Vern Freeman Dam Fish Passage
Conceptual Design Report
- FINAL -
September 15, 2010

Prepared for: United Water Conservation District

Prepared by: Vern Freeman Dam Fish Passage Panel

Vern Freeman Dam Fish Passage Conceptual Design Report

- Final -

September 15, 2010

Prepared by:

Vern Freeman Dam Fish Passage Panel

Kozmo Ken Bates, P.E., fish passage engineer consultant, Kozmo, Inc.
Dennis Dorratcague, P.E., MWH Americas
Jon Mann, P.E., HDR Fisheries Design Center
Dana Postlewait, P.E., R2 Resource Consultants, Inc.
Steve Thomas, P.E., National Marine Fisheries Service
Bill Trush, Ph.D., Environmental consultant, McBain and Trush

Panel Facilitator: Dr. Terry Roelofs; emeritus Professor of Fisheries Biology
Humboldt State University

Prepared for:

United Water Conservation District

106 N. 8th St
Santa Paula, CA 93060

Cover photo: Vern Freeman Diversion Dam, Santa Clara River. Pictometry International Corporation through Bing maps on www.bing.com. Date unknown.

CONTENTS

FIGURES

TABLES

EXECUTIVE SUMMARY

In October 2008, the National Marine Fisheries Service and the United Water Conservation District approved the appointment of six engineers and biologists to an independent panel that would evaluate the upstream passage of steelhead rainbow trout at the Vern Freeman Diversion Dam (VFDD) on the Santa Clara River. This report details how the Panel conducted its evaluation of the current fish passage issues and facilities at the dam, describes several alternative designs to improve upstream and downstream fish passage, and concludes with recommendations that the current fish passage facilities be replaced by one of the alternatives developed by the Panel.

The Panel began by collecting and evaluating available information for the project. This primarily included reviewing existing fish passage facilities, current diversion operations, hydrology and hydraulic information. This review helped Panel members to understand the current fish passage performance of the facility, as a basis to develop ideas to improve fish passage. A detailed description of this background information is in Section 2. The Panel found this information sufficient for its purposes at this phase of the project.

The Santa Clara River is at the southern fringe of the steelhead's range. In drier years, annual spawning success will be erratic even under natural, unimpaired conditions. Good spawning success may only occur in those wet years with just the right timing of brief winter storms and/or a protracted spring snowmelt runoff event. Adult steelhead migration delay at VFDD could risk annual spawning success; therefore, a risk assessment of potential delay was conducted. Results from the risk assessment, presented in Section 3, recommend a range of passage streamflows from 45 cfs up to 6,000 cfs at VFDD that would minimize loss of long-term annual spawning success within the Santa Clara River Basin. This range, or window of passage streamflows, became an important design parameter for engineering and evaluating the Panel's fishway alternatives.

Section 4 describes important flow-related terminology and concepts used in fish passage design and project development. Based on these concepts, flow data analysis, results of the spawning success risk assessment in Section 3, and professional judgment, the Panel decided to evaluate attraction for each fish passage alternative with respect to four weighted ranges of streamflows spanning 45 cfs to 6,000 cfs, rather than rely just on a single upper and lower passage design flow.

The Panel brainstormed potential fish passage solutions, narrowing the list to five alternative solutions: a vertical slot fishway, a nature-like fishway, a rock ramp, a hardened ramp, and dam removal. These alternatives are described in detail though the dam removal alternative is not developed thoroughly because issues associated with it are beyond the scope and expertise of the Panel. The alternatives were presented to United Water, National Marine Fisheries Service, and California Trout at several levels of development. Comments were received and resolved.

Throughout the study, the Panel used typical fish passage characteristics to develop and compare alternatives. A Pugh scoring matrix was used to compare these characteristics among alternatives and to refine the designs; estimated cost was not considered when comparing alternatives. The effectiveness of fish attraction to the fishway entrance is a critical characteristic. To distinguish the differences of this characteristic among alternatives, the Panel developed and used a method of comparing the attraction of the alternatives based on flow near the fishway entrance.

The Panel concluded that improvements to the existing fish ladder would not improve passage sufficiently to be a viable alternative compared to alternatives of a new passage facility. The cost to improve the existing fish ladder to state-of-the-art standards could be comparable to the cost of the fish passage alternatives developed for this report. In addition to the upstream passage issues, the Panel concluded that the existing fish screen structure is deficient and should be upgraded.

The Panel concluded that the alternative of dam removal should be investigated as a long-term goal of the interested parties. The Panel did not develop the concept because it involves many issues far beyond the scope and expertise of the Panel. The four other concepts that were developed ranked very closely to each other in the comparison matrix and, at this level of detail and precision, they should be considered to have equal scores.

Conceptual-level opinions of probable construction cost were estimated for each of the four alternatives, with the primary goal to allow comparison between them. The construction cost for the Vertical Slot Fishway was estimated as $24 million. The construction cost for the Rock Ramp alternative was estimated at $46 million. The construction cost for the Hardened Ramp alternative was estimated at $24 million. The construction cost for the Nature-Like Fishway alternative was estimated at $28 million. These cost estimates are very conceptual and should not be used for budgeting purposes until developed further.

The Panel concluded that the final four fish passage alternatives appear, at this level of analysis and design, practical and effective for passing fish at VFDD and minimizing spawning risk.

However, after considering costs and the evaluation results, the Panel recommended that additional work be focused on the development of the Vertical Slot Fishway and the Hardened Ramp alternatives. These two remaining alternatives offer unique solutions that would both offer distinct passage improvements and varying risks of development.

The Panel recommended that next steps include the consideration of these alternatives in future discussions to improve fish passage at the VFDD such as the Habitat Conservation Plan. To identify which of the alternatives is most appropriate the Panel recommended further study requirements such as additional engineering analyses, new geotechnical investigation, additional and more detailed drawings, and operational studies coordinating the diversion and fish passage operations.

1. INTRODUCTION

1.1 PROBLEM STATEMENT AND OBJECTIVES

United Water Conservation District (UWCD) operates Vern Freeman Diversion Dam (VFDD) on the Santa Clara River, Ventura County, California. The water diverted recharges ground water supplies and reduces seawater intrusion in lower reaches of the watershed and the Oxnard Plain groundwater basin. The diversion also serves surface water needs to local farms. Steelhead rainbow trout (*Oncorhynchus mykiss*), maintain a small population in the Santa Clara River and its tributaries. This population is in the metapopulation of steelhead comprising the Southern California Distinct Population Segment and is classified as endangered under the Endangered Species Act. The National Marine Fisheries Service (NMFS), Southwest Region issued a final Biological Opinion (Administrative Record File # 151422SWR01PR6149) in July 2008 that concluded that operations at the VFDD were likely to jeopardize the continued existence of steelhead trout in the Santa Clara River (NMFS, 2008a). Element 1 of the Reasonable and Prudent Alternative (RPA) of this Biological Opinion authorized Dr. Terry Roelofs, emeritus Professor of Fisheries Biology at Humboldt State University, to convene "a panel of qualified fish passage engineers, hydrologists, and fish biologists and serve as facilitator of this panel" (page 67 of the Biological Opinion). The fish passage expert panel's (Panel) charge was to review the operations by UWCD at VFDD regarding upstream passage of steelhead trout and make recommendations for modifying or replacing the existing fish passage facilities ("the Panel shall conduct a formal alternative study for two purposes: 1) identification of interim physical modifications and 2) identification of long-term physical modification"....page 68 of the Biological Opinion).

The Biological Opinion was made non-binding when the Bureau of Reclamation separated from the project in 2008. In response to a potential lawsuit by California Trout (CalTrout), UWCD agreed to abide by Element 1 of the RPA in the July 2008 Biological Opinion from NMFS. This report is the Panel's evaluation of five alternatives to provide upstream fish passage at the VFDD.

1.2 OVERVIEW OF FISH PANEL PROCESS

The six Panel members toured the VFDD on 21 November 2008 and observed a discharge of 40 cubic feet per second down the fish ladder and a water release through the dam's flushing channel. Several of the Panel members have inspected the site a number of additional times. The Panel developed a list of possible interim physical modifications that could increase the upstream

migration of steelhead through the existing fishway at VFDD. UWCD has made some of the modifications and some work on these modifications continues.

On 26 August 2009 Panel members met in Los Angeles with personnel from NMFS, California Trout, and UWCD (collectively referred to as the "Group" in this report and in various documents (Appendix A)) to discuss a lawsuit settlement (CalTrout vs. Bureau of Reclamation and United Water Conservation District) and to review and refine the Panel's proposed approaches and schedule. The judge ruled that "United will use its best efforts to encourage and enable the Fish Panel's final report to be released as early as feasible and no later than August 1, 2010." This deadline was subsequently extended to 15 September 2010 (Appendix A), for this Final report. A draft report was distributed on July 30 for Group review, and comments made on the draft are provided in Appendix A, with Panel responses summarized in Appendix D.

The Panel collected site data and background information including steelhead timing, passage, and habitats within the Santa Clara Basin and at VFDD; and hydrology of the Santa Clara River; and design details, topography, photos, and operating procedures of VFDD.

The Panel held a two-day brainstorming meeting in November 2009 to consider a wide range of long term alternative measures to provide upstream passage of steelhead in the Santa Clara River. Over 30 alternatives were discussed and after mutual agreement by Panel members, nine possible alternatives were deemed suitable for further analysis. Over a series of meetings and discussions, the Panel used various brainstorming, design, and facilitation tools to further refine and optimize the alternatives. After discussions with NMFS, California Trout, and UWCD, and through further Panel deliberations, the list of alternatives was reduced to the five alternatives presented in the Alternative Comparison Matrix of this report. A detailed description is presented in Section 7.

During the consultation process, the Group agreed that the "Operative Standard" called for in the CalTrout-UWCD settlement be termed and be made equivalent to the "Design Standard" that the Panel uses in reviewing and making recommendations regarding fish passage at VFDD.

Design Standard: The overarching goal in the design process for fish passage at the Vern Freeman Diversion Dam is to maximize spawning success of steelhead trout in the Santa Clara River that equals or approaches unimpeded migration rates past the Vern Freeman Diversion Dam. Stating an Operative Standard was called for in the settlement agreement between CalTrout and UWCD. Due to the scarcity of steelhead in the basin an Operative Standard based on biological results could not be measured. Therefore, the Panel used a Design Standard based

on flows and other more measurable parameters, which are used in the development and evaluation of alternatives. The Design Standard was:

1. Design flow range of 45 to at least 6,000 cfs in the river.
2. Maximize attraction of fish to the fishway over the flow range.
3. Provide good fish access out of the fishway to the river upstream. Minimize fallback.
4. Maximize expeditious movement of steelhead through the fishway.
5. Minimize injury risk to juvenile steelhead moving downstream.
6. Minimize risk of sediment impairing fishway function.
7. Minimize fishway operation complexities.
8. Fishway must be durable, limiting down time due to component failure and maintenance.

All aspects of the Design Standard were explicitly addressed during both the development and evaluation of the alternatives, and the characteristics of each alternative reflect the standard.

1.3 RELATED WORK BY OTHERS

The Biological Opinion by NMFS (2008a) states, "United is expected to pursue and acquire a Section 10 (a) (1) (B) incidental take permit from NMFS to cover take related to the operation of the Vern Freeman Diversion Dam." UWCD is actively working on a Habitat Conservation Plan (HCP) for the VFDD. This report is intended to inform and aide negotiations in crafting an HCP for the portions relevant to VFDD.

1.4 FISH PANEL MEMBERS

Panel members and authors of this report are:

Kozmo Ken Bates, P.E., fish passage engineer consultant, Kozmo, Inc.
Dennis Dorratcague, P.E., MWH Americas
Jon Mann, P.E., HDR Fisheries Design Center
Dana Postlewait, P.E., R2 Resource Consultants, Inc.
Steve Thomas, P.E., National Marine Fisheries Service
Bill Trush, Ph.D., Environmental consultant, McBain and Trush

Panel facilitator – Dr. Terry Roelofs; emeritus Professor of Fisheries Biology at Humboldt State University

This page intentionally blank.

2. EXISTING CONDITIONS AND BACKGROUND INFORMATION USED

2.1 HYDROLOGY AND HYDRAULICS

This section includes information describing the general nature of the hydrology in the basin, flood flows, and information on headwater and tailwater elevations at the VFDD.

2.1.1 Hydrology

Flow data are available for the Lower Santa Clara River watershed from a number of sources. Much of the data are disparate and incomplete due to the dynamic nature of the river and program changes of the local government. The general hydrology of the Santa Clara River is highly variable. A plot of all annual hydrographs for the mainstem Santa Clara River above VFDD between 1956 and 2007 is depicted in the next section of this report (Fig. 3.2-2A). It provides a visual indication of the complex intra- and inter-annual variability of daily average streamflow. To highlight this variability some flow statistics are shown in Figures 2.1-1 through 2.1-3.

The Ventura County Watershed Protection District in cooperation with others completed a flood hydrology study for the main stem of the Santa Clara River in 2006 (VCWPD, 2006). This is primarily in response for new studies of the Santa Clara River Watershed Management Plan (e.g., FEMA Flood Insurance Study) and the additional stream gage data available since the last update of 1994 (and in particular the near-record peak flow that occurred in 2005). In this study the annual peak flow data for Santa Clara River at Montalvo (USGS gage number 11114000) were used. Table 2.1-1 provides the original design, the 1994 update, and the more recent 2006 update for flood flow data used at VFDD.

Table 2.1-1. Peak flood flows (cfs), Santa Clara River at Montalvo.

Frequency	1985 FEMA Original Dam Design	1994 Ventura County Update	2006 Ventura County Update
2 Year	6,800	12,500	12,800
5 Year	23,000	39,200	41,900
10 Year	41,000	66,900	72,800
20 Year	-	100,000	111,000
25 Year	80,000	-	-
50 Year	116,000	154,000	172,000
100 Year	161,000	200,000	226,000
200 Year	-	251,000	286,000
500 Year	270,000	325,000	373,000

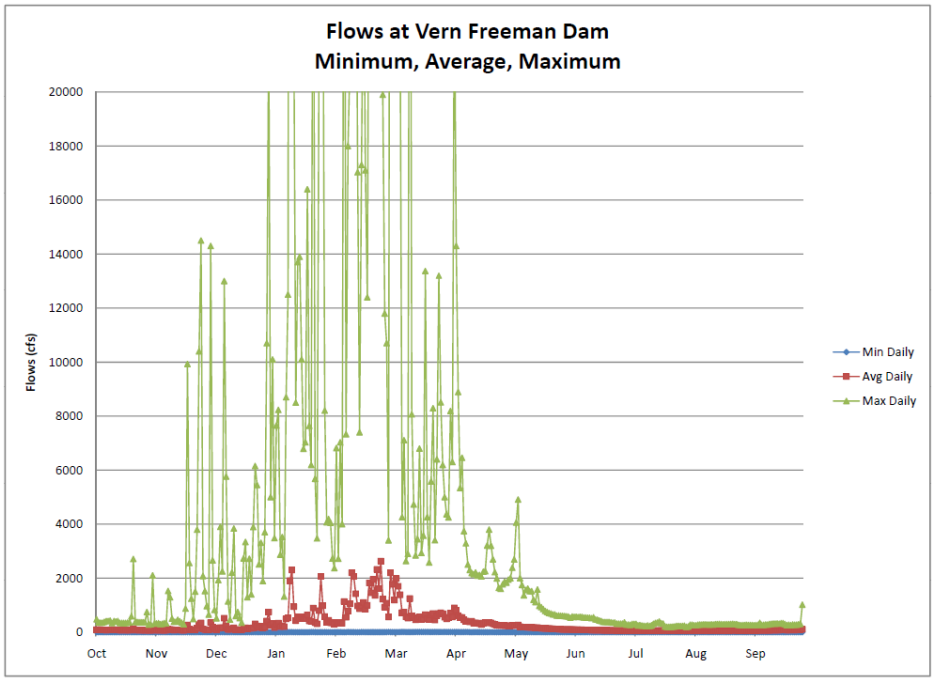


Figure 2.1-1. Minimum, average, and maximum daily average streamflow at VFDD for water years 1955 to 2007 using dataset from UWCD, Nov 26, 2008.

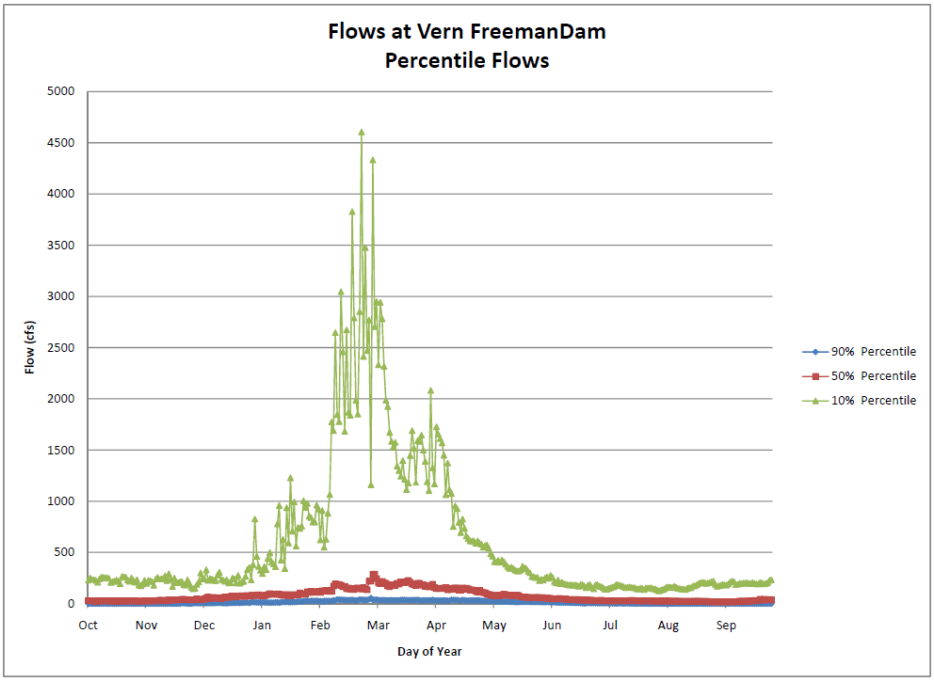


Figure 2.1-2. 90%, 50%, and 10% flow duration exceedances for daily average streamflow at VFDD for water years 1955 to 2007 using dataset from UWCD, Nov 26, 2008.

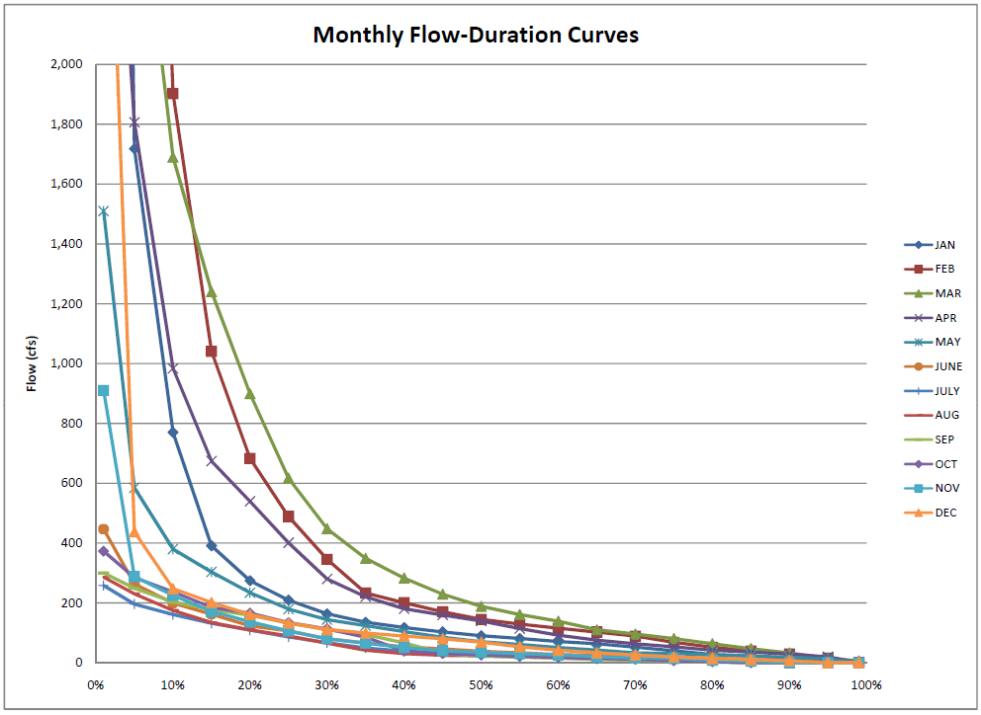


Figure 2.1-3. Monthly flow duration curves for daily average streamflow at VFDD for water years 1955 to 2007 using dataset from UWCD, Nov 26, 2008.

The Montalvo gage also has records for daily average flow. Due to the incompleteness of this gage's daily average flow record and the groundwater influences on gaining or losing portions of the river bed, UWCD has used these data in combination with other information for calculating the total river discharge at VFDD (UWCD memo, 12-23-08). A file of this calculation was sent to the Panel on November 26, 2008. These data have been used for various purposes by the Panel and where used it is outlined in those respective parts of this report.

2.1.2 Hydraulics

Headwater rating curve information is provided below in Figures 2.1-4 – 2.1-6. Figure 2.1-4 is the original curve from the design drawings. Figures 2-.1-5 and 2.1-6 provided updated curves based on measurements and observations given the current condition with much of the dam crest inactive until the stage reaches 2 to 3 feet above the dam crest.

Flow Ratings of the Freeman Dam Crest

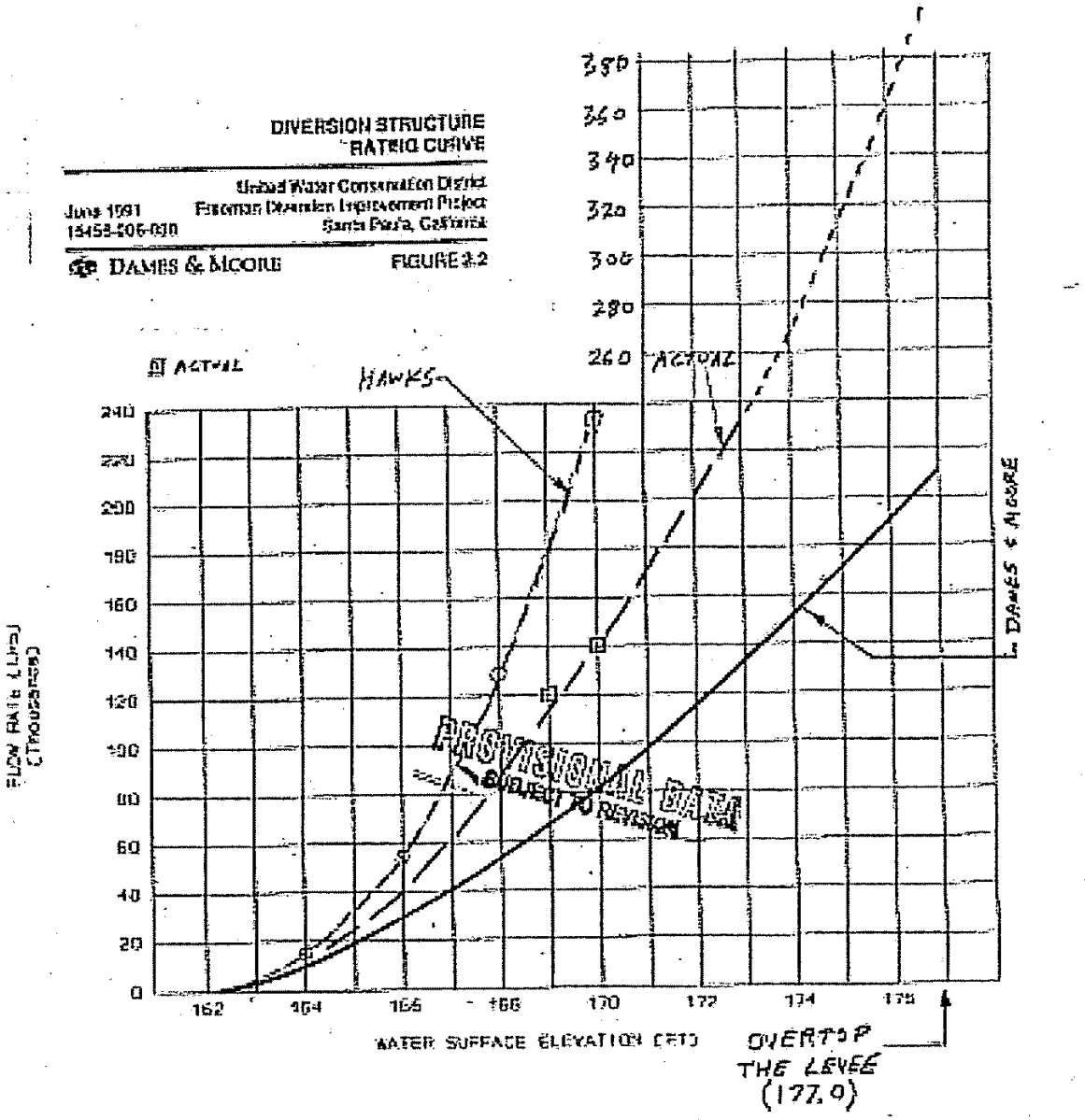


Figure 2.1-4. Stage-discharge curves upstream of the VFDD per the original design drawings.

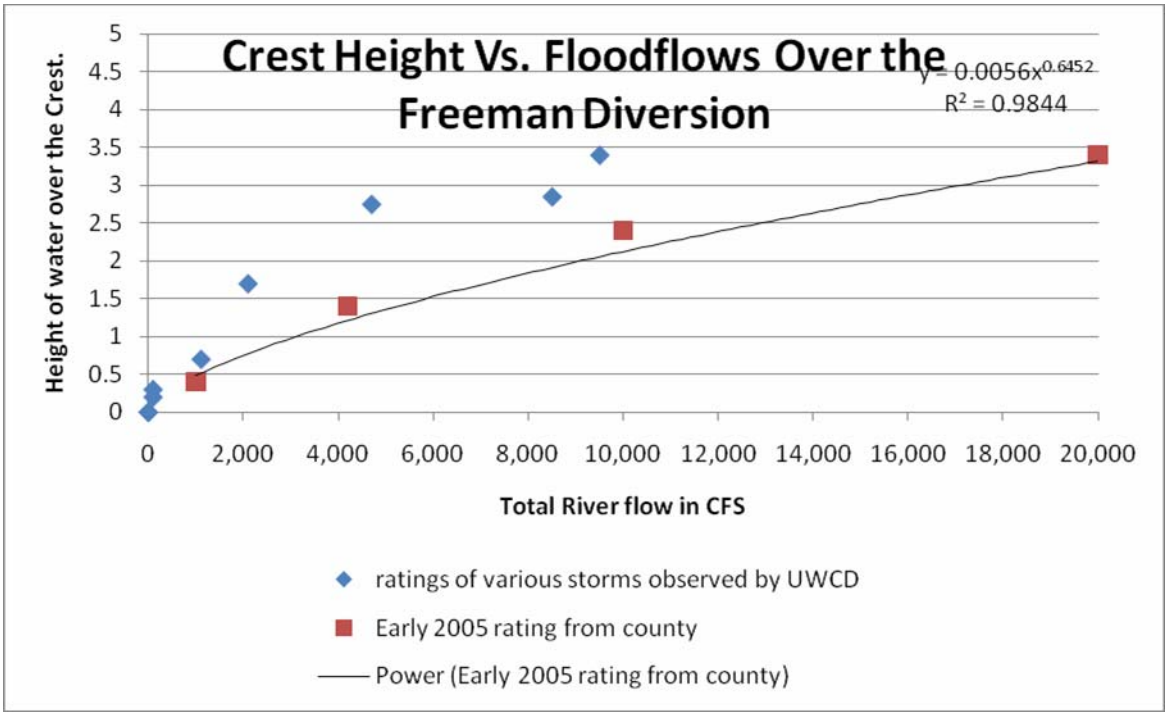


Figure 2.1-5. Forebay rating curves updated by UWCD, for flows up to 20,000 cfs (from UWCD file with name "crest flows.doc").

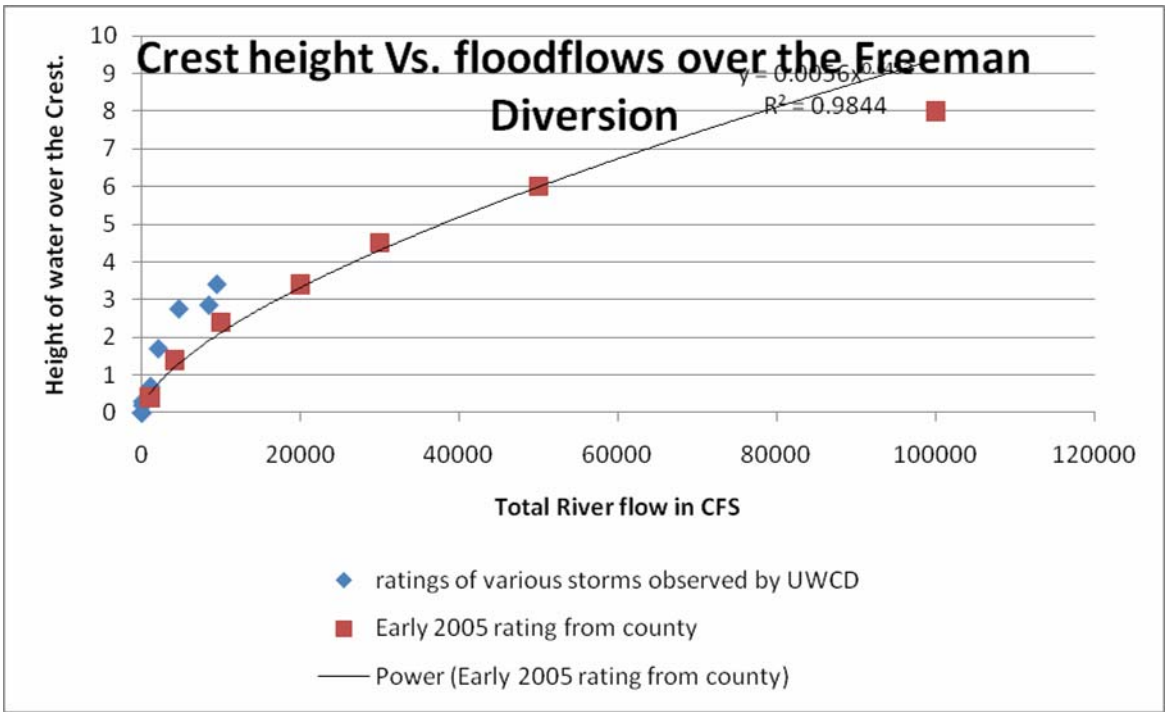


Figure 2.1-6. Forebay rating curves updated by UWCD, for flows up to 120,000 cfs (from UWCD file with name "crest flows.doc").

