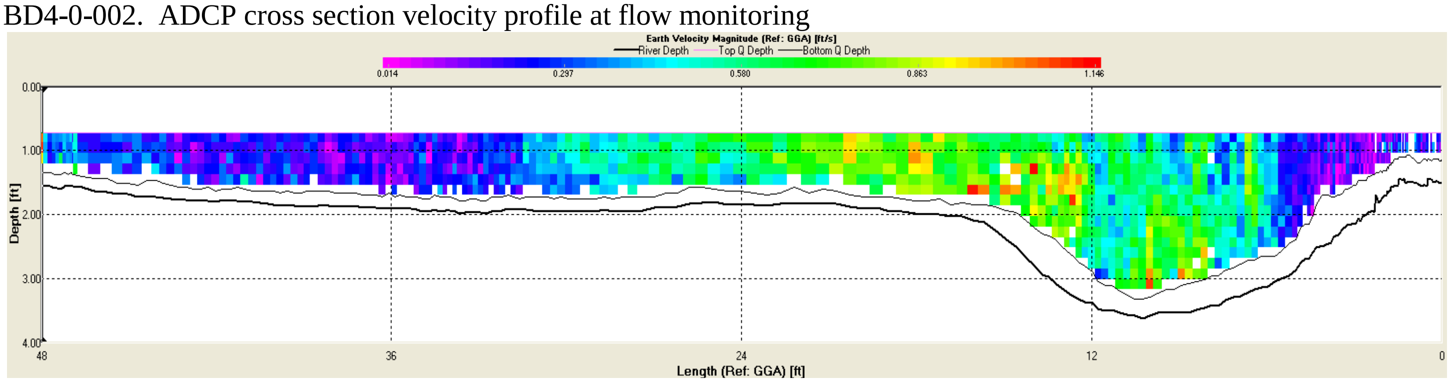
SECOND PASS DESCRIPTION

Beaver dam 4 is located within proximity to the San Luis Wildlife Refuge. Water surface elevations (WSE), flow and velocity data was collected on July 7, 2011 by DWR with an ADCP and GPS. The beaver dams were submerged during the monitoring. Flows were surveyed about 620 feet downstream beaver dam 4. DWR used an ADCP to collect flow, velocity, and depth data as displayed in the previous map. Water Surface Elevations (WSE) were collected during the time of the monitoring by GPS. The WSE are approximate elevations and may vary due to the soil conditions and access. The flow and WSE data was used to calibrate the one dimension HEC-RAS model for Task 2.

An ADCP cross sectional velocity profile from one of the flow measurements downstream both structures is provided to display a three dimensional view of the velocities. Additional cross sectional velocity profiles include the cross section just downstream beaver dam 1 and with a section that includes beaver dam 2.

<u>Data Cross Section:</u>

BD4-0-002. ADCP cross section velocity profile at flow monitoring



MONITORING DATA			
Site Name[23]: SLWR Low Flow Crossing	**I.D. Number[1]:** 69	**Reach:** 4B	**River Mile:**
Date: May 24, 2011	**Flow:** 32.5 cfs	**Average Velocity:** 0.066 ft/s	

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

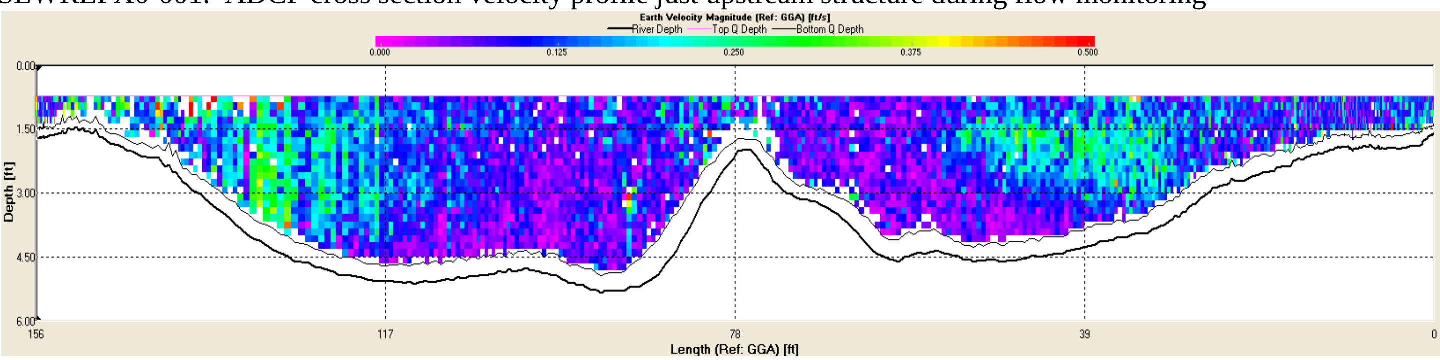
SECOND PASS DESCRIPTION

The San Luis Wildlife Refuge Low Flow Crossing had water surface elevations (WSE), flow and velocity data collected on May 24, 2011 by DWR with an ADCP and GPS. The crossing was submerged during the monitoring. Flows were surveyed about 275 feet upstream the crossing. DWR used an ADCP to collect flow, velocity, and depth data as displayed in the previous map. Water Surface Elevations (WSE) were collected during the time of the monitoring by GPS. The WSE are approximate elevations and may vary due to the soil conditions and access. The flow and WSE data was used to calibrate the one dimension HEC-RAS model for Task 2.

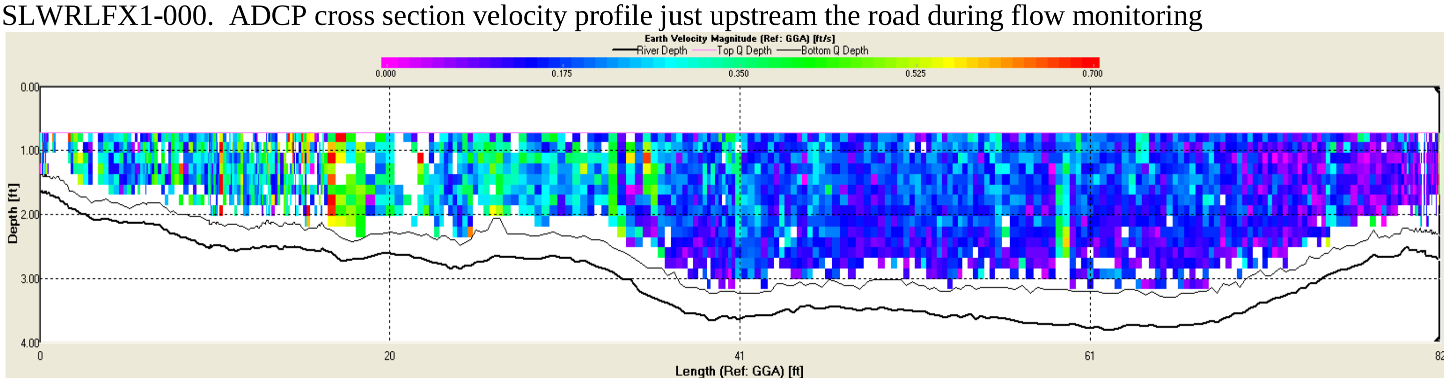
An ADCP cross sectional velocity profile from one of the flow measurements upstream the structure is provided to display a three dimensional view of the velocities. Additional cross sectional velocity profiles include the cross section just upstream the crossing.

<u>Data Cross Section:</u>

SLWRLFX0-001. ADCP cross section velocity profile just upstream structure during flow monitoring



SLWRLFX1-000. ADCP cross section velocity profile just upstream the road during flow monitoring



TOPOGRAPHY

Topographic data was collected on November 17, 2011 by using GPS and Total Station. Elevations were set based on surveyed control near the structure. Elevation data was focused on the model cross sections to supplement surface elevations to build the crossing into the model.

MONITORING DATA			
Site Name[24]: Beaver Dam 1 & 2	**I.D. Number[1]:** 41 & 40	**Reach:** 4B	**River Mile:** 137.7
Date: May 24, 2011	**Flow:** 41.0 cfs	**Average Velocity:** 0.070 ft/s	

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

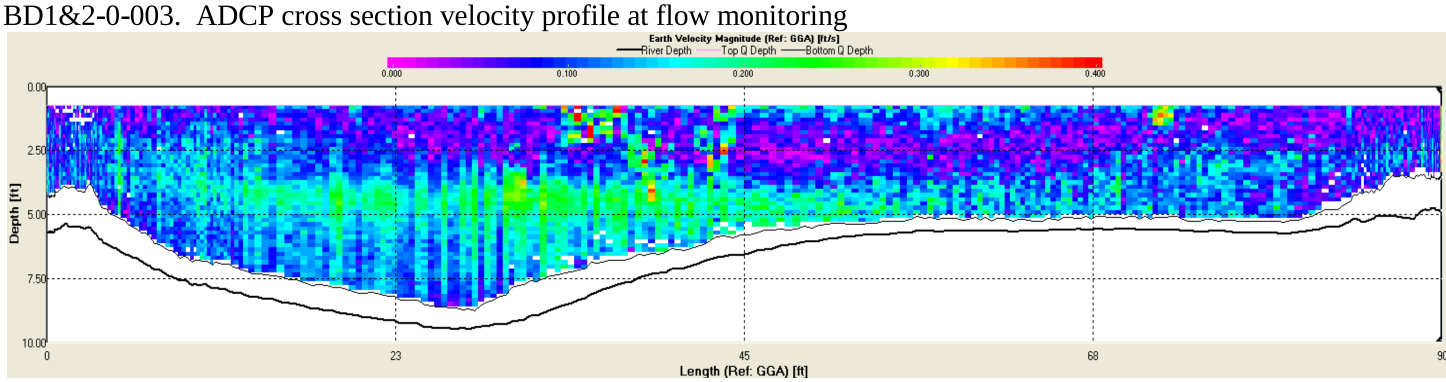
SECOND PASS DESCRIPTION

Beaver dam 1 & 2 are located within the San Luis Wildlife Refuge. Water surface elevations (WSE), flow and velocity data was collected on May 24, 2011 by DWR with an ADCP and GPS. The beaver dams were submerged during the monitoring. Flows were surveyed about 720 feet downstream beaver dam 1. DWR used an ADCP to collect flow, velocity, and depth data as displayed in the previous map. Water Surface Elevations (WSE) were collected during the time of the monitoring by GPS. The WSE are approximate elevations and may vary due to the soil conditions and access. The flow and WSE data was used to calibrate the one dimension HEC-RAS model for Task 2.