For the conceptual design development, the Panel used the curves shown in Figures 2.1-5 and 2.1-6 for the estimated headwater values. Additional refinement and agreement on a common headwater rating curve is recommended prior to development of any final design alternative. For the purposes of this analysis, a curve was faired through the upper data points measured by UWCD (the blue diamond-shaped points Figures 2.1-5 and 2.1-6). This is the upstream rating curve used in our analyses.

Tailwater elevation information was provided by UWCD as shown in Figure 2.1-7. Table 2.1-2 provides a summary of the values shown in the figure.

Table 2.1-2. Summary of tailwater data from Figure 2.1-7.

Stage (ft)	Discharge (cfs)	Date
138.5	100	July 2006
138.5	300	July 2006
140	300	2/04/2008
142	5,000	1/05/2008
143	4,000	1/25/2008
144	0	2/19/1999
145	5,000	1/21/1993
146	2,400	1/11/2001
148	22,000	2001
157	140,000	2005
160	200,000	2/11/1992

This information shows that the downstream bed is highly variable and dependent on flow conditions. UWCD has indicated that the river bed has been degrading since at least the mid-1950s. This was caused by a combination of artificial channelization and in-river mining activities. Halting degradation above the diversion was one of two primary project goals (the other being harvesting additional water yields to combat groundwater overdraft). The Simons and Li report (Simons, Li and Associates, 1985) indicated that 10 to 15 years of continued downstream degradation was expected once the dam was constructed and that it should stabilize once infilling upstream of the structure is complete dependent upon sediment mining operations that may occur in the river. UWCD backfilled the upstream area up to the crest of the dam in order to both eliminate beach erosion concerns and California Division of Safety of Dams jurisdiction. Relative stabilization of the river bed in current times has been observed, but it is difficult to estimate predictable tailwater elevations relative to the scale of variability that has occurred since construction of VFDD.

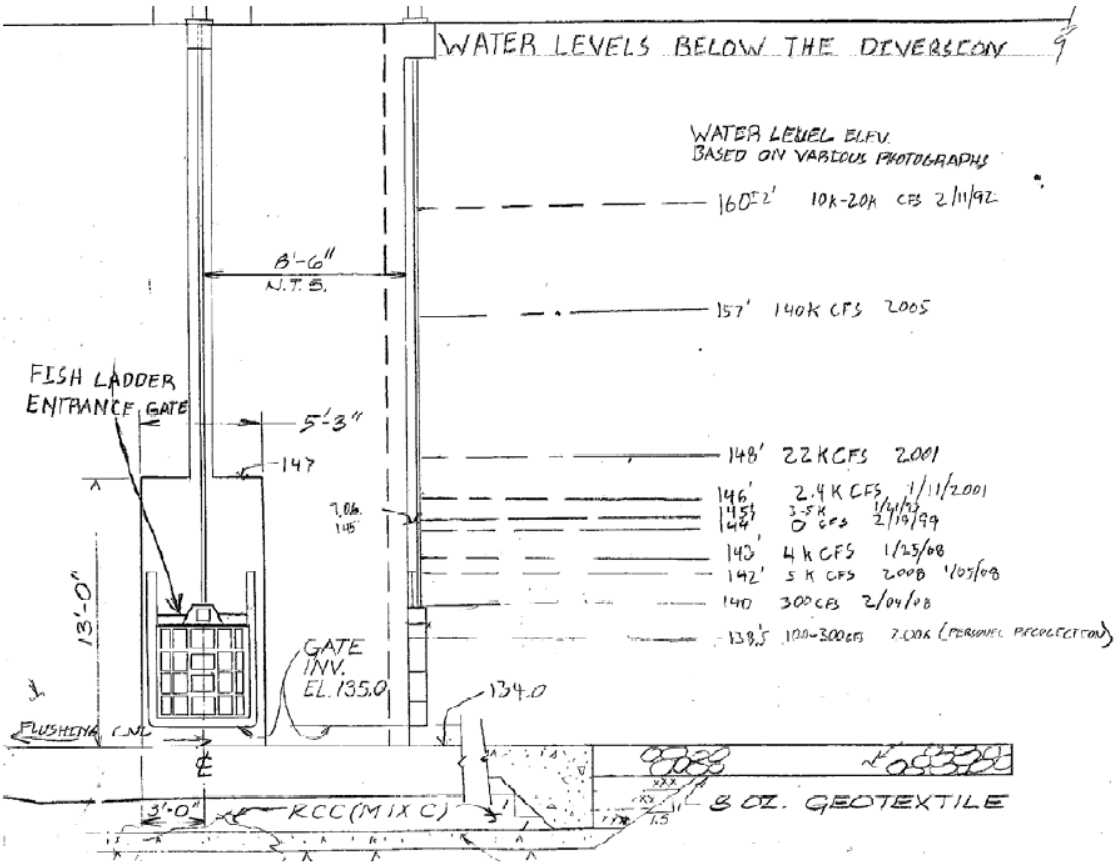


Figure 2.1-7. Tailwater elevation graphic (from UWCD file with name "DS waterlevels.pdf").

2.2 CURRENT VFDD OPERATIONS

Various operational prescriptions have been proposed and negotiated over the life of VFDD. The most recent one that the Panel has used in its evaluation of the existing facility and in development of possible long term solutions is the Proposed 2009 Interim Operations Plan dated January 16, 2009. It is understood that this interim operations plan will be in place while UWCD is working with NMFS to develop an HCP. A copy of the operation plan is included in Appendix B for reference. The most relevant criteria in the operations plan relative to upstream fish passage at VFDD are the trigger for, and the duration of, the operation of the existing fishway. These criteria were also summarized and the operations further described for the Panel in a memo from UWCD dated 11/05/2009. An excerpt from the memo describing the trigger and duration of fishway operations is shown in Figure 2.2-1.

One of the most important operational considerations is when the existing fishway can be operated within the limits of the diversion ability. When UWCD begins to divert water, called "turning in," and continues to divert water the fishway can be operated. Once UWCD is not diverting or when the water is "turned out" for sediment flushing, the existing fishway is not operated and fish passage opportunity is not provided. UWCD is unable to divert water during the peak of a storm due to sediment load. Typically, the diversion is turned out for eight hours to a few days depending on the size of the storm and prior flow conditions. The usual trigger to turn in is when the turbidity in the river falls below 3,000 NTUs. UWCD has found that the turbidity tends to stay high during the peak of a storm and falls off rapidly after the peak. Turning back in allows UWCD to divert water and operate the fishway. An example and current hydrograph-based operation of VFDD in response to a large-sized storm is shown in Figure 2.2-2 as provided by UWCD in the 11/05/2009 memo.

Over the course of the Panel's work other information about the existing facilities' capabilities has been obtained, primarily in meetings and correspondence with the Group. This information has been used to help determine the operational limits or bounds, within which long term fish passage solutions can be considered and developed. Of primary importance is the limit of maintaining the upstream water surface elevation at 162 ft or greater. The dam crest elevation of 162.0 ft was designed specifically for this purpose. This provides the hydraulic head for the diversion and infiltration system by gravity, although in more recent discussions with UWCD, there may be some room for lowering this elevation slightly after critical head losses are evaluated at gates in the diversion and in the canal.

A migration storm is considered to be a storm that happens between January 1st. and May 31st. The storm must increase the flows in the Sespe for 200 cfs on an average daily basis. Once it is determined to be a migration storm, the overall goal is to maintain enough water over the critical riffles downstream of the diversion for 14 days. After the 14 days a 4 day ramp down will commence by reducing the bypass flows to 33% of the previous days flows. The downstream bypass flows will vary depending on the percolation rates below the diversion. The first priority of the water is to maintain the target flows, if the total river flow (with no diversions) cannot maintain the target flows then the ramp down may begin before the 14 day goal. Currently UWCD and NMFS is working out flows that go beyond the 14 day ladder operation to assist for smolt migration.

Figure 2.2-1. Excerpt from 11/05/2009 memo from UWCD titled "Description of the Freeman Operations."

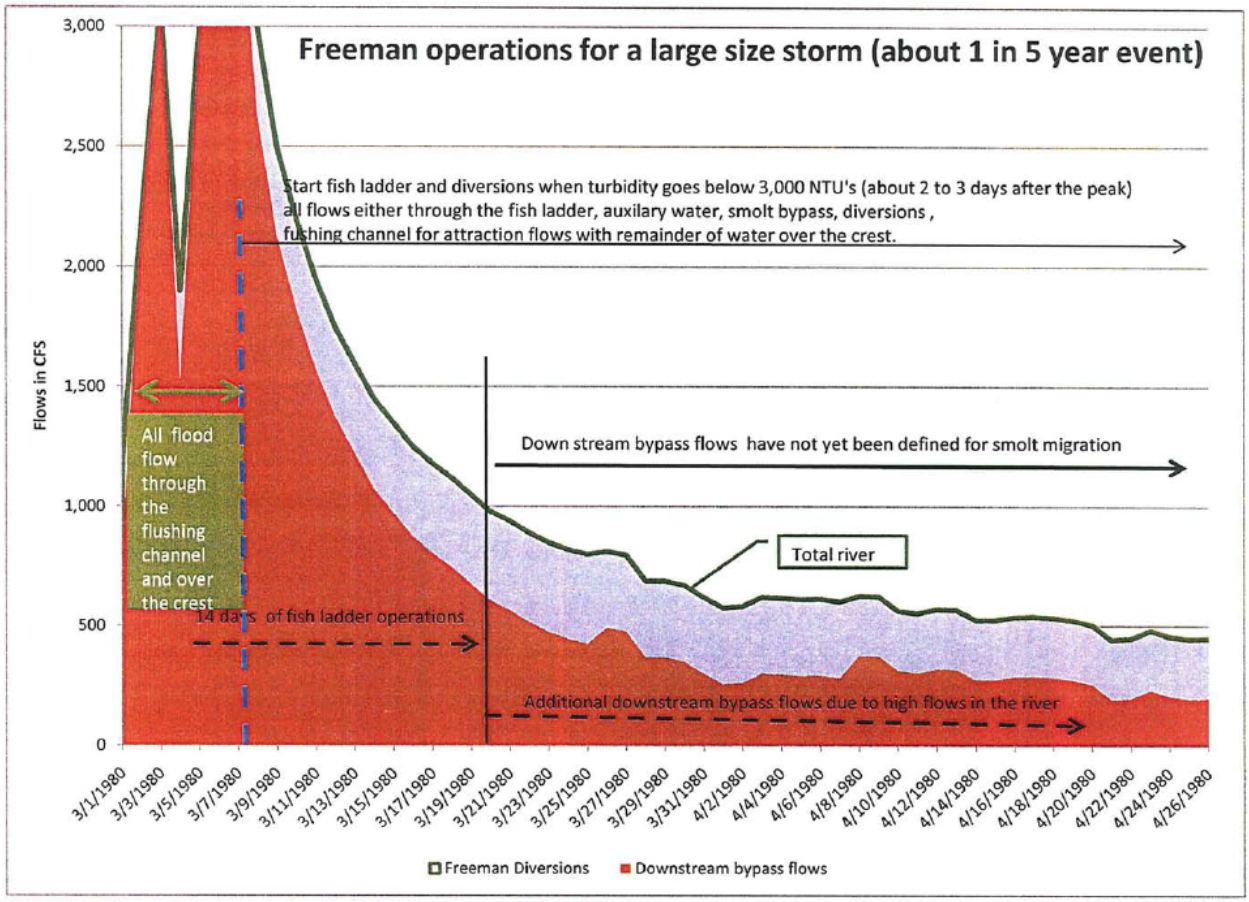


Figure 2.2-2. Example current hydrograph-based operation of VFDD in response to a large-sized storm.

2.3 ASSUMPTIONS

The Panel has assumed for design development purposes of alternatives that flow over the crest (El 162.0) will always be an un-submerged weir, except when calculating the capacities of gated notches for Alternative 6A, in Section 6.3, for which the tailwater curve data shown in Table 2.2-1 was used. The Panel also acknowledges that the tailwater elevations may vary by several feet up and down, and across the face of the dam after each significant flow event. For design at this level, the Panel used the tailwater relationship shown in Table 2.2-1 making the assumption that the downstream channel would not degrade in the life of the fishway. Any of the fishways described here will work fine if the channel does degrade as long as that degradation is accommodated in the design. It will affect the length and depth of the structure. The potential for degradation should be confirmed in the final design phase.

Table 2.2-1. Tailwater curve data for the VFDD.

Tailwater Elevation (ft)	Downstream Flow (cfs)[1]
138.5	50
140	400
140.3	500
140.5	600
141	1,000
142	2,000
143	3,000
144	4,000
145	6,000
148	20,000
154	100,000
157	140,000
162	200,000

Additionally, the effect of the alternatives on flood capacity that could not be mitigated was not included in the development, evaluation, or comparison (final scoring), because any reduction of flood capacity is considered a fatal flaw. The design flood has been increased from 161,000 to 226,000 cfs since construction of the dam so any reduction of flood capacity will not likely be allowed. Additional investigation of necessary flood protection levels with any of the design concepts presented in this report is recommended in the future.

The Panel has assumed that the thalweg of the Santa Clara channel will remain towards the left bank at VFDD. The tendency of the channel to stay at the left bank is likely promulgated by a sharp bend to the right 0.75 miles upstream. Generally, since the dam was constructed, the channel has remained on the left bank with sediment depositing on the right bank and allowing vegetation to encroach there. The concentration of flow through the flushing channel gate might help that trend. The alternatives developed by the Panel add more concentration of water in that area.

[1] Downstream flow includes spill over dam, flows emanating from the flushing channel, the fishway entrances (which includes any auxiliary water system flow), and the fish screen bypass. This may also be referred to as the river bypass flow, that is, the flow bypassing the VFDD and not diverted.

The effects of very high turbidities on steelhead migration remain unresolved. Extremely high turbidity at higher streamflows could make migration in general, and finding fishway entrances specifically, much more challenging. The Panel decided to not limit alternatives development, evaluations, or comparisons to any turbidity level.

This page intentionally blank.

3. MIGRATION DELAY AND SPAWNING RISK SUCCESS RISK ASSESSMENT

Each water year presents different challenges to migrating adult steelhead, and therefore will elicit different consequences in response to migration delay. The Santa Clara River is at the southern fringe of the steelhead's range. In drier years, annual spawning success will be erratic even under natural, unimpaired conditions. Good spawning success may only occur in those wet years with just the right timing of brief winter storms and/or a protracted spring snowmelt runoff event. Successful spawning is risky business. Migration delay could reduce annual success. Therefore, recommendation of a design window for passage streamflows at VFDD must include an evaluation of risk. What streamflow range readily negotiated by migrating steelhead at VFDD will minimize loss of potential annual spawning success within the Santa Clara River Basin?

The Panel's goal for this section is to recommend a range of migration streamflows at VFDD needed by adult steelhead to spawn successfully in the Santa Clara River Basin. This range, or window of spawning streamflows, will be an important design parameter for engineering and evaluating a fish passage facility at VFDD.

3.1 ASCENDOGRAPH BASICS

The ascendograph is a simple model for quantifying the consequences of potential migration delay on annual steelhead spawning success within an entire river basin. The ascendograph is an analytical tool for quantifying annual spawning risk. In a general graphic of the ascendograph (Figure 3.1-1), the X-axis is the days in a given water year when steelhead could be on their upstream migration run. The Y-axis is the migratory route to the spawning destination, with 0 miles at the river mouth. Although not explicitly shown on the X-axis, each day must have an associated daily average streamflow that will be modeled with an average daily adult steelhead migration rate (MR_{ave}) at any given location along the migratory route (i.e., the Y-axis). A steelhead's migratory progress up the Y-axis in the ascendograph's spreadsheet model will depend on the daily streamflow and MR_{ave}.

Horizontal solid red lines shown in Figure 3.1-1 are barriers along the migration route preventing migration over a specific range of streamflows. A 'cyber' fish in the ascendograph's spreadsheets must wait until the barrier is passable (generally, when streamflows drop below a threshold barrier flow to passage) before continuing its journey upstream. A horizontal dashed red line is a temporary barrier. When 'cyber' fish encounter temporary barriers, migration is prevented over a specific range of streamflows or for a prescribed duration in the ascendograph model. Temporary barriers delay, but do not prevent, upstream migration. During that delay, of

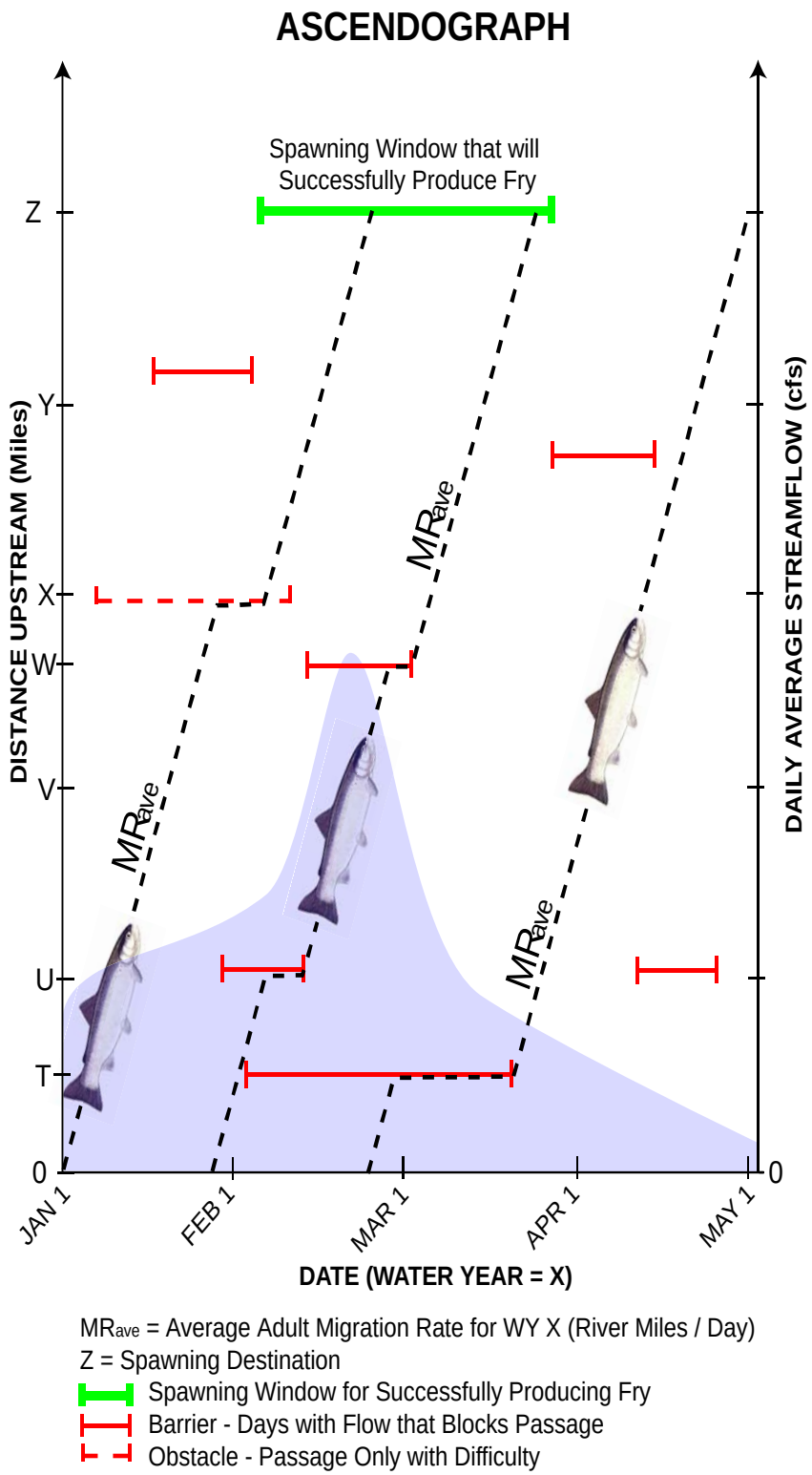


Figure 3.1-1. Basic ascendograph model.

course, fish could wander away, be taken by predators, or not continue their migration for whatever reason.

The green line in Figure 3.1-1 is located at the ascendograph's spawning destination. Each ascendograph has one spawning destination. The green line identifies those days in a specific water year providing ample spawning habitat at the destination AND that would, if a redd were built during one of those 'green' days, successfully incubate eggs (i.e., avoiding desiccation and flood scour) and eventually release emergent fry into a survivable aquatic environment. This is the prize all adult migrating steelhead seek. The green line(s) will be different every water year depending on the annual pattern of daily average streamflows. Therefore, each combination of water year and spawning destination modeled requires a separate ascendograph.

The real driver for assessing risk in this ascendograph is its green line. The three most probable deterrents for a specific day at the spawning destination not being awarded a green line are: (1) females find ample habitat but their redds de-water before fry emerge because streamflows have become too low by the time of fry emergence, (2) females arrive at the destination too far down the declining limb of a storm hydrograph and are too late to find ample viable spawning habitat, or (3) females never reach the spawning destination. "Too low" can mean too shallow for physical migration, exceedingly dangerous (highly exposed in shallow riffles), poor intra-gravel oxygen exchange for egg incubation, and excessive energy expenditure. On an even broader temporal and spatial scale, poor passage conditions at VFDD (i.e., not achieving the green line) could alter annual run timing and/or annual basinwide access to all-important spawning destinations.

Simply reaching the spawning destination is not enough for success. The green line is the binary world of the ascendograph: arrive at the destination and spawn on a green day and a female steelhead succeeds; never arrive or arrive on a non-green day and spawn, and she fails.

3.2 SANTA CLARA RIVER ASCENDOGRAPH FOR STEELHEAD TROUT

The ascendograph is an uncomplicated fish routing model with a prize at its end. A cyber adult female steelhead entering the Santa Clara River on each day of the migration period (December 15 through April 30) either wins or loses. Her success will depend on many physiological and environmental variables too complex to model completely. This will be especially true for the Santa Clara River where there are very few migrating adult steelhead to observe and too few to offer model calibration. Therefore, the ascendograph must balance the unknown with what is probable. For example, no one knows how fast adult steelhead migrate up Sespe Creek Canyon, but conservatively slow estimates of a daily migration rate (mi/day) were made. A complex

model with many parameters, each needing numerical coefficients, becomes susceptible to compounding error and false accuracy. The Panel kept the application and interpretation of the ascendograph modeling simple to avoid these pitfalls as much as possible.

Several steelhead spawning destinations were proposed initially for ascendograph modeling basinwide: (1) Lower Sespe Creek mainstem and a tributary, (2) Upper Sespe Creek and a tributary, (3) West Fork Sespe Creek, (4) Piru Creek tailwater, and (5) Santa Paula Creek mainstem (above and below the two barriers). All these destinations will be important for developing HCP flow recommendations. But the Panel decided on a single, particularly challenging location in Upper Sespe Creek for developing VFDD design flows that would also accommodate passage past VFDD to other key spawning destinations. Upper Sespe Creek mainstem at the mouth of Howard Creek, 61 miles from the Pacific Ocean, was selected. The migratory route to this spawning destination was sub-divided into 7 channel segments along the complete migration route from the Pacific Ocean up to the mouth of Howard Creek (Figure 3.2-1).

3.2.1 Annual Hydrographs for the Ascendograph Analysis

The ascendograph's outcome will depend on the daily streamflows modeled. There were several options for choosing an appropriate hydrological dataset to model. Annual streamflows below VFDD could be changed in the future relative to recent regulated streamflows released below VFDD, so the Panel used streamflows approaching VFDD in assessing spawning risk. This dataset will be extremely important in assessing an HCP but the Panel is considering VFDD design passage flows before the HCP is completed.

Another possible dataset for assessing annual spawning was to model completely unregulated (i.e., natural) daily average streamflows in an unaltered mainstem channel morphology. Any other ascendograph analysis using altered annual hydrographs and impaired channel conditions could then be contrasted with natural spawning success. Unregulated annual hydrographs for the basin have not been developed, though they could be. A third dataset is the present-day streamflows approaching VFDD (i.e., before diversions at VFDD). These also are impaired by numerous diversions and dams upstream, but nevertheless provide the range of daily streamflows that VFDD must pass if steelhead spawning success is to be protected. The Panel chose these streamflows for modeling the ascendograph.

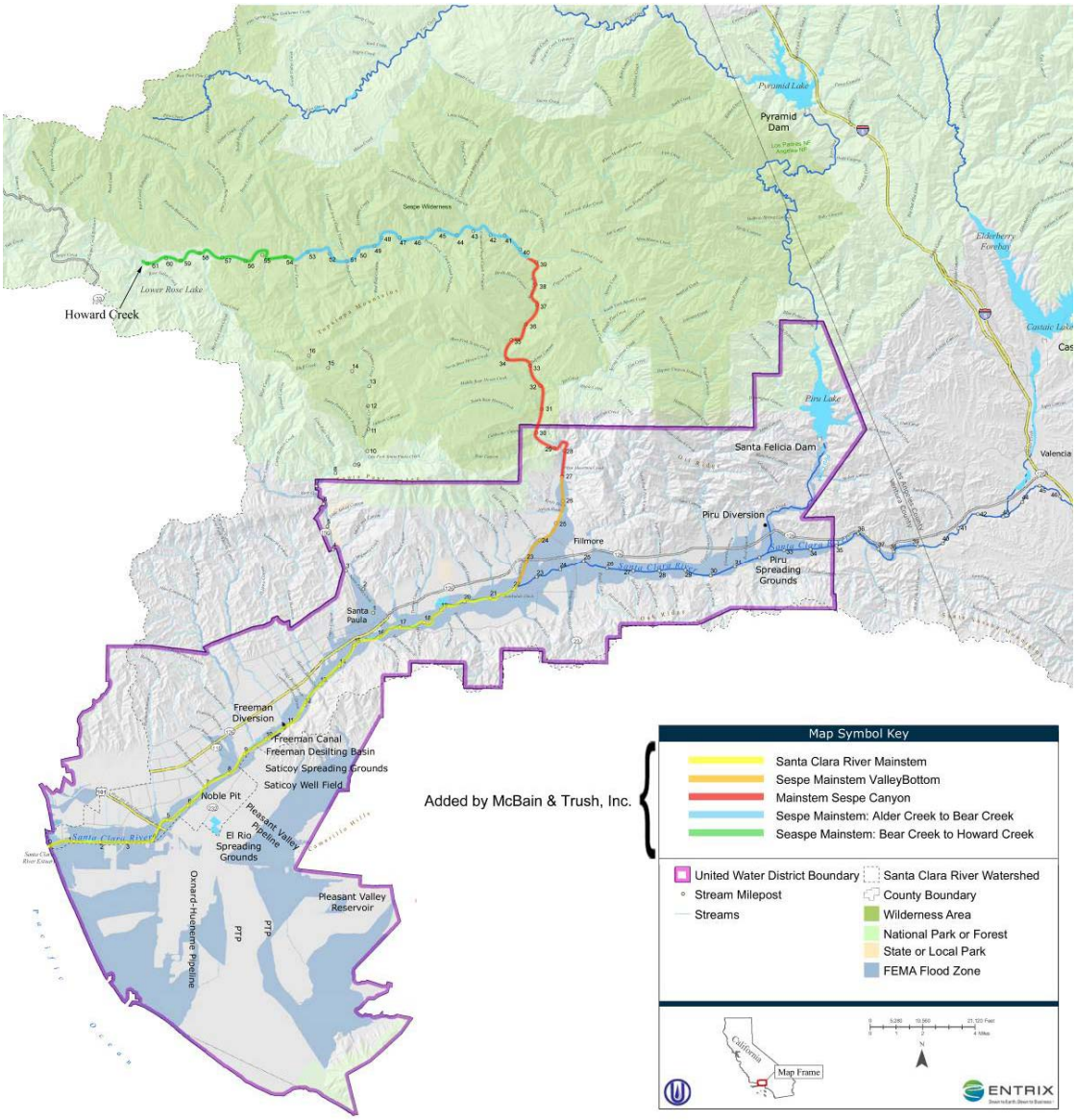


Figure 3.2-1. Spawning migration route up to the ascendograph's spawning destination: from the Pacific Ocean up to the Upper Sespe Creek Mainstem at the mouth of Howard Creek at RM 61.

Annual hydrographs for the Santa Clara River mainstem approaching VFDD (i.e., before UWCD's diversion) and segments of Sespe Creek up to Howard Creek were estimated by UWCD. The cluttered plot of all annual hydrographs for the mainstem Santa Clara River above VFDD between WY1956 and WY2007 in Figure 3.2-2A provides a visual appreciation of the complex intra- and inter-annual streamflow variability, something an extensive table of statistics cannot accomplish. Figure 3.2-2B isolates the annual hydrographs used in the ascendograph

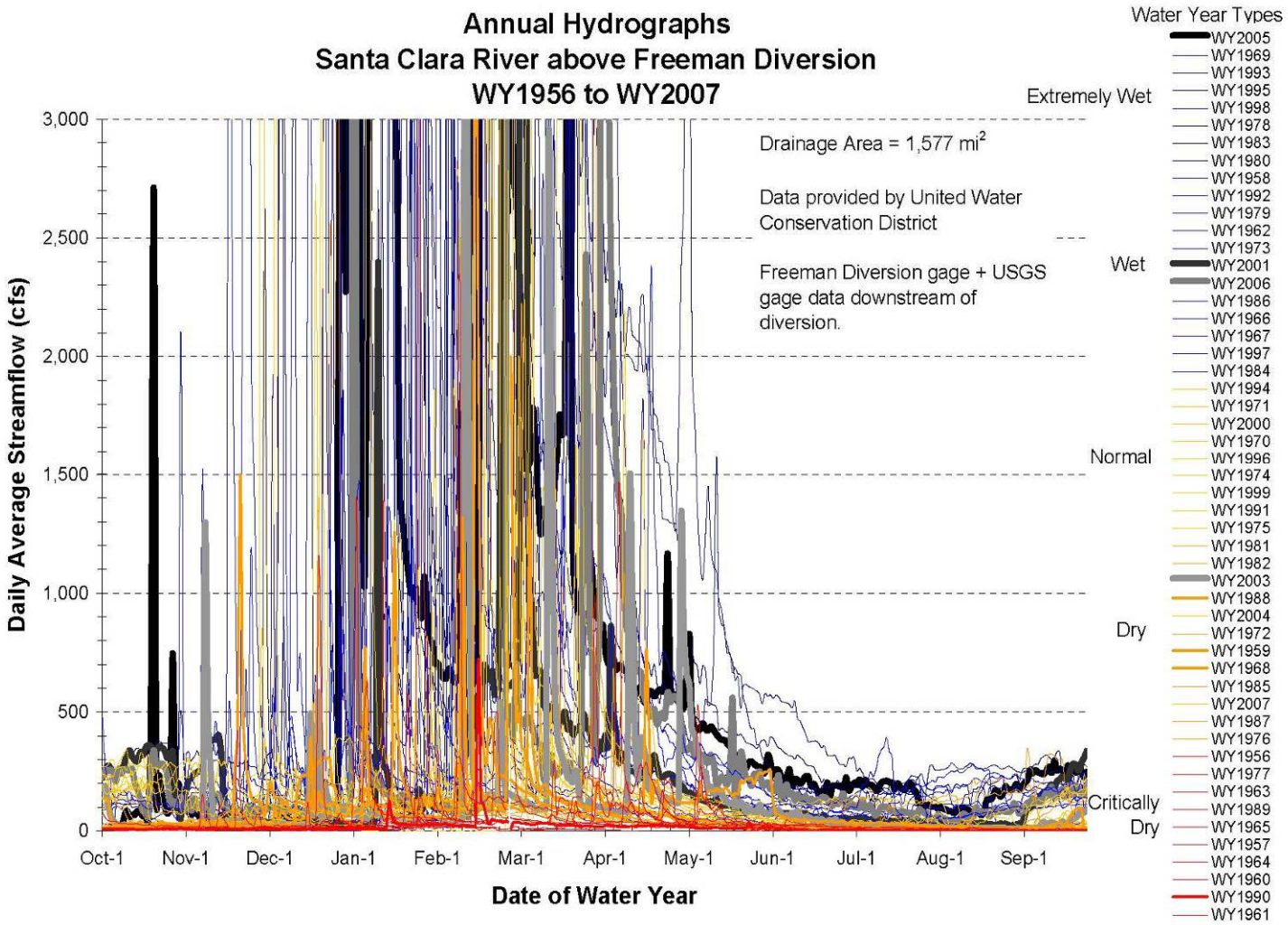


Figure 3.2-2A. Annual hydrographs from WY1956 to WY2007 for daily average streamflows approaching VFDD (before United Water Conservation District's diversion at VFDD) color-coded by WY type (ranked by total annual yield). The four WYs in the ascendograph analyses are highlighted.

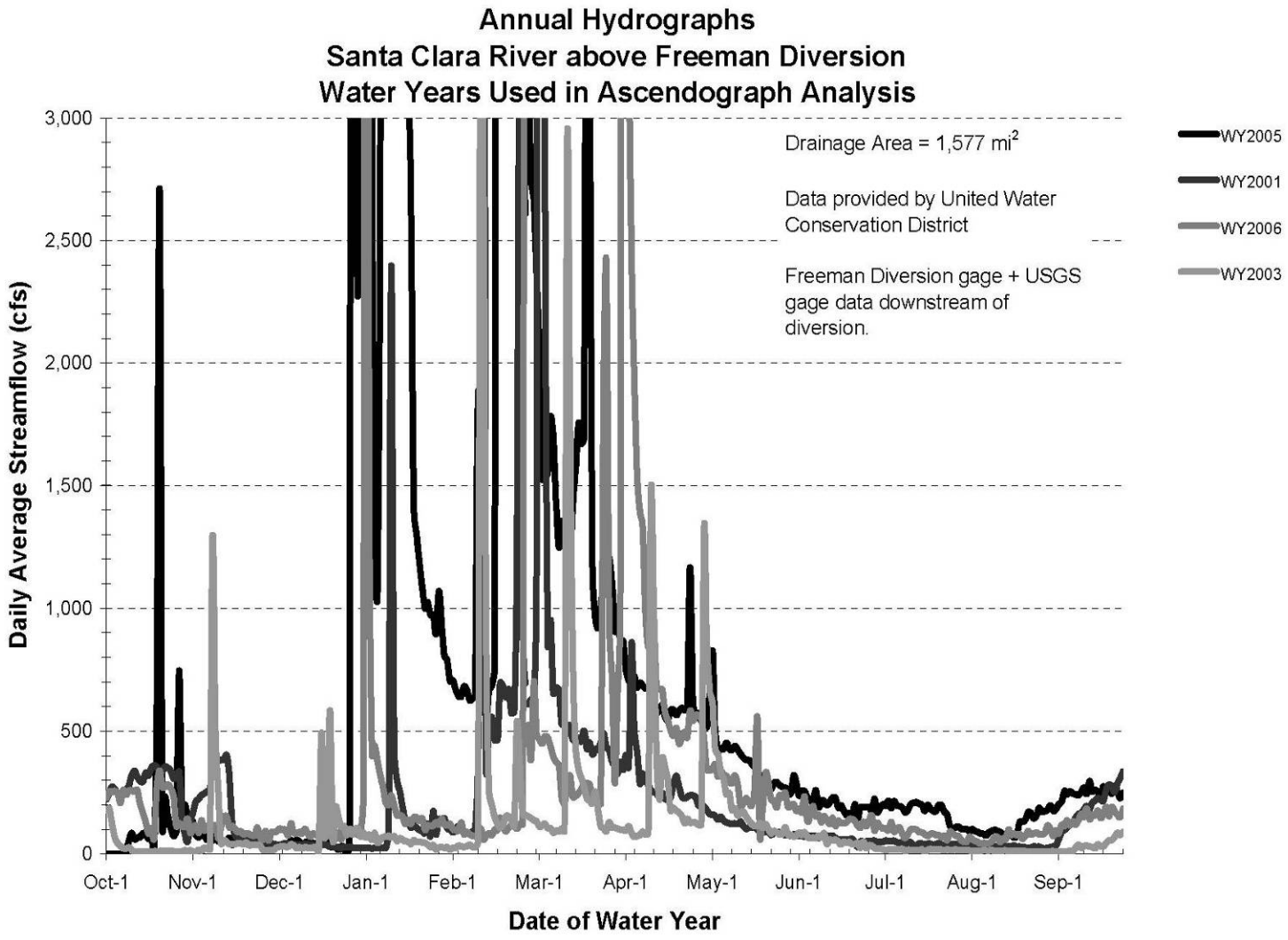


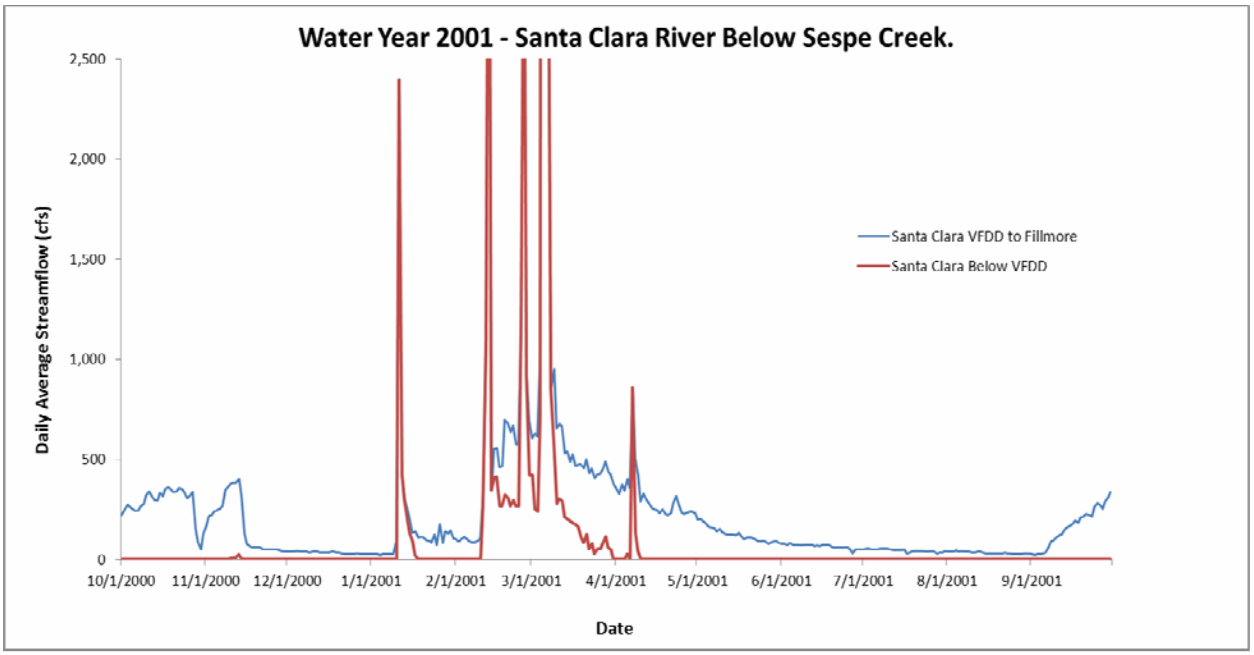
Figure 3.2-2B. WY2001, WY2003, WY2005, and WY2006 annual hydrographs used in the ascendograph analysis for streamflows approaching VFDD.

analysis. Adult steelhead migration beginning mid- to late-December and lasting through April would have been possible in many water years (WYs), with wetter years providing extended high base streamflows (greater than 300 cfs) into May, presumably sustained by snowmelt runoff.

Four WYs provided the range in hydrological conditions needed to evaluate the Panel's spawning window design goal: (1) WY2001 a wet to normal year with a single dominant winter flood event (Figure 3.2-3), (2) WY2003 a normal year with several evenly spaced, modest flood events (Figure 3.2-4), (3) WY2005 a very wet year with a substantial snowmelt runoff component (Figure 3.2-5), (4) WY2006 a wet year dominated by winter storm runoff (Figure 3.2-6). Initially, WY2002 and WY2004 were part of the analysis. But because these were drier years, continued ascendograph modeling would not be helpful for assessing higher streamflows for the design passage window. All water years should be represented for developing HCP streamflow recommendations below VFDD.

3.2.2 Steelhead Parameters for the Ascendograph Analysis

The ascendograph model required 7 parameters (Table 3.2-1): (1) daily average upstream migration rate (mi/day) for each segment of the migration route, (2) a daily average streamflow for WY2001, WY2003, WY2005, and WY2006 for each of the migration route's segments, (3) a minimum threshold streamflow for adult passage in each segment, (4) a minimum threshold streamflow for spawning habitat availability of 10 cfs at the spawning destination, (5) a 50-day egg incubation period, (6) a minimum threshold incubation streamflow of 5 cfs at the spawning destination, and (7) a 40-day or 70-day In-River Limit (maximum, in-river timeframe to migrate and spawn) from entering the Santa Clara River at RM = 0 to constructing a redd in the destination reach. These parameters were estimated by the Panel with assistance from Steve Howard (UWCD fish biologist). Unique combinations of different parameter values were almost endless, especially if assigning and evaluating multiple daily average migration rates for each stream segment. To keep the analysis manageable, two sets of ascendograph parameters were modeled: FAST migration and SLOW migration (Table 3.2-1). FAST migration was assigned the 40-day In-River Limit and SLOW migration the 70-day In-River Limit. Under FAST migration, a steelhead (i.e., each entry date in the model) has a more restrictive timeframe (40 days as opposed to 70 days) within which to succeed. Although the migration rates are faster, the In-River Limit for FAST migration is considerably shorter. If an entry date does not achieve the spawning destination within either In-River Limit, the entry date would be unsuccessful.



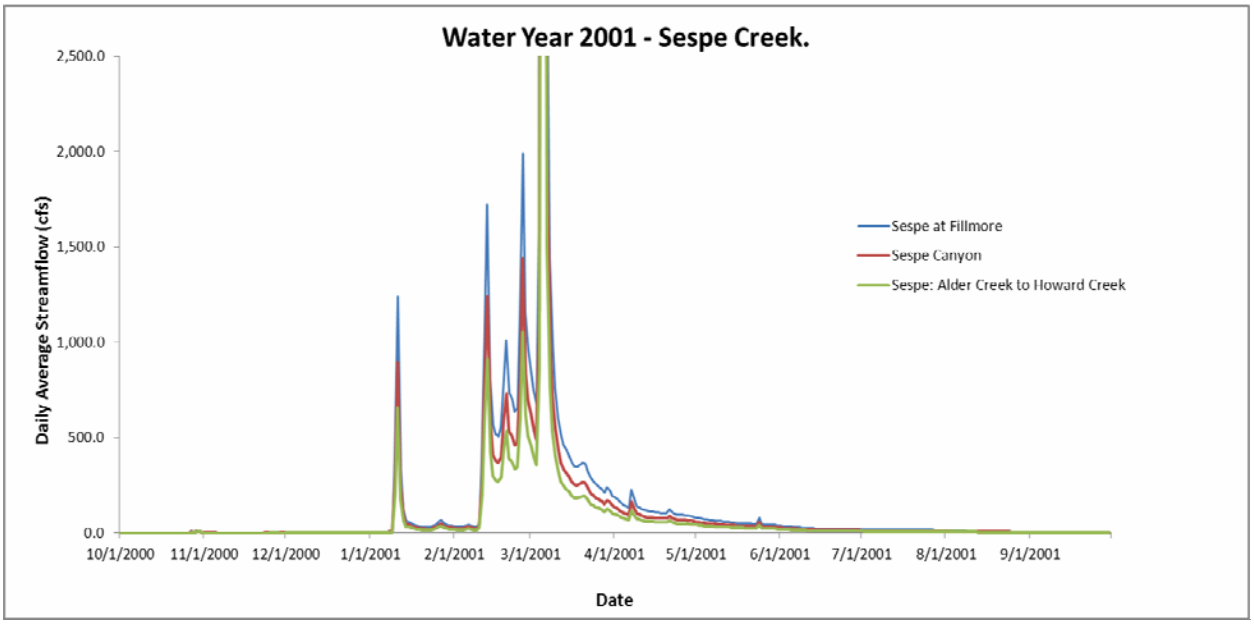
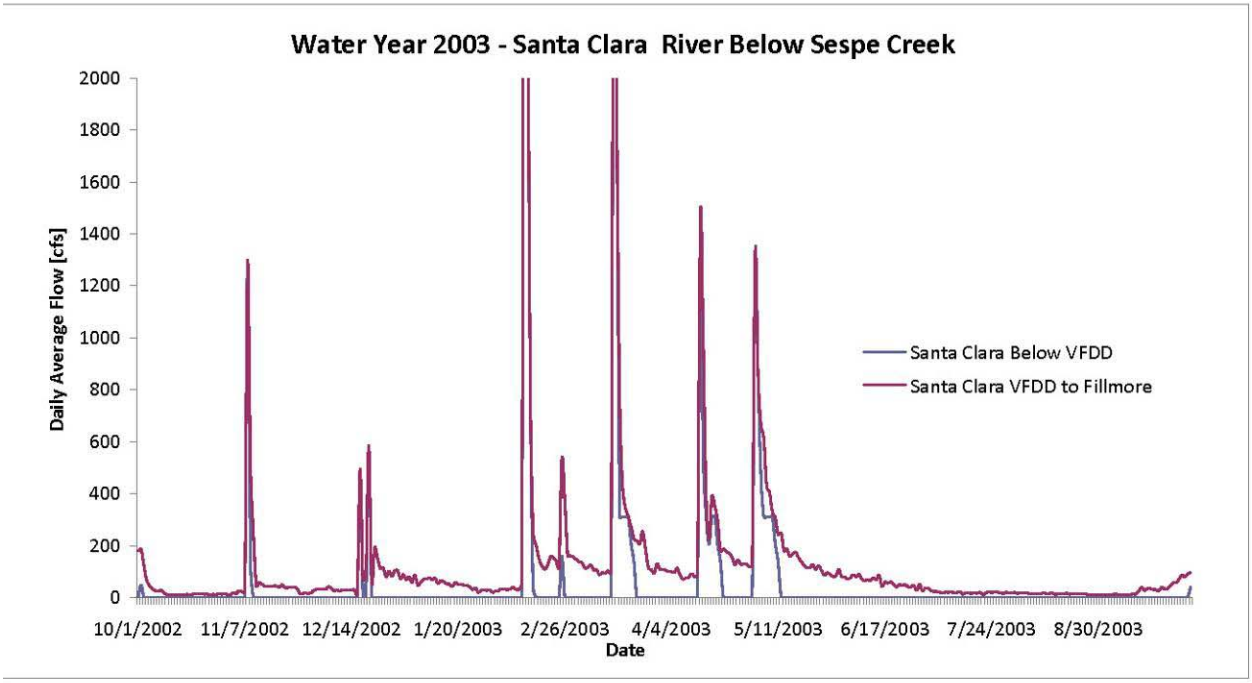


Figure 3.2-3. Estimated annual hydrographs along the ascendograph's migration route to the 'Upper Sespe Creek Mainstem at Howard Creek' spawning destination for WY2001.



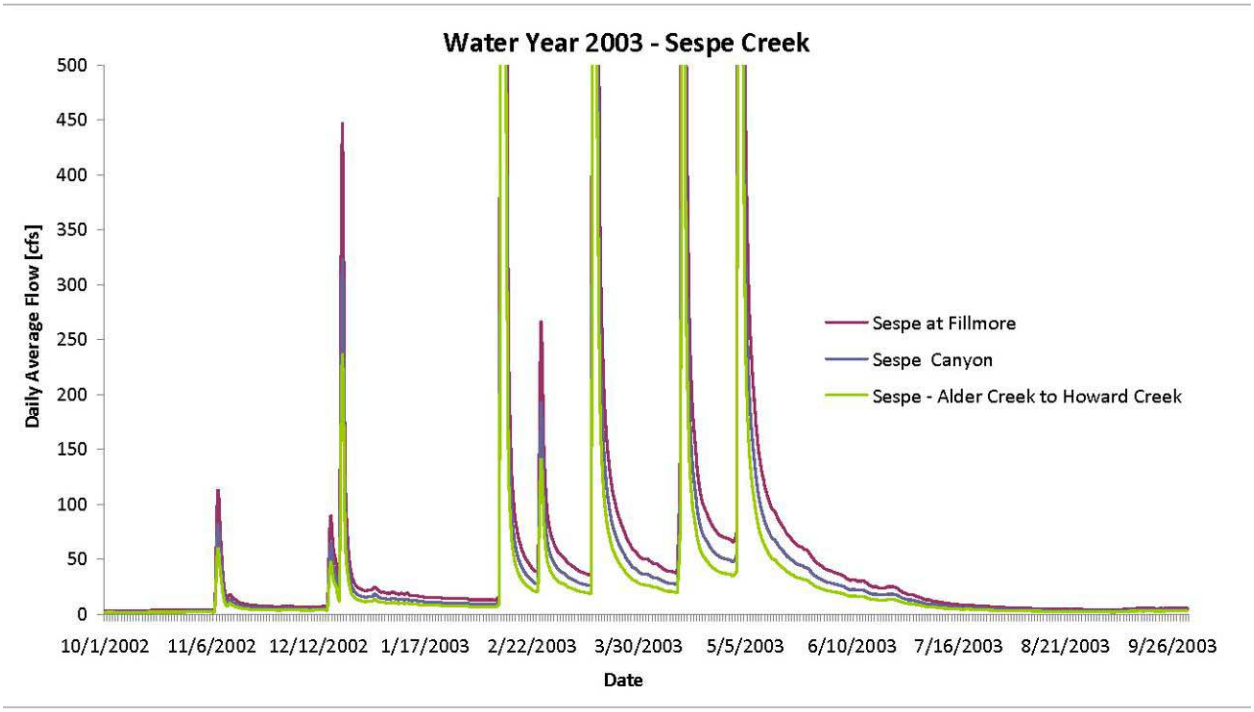
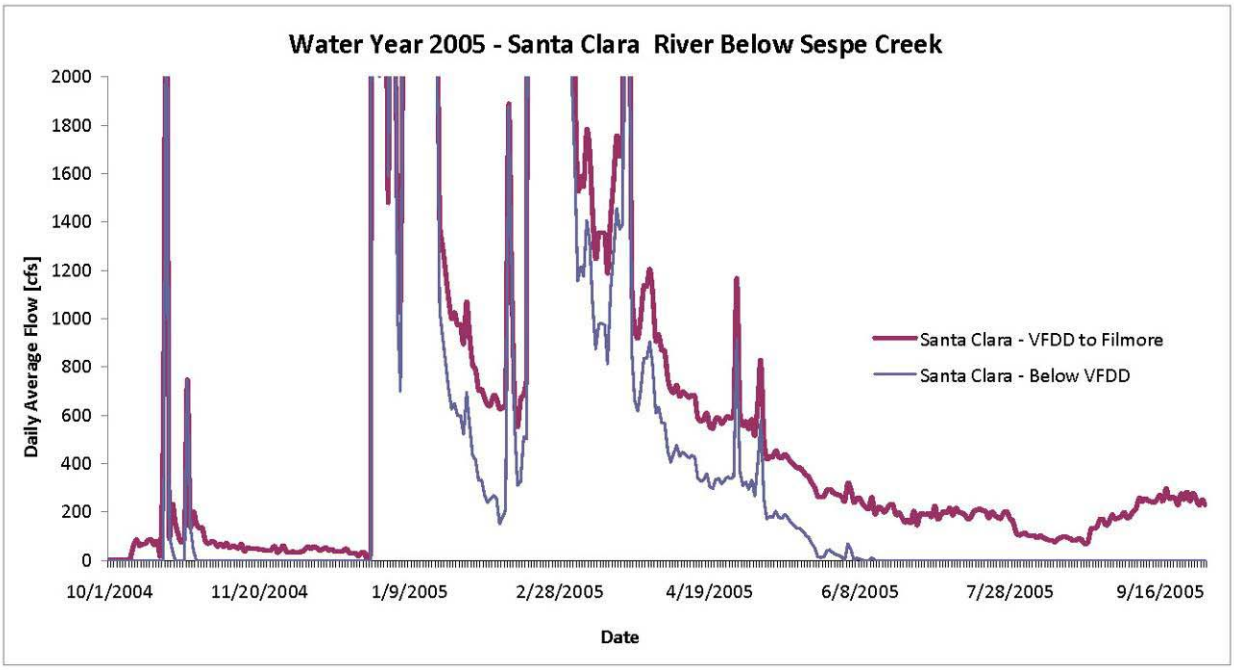


Figure 3.2-4. Estimated annual hydrographs along the ascendograph's migration route to the 'Upper Sespe Creek Mainstem at Howard Creek' spawning destination for WY2003.



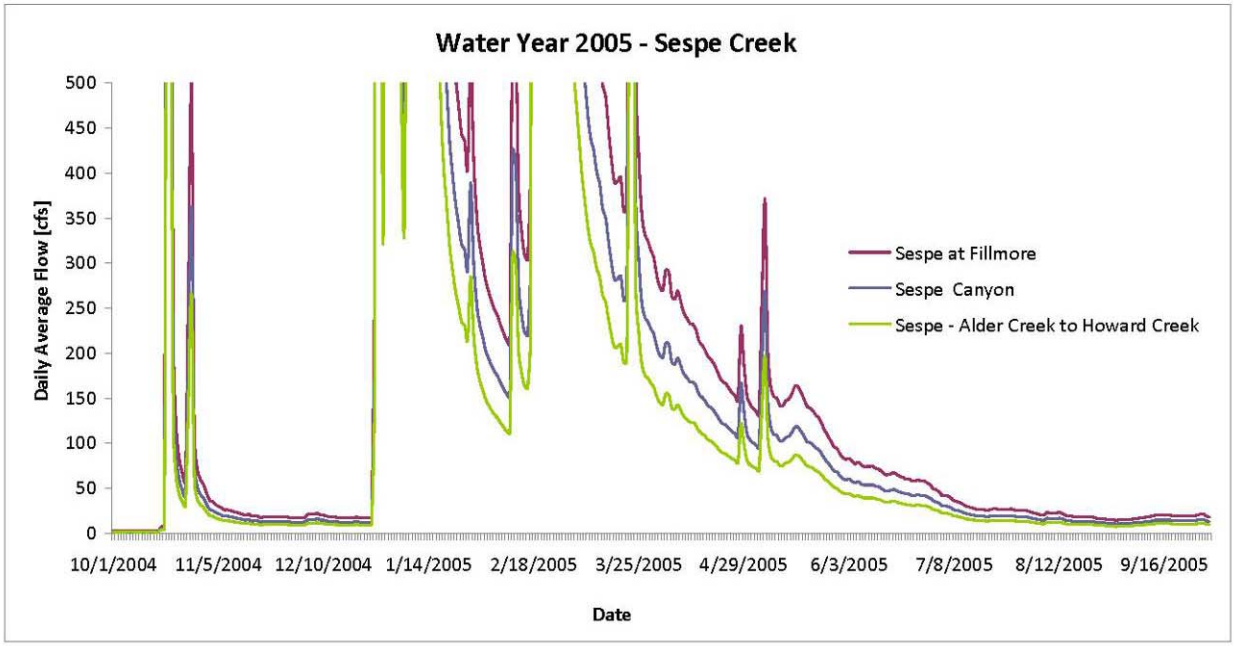
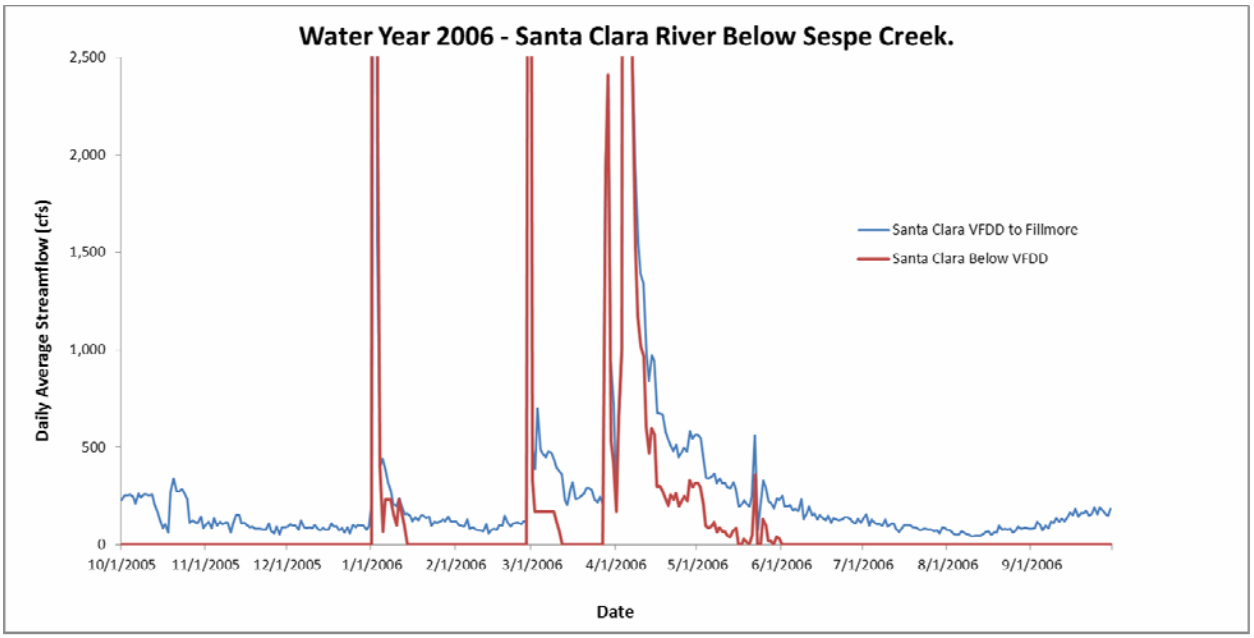


Figure 3.2-5. Estimated annual hydrographs along the ascendograph's migration route to the 'Upper Sespe Creek Mainstem at Howard Creek' spawning destination for a WY2005.



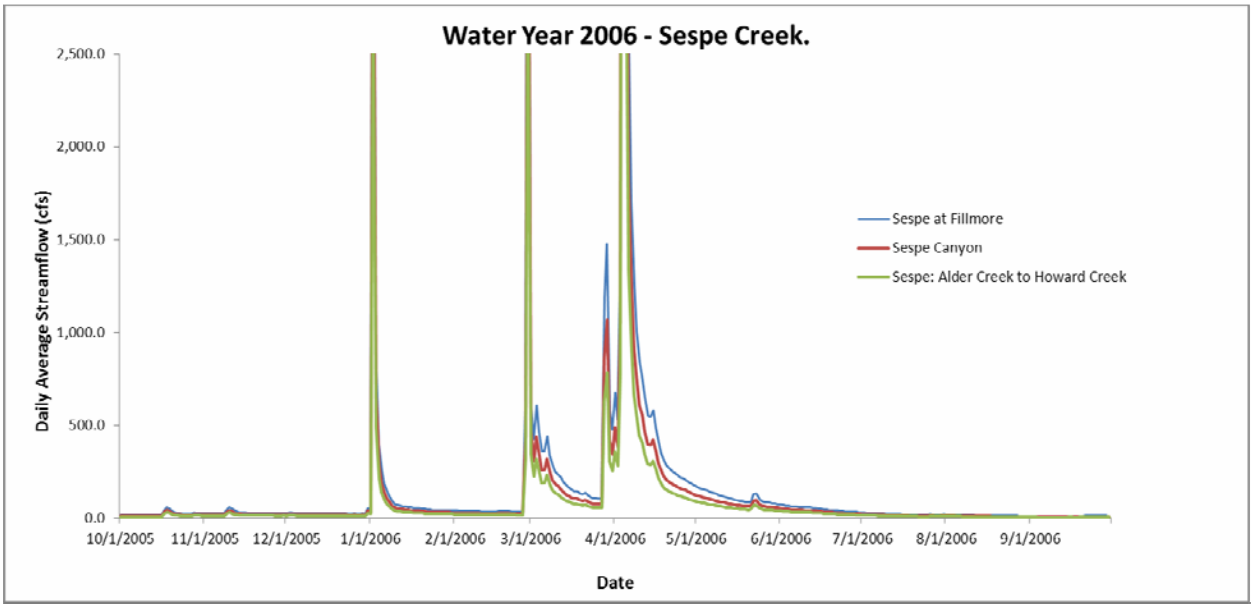


Figure 3.2-6. Estimated annual hydrographs along the ascendograph's migration route to the 'Upper Sespe Creek Mainstem at Howard Creek' spawning destination for WY2006.

Table 3.2-1. Santa Clara River ascendograph parameters.