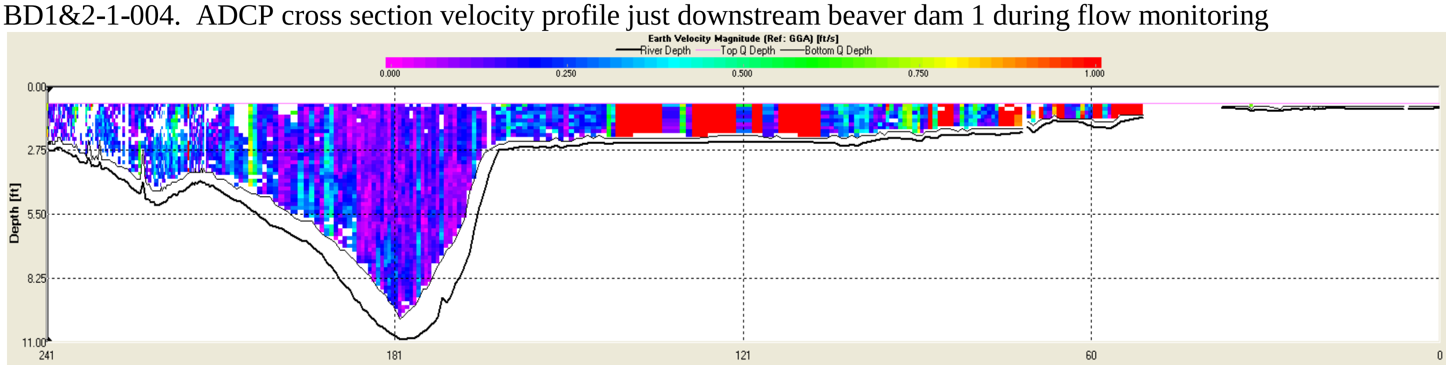
An ADCP cross sectional velocity profile from one of the flow measurements downstream both structures is provided to display a three dimensional view of the velocities. Additional cross sectional velocity profiles include the cross section just downstream beaver dam 1 and with a section that includes beaver dam 2.

<u>Data Cross Section:</u>

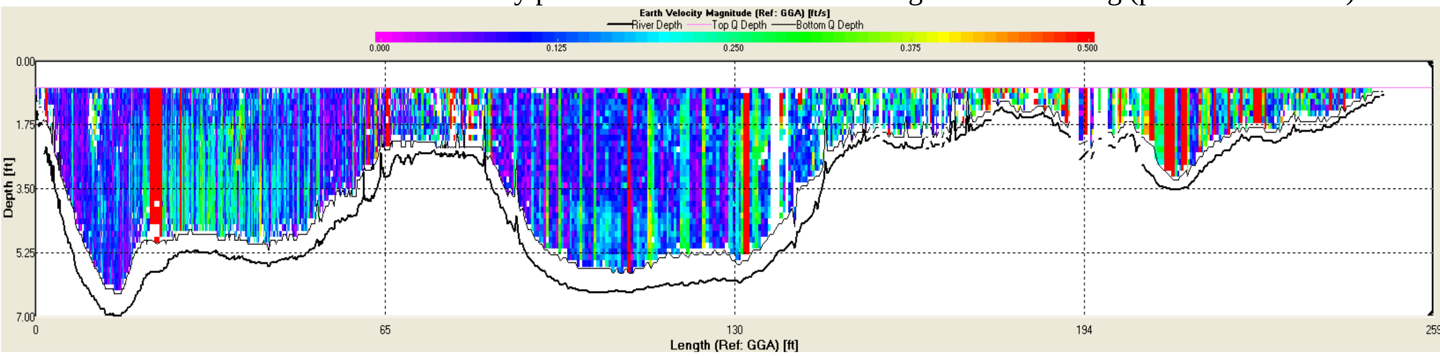
BD1&2-0-003. ADCP cross section velocity profile at flow monitoring



BD1&2-1-004. ADCP cross section velocity profile just downstream beaver dam 1 during flow monitoring



BD1&2-1-004. ADCP cross section velocity profile with beaver dam 2 during flow monitoring (portion of section)



MONITORING DATA			
Site Name[25]: Eastside Bypass Control	**I.D. Number[1]:** 48	**Reach:** 4B	**River Mile:**
Date: May 23, 2011	**Flow:** 1,720 cfs	**Average Velocity:** 1.79 ft/s	

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

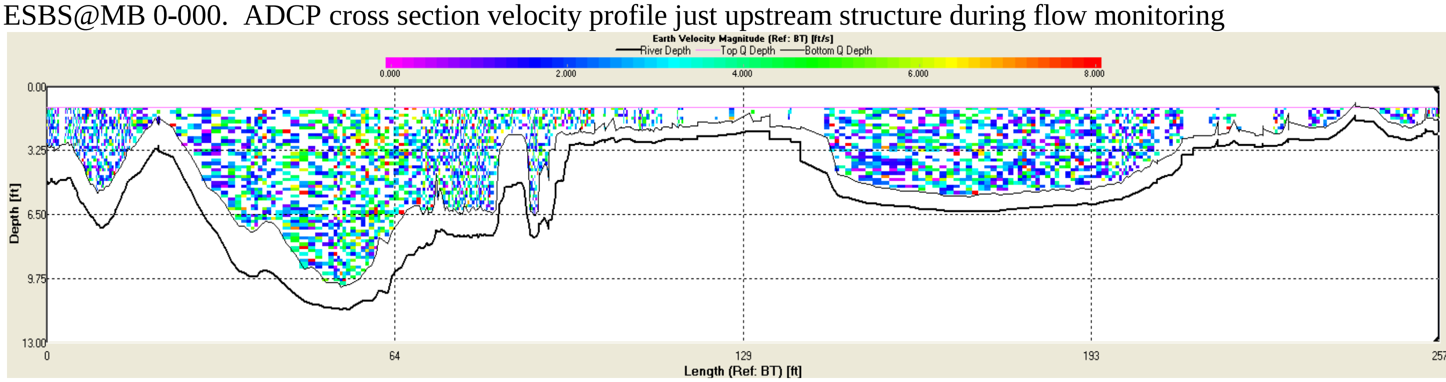
SECOND PASS DESCRIPTION

Eastside Bypass control structure had water surface elevations (WSE), flow and velocity data collected on May 23, 2011 by DWR with an ADCP and GPS. Flows were surveyed about 530 feet upstream and 545 feet downstream the structure. The flows were used to determine if there were any flow changes; none were observed. DWR used an ADCP to collect flow, velocity, and depth data as displayed in the previous map. Water Surface Elevations (WSE) were collected during the time of the monitoring by GPS. The WSE are approximate elevations and may vary due to the soil conditions and access. The flow and WSE data was used to calibrate the one dimension HEC-RAS model for Task 2.

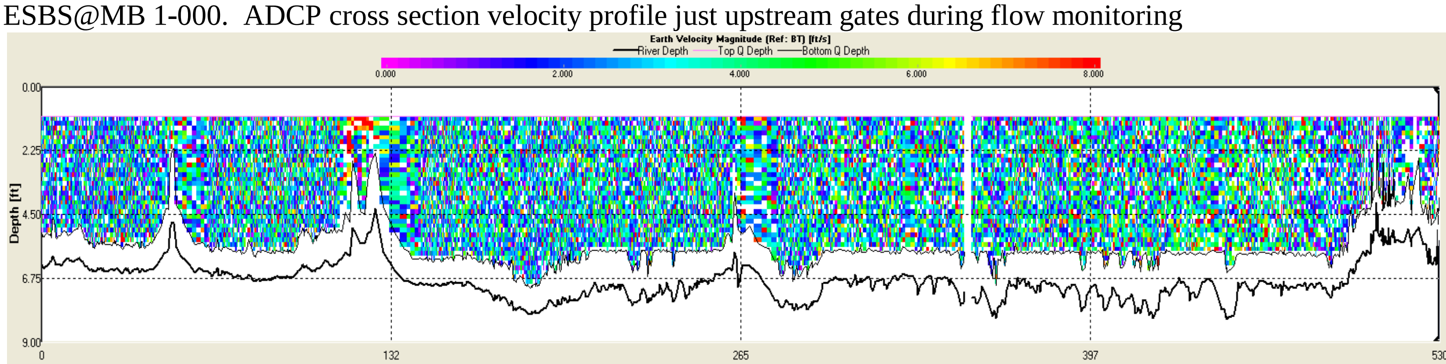
An ADCP cross sectional velocity profile from one of the flow measurements upstream the structure is provided to display a three dimensional view of the velocities. Additional cross sectional velocity profiles include just upstream the inlet gates, just downstream the baffles on the concrete apron, and just downstream the structure.

<u>Data Cross Section:</u>

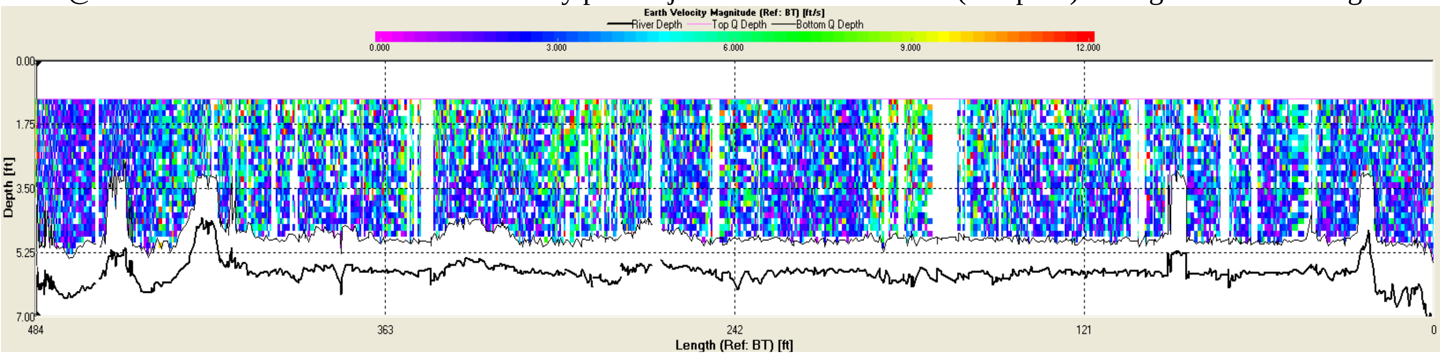
ESBS@MB 0-000. ADCP cross section velocity profile just upstream structure during flow monitoring