FAST Upstream Migration with Adult Steelhead In-River Limit = 40 Days				
Route Segment	**RM**	**RM**	**Minimum Passage Criteria (cfs)**	**Migration Rates (mi/day)**
Pacific Ocean to HWY 118	0	7.9	160	6
HWY 118 to VFDD	8	11.9	120	6
VFDD to Sespe Creek	12	21.9	120	6
Sespe Creek Valley Bottom	22	26.9	25	4
Sespe Canyon	27	39.9	150	2
Sespe – Alder Creek to Bear Creek	40	53.4	25	3
Sespe Bear Creek to Howard Creek	53.5	61	25	3

SLOW Upstream Migration with Adult Steelhead In-River Limit = 70 Days				
Route Segment	**RM**	**RM**	**Minimum Passage Criteria (cfs)**	**Migration Rates (mi/day)**
Pacific Ocean to HWY 118	0	7.9	160	4
HWY 118 to VFDD	8	11.9	120	4
VFDD to Sespe Creek	12	21.9	120	4
Sespe Creek Valley Bottom	22	26.9	25	4
Sespe Canyon	27	39.9	150	2
Sespe – Alder Creek to Bear Creek	40	53.4	25	2
Sespe Bear Creek to Howard Creek	53.5	61	25	2

Ascendograph Spawning Destination:
Upper Sespe Mainstem at Howard Creek

Spawning Migration Period between December 15 and April 30

50-day Egg Incubation Period
5 cfs Minimum Streamflow for Egg Incubation and Fry Emergence
10 cfs Minimum Streamflow for Spawning Habitat Availability

3.2.3 Assessing Spawning Risk with Ascendograph Modeling

For the Santa Clara River Basin, the Panel used December 15 through April 30 as potential dates adult steelhead may enter the river. Whether one or many adults might enter on any given day was not considered, nor whether the estuary was open or closed for a particular day in a particular water year. A 'successful' day is an entry date, for a given spawning destination in a given WY, that ultimately could have produced emergent fry if adult steelhead had begun their journey that day. The total number of modeled successful entry dates in a given year for a given spawning destination is a measure of total annual spawning success. The ascendograph analysis, therefore, evaluated each entry date between December 15 and April 30 for potential spawning success in a specific spawning destination. If a female entered Santa Clara River on December 15, 2000 and 'wanted' to spawn at the mouth of Howard Creek in the upper Sespe Creek watershed, would she have won? If she entered December 16, would she have won? December 17? This daily assessment proceeded through April 30, 2001 to tally the total number of successful entry dates in WY2001. The complete tally becomes a measure of total spawning success for that year and at that site. The ascendograph analysis modeled total spawning success for WY2001, WY2003, WY2005, and WY2006 under three modeling scenarios of migration delay at VFDD, as well as estimated total spawning success with no delay for SLOW and FAST migration.

The first ascendograph scenario modeled assessed the loss in total spawning success when high streamflows were total temporary barriers to migration at VFDD. An adult steelhead migrating under Modeling Scenario No. 1 migrates up to VFDD but only can pass VFDD when streamflows are less than the 'passage barrier flow' being modeled. For example, if the barrier passage flow being modeled is 2,000 cfs, an adult steelhead that arrives at VFDD when the streamflow is 4,000 cfs must wait until streamflows drop below 2,000 cfs before continuing upstream past VFDD. This wait can last a minimum of one day, or several weeks until the In-River Limit is exceeded.

Ascendograph modeling results for Modeling Scenario No. 1 are plotted in Figure 3.2-7 for FAST and Figure 3.2-8 for SLOW migration. The X-axis is the passage barrier flow at VFDD. The Y-axis is the total annual number of successful spawning days for the given water year. Figures 3.2-7 and 3.2-8 therefore assess risk: as the passage barrier flow drops (i.e., VFDD becomes a barrier to migration at lower flows) there will be more migration delay and consequently fewer successful spawning days at the Upper Sespe Mainstem at Howard Creek spawning destination. SLOW and FAST ascendograph curves for total spawning success under Modeling Scenario No. 1 (Figures 3.2-7 and 3.2-8) had a sharp transition in spawning success

below 1,500 cfs. A model run of the ascendograph was performed for every passage barrier flow labeled on the X-axis. Above the 1,500 cfs passage barrier flow, Modeling Scenario No. 1 incurred no losses to total spawning success in the wetter WYs under FAST and minor loss under SLOW migration (refer back to Table 3.2-1 for differences in model parameters between FAST and SLOW).

The asymptotic values in Figure 3.2-7 and Figure 3.2-8 (that extend beyond 6,000 cfs) are the total spawning success for each WY without delay imposed by passage barrier flows at VFDD (i.e., VFDD would be invisible to migration). For FAST migration, baseline total spawning success was 40 days, 0 days, 102 days, and 48 days for WY2001, WY2003, WY2005, and WY 2006 respectively. For SLOW migration, baseline total spawning success was 42 days, 11 days, 100 days, and 54 days respectively.

Figure 3.2-9 illustrates how one point was computed in Modeling Scenario No. 1 under SLOW migration when the passable barrier flow modeled was 8,000 cfs in WY2001. Between February 12 and March 22 every entry date was successful. Those entry dates encountering greater than 8,000 cfs had to wait 1 to 3 days (until streamflows dropped below 8,000 cfs) before successfully migrating to the spawning destination. Those entry dates leaving January 10 through January 14 were also successful, but waited until mid-February to negotiate Sespe Canyon (with a minimum passable streamflow 150 cfs in the ascendograph model). Entry dates after March 22 could not get past Sespe Canyon, and therefore were unsuccessful at spawning in the Sespe Mainstem at Howard Creek spawning destination. In reality, these cyber fish could have spawned in other destinations lower in the Sespe Watershed (e.g., one mile up West Fork Sespe Creek) and had been successful. If the barrier passage flow was 1,500 cfs, Figure 3.2-9 would show only a few more days of waiting before continuing upstream and successfully spawning.

This single sharp threshold between 1,000 cfs and 1,500 cfs among the four water years in Modeling Scenario No. 1 seemed suspiciously low relative to the magnitude of streamflows in the annual hydrographs of Figures 3.2-7 and 3.2-8. Particularly in wetter years, blockage of upstream migration at VFDD when streamflows exceeded 1,500 cfs should likely have some consequence on total spawning success. The ascendograph's assumptions, both explicit and implicit, were re-examined.

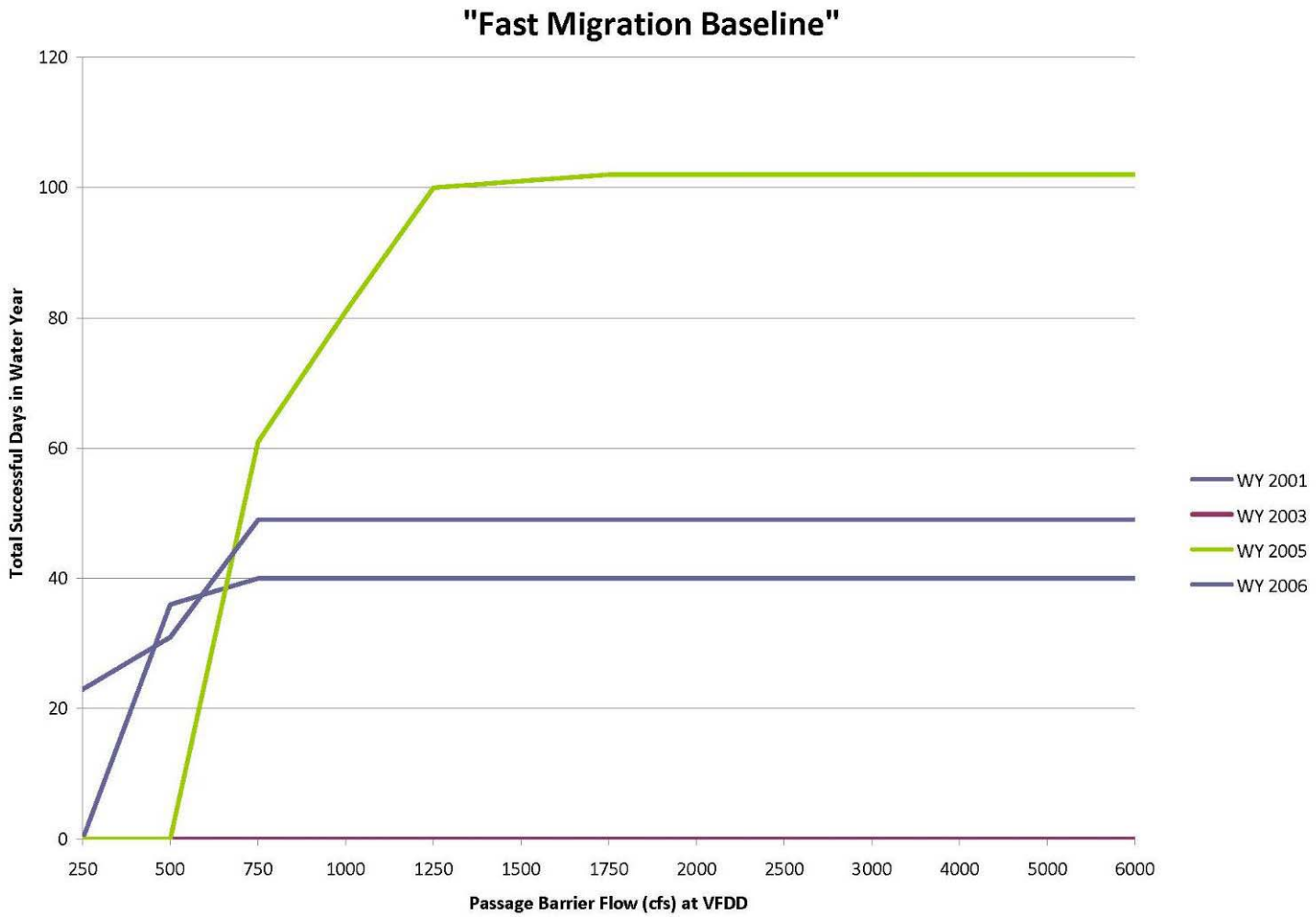


Figure 3.2-7. Effect of passage barrier flows on total spawning success under FAST migration modeled in the ascendograph for WY2001, WY2003, WY2005, and WY2006 at a single spawning destination, Upper Sespe Mainstem at Howard Creek (Modeling Scenario No. 1).

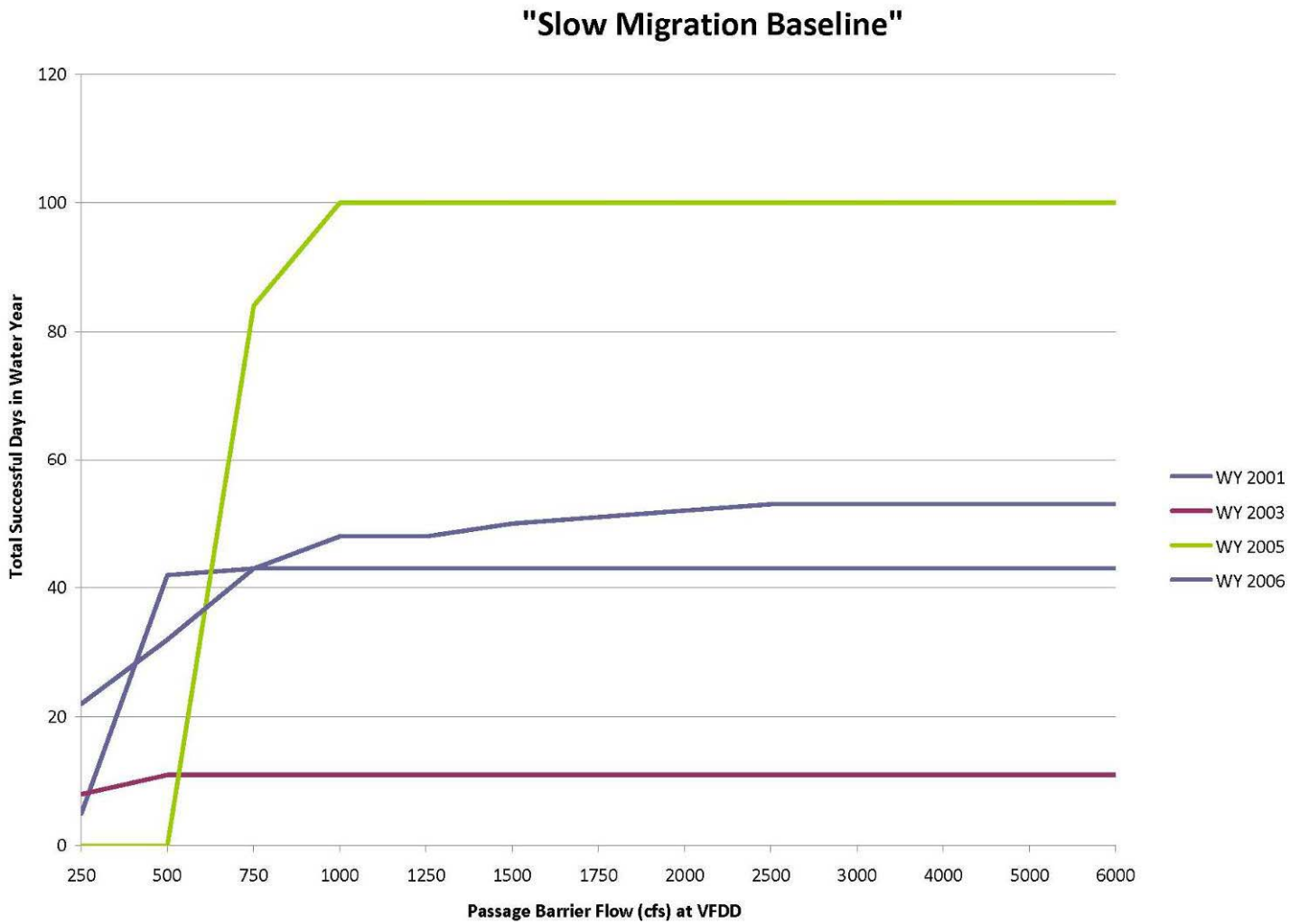


Figure 3.2-8. Effect of passage barrier flows on total spawning success under SLOW migration modeled in the ascendograph for WY2001, WY2003, WY2005, and WY2006 at a single spawning destination, Upper Sespe Mainstem at Howard Creek (Modeling Scenario No. 1).

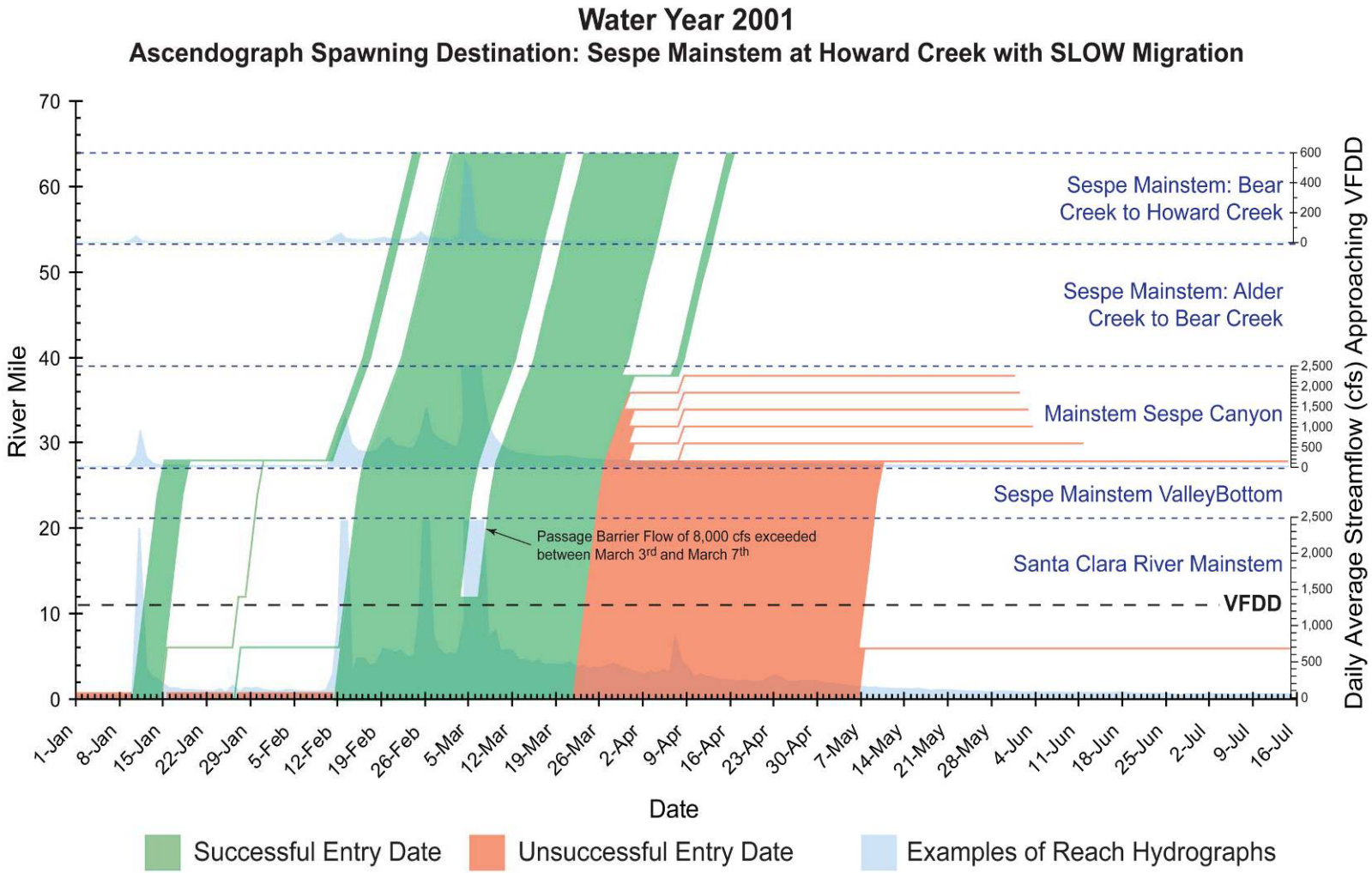


Figure 3.2-9. Example of how Modeling Scenario No. 1 computes total spawning success under SLOW migration with a passage barrier streamflow of 8,000 cfs in WY2001.

One assumption was particularly troubling biologically. The ascendograph's spreadsheet model 'allowed' fish (i.e., entry dates) to wait for extended periods just below VFDD until passage conditions were favorable again. Many entry dates could become stalled at VFDD for several weeks, up until the In-River Limit of 70 days (SLOW) or 40 days (FAST) was exceeded. As a fish waits, its condition declines and its urge to spawn somewhere, anywhere, increases. Oftentimes an adult steelhead will spawn in poor habitat rather than wait any longer.

A second ascendograph modeling scenario was run to assess this concern. The Panel's goal was to recommend a design spawning window of streamflow that should perform well under diverse annual hydrographs. Rather than accept unlimited waiting at VFDD at each passage barrier flow modeled (up to the In-River Limit as in Modeling Scenario No. 1), Modeling Scenario No. 2 conservatively accepted only a 3-day or 5-day allowable wait. If an entry date's acceptable 3-day or 5-day wait was exceeded in the Modeling Scenario No. 2 spreadsheet (i.e., the wait for the passage barrier flow at VFDD to become passable lasted longer than 3 days or 5 days), the entry date failed.

Figures 3.2-10 to 3.2-13 show effects of Modeling Scenario No. 2 on total spawning success. As expected, a 3-day allowable wait, but no longer, had a greater impact on total spawning success than an allowable 5-day wait. In WY2005 (Figure 3.2-12) where the greatest impact was expected (because of the long wait at high barrier passage flows in this very wet year), the loss in total spawning success was approximately 45% at the 1,500 cfs passage barrier flow. The 5-day allowable wait resulted in an approximate 30% loss. In reality, a stalled adult steelhead would unlikely give up and die after 3 days wait. But options are few. Spawning habitat below VFDD is not favorable. Additional waiting expends valuable energy reserves needed to negotiate Sespe Canyon. Modeling Scenario No. 2 challenged the ascendograph, conservatively, to help identify a sufficiently safe, inclusive window of design passage flows that could only marginally reduce total spawning success over a broad range in WYs.

Back to Figures3.2-10 to 3.2-13, the four WYs evaluated reached an asymptote in total spawning success under FAST migration with the 5-day allowable wait between passage barrier flows of 500 cfs (WY2003) and 4,500 cfs (WY2005). The results, while keeping aware these are model results, indicated that passable streamflows greater than 1,500 cfs likely are significant contributors to total spawning success in many water years. Above a passage barrier flow of approximately 3,000 cfs, the effect on total spawning success lessens. At 4,000 cfs, WY2005 experienced an approximate 10% loss. Less than a 10% spawning success loss in wet years seemed a reasonable threshold of concern for recommending a passage window.

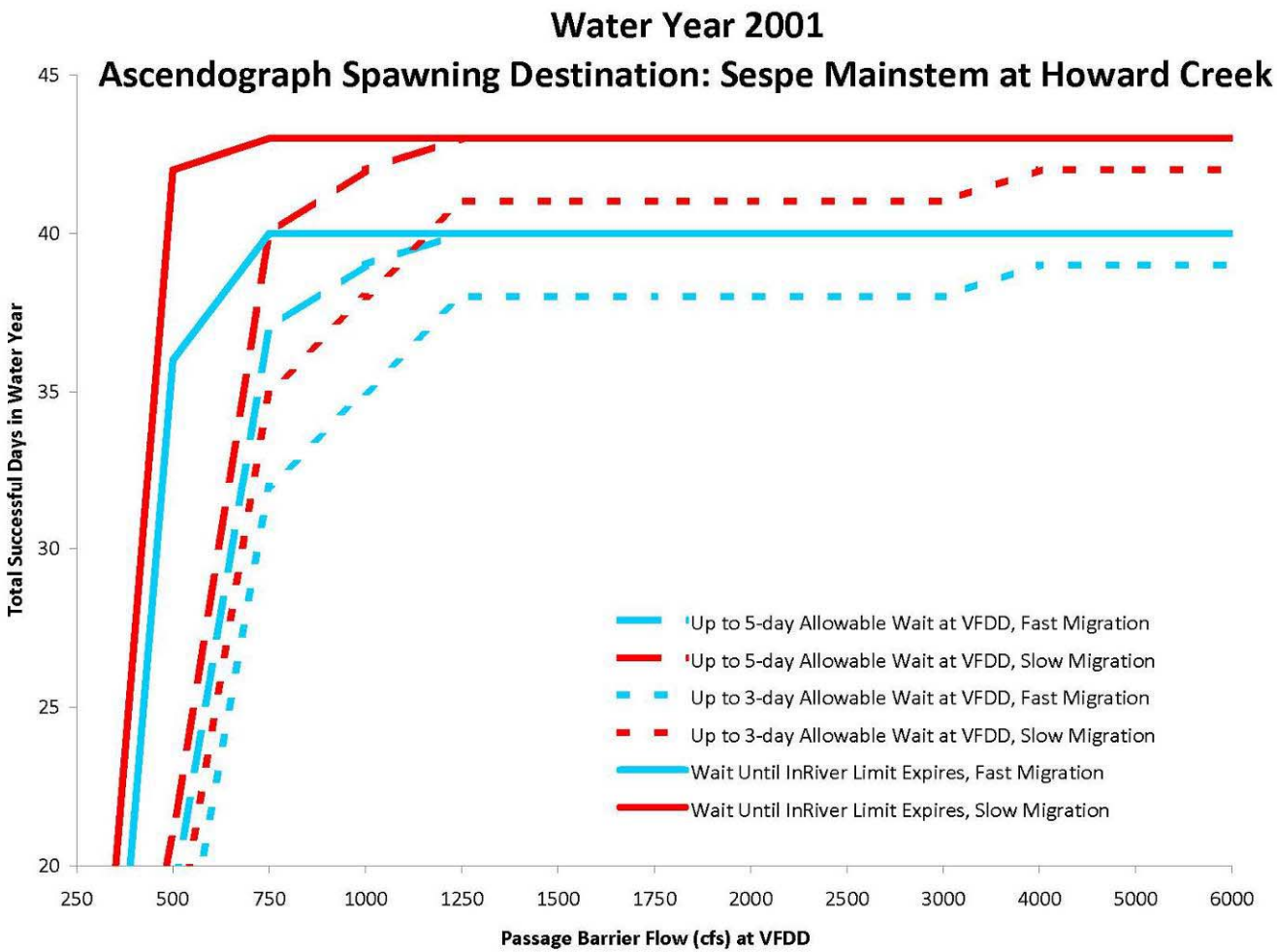


Figure 3.2-10. Effect of 3-day and 5-day allowable wait at VFDD on total spawning success under FAST and SLOW migration modeled for WY2001 at a single spawning destination, Upper Sespe Creek Mainstem at Howard Creek (Modeling Scenario No. 2).

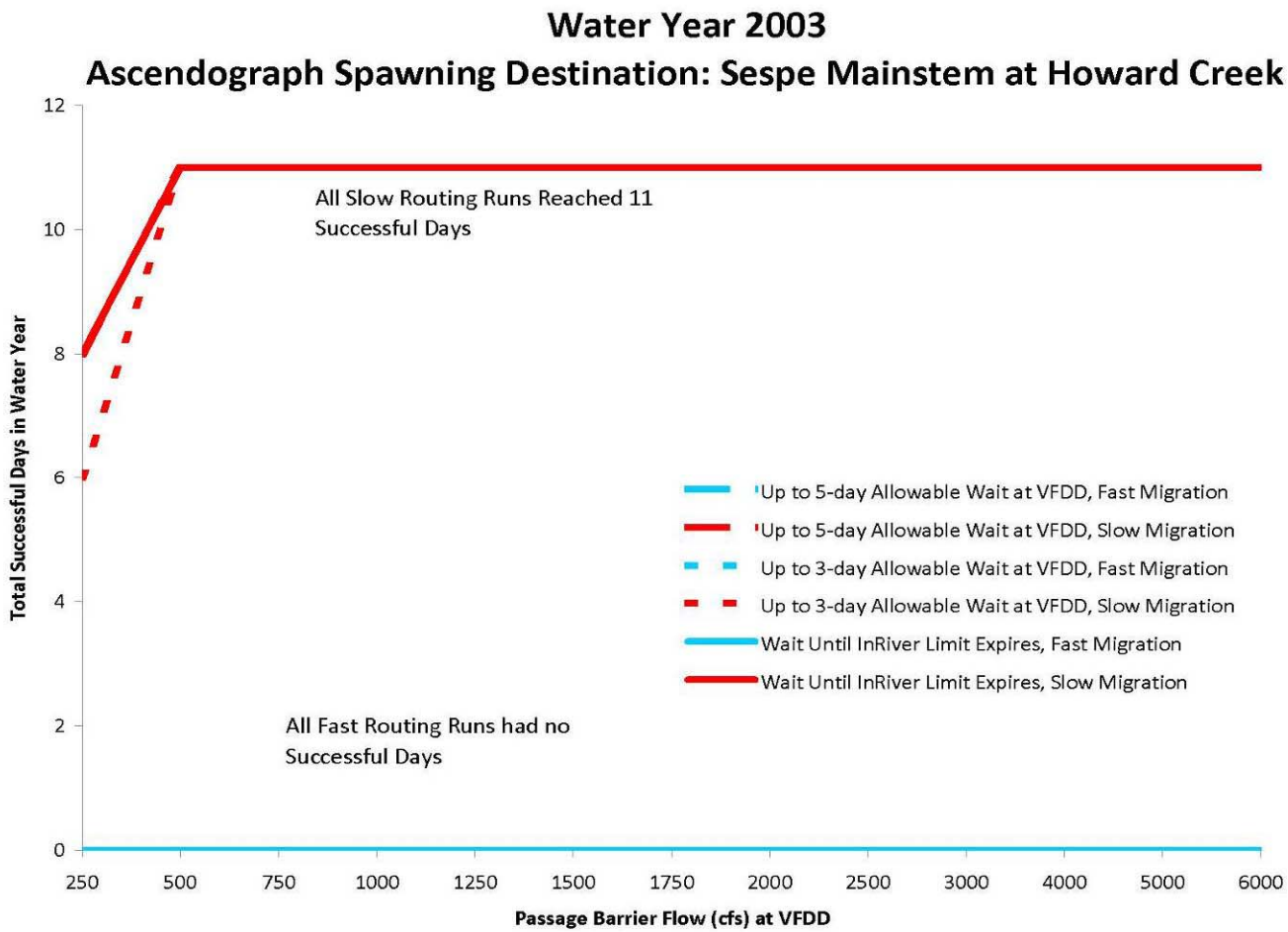


Figure 3.2-11. Effect of 3-day and 5-day allowable wait at VFDD on total spawning success under FAST and SLOW migration modeled for WY2003 at a single spawning destination, Upper Sespe Creek Mainstem at Howard Creek (Modeling Scenario No. 2).

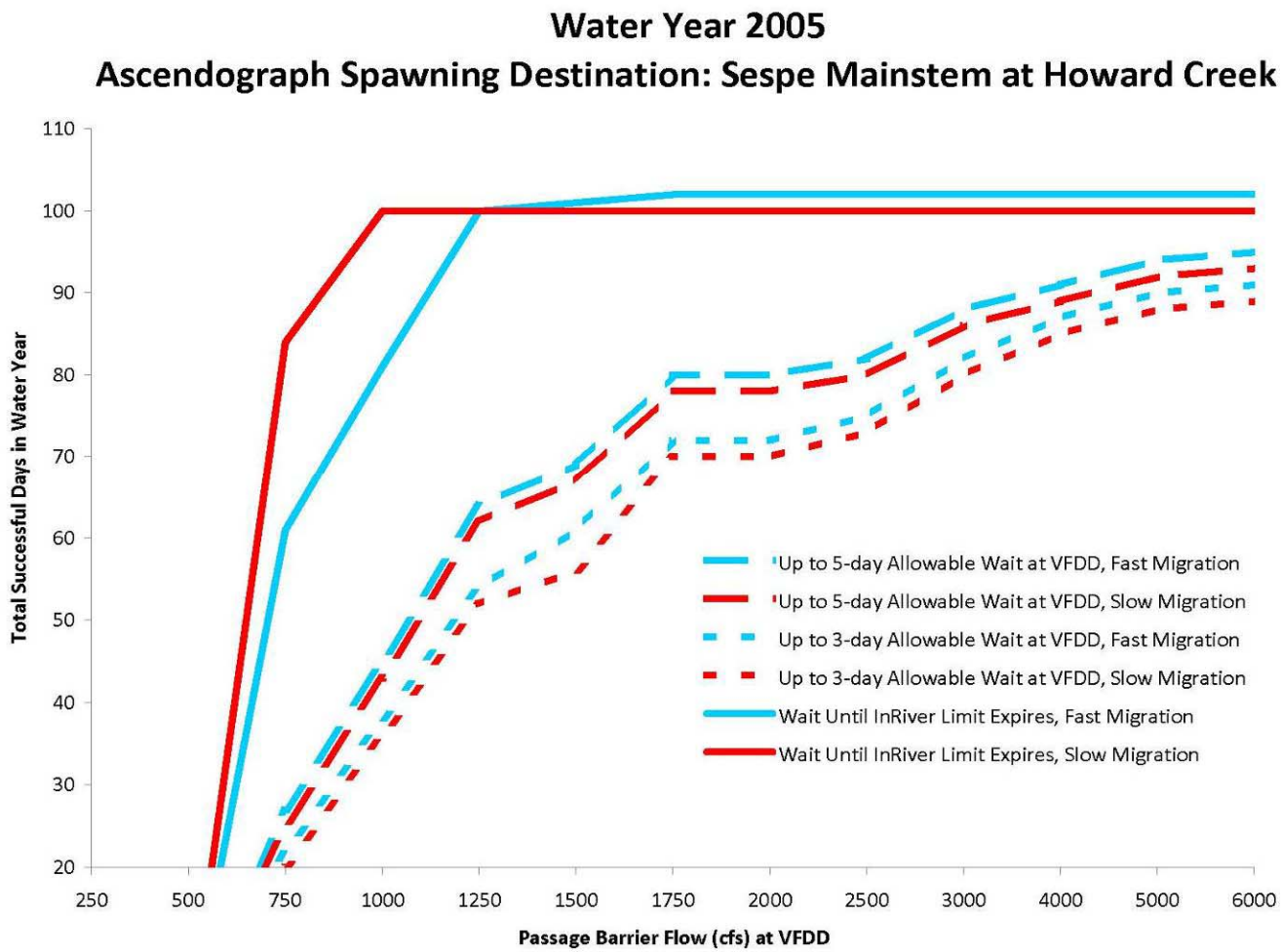


Figure 3.2-12. Effect of 3-day and 5-day allowable wait at VFDD on total spawning success under FAST and SLOW migration modeled for WY2005 at a single spawning destination, Upper Sespe Creek Mainstem at Howard Creek (Modeling Scenario No. 2).