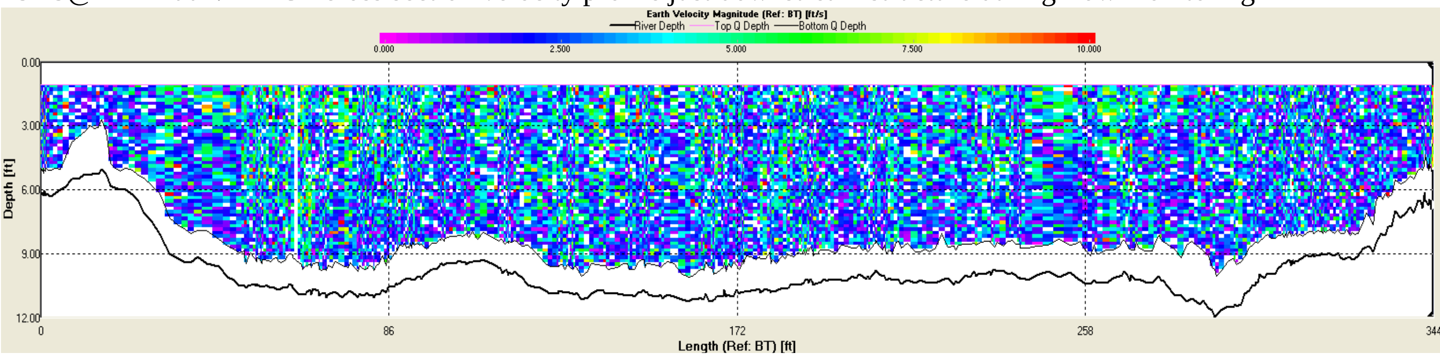
ESBS@MB 1-000. ADCP cross section velocity profile just upstream gates during flow monitoring



ESBS@MB 1-003. ADCP cross section velocity profile just downstream baffles (on apron) during flow monitoring



ESBS@MB 1-001. ADCP cross section velocity profile just downstream structure during flow monitoring



SAN JOAQUIN RIVER RESTORATION PROGRAM

TASK 2 DATA COLLECTION

EASTSIDE BYPASS CONTROL STRUCTURE

TOPOGRAPHY

Topographic data was collected on November 29, 2011 by using GPS. Elevations were set based on surveyed control near the structure. Elevation data was focused on the structure to supplement design elevations to build the structure into the model based on current conditions.

MONITORING DATA			
Site Name[26]: Mariposa Bypass Control	**I.D. Number[1]:** 49	**Reach:** 4B	**River Mile:**
Date: Nov. 29, 2011	**Flow:** 0 cfs	**Average Velocity:**	

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

TOPOGRAPHY

Topographic data was collected on November 29, 2011 by using GPS. Elevations were set based on surveyed control near the structure. Elevation data was focused on the structure to supplement design elevations to build the structure into the model based on current conditions.

MONITORING DATA			
Site Name[27]: Dan McNamara Road	**I.D. Number[1]:** 51	**Reach:** 4B	**River Mile:**
Date: May 10, 2011	**Flow:** 1,860 cfs	**Average Velocity:** 2.29 ft/s	

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

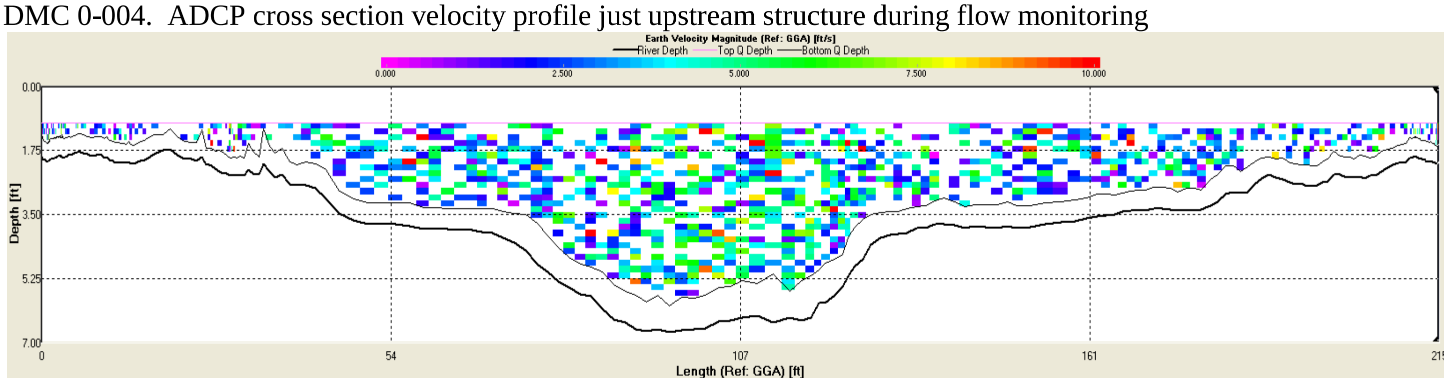
SECOND PASS DESCRIPTION

Dan McNamara Road crossing had water surface elevations (WSE), flow and velocity data collected on May 10, 2011 by DWR with an ADCP and GPS. The crossing was submerged during the monitoring. Flows were surveyed about 270 feet upstream the crossing. DWR used an ADCP to collect flow, velocity, and depth data as displayed in the previous map. Water Surface Elevations (WSE) were collected during the time of the monitoring by GPS. The WSE are approximate elevations and may vary due to the soil conditions and access. The flow and WSE data was used to calibrate the one dimension HEC-RAS model for Task 2.

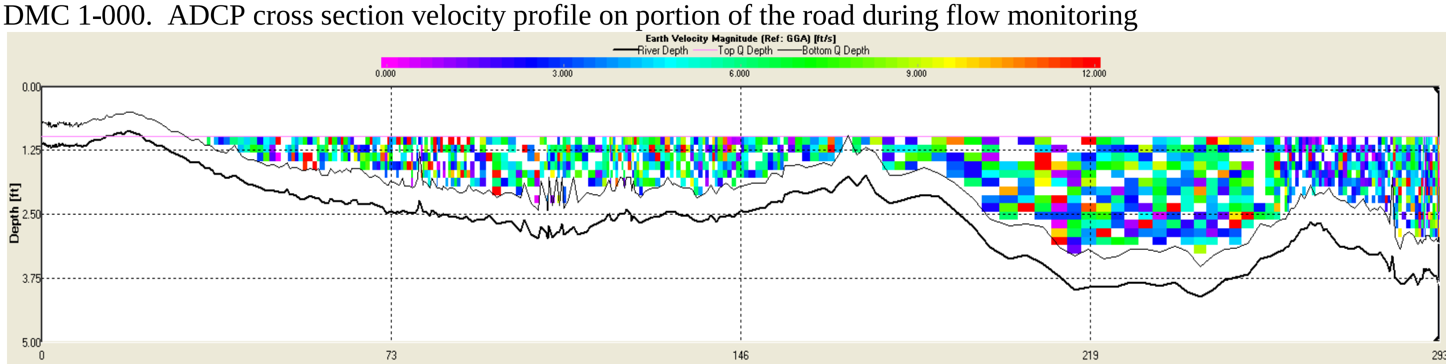
An ADCP cross sectional velocity profile from one of the flow measurements upstream the structure is provided to display a three dimensional view of the velocities. Additional cross sectional velocity profiles include the cross section for a portion of the crossing and the rest just downstream the crossing.

<u>Data Cross Section:</u>

DMC 0-004. ADCP cross section velocity profile just upstream structure during flow monitoring



DMC 1-000. ADCP cross section velocity profile on portion of the road during flow monitoring



TOPOGRAPHY

Topographic data was collected on September 28, 2011 by using GPS and Total Station. Elevations were set based on surveyed control at the Eastside Bypass Control Structure. Elevation data was focused on the road and culvert elevations to build the crossing into the model.

MONITORING DATA			
Site Name[28]: Rock Weir	**I.D. Number[1]:** 69	**Reach:** 4B	**River Mile:**
Date: July 7, 2011	**Flow:** 1,840 cfs	**Average Velocity:** 1.82 ft/s	

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

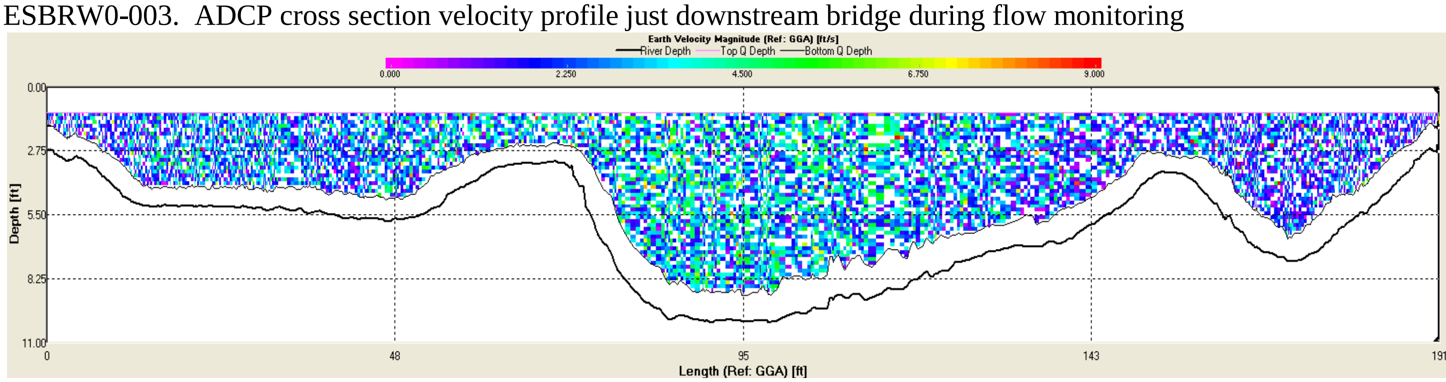
SECOND PASS DESCRIPTION

The Eastside Bypass Rock Weir had water surface elevations (WSE), flow and velocity data collected on July 7, 2011 by DWR with an ADCP and GPS. The weir was submerged during the monitoring. Flows were surveyed about 350 feet upstream the crossing. DWR used an ADCP to collect flow, velocity, and depth data as displayed in the previous map. Water Surface Elevations (WSE) were collected during the time of the monitoring by GPS. The WSE are approximate elevations and may vary due to the soil conditions and access. The flow and WSE data was used to calibrate the one dimension HEC-RAS model for Task 2.