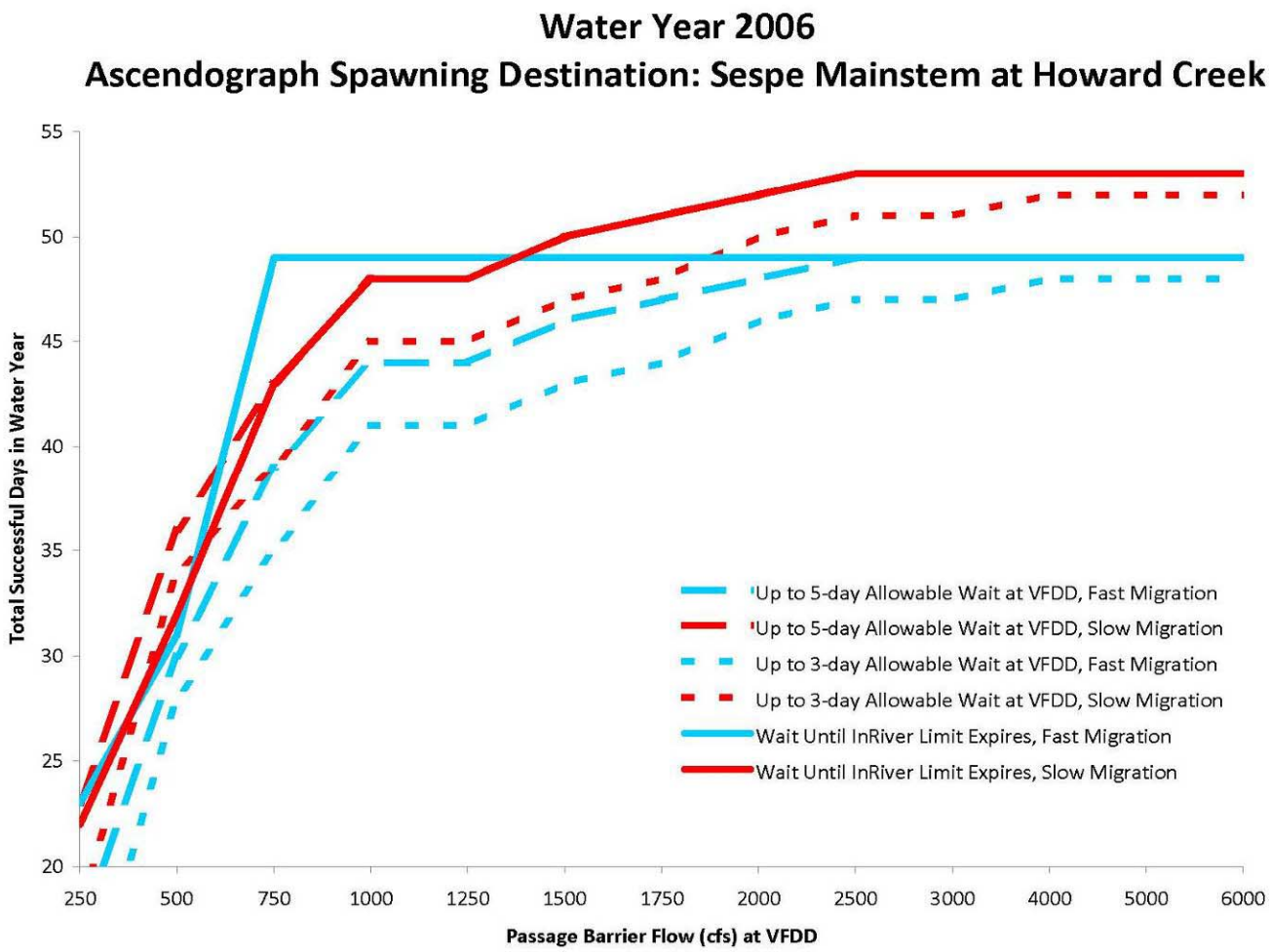


Figure 3.2-13. Effect of 3-day and 5-day allowable wait at VFDD on total spawning success under FAST and SLOW migration modeled for WY2006 at a single spawning destination, Upper Sespe Creek Mainstem at Howard Creek (Modeling Scenario No. 2).

Modeling Scenario No. 1 and No. 2 both evaluated delay imposed by passage barrier flows. Modeling Scenario 3 evaluated the effects on total spawning success of delay that was not associated with a passage barrier flow. Biologically, the difference between Scenario 3 and Scenarios 1 and 2 coarsely modeled the difficulty in finding the fish facility's entrance. Although higher streamflows and associated higher turbidities should make entrance location more difficult, there was no objective way to devise a quantitative function for the ascendograph's modeling. Once a fish reached VFDD, a 1 to 10 day delay was imposed in the Scenario No. 3 spreadsheet model regardless of streamflow magnitude. FAST migration parameters were assessed in Modeling Scenario 3 (Figure 3.2-14).

For evaluating the fish passage design alternatives, the ascendograph results, conservatively interpreted, indicate no single, decisive upper streamflow for passage design. Readily passable streamflows up to 1,500 cfs, and extended up to 2,000 cfs given the uncertainties of modeling, will be extremely important design passage streamflows at VFDD to keep total spawning success high, though remembering that and future modifications to hydrographs could be a very large factor. From 2,000 cfs to 3,000 cfs, passable streamflows would improve total spawning success in wetter years (although the outcome of high turbidity on migration at higher streamflows is unknown). As stated previously, keeping success high in the few good wet years should be an explicit goal for passage at VFDD. From 3,000 cfs to 4,000 cfs, modeled ascendograph effects were considerably more subtle and even more focused on the wet years. Above 4,000 cfs, Modeling Scenario No. 2 showed even less effects, and these may not be significant. Nevertheless, opportunity for passage should still be considered up to 6,000 cfs in design.

Extremely high turbidity at higher streamflows could make migration in general, and finding ladder entrances specifically, much more challenging. The Panel decided to not limit the design based on turbidity (e.g., have a relatively low upper passage design flow). Favorable passage at VFDD between 4,000 cfs and 6,000 cfs may not improve total spawning success measurably, but modeled results simply are not as reliable as monitoring spawning success with real fish in the basin. The minimum recommended flow for design at VFDD (not through the channel or for instream flow) is about 50 cfs.

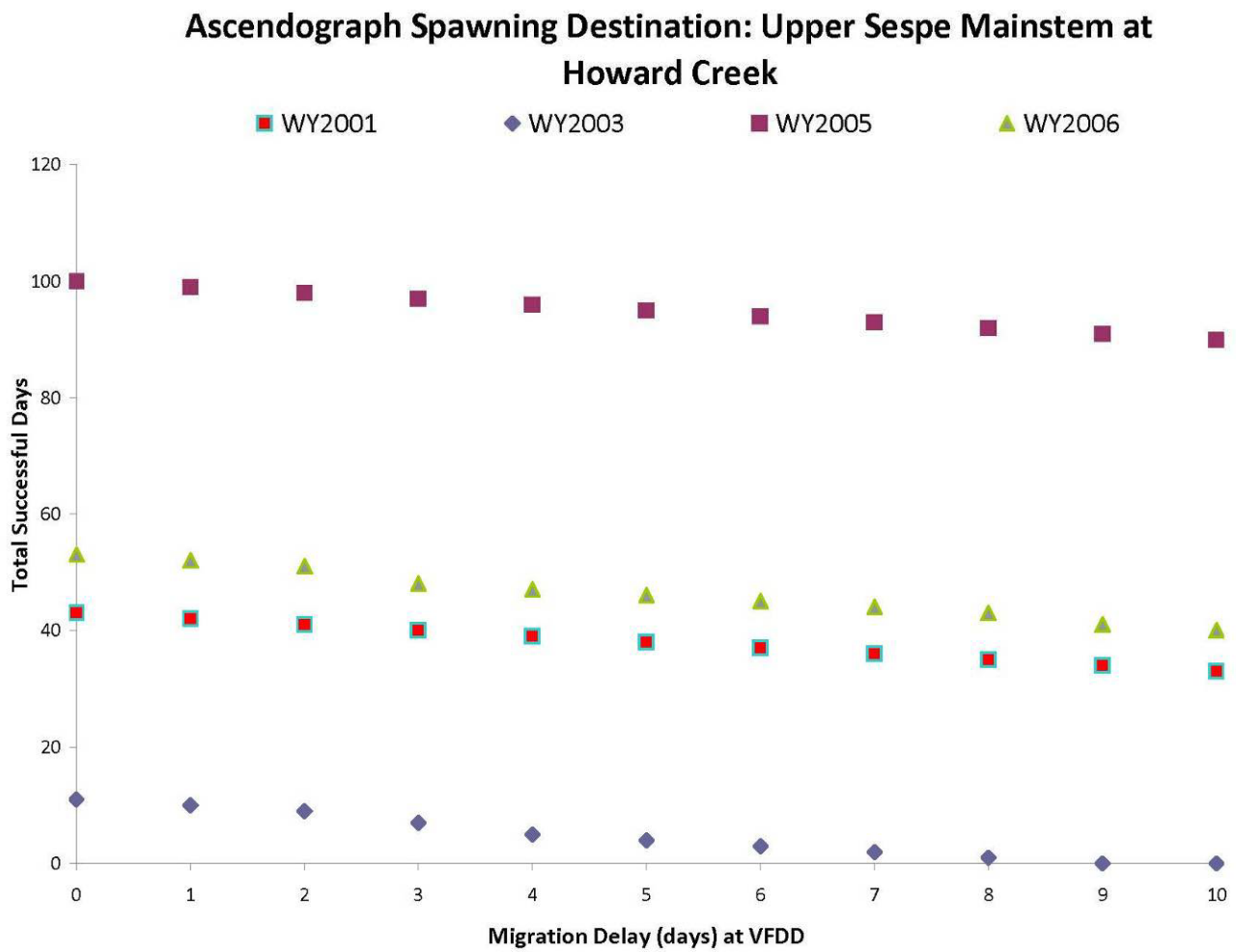


Figure 3.2-14. Effect of delay at VFDD on total spawning success under FAST migration modeled for WY2001, WY2003, WY2005, and WY2006 at a single spawning destination, Upper Sespe Creek Mainstem at Howard Creek (Modeling Scenario No. 3).

3.2.4 Minimum Passage Streamflow Analysis

Sustained steelhead passage at 40 cfs to 50 cfs could have been possible in an unaltered Santa Clara River for much of January through March in normal and wetter water years. This broad window of opportunity means that adults may not have been obliged to migrate only on peak flows. Substantial loss in streamflow attributable to an overdrawn groundwater table and wider, shallower channel morphology significantly contributes to decreased spawning success in the Santa Clara River Basin. The consequences of changing the minimum baseflow on spawning success were quantitatively assessed with the ascendograph for WY2001 and WY2005 under Modeling Scenario No. 2.

Not surprisingly, the 45 cfs threshold baseflow for adult steelhead migration on the Santa Clara River mainstem, rather than 160 cfs below VFDD and 120 cfs above VFDD (Table 3.2-1), resulted in more successful spawner days (Figures 3.2-15 and 3.2-16). Total spawning success in WY2005, under FAST migration routing and the 45 cfs threshold, was approximately 130 successful spawner days compared to approximately 100 successful days (Figure 3.2-16) under the minimum 160 cfs below VFDD. The Panel investigated whether a 45 cfs threshold in the future (i.e., rather than present 160 cfs needed to compensate for groundwater losses) might be even more affected by VFDD delay than under the 160 cfs threshold. Modeling results revealed a small relative difference in total spawning success for the two water years. At a passage barrier flow of 2,000 cfs in WY2005 under the 45 cfs threshold, total spawning success for the 5-day allowable delay was 80% of the baseline total spawning success (i.e., the solid blue line in Figure 3.2-16), but approximately 75% under the 160 cfs passage flow threshold in Modeling Scenario No. 2 (Figure 3.2-12). Above 4,000 cfs, however, there seemed little relative difference in total spawning success. More analyses might be warranted for increased accuracy.

3.2.5 Estuary ‘Stacking’ in Ascendograph Modeling

An entry date that does not encounter $Q_{VFDD} > 160$ cfs is automatically unsuccessful in the ascendograph. This requires adult steelhead to wait in the Pacific Ocean at the Santa Clara River mouth until passage conditions in the mainstem channel improve. However, there are other possibilities. Adults could enter the estuary on an entry date when $Q_{VFDD} < 160$ cfs, then must remain in the estuary until $Q_{VFDD} > 160$ cfs before commencing migration. In effect, potentially successful entry dates can stack-up in the estuary (i.e., within the ascendograph’s spreadsheet), with several or many entry dates beginning upstream movement the same day (as soon as Q_{VFDD} exceeds 160 cfs). This ‘estuary-stacking’ effect likely will be important in assessing possible future hydrographs, but not a deciding factor in the Panel’s design flow assessment.

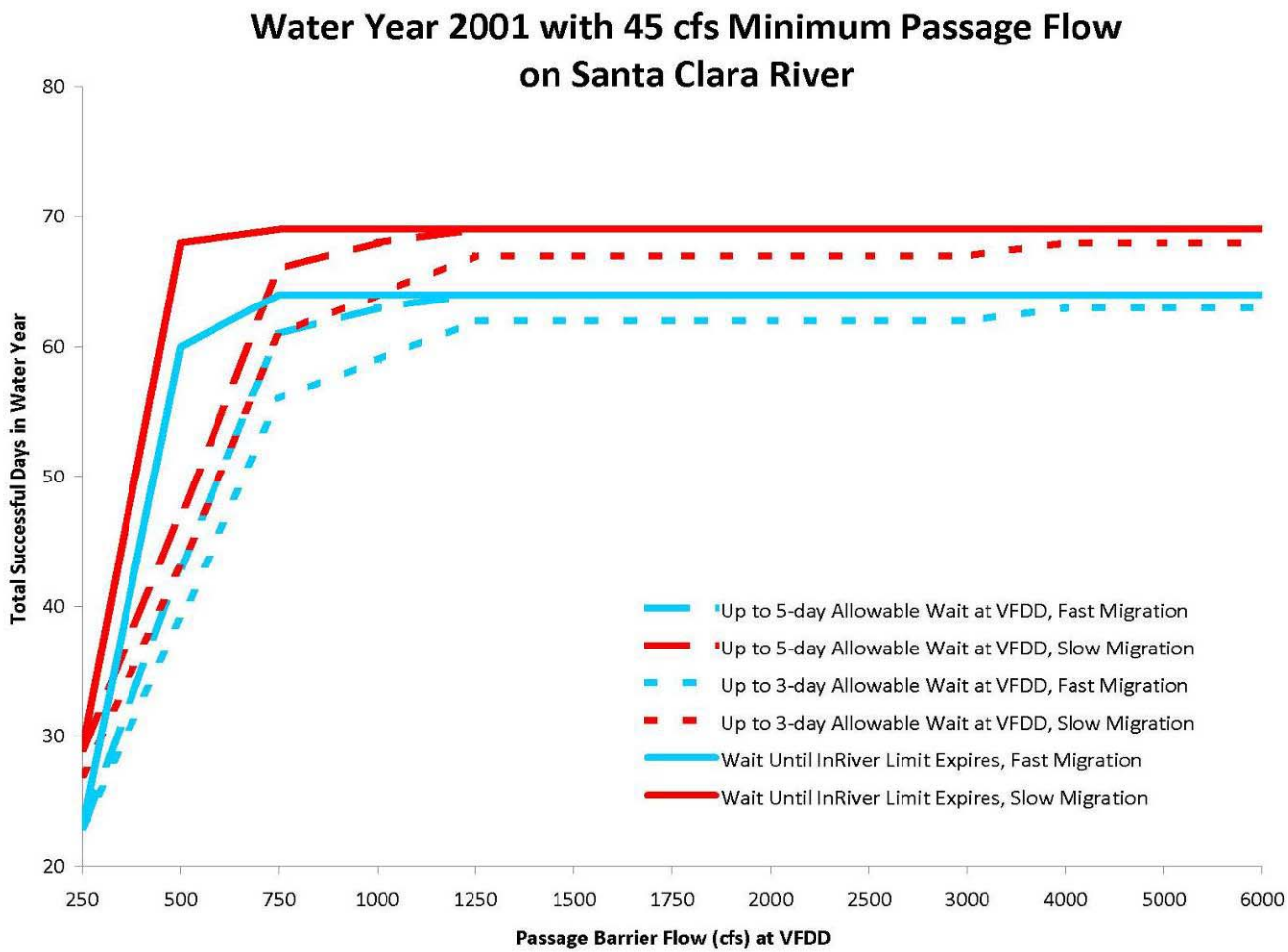


Figure 3.2-15. Effect on total spawning success using the 45 cfs minimum mainstem Santa Clara River passage flow under FAST and SLOW migration in WY2001 (modified Modeling Scenario No. 2).

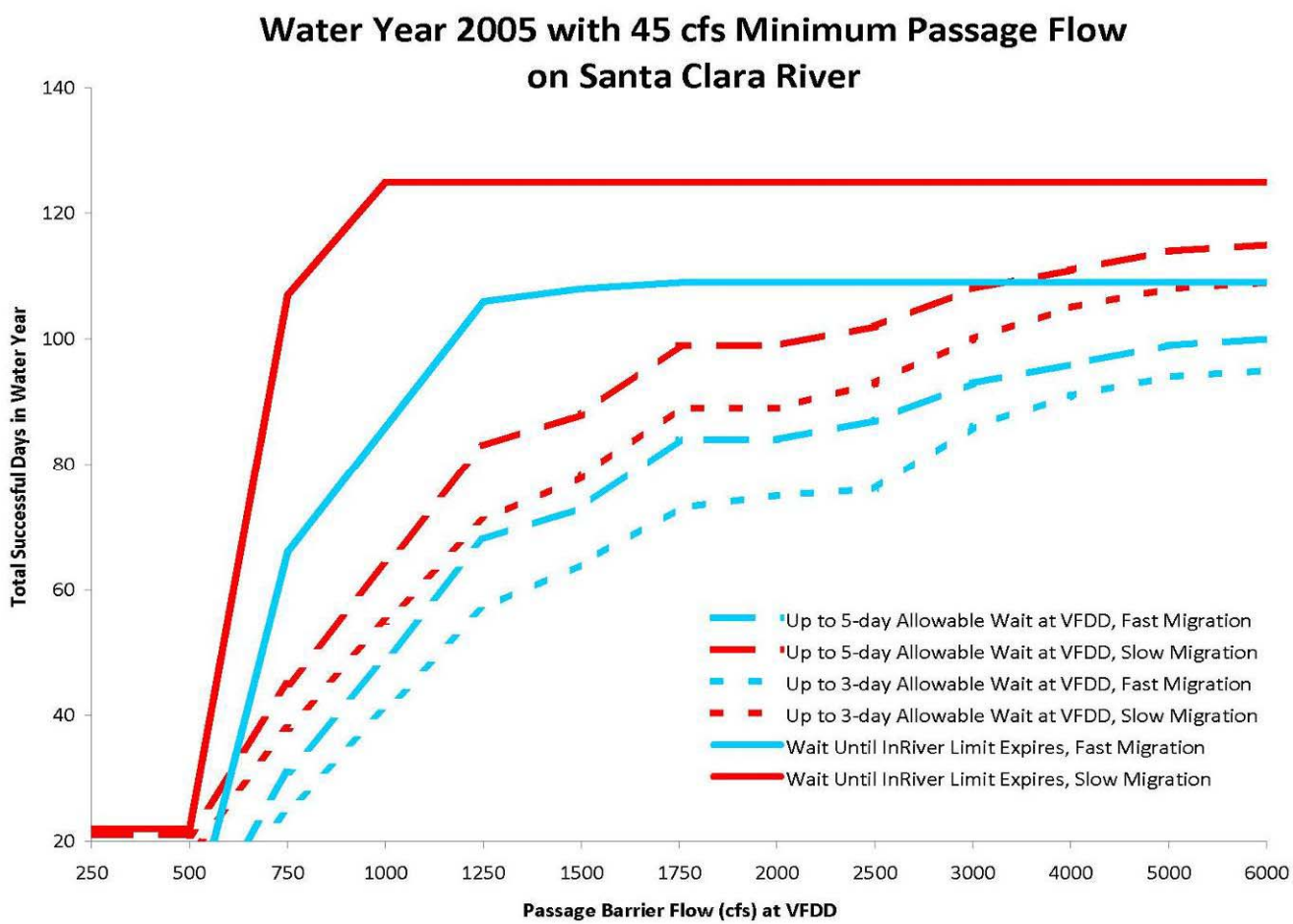


Figure 3.2-16. Effect on total spawning success using the 45 cfs minimum mainstem Santa Clara River passage flow under FAST and SLOW migration in WY2005 (modified Modeling Scenario No. 2).

3.3 OTHER APPLICATIONS OF ASCENDOGRAPH RESULTS

The Panel has no definitive formula estimating 'delay': the total time required for an upstream migrating adult steelhead to first encounter the dam's holding pool, then find the passage facility entrance, negotiate the facility, and finally exit upstream of VFDD. Most delay likely incurs locating the ladder/ramp entrance. A more attractive entrance should shorten the effort expended. The ratio of streamflow passing through the passage facility relative to total streamflow passing the dam offers one way to indirectly quantify attractiveness. This ratio is applied to the project alternatives in Section 7. Whenever more of the total streamflow passes through the fish passage facility, the entrance should be easier to find. Adult steelhead migrating through the first 10 miles of the exposed and shallow Santa Clara River mainstem may find VFDD's holding pool an attractive place to recuperate and rest. This may confound quantifying 'delay' attributable to the fish passage facility.

Why assess spawning risk now, if we must wait until there are enough fish in the Santa Clara River to empirically measure delay at VFDD? Risk assessment, without knowing the true migratory delay at VFDD, still retains considerable management value. The assessment may reveal that other migratory impediments cause more 'significant' delay (i.e., decreased spawning success) than would likely occur at VFDD (i.e., give VFDD widely ranging delay in a sensitivity analysis). Such a finding would not justify continuing migratory delay at VFDD, but it would help prioritize remedies. Significant risk could show a sharp threshold, where a relatively small increase in modeled delay at VFDD would significantly reduce steelhead spawning success in the Santa Clara River Basin. If this were true for VFDD, then monitoring should focus on quickly determining whether migratory delay at VFDD was above or below this threshold (e.g., radio tracking introduced adults). Last, experience accumulated from disciplined thought and measurement directed at a specific biological issue/shortcoming almost always reveals solutions not contemplated previously.

3.4. SUMMARY

Four streamflow ranges were identified from the ascendograph analyses that reflected different levels of spawning success and unique hydraulic conditions affecting fish attraction (e.g., tailwater flow patterns) for each fishway alternative.

Peak runoff in the annual hydrograph transitions from steeply receding peak streamflows to gradually receding streamflows at approximately 500 cfs. Using the 'VFDD to Filmore' daily average streamflows in the annual hydrograph plots for WY2001, WY2003, WY2005, and WY2006 (Figures 3.2-3 to 3.2-6), this approximate transition from steep to gradual occurred at

500, 180, 600, and 500 cfs respectively. Baseflows approaching VFDD, therefore, were considered ranging between 0 cfs and approximately 500 cfs. The Panel distinguished baseflows from all other higher streamflows to emphasize their importance influencing fish passage design. Long duration, low magnitude streamflows would allow adult steelhead to access much of the watershed in most water years (except the driest years).

Ascendograph analyses, at their earliest stage of development, indicated passage streamflows between 500 cfs and 2,000 cfs strongly influenced the number of potential successful spawning days in each water year modeled (Figures 3.2-10 through 3.2-13 Scenario No. 2). The Panel prioritized this 'mid-low' streamflow range and baseflows in the fish passage design (i.e., from minimum streamflows necessary to negotiate shallow riffles below VFDD up to 2,000 cfs), recognizing that a fishway entrance designed to contain a very high percentage (>50%) of a peak flow (exceeding 2,000 cfs) could not be designed to also provide optimal passage conditions at low streamflows.

As stated often, beginning at the start of the Panel's design effort, wetter water years could exert a strong influence on overall population sustainability and vigor. Preliminary and subsequent ascendograph analyses indicated that passage streamflows between 2,000 cfs and 6,000 cfs ('mid-high' streamflows) significantly improved modeled spawning success in WY2005 (a very wet year) and WY2006 (a marginally wet year) (refer to Figure 3.2-2A for a ranking of water years from Critically Dry to Extremely Wet). Given the necessary design tradeoffs between providing optimal passage during low versus high streamflows, streamflows between 2,000 cfs and 6,000 cfs (and greater) did not dominate the engineering design for alternatives, but were nevertheless accommodated in each alternative's design. For example, in the ramp alternatives, a lower percentage attraction flow and a passage route along the ramp margins rather than up the centerline were considered in the design.

Passage at streamflows exceeding 6,000 cfs ('high' streamflows) improved total modeled spawning success in WY2005 (Figure 3.2-12). Design specifications accommodating passage at 5,000 cfs to 6,000 cfs will extend to even higher streamflows, though how much higher and to what extent passage conditions diminish were not assessed by the Panel.

4. FISH PASSAGE DESIGN FLOWS

A number of flow magnitudes are important in the design of fish passage facilities and there can be differences between a fish passage design flow range and flows within or emanating from a fishway. This section describes the concepts of fishway flows, attraction flows, and fish passage design flows and how they are factored into the design alternatives. A comparison and summary of the flows described here as applied to the fish passage alternatives that were developed in this study is included in Section 7.1.1 of this report.

Fish passage design criteria and guidelines are published by NMFS for the Northwest Region and are used here as guidance and comparison (NMFS, 2008b). Guidance for fish passage design flows is provided by the NMFS Southwest Region for stream crossings (NMFS, 2001) and through CDFG (2009) for formal fishways.

4.1 DESCRIPTION OF FLOW RELATED FISH PASSAGE CONCEPTS FOR DESIGN

Definitions of key terms and descriptions of important flow related fish passage concepts for design are provided here.

4.1.1 Fishway

NMFS (2008b): “The Fishway is the set of facilities, structures, devices, measures, and project operations that together constitute, and are essential to the success of, an upstream or downstream fish passage system.”

4.1.2 Fishway Entrance

NMFS (2008b): “The fishway entrance is the component of an upstream passage facility that discharges attraction flow into the tailwater, where upstream migrating fish enter (and flow exits) the fishway.”

4.1.3 Fishway Flow

Fishway flow is the flow through the fishway itself.

4.1.4 Auxiliary Water System

NMFS (2008b): “The auxiliary water system is a hydraulic system that augments fish ladder flow at various points in the upstream passage facility. Typically, large amounts of auxiliary water flow are added in the fishway entrance pool in order to increase the attraction of the fishway entrance.”

4.1.5 Attraction Flow

Attraction is the guidance of fish to find the migration pathway over a dam or impediment. It is a key component to minimizing migration delay. It could account for a high portion of the success of fish passage and it is often the most difficult to predict during design. This is because of variables such as uncertainty of behavior of individual fish, and variable and changing hydraulic conditions below the dam and fishway entrance.

Fish attraction includes attraction to the vicinity of the fishway entrance and passage into the entrance. The ratio of fishway entrance flow to the river flow downstream is often used as a design guide. Ratios of fishway flow of five to ten percent of downstream flow are often applied. For example, if the flow coming out of a fishway entrance is 100 cfs and the total river flow in the vicinity of the fishway is 1,000 cfs then the attraction ratio is 0.10. The ratio of momentum (equivalent to the product of flow rate and velocity) has also been used. It is important to note that simple percentages or ratios alone do not account for the other attraction considerations.

NMFS (2008b) describes attraction flow: “Attraction flow from the fishway entrance should be between 5% and 10% of fish passage design high flow … Generally speaking, the higher percentages of total river flow used for attraction into the fishway, the more effective the facility will be in providing upstream passage. Some situations may require more than 10% of the passage design high flow, if site features obscure approach routes to the passage facility.”

CDFG (2009) refers to these NMFS criteria and to Bates (1992), who described entrance flows, which include fishway flow and can include an auxiliary water system flow, as typically three to ten percent of the downstream flow at the high fish passage design flow in a sample of effective fishways in simple tailwater situations.

4.1.6 Design Flow Range

NMFS (2008b): “The design streamflow range for fish passage, bracketed by the designated fish passage design high and low flows, constitutes the bounds of the fish passage facility design where fish passage facilities must operate within the specified design criteria. Within this range of streamflow, the fishway design must allow for safe, timely, and efficient fish passage. Outside of this flow range, fish must either not be present or not be actively migrating, or must be able to pass safely without need of a fish passage facility. Site-specific information is critical to determine the design time period and river flows for the passage facility – local hydrology may require that these design streamflows be modified for a particular site.”

4.1.7 High Fish Passage Design Flow

NMFS (2008b): "Design high flow for fishways is the mean daily average streamflow that is exceeded 5% of the time during periods when migrating fish are normally present at the site. This is determined by summarizing the previous 25 years of mean daily streamflows occurring during the fish passage season, or by an appropriate artificial stream flow duration methodology if streamflow records are not available. Shorter data sets of stream flow records may be used if they encompass a broad range of flow conditions. *The fish passage design high flow is the highest streamflow for which migrants are expected to be present, migrating, and dependent on the proposed facility for safe passage"* (emphasis added).

4.1.8 Low Fish Passage Design Flow

NMFS (2008b): "Design low flow for fishways is the mean daily average streamflow that is exceeded 95% of the time during periods when migrating fish are normally present at the site… *The fish passage design low flow is the lowest streamflow for which migrants are expected to be present, migrating, and dependent on the proposed facility for safe passage"* (emphasis added).

4.2 DISCUSSION OF DESIGN FLOWS

The relevance of the low fish passage design flow in this project is that a fishway should provide appropriate hydraulic conditions, primarily adequate water depth, for fish passage at that flow. It is often not a critical factor of fish passage design but can constrain options or design elements of a fishway. The 95% mean daily exceedance flow during the fish migration period (January to May) is approximately 50 cfs and it has been generally accepted to use this as a lower bound for fish migration opportunity in the lower Santa Clara River (see NMFS letter of June 23, 2010 in Appendix A).

The relevance of the high fish passage design flow in this project is that a fishway should provide appropriate hydraulic conditions, primarily attraction to the fishway and limited turbulence and velocities within the fishway, for fish passage at that flow. It can be a very critical factor of fish passage design in that it often determines the type, size and configuration of the fishway. It may be unreasonable to contain all of the high fish passage design flow in the fishway itself so auxiliary water sources for entrance attraction may be necessary as described later.

The 5% mean daily exceedance flow for the Santa Clara River at VFDD during the fish migration period (January to May) is approximately 5,000 cfs (see NMFS letter of June 23, 2010 in Appendix A) and the 2-year annual flood flow frequency is currently 12,800 cfs. Half of the

2-year annual flood flow frequency is sometimes uses as a surrogate for the high fish passage design flow when the quantity and/or quality of hydrologic data are not sufficient.

As mentioned above fishway attraction is the key component to minimizing migration delay. It could account for a high portion of the success of fish passage but it can also be the most difficult to predict during design. This is because of variables such as behavior of individual fish, variable and changing hydraulic conditions below the dam and fishway entrance over a range of river flows. Characteristics of the tailwater that affect attraction are bathymetry or competition (fish distraction) from flows coming from other facility components.

The generally accepted guideline for attraction flow is to have the fishway entrance flow, which includes the fishway flow and can include an auxiliary water system flow, be up to 10% of the high fish passage design flow. It is also recognized that the higher percentage of downstream flow that is fishway entrance attraction flow, the more effective the facility will generally be in providing upstream passage. However, there are very real constraints and tradeoffs to designing a fishway entrance to contain a higher percentage of downstream flow. If a fishway entrance is designed for a very high percentage of the high fish passage design flow, it may not provide optimal passage at more frequent lower flows.

For this project, if a high fish passage design flow of 5,000 cfs were selected, designing a fishway entrance flow for 500 cfs would meet the 10% flow ratio guideline. Again, it should be noted that this is just a guideline. NMFS (2008b) states that: “Guidelines should be followed in the fishway design until site-specific information indicates that a different value would provide better fish passage conditions or solve site-specific issues.” Considering these guidelines and the results of the flow-based migration delay risk assessment outlined in Section 3, the Panel decided to evaluate attraction into a fishway with respect to four ranges of river flows applied to each alternative, rather than just rely on single upper and lower flow parameters. The four streamflow ranges were identified from the ascendograph analyses (see Section 3.4) that reflect different levels of spawning success and unique hydraulic conditions affecting fish attraction. These flow ranges and the weighting factors used in the evaluation of those flow ranges as characteristics of the alternatives considered are shown in Table 4.2-1. The weighting scale is from zero to ten with zero meaning the characteristic is of no importance and ten meaning it is essential to the success of the project.

Table 4.2-1. Ranges of flows evaluated.

Flow Range Descriptions	Flows	Weighting Factor
Low flow range	40 – 500 cfs	10
Mid-low flow range	500 – 2,000 cfs	10
Mid-high flow range	2,000 – 6,000 cfs	6
High flow range	Over 6,000 cfs	2

To show the context, the 5% mean daily exceedance flow is approximately 5,000 cfs and the two-year flood is approximately 12,800 cfs.

The Panel considers the attraction flow ratio as an important factor in the development of alternatives, however, simply using just the fishway entrance flow for attraction does not account for other hydraulic conditions, such as flow from the flushing channel gate, or possible sluice gates or dam crest gates, that can help attract fish to the vicinity of the fishway. These components are explained more fully in each alternative's description (Section 6) as well as how each alternative operates and the fish attraction effectiveness relative to the flow ranges evaluated. That attraction evaluation and comparison between the alternatives considered is described in Section 7.1.1 of this report.

This page intentionally blank.

5. DEVELOPMENT OF FISH PASSAGE ALTERNATIVES

5.1 SHORT LIST OF TEN PREFERRED ALTERNATIVES

To begin the process of developing and selecting feasible and preferred alternatives for fish passage at VFDD, the Panel held an internal brainstorming workshop on November 18 and 19, 2009 to develop an initial list of possible fish passage improvements. The workshop was described in workshop notes dated 12/17/09.

A list of 30 design elements was identified at the workshop that could each improve fish passage at the VFDD. As a matter of definition, each of these elements was considered a means to improve passage alone, or in combination with another element. From the elements, ten alternatives were developed for further consideration. Some alternatives are made up from a single design element, but most are composed of two or more elements.

The ten alternatives are fully described in a memo to the Group dated February 3, 2010. For each alternative, notes include description, critical items to consider, advantages, disadvantages, risks, and other elements that might be added. Just the descriptions are included in this section of the report. Full descriptions of the five alternatives carried forward are included in Section 6 of this report. Those alternatives and initial concepts that were not carried forward are described here (and summarized in Table 5.2-1) including reasons they were not pursued.

In narrowing the alternatives developed in the brainstorming meeting, the technical aspects of fish passage and water delivery to the district were considered. At this stage of analysis costs of the alternatives were not considered.

5.1.1 Alternative 1: Dam Removal and Pipeline from Lake Piru

Remove VFDD to below downstream grade. Construct a pipeline to carry water directly from Lake Piru (with a new intake or use a modified low level release at the dam) or the existing Piru Creek diversion to the existing VFDD intake and spreading ponds for normal operations.

It is easy to ascertain that any dam removal alternative greatly improves fish passage in that there would not be any structural impediment in the river channel. However, the Panel has decided it can not further the development this alternative because of significant issues with surface water and ground water supply and management, water rights, and channel geomorphology. Study of these issues is outside the scope of the Panel’s charge and expertise. These reasons for not

developing this alternative further are also described in UWCD's and NMFS' letters of February 23rd and 25th, respectively.

A reason for considering this alternative, given the considerable human and economical consequences of dam removal, will be if the Panel's work concludes that a technological fix will not eliminate VFDD as a factor for steelhead recovery in the Santa Clara River Basin. Also, consideration of dam removal could happen if the Panel's proposed design for improving fish passage at VFDD costs more than an alternative solution that handles the issues described above. Dam removal could be a viable alternative and long term goal if conditions change in the basin such that sea-water intrusion into the aquifers is abated, groundwater conditions are in a steady-state, and water supplies for land uses are obtained through other means. Water conservation and improved water use planning within a time frame of 50 or 100 years could lead to this possibility.

Because dam removal is the best solution for achieving ecosystem restoration and is consistent with goals of NMFS and other resource agencies and environmental groups, eventually removing the VFDD should remain United's ultimate goal.

5.1.2 Alternative 2: Replace VFDD with a New, Inflatable Dam near Hwy 101

Remove existing dam. Build a new, low head, inflatable dam near Highway 101, at the downstream end of the in-stream infiltration. Build a new fish ladder there to provide fish passage around the dam at low flows. Build a new on-river pumping plant and fish screen within new water impoundment.

The rationale of this alternative is there would be no fish passage barrier when the new dam is lowered during high flows. At low and moderate river flows fish passage is provided via a new fish ladder. The fish ladder would need to be capable of operating over a wide range of impoundment water elevations. Groundwater recharge requirements would be met in part or wholly by making use of the infiltration zone in the river channel. Surface water needs may have to be supplemented by way of a riverside, screened, pumping plant located within the impoundment area.

There are substantial issues that must be resolved to make this a feasible alternative. In addition to the water supply and geomorphology issues described for Alternative 1, this alternative potentially just moves the fish passage barrier issue to a new location since this alternative needs a fishway, which must operate over a wide range of forebay elevations. The status of this and any dam removal alternative is described above in Alternative 1.

5.1.3 Alternative 3: Left Bank Vertical Slot Fish Ladder around Diversion with Notch in Dam

Construct a new vertical slot fish ladder with an entrance near the existing fishway entrance, and exiting upstream of the water diversion intake. This alternative is carried forward and is described in Section 6.2.

5.1.4 Alternative 4: Full Depth Notch in Dam with New Technical Fishway

Construct a full-depth, high flow bypass gate structure adjacent to the flushing channel to provide fish passage at higher flows and when diversion does not occur (i.e., during floods and periods of high sediment). Improve fish passage around the diversion with a new right bank fishway for times when diversion occurs during the migration season. With a gate structure that has an overall width of 200 ft the velocity is estimated to begin to exceed 8 ft/s (decreasing fish passage effectiveness through the gates) when the flow is approximately 4,000 cfs or greater. The overall width of the gate structure and the number and type of gates is to be determined through detailed hydraulic analysis.

The full depth notch alternative was rejected because it does not add substantial value to the left bank fishway alternatives and its operation conflicts with water diversion.

5.1.5 Alternative 5: Full Active Channel Width Rock Ramp with Dam Crest Modifications

Construct a 450 ft-wide, 500 ft-long rock ramp fishway on a 5% slope on the downstream face of the VFDD. Include a low flow channel provide adequate water depth at the low fish passage flow. Partially notch the dam to allow low flows to enter the fishway.

The alternative was dropped from further considerations because, for fish passage, it is no better than Alternative 6, and it is likely infeasible to construct because there is no stable foundation to support such a structure just downstream of VFDD.

5.1.6 Alternative 6: Partial Width Rock Ramp with Dam Crest Modifications

Remove a section of the VFDD to approx elevation 142 adjacent to the flushing channel and build new walls roughly perpendicular to and upstream of the dam to elevation 177 to contain the rock ramp. Construct a rock ramp fishway through the notch in the dam. Construct a gated flow control structure in a notched section of the dam crest to the right of the fishway. This alternative is carried forward and is described in Section 6.3.

A roughened channel with engineered concrete baffles in lieu of rocks (hardened ramp) evolved during consideration of the rock ramp alternative. The hardened ramp concept will have lower containment walls than the rock ramp alternative and a flow control structure at the upstream end of the ramp, but no gated notch. This alternative is carried forward and described in Section 6.3.

5.1.7 Alternative 7: Left Bank Vertical Slot Fish Ladder in Expanded Footprint of Existing Fish Ladder

This alternative was examined, with the goal of fitting fishway improvements into the general area of the existing structure footprint. The space and floor elevation available was not sufficient to meet the goal and the concept was found to be essentially the same as Alternative 3. This alternative was dropped in favor of that alternative.

5.1.8 Alternative 8: Left Bank Nature-Like Fishway

Construct a new nature-like fishway with an entrance within or near the existing fishway entrance and a gated exit upstream of the water diversion intake. Route the fishway over or under the diversion canal. The fishway exit would be equipped with several flow control weirs to maximize the operational range of the fishway and to protect the fishway from excess flow as the forebay fluctuates. To maximize fish attraction, the entrance would be similar to the entrance described for Alternative 3 with gated entrances, an entrance pool, and auxiliary water system. Construct a new screened auxiliary water system or provide capacity within existing screen.

This alternative is carried forward and is described in Section 6.5.

5.1.9 Alternative 9: Trap and Haul

Build a technical fish ladder with the entrance near the existing fish ladder entrance leading to a trap and haul facility. Build a new auxiliary water system with fish screen to increase attraction flow from the fish ladder. Build a gated notch in the dam crest adjacent to the flushing channel to concentrate low and moderate river flows to river left. A trap and haul system could be built at any time as a spur to other technical fish ladder alternatives.

This alternative was dropped from further consideration at this time because, as described in the NMFS letter dated February 25, 2010, it “does not comport with NMFS’ primary management objective of providing volitional passage for this endangered species. Collecting and relocating steelhead can only be considered in the context of rescue operations and research.”

5.1.10 Alternative 10: Improve the Existing Fishway

All of the previous alternatives are designed to replace the existing Denil fishway and some of the alternatives could work in conjunction with it. The Panel judged that the existing fishway was not an adequate fish passage system for the following reasons:

- Fishway is not operable when flow is turned out of the canal or when the flushing gate is open.
- Attraction water capacity is not adequate. For calculation of fishway attraction (Section 7.1.1) the auxiliary water system was included though the likelihood of injury to juvenile fish passing through it is high; therefore, NMFS considers operation of that system not appropriate unless modifications are made to exclude fish.
- Auxiliary water system is not screened.
- Turbulence in the entrance pool and turning pools is excessive.
- A Denil fishway, though passable for adult fish, is not the best solution for adult steelhead. Some fish may reject it because of the shallow, turbulent flow. The turbulence can be a barrier to smaller fish and some lamprey.
- Entrance hydraulic conditions are inadequate at high flows when water is discharged through the flushing channel. There is excessive turbulence at the two existing entrances.
- Exit conditions are less than ideal. Fish exit into the canal and perpendicular to the canal flow and then have to find an exit through the diversion trashrack.

Elements identified to improve the ladder include rerouting the fish ladder to exit upstream of the existing water diversion intake; a new water intake solely for auxiliary water supply; changing diversion operations and flushing channel dissipation to allow for greater flow releases through the that channel; and operating the fishway at all river flows.

These potential improvements to the existing fishway, when performed together, are essentially the same as, and with no apparent cost advantage over the vertical slot or nature-like fishways. This alternative was therefore dropped from consideration.

In addition to a stand-alone alternative, an improved fishway may offer some benefits to supplement other alternatives. The rock ramp and hardened ramp alternatives were designed to operate over the entire range of fish passage flows, but neither will offer ideal fish passage conditions at the low fish passage flow. Additionally, the existing fishway could continue in service for fish passage during construction of some of the other alternatives.

5.2 DOCUMENTATION OF DROPPED CONCEPTS

In addition to the ten alternatives described above, an additional 13 initial concepts were initially considered by the Panel but were rejected. They, together with the four alternatives described above that were dropped in the second round of consideration, are listed in Table 5.2-1. If the faults of any of these are overcome, they could be pursued.

Table 5.2-1. Initial concepts that were dropped.

Alternative	Description	Reasons for Dropping
Dam removal with pump intake on river	New screened pumping plant, and in-river constriction point to create pump forebay.	Sediment issues, ability to maintain pump sump is questionable
Though dam removal was not developed in detail, some sort of the dam removal alternative should be considered as a long-term goal. See the description with Alternative 1.		
Dam removal with pushup dam and berm to divert water to existing water intake.	Similar to pre VFDD operations. The berm would be designed to fail at high flows to provide fish passage.	Environmental issues. Unreliable passage and water delivery. Extensive in-river maintenance.
Dam removal Use river channel for groundwater recharge through channel modifications.	Construct in-channel berms to route flows in circuitous path to increase residence time.	Low reliability. Extensive in-river maintenance.
Dam removal with infiltration gallery.	Construct buried perforated pipe gallery under the river bed and just upstream of the VFDD site to divert subsurface flow to the existing water intake channel or to a new pump plant.	Reliability is questionable, especially at low flows and in dry years.
Dam removal with new gravity intake upstream of VFDD.	Construct a new gravity, surface water intake with a fish screen, and in-river constriction point to maintain diversion forebay.	Diversion without dam is not reliable.

Table 5.2-1. Initial concepts that were dropped.

Alternative	Description	Reasons for Dropping
Full-depth notch in dam with new technical fishway (Alternative 4)	Construct full-depth gated notch through dam that would be opened at high flows. Additional fishway would be required for low flows.	No advantage over formal fishway alternatives and has operational conflicts with water diversion.
Full-width rock ramp with a low flow channel for adequate water depth at the low fish passage flow and a notch to supply water to the fishway at low flows. (Alternative 5)	Construct a 450 ft-wide, 500 ft-long rock ramp fishway on a 5% slope on the downstream face of the VFDD.	No advantage over Alternative 6. No stable foundation to support such a structure just downstream of VFDD.
Roughened channel along face of dam.	Construct a ramp along the downstream face of dam with its entrance near flushing channel. The ramp would have a switch back to exit at the left bank end of the dam.	Fish passage is limited at high flows due to spill over dam.
Technical fishway on right bank.	Construct a new fish ladder at the right bank of the active channel near center of dam. Could be added at any time.	Left bank location, which is carried forward, has many advantages.
Pool & chute fishway on north side of flushing channel and parallel to flushing channel.	Construct a new ladder parallel to flushing channel with entrance near end of flushing channel on 7%-8% slope.	Uncertainty of high head differential for this type of ladder. Untested above 10 ft. Access for maintenance may be difficult.
Technical fishway along dam face.	Construct a vaulted fishway with entrance near end of flushing channel, Fishway would run along face of dam with one switchback and exit near flushing channel.	Requires passage in a darkened fishway. Fishway blocks a portion of the dam crest. Access difficult.

Table 5.2-1. Initial concepts that were dropped.

Alternative	Description	Reasons for Dropping
Vertical slot fish ladder on north side of flushing channel and parallel to flushing channel.	Construct fishway with entrance adjacent to flushing channel. Extends to approx upstream end of existing structure (~250 ft).	Inferior to similar alternatives.
Nature-like fishway at right bank in conjunction with Todd Barranca Creek.	Construct a nature like fishway channel connecting VFDD's impoundment to Todd Barranca. Construct a flow control structure at the fishway exit.	Remote location. Poor access. Intake Location not dependable water supply. Divides water supply from diversion.
Nature-like fishway at left bank fishway around diversion.	Build a new fishway using nature-like design without a formal entrance.	Poor entrance conditions. This alternative is similar to Nature-like fishway with formal entrance, which is carried forward.
Nature-like fishway at right bank of active channel near dam.	Ladder entrance is near center of existing dam. Ladder follows base of dam and ascends around the RB.	Remote location. Poor access. Intake location not dependable water supply. Divides water supply from diversion.
Trap and haul system in conjunction with fishway (Alternative 9)	Build trap and haul in conjunction with any fishway.	Not appropriate for restoration of this endangered species.
Improve existing fishway (Alternative 10)	Add more auxiliary water, solve enlarge entrance and turning pools, reroute exit	When all modifications are done, there is no apparent advantage over a new fishway.

6. SELECTED FISH PASSAGE ALTERNATIVES

Five alternative designs for fish passage improvements are described in this section. Drawings of the alternatives developed are included in a Section following Section 10 of this report. The alternatives are:

- Alt 1 – Dam Removal
- Alt 3 – New Vertical Slot Fishway
- Alt 6A – Partial Width Rock Ramp at 4% slope
- Alt 6B – Hardened Ramp at 6% slope
- Alt 8 – Nature-Like Fishway on Left Bank.

6.1 ALTERNATIVE 1 – DAM REMOVAL

The alternative would remove VFDD to below channel grade. The Panel's initial concept included a pipeline to the existing VFDD intake and spreading ponds for normal operations that will carry water directly from Lake Piru with a new intake or use a modified low-level release at the dam or from an improved, existing Piru Creek diversion. At a review of design concepts after the Panel's November 2008 brainstorming meeting, UWCD determined a direct link between VFDD and Piru Creek projects was infeasible due to water rights, flow timing, and other issues.

Dam removal will require a combination of efforts to modify the water supply and usage. Integrated, regional water resource planning over a long term is extremely important in considering this alternative. The Panel considered the following options when looking at this alternative; these are described further in Section 5:

- Pipeline from Piru.
- Pump intake on River.
- Additional groundwater recharge in riverbed by channel modifications and/or impoundment.
- New gravity intake upstream from VFDD.
- Change to water use and water conservation.

Implementation of this alternative includes a feasibility study of dam removal components and options. Some critical items to consider for the general alternative of dam removal include:

- New pipeline routes may require property acquisition or easements.
- Dam removal will result in channel instability and morphology changes to the Santa Clara River. Headcutting may threaten infrastructure and exacerbate or create fish

passage barriers at Santa Paula Creek and Sespe Creek. Bank stabilization and erosion control may be required. The channel is artificially confined and will not likely return to its historical grade. Other measures to mitigate the channel morphology changes will need study.

- The hydrology (water availability) and management of alternative sources need additional study.
- Dam removal implies an alternate water supply, which has its own effect on that source and on any channel that acts now or will act as a conveyance channel for that flow.
- Additional study is needed regarding the alternative and its relationship to water rights, water use, and water management.

Some advantages of this alternative include:

- Removes fish passage barrier at VFDD.
- Improves water reliability to UWCD (when river is dry there would be fewer losses due to infiltration between Piru and VFDD and water availability and timing relative to demand needs can be more responsive).
- Improves water quality to UWCD.
- Restores natural river processes.
- May reduce flood risk upstream.
- This alternative may be attractive to some stakeholders that can offer support and funding.

Some disadvantages and potential risks for this alternative include:

- Limits water availability to just coming from the Piru watershed which is estimated at only 20% of total average annual diversions at VFDD.
- Reduces flow in Santa Clara River upstream of VFDD.
- Controlled infiltration to Santa Clara River groundwater from Piru confluence to VFDD could be reduced.
- Dam removal would result in a head cut moving upstream, which may lead to bank erosion and other channel morphology changes. The river would likely regrade to its pre-dam condition.
- The river bed could aggrade downstream of the dam requiring some new flood and bank protection measures.
- Out-migrating fish cannot be captured and trucked downstream as they are currently when flow is not continuous.
- Out-migrating fish may become stranded within the river channel at low flows.

It is easy to ascertain that a dam removal alternative greatly improves fish passage in that there would not be any structural impediment in the river channel and fish migration could occur naturally at the site of VFDD. For this reason this alternative remains within this study. However, the Panel has decided it cannot further the development of this alternative with the same level of detail as the other alternatives that are carried forward because of significant issues with surface water and ground water supply and management, water rights, and channel geomorphology. Study of these issues is outside the scope of the Panel's charge and expertise.

A reason for considering this alternative further will be if it is concluded that a technological fish passage fix will not eliminate VFDD as a factor for steelhead recovery in the Santa Clara River Basin. Dam removal could also be a viable alternative and long term goal if conditions change in the basin such that sea-water intrusion into the aquifers is abated, groundwater conditions are in a steady-state, and water supplies for land uses are obtained through other means. Water conservation and improved water use planning within a time frame of 50 or 100 years could lead to this possibility.

6.2 ALTERNATIVE 2 – NEW VERTICAL SLOT FISHWAY

6.2.1 Description of Vertical Slot Fishway

The new Vertical Slot Fishway alternative consists of an entrance structure, fish ladder, and exit structure. Auxiliary water at the entrance will be provided through two intake screens and a buried pipeline. Three options to this alternative have been evaluated; these vary from the one described here by varying the auxiliary water arrangement. One utilizes a single intake and therefore reduces the auxiliary water and fishway entrance flows. The other one increases the approach velocity when only larger downstream migrants are present at the intake and increases the auxiliary water and fishway entrance flows.

The fishway design described here is somewhat based on working around the existing canal, diversion and fish screen. If major changes are made to any of these facilities, they could greatly affect the fishway layout but the concepts, scope, and cost of the alternative as described here are not expected to change significantly.

The base alternative is described below and the options are described at the end of Section 6.2. This alternative is shown in Drawings 6.2-1 through 6.2-4. A photograph of a vertical slot fishway is shown in Figure 6.2-1. The fishway in the figure has two vertical slots; the alternative described here has a single slot.

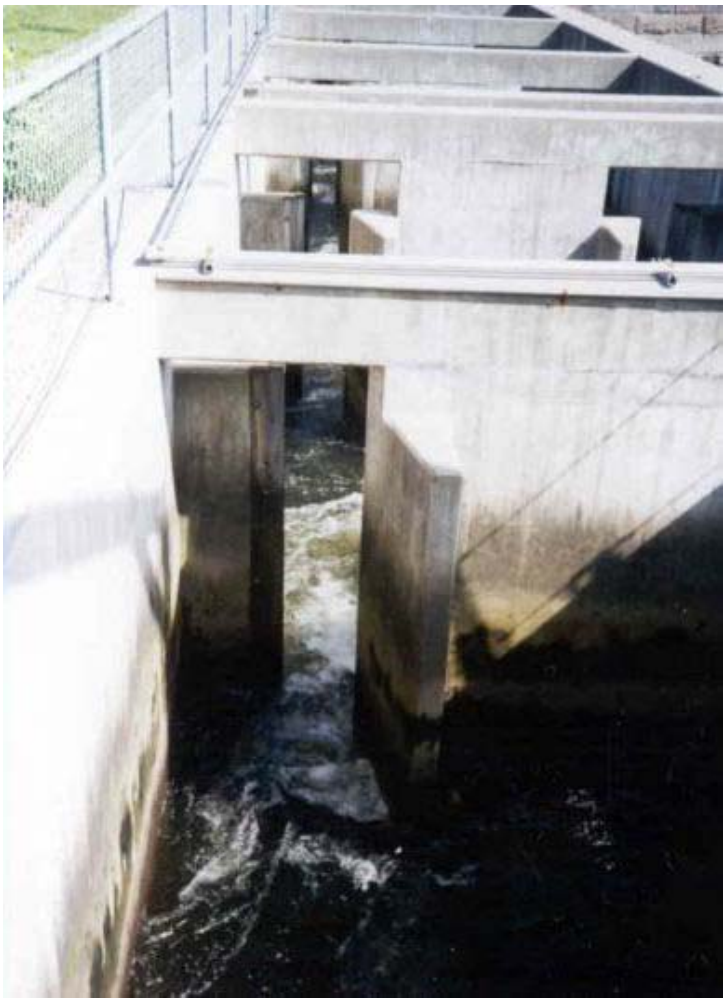


Figure 6.2-1. Vertical slot fishway.

All structures of this alternative were designed to have the same flood protection as the existing canal and fish ladder facilities.

6.2.1.1 Entrance Structure

The entrance structure will be located adjacent to and just downstream of the existing entrance pool. The structure will have multiple sluice gate entrances with the ability to direct the entrance flow in three different directions. Each direction will consist of a pair of sluice gates. Each gate would be 5 feet wide and 6 feet high. The upstream pair of gates would direct flow to the north, and the center pair of gates would direct flow to the northwest. The downstream gates would direct flow to the west (Drawings 6.2-1 through 6.2-3). The anticipated operation of the gates is described in the operations section below.

The entrance structure would also contain a stilling chamber and diffuser grating to add auxiliary water to the entrance pool. The water would issue from the auxiliary water pipe and be stilled with baffles. A weir and under flow wall would spread the auxiliary water evenly through the wall diffusers. In the entrance pool the channel width between the wall containing the entrance gates and the wall diffuser gradually narrows toward the fish ladder. The flow in this channel decreases toward the fish ladder. This arrangement is to maintain a guidance velocity through the entrance pool and draw fish to the ladder entrance on the southwest corner of the entrance structure.

The greatest single factor that contributes to successful fish passage at a fishway is the degree of attraction of fish to the entrance. The fishway, tailrace flow patterns, banklines, other structures, bathymetry, and other flows can all contribute to, or diminish, effective fishway attraction. The discretization of effective fishway attraction gave the Panel a method to optimize the attraction of each alternative and to compare the alternatives. The definition and an example of calculation of effective attraction are presented in Section 7.1.1.

To provide better access for fish along the left bank to the fish ladder, the bulge in the bank line just downstream of the entrance pool would be removed. The objective is to move the bank back far enough so that fish have good access along the bankline when flow is issuing from the sluice gate and crest gate, which are just upstream. The new entrance will support the bank behind it, which is the purpose of the bulge. The configuration of this bank should be tested in a hydraulic model.

The fishway entrances are designed to optimize attraction and passage for adult steelhead. The velocity and shape of the entrances might be a barrier to lamprey and other species that are weaker than steelhead. In that case, a secondary fishway entrance could be added in the downstream wall of the fishway. The secondary fishway entrance could consist of a metal channel two feet wide with several weir steps or a roughened chute. That fishway would only operate up to about 1,000 cfs because it would take too much water at higher flows. The channel would be closed at higher flows. Alternatively, it could be designed to automatically adjust to tailwater elevations and operate through a wider range of flows.

The elevation of the fishway and entrances depend on the rating curve shown in Table 2.1-2. If there is a possibility that the tailwater will be lower at any point in the future, the fishway design elevations must adjusted accordingly.

6.2.1.2 Fish Ladder

A 23-step vertical slot fish ladder will run from the entrance pool around the left abutment to an exit into the reservoir forebay. A vertical slot fish ladder was selected over other ladder types for three reasons: first, flow in a vertical slot fish ladder is self-regulating based on the upstream water surface elevation; second, the full-height opening of the vertical slots will allow for lamprey passage; and, third, the ladder can pass bed load easily.

The ladder consists of a series of pools separated by vertical baffles. The vertical baffles have a 1-foot wide slot opening between pools. Each pool will be 10 feet long, 8 feet wide, and nominally 5 feet to nine feet deep depending on the flow in the river. The head drop will be one foot between pools during normal operation. Refuge pools could be provided in the ladder by lowering the floor to be 2 feet deeper at every 5th pool. If so, a small water supply would be required to supply the refuge pools while the ladder is temporarily dewatered, if necessary.

The fish ladder is separated into two different sections, a lower section and an upper section, and a transport channel connecting the two. The fishway is described here starting at the downstream end and moving upstream. The lower section has 20 steps, and the upper section has 3 steps to the exit. The transport channel is approximately 350 feet long and sloped minimally for hydraulics and drainage. In the lower section, the first baffle is located at the edge of the entrance structure and is oriented to discharge directly into the pool to attract fish into the ladder. The ladder goes through the location of the existing retaining wall on the left bank downstream of the existing ladder structure, then turns and runs downstream parallel to the retaining wall, switching back once to create two adjacent rows of ladder steps.

Upon reaching the top step in the lower section, fish swim into a 3-feet wide transport channel. The transport channel flow width is a consistent 3 feet wide throughout to maintain a velocity that will prevent deposition of sand and finer sediment (Drawings 6.2-1 through 6.2-4).

The transport channel then crosses the existing canal. To maintain appropriate depth in the transport channel, the existing invert of the canal and the invert of the transport channel are at approximately the same elevation. As a result, the canal will be excavated approximately 6.5 feet to create a flow way dip beneath the transport channel for canal flow. The top of the transport channel is at elevation 166.0 to provide two feet of freeboard for water deliveries for the design fishway flow.

After crossing the canal, the transport channel turns and follows the toe of the hill for approximately 300 feet before turning back towards an exit into the forebay. In this segment, the existing ground slopes up to elevation 177 feet, which will result in extremely deep excavation cuts for the transport channel, up to 25 feet. The ground will be cut down in this area to limit the depth of the transport channel and let light into the channel to aid fish movement. In this segment, each side of the transport channel will have retaining walls up to the surface. Due to the length of the transport channel, this segment also includes refuge pools. The refuge pools will be 20 feet long and 2 feet deeper than the rest of the channel.

The upper portion of the ladder consists of only 2 pools to raise the water level to the varying water level in the forebay. These pools are designed the same as the pools, baffle walls, and vertical slots as in the rest of the fish ladder.

6.2.1.3 Auxiliary Water System

Auxiliary water is provided to better attract fish to the fishway entrance, since the capacity of the fish ladder itself is limited. The auxiliary system consists of two intakes with fish screens and a pipeline to convey the flow to the entrance structure. The intake screens are located in two places, (1) in the flushing channel leading to the canal intake on left bank and (2) in the canal just downstream of the trash racks. The two intakes are described below and shown on Drawings 6.2-1 and 6.2-3.