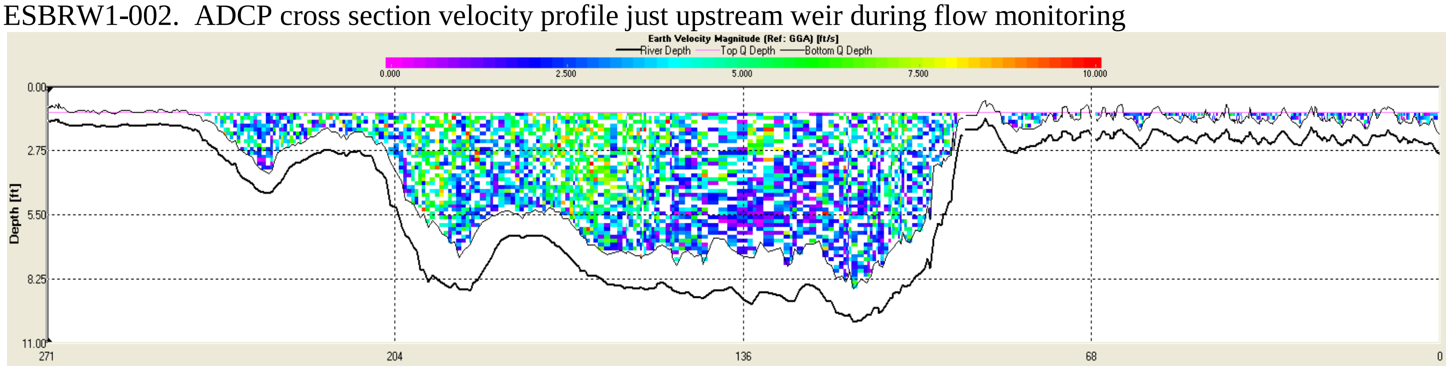
An ADCP cross sectional velocity profile from one of the flow measurements upstream the weir is provided to display a three dimensional view of the velocities. Additional cross sectional velocity profiles include the cross section just upstream and downstream the weir.

<u>Data Cross Section:</u>

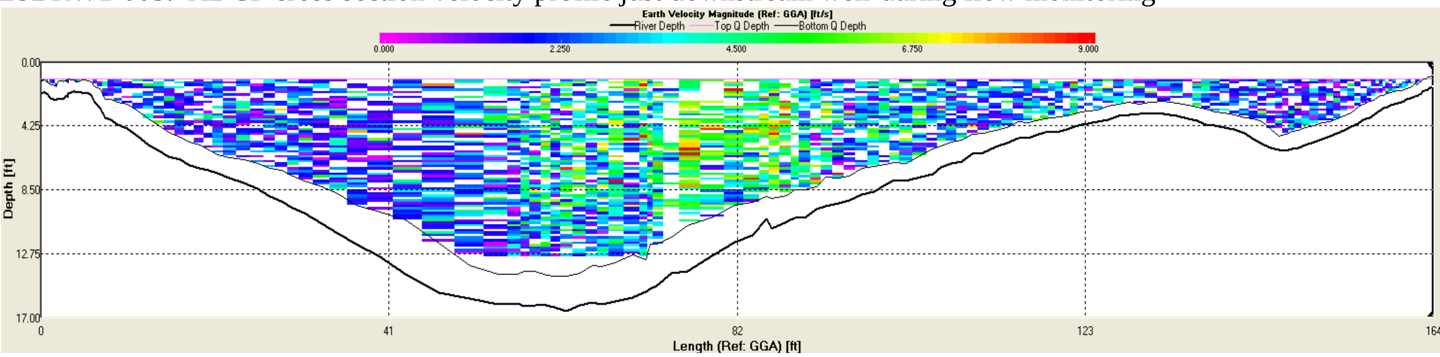
ESBRW0-003. ADCP cross section velocity profile just downstream bridge during flow monitoring



ESBRW1-002. ADCP cross section velocity profile just upstream weir during flow monitoring



ESBRW1-003. ADCP cross section velocity profile just downstream weir during flow monitoring



TOPOGRAPHY

Topographic data was collected on October 4, 2011 by using GPS and Total Station. Elevations were set based on surveyed control at the bridge just upstream the weir. Elevation data was focused on the model cross sections to supplement surface elevations to build the weir into the model.

MONITORING DATA			
Site Name[29]: Merced Refuge Weir #1	**I.D. Number[1]:** 71	**Reach:** 4A	**River Mile:**
Date: January 18, 2011	**Flow:**		**Average Velocity:**

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

TOPOGRAPHY

Topographic data was collected on January 18, 2011 by using GPS. Elevations were set based on surveyed control near Dan McNamara Road. Elevation data was focused on the structure to build the structure into the model based on current conditions.

MONITORING DATA			
Site Name[30]: Merced Refuge Weir #2	**I.D. Number[1]:** 70	**Reach:** 4A	**River Mile:**
Date: January 18, 2011	**Flow:**	**Average Velocity:**	

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

TOPOGRAPHY

Topographic data was collected on January 18, 2011 by using GPS. Elevations were set based on surveyed control near Dan McNamara Road. Elevation data was focused on the structure to build the structure into the model based on current conditions.