6.2.1.3.1 Flushing Channel Intake Screen

The flushing channel intake screen is located just upstream of the existing trash racks along the existing retaining wall on the left bank of the flushing channel to the canal intake and flushing gate. The screen will be a series of vertical flat plate screens that align with the wall of the diversion just upstream of the trashracks. There will be a guide wall in the flushing channel 10 feet in front of the screen with a top at elevation 160.0. This will maintain a sweeping flow component along the face of the screen. The sill, on which the screen rests, will be approximately 2 feet wide, and the elevation will vary from 155.0 to 157.0 along the length of screen (Drawing 6.2-3). The top of the screen will be at elevation 161.0. The screen and the guide wall will create a corridor in front of the screens. At the downstream end of this corridor is a sluice gate, with the top elevation at 160 feet. At low flows the sluice gate will remain closed during normal operation to create the proper water depth in front of the screens. The sluice gate will be opened during high river flows to flush the sediment that has deposited in the corridor. Adjacent to or built into the sluice gate will be an 18-inch diameter bypass pipe to carry downstream migrating fish from the corridor to a release point inside the canal intake.

A new Obermeyer or similar crest gate will be installed on the river-side of the guide wall across the flushing channel, with the top of the gate also at elevation 160 feet. This gate will also act to maintain the proper water level on the screens. This crest gate will allow the existing sluice gate at the downstream end of the flushing channel to be opened, as it is now, to flush sediment from the flushing channel, without affecting the fishway or auxiliary water supplies. The gate will be lowered to pass sediment when it is necessary to flush the upper portion of the flushing channel.

The screen structure is approximately 110-feet long and the screens vary from 4- to 6-feet high (Drawing 6.2-3). The screen heights vary because of the slope in the existing flushing channel. The bottom of the screens will be a minimum 6 inches above the invert of the channel to help prevent bedload from accumulating in front of the screens or entering the screen structure. The top of the screens will be at elevation 161 feet. Above the screens will be blank panels or a concrete head wall up to the top of the structure at elevation 177 feet. The screens would be cleaned with a back spray system behind the screens. This would protect the cleaning system from large debris in the river. A clean or filtered water supply would be developed for the screen cleaning system. Adjustable baffles would be installed behind the screens. These would be set during startup to provide as uniform approach velocity as possible.

The maximum flow through the screens will be 160 cfs at an approach velocity of 0.33 fps or less, which is the State of California approach velocity criterion when fish are exposed to the screen for less than 15 minutes. The criterion is increased to 0.4 fps when the exposure is less than a minute. It is not clear that the one-minute exposure time can be achieved in this situation so the lower conservative value is used at this point. The design includes the option though of increasing the flow to 240 cfs at an approach velocity of 0.6 fps. That approach velocity would depend on both a short exposure and only larger fish (greater than 60 mm fork length) being present. Water passing through the screens will flow through a control gate, which controls the flow into a pipeline at the rear of the intake structure. The pipeline will be 48 inches in diameter.

6.2.1.3.2 Canal Intake Screen

The canal screen is an optional screen that would be constructed into left wall of the existing canal intake, just downstream of the trash racks. The screen and cleaning system are similar to the flushing channel screen described above. The screen can be up to 90 feet in length, which will provide up to 190 cfs with an approach velocity of 0.33 fps and 285 cfs at an approach velocity of 0.6 fps. The canal intake screen does not have the option of increasing the base velocity to 0.4 fps because there is no sweeping flow in the canal when flow is not being diverted. The bottom of the screens would be at elevation 153.5, which will provide clearance over the invert of the existing canal channel to limit sediment accumulation in front of the

screens and reduce sediment into the auxiliary water system. The top of the screens will be at elevation 161 feet. Blank panels or head wall will extend up to the existing top of wall at elevation 177 feet. The screens will be cleaned with a back spray arrangement or a brush cleaning system. The brush cleaning system is feasible at this location because it is protected behind the trash racks. Two different types of brush system could be employed. These are a brush moving horizontally or a brush that moves upward removing debris out of the canal. Adjustable baffles would be installed behind the screens. These would be set during startup to provide as uniform approach velocity as possible.

Flow passing through the canal intake screens will flow through a control gate, which controls the flow into a pipeline at the rear of the structure. The pipeline will be 54 inches in diameter depending on the design approach velocity to the screens.

6.2.1.3.3 Auxiliary Water Pipe

A buried 48-inch pipe extends from the flushing channel fish screen structure to a 90-degree bend. The pipe is buried beside the transport channel to where it tees into a 54-inch pipe from the intake canal screen structure (Drawing 6.2-1). From this point, the combined pipeline increases to a 72-inch diameter pipe. The combined auxiliary water pipeline continues to parallel the transport channel, sloping down in elevation to cross underneath the channel. The pipeline is buried beneath the canal and along the transport channel to a 90-degree bend where it enters the entrance structure. It may also be possible to route the pipeline over the ladder so that flow will drop into the entrance structure using a smaller energy dissipation device in the entrance pool.

6.2.1.4 Fishway Exit

The fishway exits into the forebay about 50 feet upstream of the upper end of the flushing channel screen structure. Between the uppermost ladder pool and the fishway shutoff gate, the channel narrows to 4 feet wide at the exit, and the floor rises up to elevation 158 feet. A 4-foot wide by 10-foot high sluice gate is included at the exit. A head wall will allow the gate to completely shut off flow to the ladder. Under most operating conditions, the gate will remain fully open and out of the flow. The gate can be used to dewater the ladder for maintenance. It can also be lowered to force a head drop across the exit allowing the ladder to operate at higher forebay levels corresponding to flows up to about 20,000 cfs.

6.2.1.5 Crest Gate

A 4-feet high and 40-feet long crest gate will be notched into the dam crest adjacent to the flushing channel. The crest gate will keep additional flow on the left bank to draw fish towards the left bank and the fishway entrance. It will have a second function controlling the forebay

water surface to an elevation of 161.0 up to a river flow of about 5,000 cfs. The gate will be an Obermeyer or similar downward-opening adjustable weir gate.

6.2.1.6 Facility Access

The transportation channel will cross the existing access leading up to the flushing channel gate and canal head gates. Stair crossings will be provided across the transport channel at several locations to allow personnel access to these facilities. A new access road will be added on the south side of the existing south fence line. The new access road will cross the transport channel at a point where it is deep in the ground to provide access to the new auxiliary water intakes and existing facilities next to the dam (Drawing 6.2-1).

6.2.1.7 Optional Auxiliary Water Arrangements

There are several options for the auxiliary water structures and operations. These are:

Option A: The approach velocity to the auxiliary water intake screens could be increased during periods when only larger size fish are present. This could increase the amount of attraction water at the intake from 400 to about 600 cfs. The base option described above is for an approach velocity of 0.33 fps. A higher approach velocity such as 0.6 or 0.8 fps would violate the NMFS diffuser rack velocity criterion, but the high screen velocity is likely acceptable as a variance to the criterion when no small fish are present. As part of this option the gates could be opened to test this higher flow. If it is found to better attract fish the entrance pool could be expanded to provide a diffuser rack that meets criteria.

Option B: The canal intake screen could be eliminated if it is found that steelhead movement occurs at lower flows and the additional attraction water is not required. Entrance flows would be from 200 to 220 cfs.

Option C: The flow could be increased for the one intake in Option B similar to that described in Option A above. Entrance flows would be from 270 to 290 cfs.

6.2.2 Vertical Slot Fishway Operation

The fishway will operate at flows approaching VFDD from 31 to 20,000 cfs though the attraction of the fishway is greatly diminished at higher flows. The water surface elevation at the upstream side of the dam is assumed to be controlled to a minimum level of 161 feet. The goal is to operate the ladder facilities to optimize fish passage up to a flow of 6,000 cfs though it will continue to operate at higher flows. The maximum flow will be divided between the facilities as follows:

Fish Ladder and Auxiliary Water	400 cfs
Existing Flushing Channel	2,800 cfs
Crest Gate	2,800 cfs

The subsections below describe the operation of the upstream passage facilities. The canal intake and fish passage facilities will be operated together. It is assumed that the fish passage flows take priority over canal diversions during low flows when fish can access the dam from downstream.

6.2.2.1 Entrance Structure

The design low water level in the tail water at the entrance pool is estimated to be at elevation 138.5 feet based on water levels measured below the diversion over a range of flows in the last 5 years. The high tail water elevation is estimated to be 144 feet. That range of elevations might be extended higher or lower if it is determined likely that the tailwater channel might be higher or lower than it has been as represented by these data.

Water entering the entrance structure will vary depending on the flow (water stage) in the river upstream of the dam. As long as the water level upstream is maintained at elevation 161.0 or higher, the auxiliary water flow from both fish screen intakes will be 350 cfs. The flow into the ladder will vary as shown in Table 6.2-1.

Table 6.2-1. Vertical Slot Fishway operational summary.

River Flow over VFDD (cfs)	Pool Elevation (ft)	Tailwater Elevation (ft)	Fish Ladder Flow (cfs)	Auxiliary Water Flow (cfs)	Flushing Channel (cfs)	Crest Gate in Notch (cfs)	VFDD Crest (cfs)
50	161.0	138.5	31	19	0	0	0
500	161.0	140.3	31	350	119	0	0
1,000	161.0	141.0	31	350	619	0	0
2,000	161.0	142.0	31	350	1,619	0	0
6,000	162.0	145.0	38	350	2,800	2,320	492
20,000	162, 167[1]	148.0	38-55	350	2,800	2,320	14,492

1 – The pool elevation of 162 assumes that the existing flushing channel gate and new crest gate on the spillway control the water surface to elevation 162. If the crest gate remains up, the pool elevation will be 167. The fishway can operate at either elevation.

Flow exiting the entrance structure will be a combination of ladder flow and auxiliary water. The average flow velocity through the entrance gates is 8 fps. The drop in water surface from the

entrance pool to the tailwater is about 1 foot, although this can be increased to 1.5 feet by operation of the entrance gates. Different entrance gates might be used at different flows. The selection of which entrance gates to open will depend on hydraulic modeling and after observations of hydraulic conditions downstream of the entrances after the structure is built. At low flows it will probably be best to operate the furthest upstream gate. At high flows when the flushing channel gate is operating, it would be difficult for the fish to access those entrance gates and the entrances discharging northwest or west will probably provide the best attraction. At extremely high flows, the gate facing west may provide the best attraction, since fish approaching the ladder might be swimming along the south bank and out of the main, turbulent, high velocity flow path.

The entrance gates can be opened or closed to divide the total flow among the different entrance gates. It is estimated that for the total flow of about 400 cfs issuing from the entrance structure, three or four gates will be in operation. Multiple gates are suggested because a single gate, using off-the-shelf technology, might be impractical. An alternative would be to develop custom bulkhead gates.

6.2.2.2 Fish Ladder

Flow through the fish ladder is passively controlled by the elevations and dimensions of the slots in the upstream end of the ladder and depends on the forebay water surface elevation. The forebay water surface elevation can be controlled by operation of the flushing channel sluice gate and/or the crest gate. The degree to which they will be operated will depend on this function as well as the other functions of the gates, sluicing and attraction of fish to the fishway entrance.

At the proposed minimum normal operating water surface elevation, 161 feet, flow through the ladder will be approximately 31 cfs. At elevation 162 feet, the ladder flow will be approximately 38 cfs (Table 6.2-1). If the water level is not controlled by the flushing channel gate and crest gate, at a flow of 5,000 cfs, the upstream water surface will be at about 165 and the ladder flow will be about 55 cfs. By partially closing the exit gate to act as a sluice, the fish ladder is capable of operating at water levels in the reservoir of up to 167 feet, corresponding to a flow rate of approximately 20,000 cfs. To operate at this elevation, the sluice gate would be lowered to create an orifice at the ladder exit with up to 2 feet of head across the gate.

Water surfaces in the ladder will vary from 5.5 to 11 feet during normal operation over a range of 50 cfs to 6,000 cfs in the river. The velocity in the transport channel will be 2 fps. This should be sufficient to keep sand moving through the channel. If sand does settle in the transport channel it can be removed with a backhoe straddling the channel.

6.2.2.3 Auxiliary Water Intake Screens

The average approach velocity to the intake screens will be about 0.33 fps. At this approach velocity, the capacity of the flushing channel intake screen is 160 cfs, and the canal intake screen will have a capacity of 190 cfs. The screen cleaning systems will be activated by a timer setting, which can be overridden by exceeding a differential head limit across the screens. Each individual screen panel will have a preset baffle panel to balance the flow distribution across entire screen face. During system startup, velocities of approach to the screens will be measured and the baffles adjusted. This procedure will be repeated until the most even approach velocity possible is achieved.

6.2.2.4 Auxiliary Water Pipeline

The maximum flow through the auxiliary water pipes will be 350 cfs. The velocity through all the AWS pipelines is sized for approximately 12 fps at that flow. Once the flow reaches the entrance structure, excess energy will be dissipated on baffle blocks and distributed over weirs before passing through wall diffuser panels into the entrance pool. The wall diffusers in the entrance structure will have a maximum approach velocity of 1 fps.

6.2.2.5 Sediment Control

Deposition of sediment in the fishway structures may create a significant challenge for maintenance. In the fish ladder, the flows in the ladder will prevent sediment from accumulating. In the transport channel any accumulation of sediment can be removed with a backhoe straddling the channel. In the intake screens, sediment jets along the floor of the structure will be used for keeping the sediment in suspension where it can be carried by the high flows in the auxiliary water pipeline.

Sediment may accumulate at the face of either screen. The channel at the face of the flushing channel screen can be sluiced when the existing flushing channel sluice gate is open. This is done by temporarily opening the sluice gate at the downstream end of the screen channel. This operation will interrupt the fishway auxiliary water supply but the fishway itself will remain in operation. Sediment may have to be removed from near the auxiliary water supply screen in the canal. This operation is done periodically now though will be an increased need because of the increased flow through the area and the increased period of operation. Removal will have to be done mechanically by closing and draining the intake as it is currently done.

The area of the existing flushing channel upstream of the screen and in the vicinity of the fishway exit can be sluiced as well by lowering the crest gate that crosses the flushing channel

when the existing flushing channel gate is open. If the crest gate is lowered entirely, the fishway will be dewatered. The fishway transportation channel includes several pools where fish can hold in this situation. Water should be pumped to the fishway to keep fish healthy and/or the fish should be removed and relocated upstream.

The net effect of sediment management in the flushing channel is not clear. It is expected that the sluice gate will be operated more frequently to help guide fish to the fishway entrances; this will help keep sediment flushed from the flushing channel. On the other hand, the crest gate across the flushing channel reduces the volume and storage capacity of that area so more frequent but shorter duration flushing operations may be necessary.

The entrance structure is the most likely place where sediment deposition will be an issue. The floor of the entrance pool is countersunk below the elevation of the entrance gates and is susceptible to sediment accumulation. This risk is exacerbated by the fact that velocities and turbulence in the pool will be low when the fishway is operated at low river flows without full auxiliary water. The risk is minimized by the layout of the entrance pool and building sluice capability into the diffuser panels. Sediment in the auxiliary water will be slowed as it passes over the weir and deposit in front of the weir. One possibility for sediment control is to add sluice gates to the weir wall. These could be opened for maintenance to sluice sediment under the baffle wall. Another option is to provide a pipe branch off the auxiliary water pipe, which would be a manifold to direct high velocity jets into the entrance pool to re-suspend sediment.

6.2.3 Construction Considerations

6.2.3.1 Facility Operation and Care of Water

Construction of the fishway and intake screens will require coordination of construction timing with the intended use of the canal, existing fishway, and other facilities, since construction will likely require shutdown of each facility for a period of time. A cofferdam will be required both upstream and downstream of the dam to build the auxiliary water intakes and fishway exit upstream and the entrance structure downstream. Design of the cofferdams and construction of the entrance and exit structures will need to consider fish passage timing and operation and be certain not to impede migratory fish. Some facilities, such as the crest gate, could be constructed by directing low flows in the summer into the intake or through the sluice gate. The existing Denil fishway will continue to be operated during construction except during periods when cofferdams will block flow to it or access from the tailwater.

6.2.3.2 Demolition

Riprap will be removed from the left bank downstream of the dam and upstream at the location of the fish ladder exit. The retaining wall on the left bank downstream of the present fish ladder would be removed to make way for construction of the new entrance structure. The retaining wall upstream of the canal intake would be removed to make way for the fishway exit. The south wall of the canal behind the trash rack will be demolished to build the fish screen intake for the canal auxiliary water structure.

6.2.3.3 Construction Access

Access to the site would be from downstream along the existing road on the south bank of the river. Staging and laydown areas would be required as close to the structure as possible along this road.

6.2.3.4 Ladder Construction

The fish ladder construction will impede access to the intake screens and other facilities until the new access roads are completed. Construction of the transport channel south of the canal will require removal of soil down to about elevation 167.0. This will lessen the burial of the transport channel allowing more light into the channel. It is anticipated that trench boxes will be used instead of open cut to reduce the amount of material that needs to be moved. The access road will be moved to the south of the transport channel.

6.2.4 Opinion of Probable Construction Cost

A conceptual level opinion of probable construction cost (OPCC) was made for this alternative based on the drawings and descriptions contained in this section. The cost estimate should be considered Class 5, as designated by the Association of American Cost Engineers (AACE), for which engineering is typically 0% to 10% complete. Expected accuracy ranges are from -20% to -50% on the low side and +30% to +100% on the high side. Ranges could exceed these in unusual circumstances. These cost opinions are primarily for comparative purposes between alternatives, and are not intended to be used for economic analyses and financial planning. The Panel has no control over costs of labor, materials, competitive bidding environments and procedures, unknown field conditions, financial and/or market conditions or other factors affecting the cost of the construction and the operation of the facilities, all of which are beyond the Panel's control and are unavoidably in a state of change. The Panel cannot and does not make any warranty, promise, or representation either expressed or implied, that proposals, bids, or cost of operation or maintenance associated with these alternatives will not vary substantially from

their opinion of probable construction cost. Note that a similar and consistent approach to preparing the OPCC was utilized for all of the alternatives.

Quantities for excavation, backfill, structural demolition, concrete, intake screens, piping, and other materials were estimated using the conceptual drawings prepared for this report and based on the structures and finished grades shown in the original construction drawings. For excavation it was assumed that the contractor will minimize the amount of trenching or shoring required and, therefore, will excavate down to elevation 165 between the fishway and the base of the new intake screens. Stability or reinforcement of existing facilities impacted by construction was not considered at this level of analysis.

Unit prices for the major items such as concrete, excavation, and backfill were assigned based on recent bidding experience. Lump sum prices for items such as dewatering and electrical and controls were estimated parametrically from similar projects. Costs for the crest gates were estimated by obtaining budget quotes from the manufacturer and by applying doubling factor to account for shipping, installation, startup, and contractor markups.

Invariably, as designs continue into more detail, additional items of construction are necessary. Therefore, an unlisted items provision of 20% of construction costs is included. A contingency of 25% was added to account for possible changes in bidding climate, material prices, and the general economy. The costs of design, permitting, contract administration, and professional services during construction were estimated at 30% of construction cost including contingencies. No mitigation costs are included in the estimate. Owners' soft costs or program expenses have also been excluded.

The total construction cost for the vertical slot fishway option was estimated as $18.4 million, in 2010 dollars, including the 25% contingency. Adding an additional 30% for engineering, construction management, and permitting brings the total project cost to $23.9 million. See Table C-1 in Appendix C for a line-item breakdown of costs.

6.2.5 Evaluation of Vertical Slot Fishway

6.2.5.1 Strengths

- Proven passage technology.
- Sediment is easily passed through the fishway.
- Entrance flows can be directed in different directions into the tailwater to attract fish.

- Facilities are located on shore where access for inspection and maintenance is good.
- Entrance is near sluice gate, which can be used to release additional attraction flows.
- Does not restrict the flood capacity of the dam.
- Construction is relatively easy – good access.

6.2.5.2 Weaknesses

- Attraction flows out of the entrance pool are limited.
- Fish attracted to the sluice gate releases or crest gate flows might have to cross those flows and have difficulty finding the entrances.
- Narrow and deep transportation channel could hinder fish movement.
- Sediment may accumulate in the entrance pool at times.

6.3 ALTERNATIVE 6A – PARTIAL WIDTH ROCK RAMP AT 4% SLOPE

The partial width rock ramp alternative includes a rock ramp, a head works structure, two gated notches in the dam, and a rubber dam near the ramp exit. The head works structure controls flow through the rock ramp and separates the control weirs from the ramp and serves as a resting area for fish after they ascend the rock ramp. The gated notches were sized to compensate for lost flood flow capacity over the dam because the rock ramp would need to be closed to high flows (river flows greater than 18,900 cfs) to protect its substrate. The gated notches are located on each side of the rock ramp, and would be operated to concentrate river flow to form a thalweg to river left. The gated notches will also promote fish attraction to the fishway. The rubber dam allows the flushing channel to be operated without affecting flow in the rock ramp. Each element is described below. This alternative is shown in Drawings 6.3-1 through 6.3-6.

6.3.1 Description of Rock Ramp

6.3.1.1 Overview

A rock ramp is a constructed riffle or cascade or series of riffles or cascades in a waterway for the purposes of gradually increasing river bed elevation, a method often used to provide fish passage over a dam or other fish passage barrier or to stabilize a channel. When used for fish passage, rock ramps are designed to meet fish passage design guidelines over a chosen range of design flow rates. When flow rates exceed the fish passage design range, fish passage efficiency is less than optimal but fish may still be able to pass. Design criteria are intended to provide sufficient depths and velocities at a design range of flows that will allow fish passage through that range of flows.

Designing a rock ramp is an exercise in balancing design parameters to meet the specific needs of a project. Slope, width, cross-section shape, bed material, fish passage design flows, and stability during flood flows are factors to consider. A compound channel shape will provide a narrow thalweg, or deep section of the channel, to provide sufficient water depth at low flows and a broader floodplain section for shallow, low velocity zones along the margins during high river flow rates. With a given a channel cross sectional shape a rock ramp slope must be mild enough to provide sufficient water depth for fish passage at low flows and water velocities that are not excessive for fish passage at high fish passage design flows. At flows greater than the high fish passage design flow, the ramp must be able to sustain predicted hydraulic and debris forces imparted on the rocks to maintain structural stability. A rock ramp on a steeper slope will allow for a shorter structure, which will provide quicker passage, minimize the project footprint, and reduce project costs.

If a rock ramp is designed to carry only a portion of river flow, maximizing ramp capacity will improve attraction to the fishway by providing a larger percentage of total river flow through the fishway, i.e., the ramp.

Designing a rock ramp to provide adequate fish passage conditions over a large range of flows is difficult. Designing for high flow requires larger bed material to ensure sheer stresses created by the fast moving water do not move the largest bed material; however, very large rocks are not only more costly and sometimes difficult to acquire, they also have large interstitial spaces that can create fish passage barriers for upstream-migrating fish at low flows, and strand adult and juvenile fish as flows recede.

6.3.1.2 Rock Ramp

The rock ramp is 82 feet wide and 565 ft long with a compound cross sectional shape. The ramp will meet fish passage design criteria from 50 cfs to 1,500 cfs. The ramp substrate is made up of rocks with a D_{50} of about 2 feet, a D_{84} of about 2.71 feet, and a D_{100} of about 3.0 feet. The rocks are placed into the ramp without additional support such as grouting or anchoring. Due to dewatering concerns at low flows, we have assumed that a concrete slab is provided below the rocks to help maintain a minimum flow level. A well graded filter layer with an impermeable liner may be possible, which would result in some cost savings of this alternative.

The ramp is on a slope of 4%, which is about the upper end of a plane bed or pool-riffle morphology. Decreasing the slope would result in a longer ramp, which would be more difficult to locate in the river channel and would increase the cost of the project. Increasing the slope would decrease the overall length of the ramp but would require larger rock material and could

result in a greater risk of stranding fish when the ramp is dewatered. Trade-offs between rock size and ramp length would be optimized in the design phase.

It should be noted that the analysis for water depths and velocities for this level of assessment assumes water flows over a continuous rough bed. This is a conservative assessment based on a one-dimensional hydraulic model broken into lateral cells across the channel. In reality, water flows between the roughness boulders creating greater depths in those slots, lower average velocities, and even lower velocities in slack areas behind boulders. The numbers derived here are considered an index of passage since the hydraulics at the scale of the fish includes slots and backwaters as described above throughout the channel width. The assessment should be refined in the design phase.

The ramp cross section was designed with a center low flow channel with a capacity equal to the low fish passage flow of about 50 cfs and a minimum water depth of 0.8 foot. A maximum water velocity of 5.6 fps was calculated by determining the net swimming speed of steelhead required to ascend the ramp in 30 minutes, the time to exhaustion for swimming at the maximum prolonged swimming speed of 6.0 fps (CDFG, 2003).

By this analysis, steelhead will not be able to utilize the entire width of the rock ramp at all flows. At a flow of 50 cfs the entire wetted width of the ramp (20 feet) will be within the fish passage range of 0.8 foot minimum depth and an average water velocity less than or equal to 5.6 fps. At 660 cfs and 1,000 cfs, approximately 70 feet and 55 feet of the ramp width fall within the passage criteria, respectively.

The downstream end of the ramp is located 50 feet downstream of the exiting VFDD near the outlet of the existing flushing channel. This location was thought to be the furthest downstream location practical for allowing steelhead to find the fishway entrance under high flow events. Locating the entrance closer to the dam could mask the fishway entrance at high flows.

The ramp extends upstream through a notch in the dam and about perpendicular to the dam and is flanked on both sides with concrete containment walls extending to elevation 177, 15 feet higher than the dam crest and equal in height to the existing dam abutments. The containment walls are necessary to prevent water from spilling onto the rock ramp from the sides, which would confuse the flow patterns for fish migrating at higher flows, and could cause structural damage to the ramp.

A photograph of a rock ramp is shown in Figure 6.3-1. The rock ramp shown is a full width ramp that does not require containment walls or a head works structure, but shows the general concept of large rocks providing the roughness required to dissipate energy to allow fish passage as well as the flow between boulders and still areas downstream of them. A final design for VFDD should consider breaking the ramp into a series of chutes and pools, similar to what is shown in the figure, to allow resting areas throughout the ramp and to help dissipate energy. The overall slope would remain about the same as suggested here.

Steelhead successfully ascending the rock ramp will enter a resting pool within the head works structure described below.

6.3.1.3 Head Works Structure

The head works structure includes an exit (resting) pool, a ramp gate, a headwall, and a roller gate located on the headwall.

The ramp gate is envisioned as an overshot (Obermeyer or similar) weir, which may be configured in one or more panels. If multiple panels are used, only one panel could be operated to control flow through the ramp at low flows which would allow for greater depth of flow over the weir and greater control of the flow released. An alternate approach to this concept would be to provide a narrower slot for fish to exit the ramp, with a single gate. The ramp gate(s) would be controlled by inflating or deflating air bladders under steel leaf gates hinged at the bottom. Water spilling over the weirs plunges into the exit pool where upstream-migrating steelhead, having already ascended the rock ramp, may rest. To continue upstream fish will either swim or jump over the ramp gate, depending on hydraulic conditions, to exit the fish passage facility. The jump height will not exceed 1.5 feet over the range of fish passage flows (Figure 6.3-2). The ramp gate will need additional development, and a single ramp gate is shown on the drawings to illustrate the general concept.

The head works structure will have a headwall above and just upstream of the ramp gate to create an orifice to restrict flow to the rock ramp at high flow events and prevent damage to the structure of the ramp. The ramp gate cannot cut off flow to the ramp; therefore, a roller gate is included at the headwall to perform this function. The roller gate shown on the drawings is intended to be conceptual, and is shown as a single 82 foot wide gate. This width is likely not practical, and multiple gates with divider piers would typically be required for this wide span. Additional details for the roller gate(s) will require further development during design. At river flows above 6,000 cfs flow through the ramp will be restricted by lowering the roller gate(s) to 50 cfs, to avoid stranding fish that may be ascending the ramp.

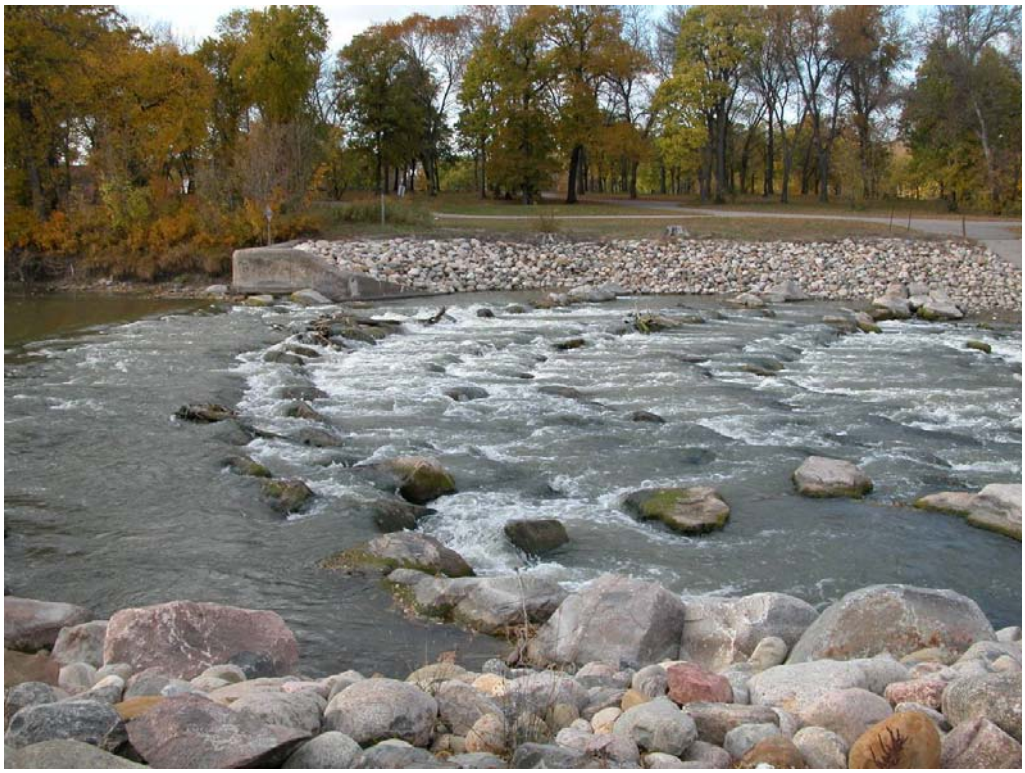


Figure 6.3-1. Photograph of a rock ramp. Photo: Luther Aadland.