This page was intentionally left blank

APPENDIX C

Friant Routing

This page was intentionally left blank

Table 2.2 Summary of local flows and average annual change in duration under project conditions associated with Friant release flows.							
Friant Release (cfs)	Local Discharge (cfs)						
	Reach 2A (Gravelly Ford)	Reach 2B[1]	Reach 3	Reach 4A	Reach 4B1 (lower)[2]	Reach 4B2	Reach 5
200	50	0	300	0	0	0	0
500	350	240	540	240	240	240	290
1,000	850	710	1,010	710	475	710	810
1,200	1,050	900	1,200	900	475	900	1,040
1,400	1,250	1,090	1,390	1,090	475	1,090	1,250
1,600	1,450	1,290	1,590	1,290	475	1,290	1,450
2,000	1,850	1,670	1,970	1,670	475	1,670	1,870
2,500	2,350	2,160	2,460	2,160	475	2,160	2,400
3,000	2,850	2,650	2,950	2,650	475	2,650	2,950
3,500	3,350	3,150	3,450	3,150	475	3,150	3,530
4,000	3,850	3,640	3,940	3,640	475	3,640	4,100
4,500	4,350	4,130	4,430	4,130	475	4,130	4,690
Friant Release (cfs)	Chowchilla Bypass	Eastside Bypass (below Sand Slough)[3]	Eastside Bypass (at Mariposa)[3]	Eastside Bypass (at Bear Ck)[3]	Mariposa Bypass[3]		
200	0	0	0	0	0		
500	0	240	240	290	240		
1,000	0	710	710	810	710		
1,200	0	900	900	1,040	900		
1,400	0	1,090	1,090	1,250	1,090		
1,600	0	1,290	1,290	1,450	1,290		
2,000	0	1,670	1,670	1,870	1,670		
2,500	0	2,160	2,160	2,400	2,160		
3,000	0	2,650	2,650	2,950	2,650		
3,500	0	3,150	3,150	3,530	3,150		
4,000	0	3,640	3,640	4,100	3,640		
4,500	0	4,130	4,130	4,690	4,130		

[1] Changes in flow duration are based on interim flow conditions hydrology.
[2] Based on full restoration conditions only. No flow is diverted into Reach 4B1 under interim conditions.
[3] Changes in flow duration are based on interim-condition operating rule at SSCS.

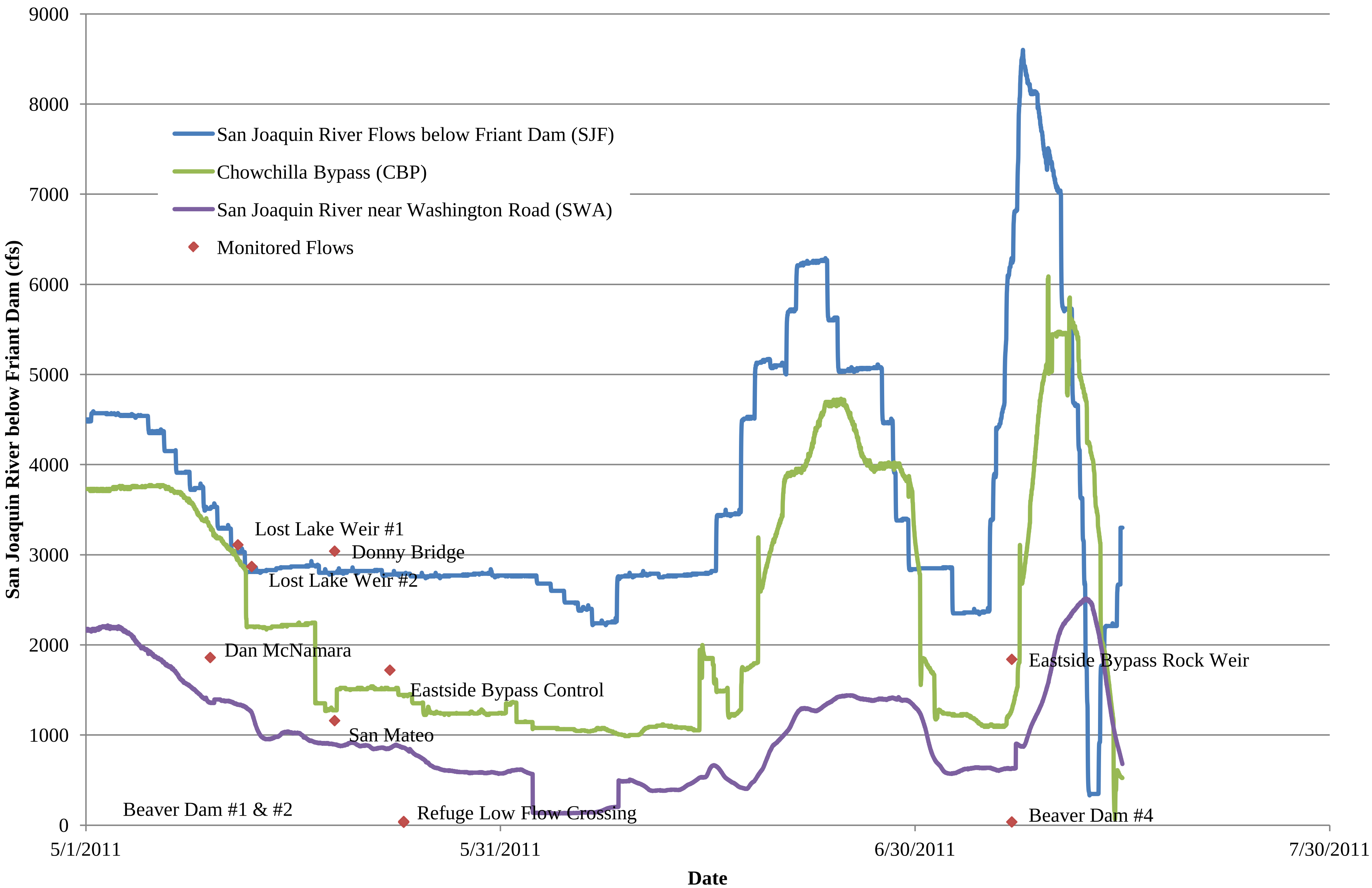


Figure 4. Monitored flows at each structure compared to flow downstream Friant Dam and the bypass system