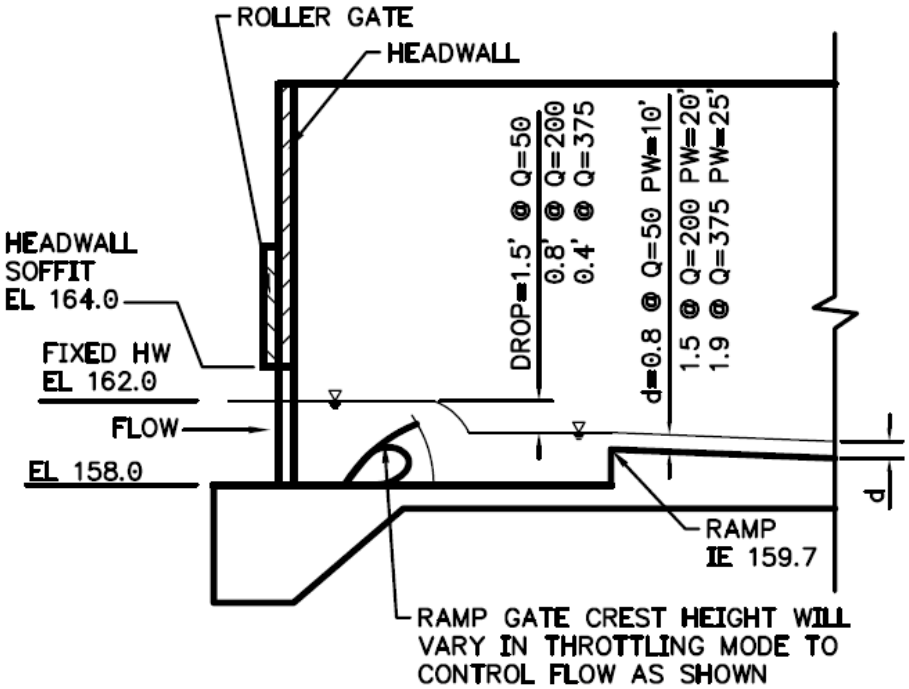


Figure 6.3-2. Diagram of an Obermeyer style ramp gate in head works structure.

Lamprey should be able to ascend the rock ramp under a wide range of flows and swim out of the head works structure when the ramp gate is lowered; however, at the higher and lower ends of the steelhead passage flow range a hydraulic drop at the ramp gate will prevent lamprey from being able to exit the fish passage structure unless a lamprey-specific fishway is provided, i.e., a lamprey passage structure (LPS) or "lamp ramp." LPSs are wetted ramps of aluminum or other material installed at an incline of approximately 45 degrees that may be bolted to a concrete wall. Lamprey use their mouth to attach to the ramp and ascend the ramp by using their bodies to lunge forward. The head works structure would have two such ramps to provide lamprey passage from the exit (resting) pool to the main river channel.

6.3.1.4 Gated Notch Structures

Two gate structures will be constructed in eight-foot deep notches cut into the VFDD. One will be 40 feet long and located immediately south of the rock ramp, between the existing flushing channel and the rock ramp structure. The other will be 85 feet long and be located immediately north of the rock ramp. The purpose of the gated notches is three-fold: to help concentrate river flows to river left to maintain a defined thalweg below the dam, to aid in attracting upstream-migrating fish towards the rock ramp, and to compensate for lost flood capacity resulting from construction of the rock ramp structure. Because the rock ramp structure cannot accommodate more than 1,500 cfs, the structure will reduce channel capacity when its flood protection gate is closed. Each gated notch structure will consist of an Obermeyer style crest gate at an invert elevation of 154, eight feet below the dam crest. The downstream face of the dam below each notch would be modified to an ogee shape with side walls to direct spill through the notch in a horizontal direction rather than a plunging action. This will help define a deeper river channel near the fishway, and will protect the downstream face of the dam and energy dissipation pool.

6.3.1.5 Flushing Channel Rubber Dam

This alternative includes a rubber dam extending between the south ramp containment wall and the left bank shoreline to allow operation of the flushing channel without affecting flow in the rock ramp. When upstream river flows are low to moderate, if the flushing channel were opened without the rubber dam raised the water surface elevation upstream of the rock ramp would lower, potentially causing flow in the ramp to drop or cease altogether. The rubber dam may not be necessary if the flushing channel is operated such that it does not result in excessive drawdown that would affect flow in the rock ramp, or if operation of the flushing channel can be limited to periods of high flow only, that would not affect the pool elevation or depth in the ramp. Additional hydraulic analysis and discussions with UWCD regarding their sluicing needs will determine if this rubber dam feature is necessary.

6.3.2 Rock Ramp Operation

The rock ramp alternative provides flexibility on how the facility could be operated. If there ever is a time when fish passage is not required the first 2,000 – 3,000 cfs flow passing downstream could be routed through the either the existing flushing channel or the gated notches. Dates of operation for fish passage and minimum downstream flows will be determined through other processes.

6.3.2.1 Operations When Upstream Fish Passage Is Required

The rock ramp is designed to provide fish passage over a range of upstream water surface elevations of 160.5 feet to 164 feet and predicted river flows of 50 cfs to 18,900 cfs. Ramp invert elevations were selected to provide 0.8 foot water depth at the low fish passage flow of 50 cfs with a maximum drop of 1.5 feet across the ramp gate. Figure 6.3-2 shows the hydraulic drop that will result when holding the upstream water surface at elevation 162 feet for three ramp flows. The drop height may be reduced or eliminated by lowering the upstream water surface elevation for the same ramp flows. Holding the upstream water surface at an elevation that minimizes the drop across the ramp gate will benefit fish. Controlling downstream flow is independent of water diversion operations as long as sufficient flow is available to discharge past the dam.

Table 6.3-1 provides a summary of downstream flow routing for the Rock Ramp alternative. “Total D/S” is the flow in the downstream river channel; “Ramp” is flow within the rock ramp; “Flushing Channel” is flow in the flushing channel; “Crest Gate 1” is flow in the southern gated notch; “Crest Gate 2” is flow in the northern gated notch; and “Dam Spill” is flow spilling over the dam crest.

At low river flows a minimum of 50 cfs will be allowed to spill over the ramp gate in the head works structure and into the ramp. The headwater elevation will be controlled at or below 162.0 by the rate of water diverted through UWCD’s existing diversion structure. Water diversion flows will have to be reduced when the upstream flow is less than the sum of the desired diversion flow and the minimum downstream flow. At the lowest flow conditions a minimum water depth of 0.8 foot will be maintained in the rock ramp for fish passage and steelhead will be required to jump a hydraulic drop of up to 1.5 feet to exit the fish passage facility.

Table 6.3-1. Potential flow split operations for the Rock Ramp alternative. All values are in cubic feet per second (cfs).

Total D/S	Ramp	Flushing Channel	South Crest Gate	North Crest Gate	Dam Spill
50	50	0	0	0	0
500	500	0	0	0	0
690	660	0	0	0	30
2,000	1,000	570	0	0	430
6,000	1,000	2,700	1,972	0	328
16,100	1,500	2,800	3,300	7,000	1,500
18,900	1,500	2,800	3,300	7,000	4,300

As river flow increases the ramp gate in the head works structure will be lowered allowing up to 660 cfs to pass down the rock ramp while maintaining the headwater at elevation 162.1. As river flow increases further, the headwater elevation will increase up to elevation 162.6 at which point approximately 330 cfs will be spilling over the dam and 1,000 cfs will be flowing through the rock ramp. Further increases in river flow will be routed through the flushing channel (up to approximately 2,700 cfs[2]), then through the small gated notch (up to approximately 3,000 cfs) while maintaining the headwater elevation at 162.5. The flushing channel will need to be operated carefully at moderate flows to prevent drawing down the upstream water surface elevation, which would reduce flow through the rock ramp.

If the minimum required downstream flow is increased, the large gated notch may be operated to maintain the headwater at a lower elevation, or the headwater elevation may be allowed to rise forcing more water to spill over the dam crest. For headwater elevations 163.1 to 164.0 the head works ramp gate will rise to limit flow in the rock ramp to 1,500 cfs and create a hydraulic drop from the headwater to the exit pool of up to 1.0 foot. At headwater elevations greater than 164.1, flow through the rock ramp will be greatly reduced to protect the ramp though about 50 cfs will be provided to sustain any fish in the ramp. The head works flow control gates can be raised at low flow to dewater the ramp if necessary. If there is any possibility that fish are in the ramp at the time, the rate of closure must be controlled to minimize fish standing and the entire ramp should be inspected to salvage any stranded fish.

[2] The capacity of the flushing channel is limited to approximately 2,700 cfs when maintaining a headwater elevation of approximately 162 feet and the flushing channel is operated as an orifice.

Because the rock ramp was designed to operate over a very large range of flows, its performance at low flows could be less than ideal. Operating a second, low flow fish ladder (possibly the existing fish ladder if modified to remedy identified deficiencies) was considered but ultimately not included in the design due to the added complexity to facility operations including the need to rescue stranded fish from the rock ramp when flows are switched from the ramp to the low flow ladder.

Decreasing flow within the ramp to sub-fish passage levels could result in fish, both upstream- and downstream-migrating fish, to become stranded in rock interstices and in the exit pool. To dewater the ramp flows will need to be decreased gradually to allow teams of personnel to survey the entire rock ramp for stranded fish.

6.3.2.2 Efficacy of Fish Passage

The primary strength of a Rock Ramp alternative is its high flow capacity. The flashy nature of the Santa Clara River calls for a fish passage structure at the VFDD that steelhead will be able to find quickly to minimize delay. The rock ramp entrance will be easy to find due to the relatively large volume of flow emanating from the ramp entrance. Data in Table 6.3-1 show over the range of fish passage design flows (up to 6,000 cfs) at least 17% of downstream flow will emanate from the fishway. A typical design value is 10% of the high design flow, thus this alternative exceeds the design standard; however, as stated above, only a portion of the rock ramp may be passable to steelhead at higher flows. The high volume emanating from the rock ramp will attract fish to the fishway where fish will then seek out lower velocities areas, primarily along the margins of the ramp, to ascend the ramp.

Fish exiting the head works structure and reentering the Santa Clara River may experience high velocities to river left leading to the flushing channel, small gated notch, and diversion intake. At a high fish passage flow of 6,000 cfs, up to 4,700 cfs will pass between the rock ramp and the river's left bank over the rubber dam. As currently configured, average water velocity through this area could be as high as 10.4 fps. Steelhead are expected to avoid high velocity areas and continue to move upstream, but there is a chance steelhead could be entrained in the high velocity and fall back through the flushing channel or gated notch under these circumstances. Additionally, fish exiting the ramp have no physical structure such as a bankline to guide them upstream.

The ramp is designed to accommodate a very wide range of flows, which has drawbacks. Very large rock is needed to withstand the forces of higher flows, but spaces between large rocks may result in stranding opportunities for adult and juvenile steelhead and other fish when flows are

restricted to less than the minimum fish passage flow or the ramp is dewatered. If the minimum fish passage flow is unavailable within the fish passage season a sustaining flow may be released through the ramp to keep fish alive until either higher flows are available or fish can be rescued and released to a safe environment. Additionally, although the ramp is theoretically designed to accommodate the low fish passage flow at 0.8 foot of depth, the precision at which these large rocks can be placed may result in deeper and shallower areas, i.e., small pools and chutes between boulders through with fish will need to navigate.

6.3.2.3 Potential Impacts on River Flood Capacity

The rock ramp and head works structure will be constructed in the active channel of the Santa Clara River. The ramp and its head works structure will obstruct a portion of the dam crest reducing the ability of the dam to pass the design flood. The gated notches mitigate for the lost capacity.

6.3.3 Construction and Special Design Considerations

6.3.3.1 Materials Required

This alternative would be constructed primarily of reinforced concrete and angular quarry rock for the ramp substrate. Rock used in a fishway of this type must be of a density and hardness to stand up to the forces imparted over the life span of the structure. Transporting material to the site is an issue that must be considered in the final selection of alternatives and environmental review process and is out of the scope of this report.

6.3.3.2 Foundation Considerations

UWCD has shared their history of the design development and construction of the existing VFDD, and their concerns for a proper foundation in this flashy river system to assure stability of any fish passage alternative. The river has a very mobile bed, with a soft siltstone bedrock layer that the current dam is founded on. Development of a proper foundation and the structural system to support the rock ramp containment walls, head works structure, and gated notches will require additional subsurface geotechnical investigation, and the designs developed by the Panel do not sufficiently address this need. It may be necessary to tie the entire structure into bedrock to ensure the structures remain stable.

At the VFDD bedrock slopes from river left to river right from an elevation of 124 to 103. Borings taken in 1987 suggest bedrock becomes shallower upstream of the dam. Interpolating between bedrock elevations at the VFDD site and another boring 1,500 feet upstream implies

bedrock slopes upstream at approximately 2%. According to this analysis the maximum depth to bedrock is approximately 31 feet which occurs at the VFDD site.

Foundations and wall systems illustrated in the drawings are intended to be schematic only, and the quantity / cost estimates provided later in this chapter note that the foundation and wall costs could vary significantly from the values shown. If this alternative is carried forward, the Panel recommends that additional geotechnical work and structural design be pursued to better define its feasibility.

6.3.3.3 Flotation Considerations

When the ramp is dewatered during high flows, the ramp structure will create substantial uplift force. Extending the ramp containment walls to an impervious subsurface layer will reduce or eliminate this issue. If the ramp is built on a matrix of piles, the piles must be designed to withstand tension forces as well as compression and torsional forces. Further consideration of this issue is out of scope of this document; however, the design development process should consider this concern.

6.3.3.4 Construction Excavation

A large quantity of sediment upstream of the dam must be removed to construct the rock ramp, the containment walls and head works structure. Additional sediment must be removed if the chosen construction plan calls for the containment walls to extend to bedrock as the existing dam does currently.

6.3.3.5 Dewatering Area

Construction would be desirable during a low-flow time of year; however, it is likely that a section of the Santa Clara River will need to be cordoned off with a sheet pile cofferdam for the duration of construction of the containment walls and headworks. During this period, flood capacity of the Santa Clara River may be reduced by up to 30,000 cfs during a 100 year storm. If the north gated notch is constructed prior to constructing the rock ramp the additional capacity could mitigate for lost capacity while the ramp is being constructed.

6.3.3.6 Placement of Ramp Rock

Rocks forming the ramp thalweg are large and must be placed individually to ensure they remain stable when subjected to high flows. Placement should be at the direction of an engineer and will be tedious and could take considerable time.

6.3.4 Opinion of Probable Construction Cost

Similar to the fishway alternative presented in Section 6.2.4, an OPCC was developed for the Rock Ramp alternative. Quantities were estimated as noted in Appendix C, Table C-2, with unit costs developed to be consistent in approach with all of the alternatives.

Including unlisted items, contingencies, and an allowance for engineering, permitting, and construction services, the OPCC for this alternative is $46 million in 2010 dollars. The largest unknown associated with this alternative is the foundation needs and resulting structural system. The rock source and cost of transport is also a significant item, as there are no quarries in the immediate vicinity of the VFDD. Additional study is recommended to confirm the cost of rock values used in the OPCC.

6.3.5 Evaluation of Rock Ramp

6.3.5.1 Strengths

- Very good attraction flow over a wide range of river flows.
- Proven concept, although scale of project unprecedented to our knowledge.
- Many diverse fish passage pathways.
- Flexible operations with multiple flow routing paths.
- Easily passes sediment.
- Will pass other species in addition to Steelhead.

6.3.5.2 Weaknesses

- Construction difficult for large, in-stream structure and cut through the dam.
- Possibly complex operations due to many flow paths.
- Ramp difficult to access for maintenance in wet season.
- Designed for wide range of flows, thus hydraulic conditions are not optimal at the low fish passage flow.
- Fish rescues will be required when flow is cut off to the ramp.
- Local availability of rock material uncertain.
- Head works restricts the flood capacity of dam (compensated by crest gates).

6.3.6 Next Steps to Advance Rock Ramp

Additional hydraulic analysis, likely including a physical model of this alternative is required to study hydraulic patterns and sediment movement through the system and hydraulic patterns associated with all flow paths past the dam for attraction to the fishway. At the current stage of

development the need for a rubber dam between the rock ramp structure and the left bank of the Santa Clara River is uncertain. A physical model can help determine flow combinations that will allow sediment to be flushed from in front of the diversion intake while the rubber dam is raised, and determine a range of flows over which the flushing channel may be operated without the rubber dam and not have a negative effect on flow in the rock ramp.

A physical model could also determine if the gated notches will mitigate for lost channel capacity as a result of the large in stream civil works. The model could help refine the sizes and placement of gated notches and the orientation of the rock ramp to minimize negative impacts on the fluvial morphology of the river. Agreement on the necessary flow design value would be required prior to any hydraulic analysis.

Additional borings and a geotechnical investigation are needed to confirm that bedrock is at the expected elevation and is suitable for founding the structure. Once the foundation needs are quantified, addition work should be done to optimize the design of the retaining walls and cutoff walls for this alternative.

Additional hydraulic analysis is needed to better understand the hydraulic conditions at the scale of the fish and to thereby refine ramp slope, flows, and dimensions.

Research into available rock sources suitable for a long ramp life should be identified, and the OPCC updated to reflect likely procurement, transport and placement costs considering the large quantity of rock required.

6.4 ALTERNATIVE 6B – HARDENED RAMP AT 6% SLOPE

The Hardened Ramp alternative is a variant of the Rock Ramp alternative employing engineered concrete roughness elements in lieu of loose boulders. A weakness of the Rock Ramp alternative is flow on the ramp must be restricted to 1,500 cfs to prevent damaging the integrity of the placed rocks. Restricting the flow requires containment walls and a head wall to elevation 177, and a flow closure gate. The Hardened Ramp can accommodate very high flows with little risk of structural damage thus the alternative allows shorter containment walls, no head wall, and no flow closure gates.

A hardened ramp alternative was researched by the U.S. Bureau of Reclamation's (USBR) Technical Service Center in Denver, CO for a project on the Ventura River (USBR, 2010). USBR engineers studied the concept in a physical model at a slope of 8.9% and in numeric models at other slopes. Results of that research demonstrated a ramp at a slope of 8.9% could

meet fish passage criteria for steelhead trout. USBR research noted the concept would work as well or better at milder slopes and eventually specified a ramp slope of 8.0% be used in their project. They would have lowered the slope further but for limitations in the available footprint at the Ventura River site. The final report of the USBR research will be published in the fall of 2010. To be conservative for this project a slope of 6% was chosen. An optimum slope could be determined in the design stage of the project if desired.

6.4.1 Description of Alternative

The proposed Hardened Ramp alternative includes a ramp containing constructed concrete roughness elements and a head works structure. Both features are described below. A gated notch is not required for this alternative because the ramp does not significantly reduce flood capacity of the VFDD. A gated notch could be included with the project if so desired to aid in maintaining a thalweg to river left and to increase flood capacity at the dam.

The 6% Hardened Ramp alternative is shown in Drawings 6.4-1 through 6.4-5.

6.4.1.1 Hardened Ramp

The hardened ramp is 80 feet wide and 367 ft long with a compound cross sectional shape. Concrete roughness elements (low weirs, columns, etc.) would be embedded in the concrete floor to dissipate energy and create low velocity resting areas. Figure 6.4-1 provides a photograph of the USBR model, which helps to illustrate the roughness element design feature. The ramp floor would be formed with concrete to simulate a roughened surface similar to cobble. One approach would be to use large aggregate in the concrete with a release agent, which would provide a rough, exposed aggregate finish. The USBR model included a substrate of loose rock and cobble retained by subsurface weirs to create a thicker boundary layer where lower water velocities would allow for easier fish passage and holding. USBR engineers believe some of this rock may scour out at high flows, but the ramp will continue to allow fish passage, and noted that the loose rock is not necessary.

The ramp will meet fish passage design criteria from 50 cfs to 1,500 cfs. At higher ramp flows cross sectional average velocities will exceed the design criterion but fish may still be able to utilize boundary layer effects to ascend the ladder. The flashy nature of the Santa Clara River calls for a fish passage structure that steelhead will be able to find quickly to minimize delay. Fishways with a higher percentage of downstream flow emanating from the fishway entrance will attract fish easier to the fishway. Entrance pools for fish ladders are commonly designed to provide 10% of the high fish passage flow; the Hardened Ramp alternative has a capacity of 24% of the downstream flow at the high fish passage flow of 6,000 cfs.

Figure 6.4-1. Model of a hardened ramp constructed for hydraulic testing at U.S. Bureau of Reclamation's Technical Service Center. Photo: USBR-TSC.

The downstream end of the ramp is located 50 feet downstream of the face of the exiting VFDD near the existing flushing channel. The ramp extends upstream through a notch in the dam and is flanked on both sides with containment walls extending to elevation 165.0, three feet higher than the dam crest. The relatively low containment walls will allow river flows to spill into the fishway from the sides at river flows greater than 6,000 cfs. This will have a negative effect on ramp hydraulics and an unknown effect on steelhead passage.

Roughened ramps such as the Hardened Ramp alternative have not previously been attempted for a total head drop of 22 feet (to our knowledge). Although the specific geometry of the hardened ramp has never been tested outside the one USBR laboratory study, we believe the parameters presented in this report are feasible.

6.4.1.2 Head Works Structure

The head works structure for the Hardened Ramp alternative is nearly identical to that in the Rock Ramp alternative. It includes a resting (exit) pool, a ramp gate (or multiple leaf gates), and

two lamprey ramps. Unlike the head works structure in the Rock Ramp alternative, no head wall and flow closure gate is required. Because the roughness elements in the Hardened Ramp alternative are concrete protrusions fixed in place, deformation of these elements is not a concern at higher ramp flows. The jump height at low flow will not exceed 1.5 feet over the range of fish passage flows (Figure 6.4-2). As illustrated on Drawing 6.4-4, an identical headwater rating curve was utilized for this alternative, in order to meet the headwater conditions and similar design flows for comparison.

6.4.2 6% Hardened Ramp Operation

The hardened ramp will work similarly to the Rock Ramp alternative, although because high flows will not cause structural failure of the roughness elements, the amount of flow passing through the ramp does not need to be limited. Additionally, because there are no gated notches, operations are limited to manipulating the head works structure weir to maintain headwater elevations and regulate flow through the ramp, a process that would be automated. The Panel recommends the flushing channel gate be automated so it can control headwater elevation during ramp operation at higher flows.

If ever there is a time when fish passage is not required and the headwater elevation does not exceed 164.5, the ramp can be closed to limit operations and allow maintenance of the structure. The first 2,000 – 3,000 cfs of downstream flow will be routed through the existing flushing channel. Seasons of ramp operation and minimum downstream flows will be determined through other processes.

6.4.2.1 Operations When Upstream Fish Passage Is Required

The Hardened Ramp alternative can be designed to provide fish passage over a similar range of upstream water surface elevations as the Rock Ramp alternative. Ramp invert elevations were selected to provide 0.8 foot water depth at the low fish passage flow of 50 cfs with a maximum drop of 1.5 feet across the ramp gate. Figure 6.4-2 shows the hydraulic drop that will result when holding the upstream water surface at elevation 162 feet for three ramp flows. The drop height may be reduced or eliminated by lowering the upstream water surface elevation for the same ramp flows. Holding the upstream water surface at an elevation that minimizes the drop across the ramp gate will benefit fish passage. Controlling downstream flow is independent of water diversion operations as long as sufficient flow is available to discharge past the dam.

Table 6.4-1 provides a summary of downstream flow routing for the Hardened Ramp alternative.

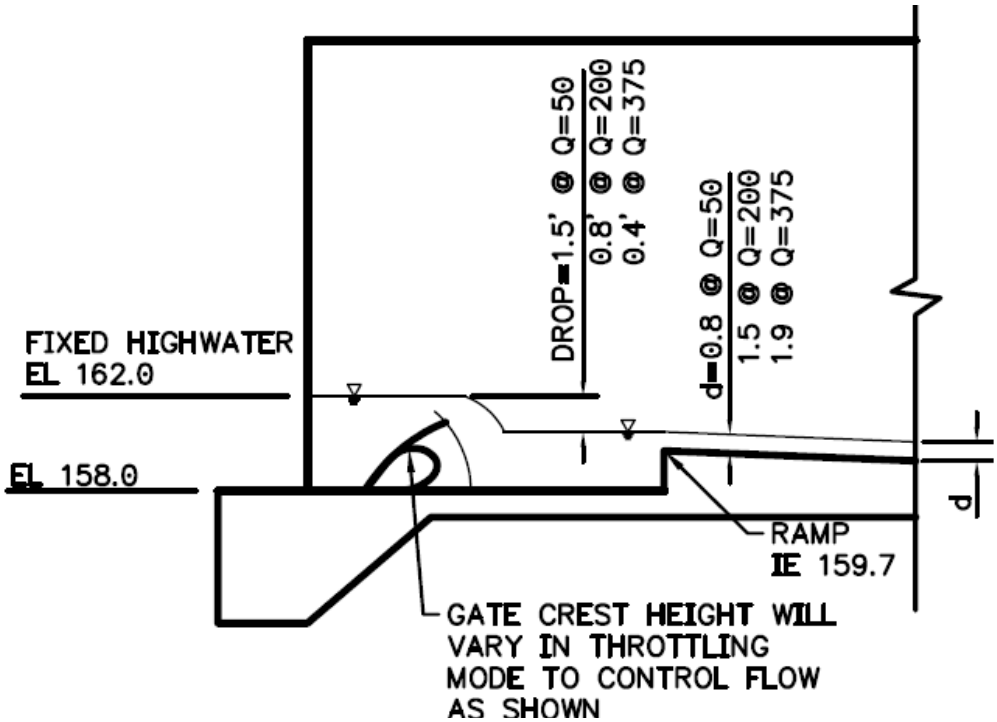


Figure 6.4-2. Diagram of an Obermeyer style ramp gate in head works structure.

Table 6.4-1. Potential flow split operations for the Hardened Ramp alternative. All values are in cubic feet per second (cfs).

Total D/S	Ramp	Flushing Channel	Dam Spill
50	50	0	0
500	500	0	0
1,600	1,000	0	600
2,000	1,000	400	600
6,000	1,300	2,800	1,900
12,000	1,500	2,800	7,700

At low river flows a minimum of 50 cfs will be allowed to spill through the ramp gate in the head works structure and into the ramp. The headwater elevation will be controlled by the rate of water diverted through UWCD's existing diversion structure. Water diversion flows will have to be reduced when the upstream flow is less than the sum of the desired diversion flow and the minimum downstream flow. At the lowest flow conditions a minimum water depth of 0.8 foot

will be maintained in the rock ramp for fish passage and steelhead will be required to jump a hydraulic drop of up to 1.5 feet to exit the fish passage facility.

As river flow increases the gates in the head works structure will be lowered allowing up to 660 cfs to pass down the ramp while maintaining the headwater at elevation 162.1. As river flow increases further, the headwater elevation will increase up to elevation 162.6 at which point approximately 330 cfs will be spilling over the dam and 1,000 cfs will be flowing through the rock ramp. Additional increases in river flow will be routed through the flushing channel (up to approximately 2,800 cfs[3] while maintaining the headwater elevation at 162.6. The flushing channel will need to be operated carefully in a throttling mode at moderate flows to prevent drawing down the upstream water surface elevation which would reduce flow through the rock ramp.

As flow in the river increases further, the headwater elevation will rise. For headwater elevations 163.0 to 164.0, the head works gates will rise to limit flow in the ramp to 1,500 cfs and create a hydraulic drop from the river to the exit pool of up to 1.0 foot. During high flows (greater than 12,000 cfs) steelhead are likely not actively moving upstream so the gate may be lowered to remove the obstruction to river flow.

The head works weirs can be raised at low flow to dewater the ramp if necessary. If there is any possibility that fish are in the ramp at the time, the rate of closure must be controlled to minimize fish standing and the entire ramp should be inspected to salvage any stranded fish.

Because the Hardened Ramp alternative was designed to operate over a very large range of flows, its performance at low flows could be less than ideal. Operating a second, low flow fish ladder (possibly the existing fish ladder if modified to remedy identified deficiencies) was considered but ultimately not included in the design due to the added complexity to facility operations including the need to rescue stranded fish from the Rock Ramp alternative when flows are switched from the ramp to the low flow ladder.

Decreasing flow within the ramp to sub-fish passage levels could result in fish, both upstream- and downstream-migrating fish, to become stranded within the ramp and in the exit pool. To dewater the ramp, flows will need to be decreased gradually to allow teams of personnel to survey the entire rock ramp for stranded fish. The risk of stranding in the Hardened Ramp

[3] The capacity of the flushing channel is limited to approximately 2,700 when maintaining a headwater elevation of approximately 162 feet and the flushing channel is operated as an orifice.

alternative is lower than for Rock Ramp alternative due to the relatively smooth floor and regular pattern of roughness elements of the hardened ramp. Rescuing fish from the hardened ramp would be easier than for the rock ramp for the same reasons.

6.4.2.2 Efficacy of Fish Passage

Fish will easily find the hardened ramp entrance due to the relatively large volume of flow emanating from the ramp entrance. Data in Table 6.4-1 show over the range of fish passage design flows (up to 6,000 cfs) at least 24% of downstream flow will emanate from the fishway. A typical design value is 10% of the high design flow, thus this alternative exceeds the design standard; however, as stated above, only a portion of the rock ramp may be passable to steelhead at higher flows. The high volume emanating from the rock ramp will attract fish to the fishway where fish will then seek out areas of lower velocities, primarily along the margins of the ramp, to ascend the ramp.

Lamprey may be better able to ascend the hardened ramp if the floor were not lined with cobble. A smooth concrete floor (or strip of the floor) would provide a good substrate for lamprey to grasp with their mouths; however, lamprey would also benefit from a thicker low velocity boundary layer created by a rock-lined floor to the structure. Using smooth, river rock and cobble in the hardened ramp aggregate is likely an optimum design for the passage of both lamprey and steelhead.

Fish exiting the head works structure and reentering the Santa Clara River may experience high velocities to river left leading to the flushing channel and diversion intake. At a high fish passage flow of 6,000 cfs, up to 2,800 cfs will be passing between the hardened ramp and the river's left bank through the rubber dam. The average water velocity though this area would be as high as 12.4 fps. This assumes there is just 30 feet of separation between the ramp and the left river bank (Drawing 6.4-2); this dimension could be increased to reduce the velocity near the exit. Steelhead would attempt to avoid high velocity areas and continue to move upstream, but there is a chance steelhead would be caught up in the high velocity and fall back through the flushing channel under these circumstances. Alternatively, the rubber dam could be raised during all flushing channel operations to prevent fall back, but this will negatively affect the efficacy of flushing operations. Additionally, fish exiting the ramp have no physical structure such as a bankline to guide them upstream.

6.4.2.3 Potential Impacts on River Flood Capacity

Although the hardened ramp and head works structure will be constructed in the active channel of the Santa Clara River they will not reduce the dam's ability to pass the design flood capacity.

6.4.3 Design and Construction Considerations

The construction considerations for the Hardened Ramp alternative are very similar to the Rock Ramp alternative, with the following notable differences.

- The substrate of the ramp would be an engineered concrete sill with roughness features, so large volumes of large diameter quarry rock would not be required. This would eliminate the need to transport and install the large rock, and would be easier to construct with less risk of needing repairs in the future.
- Due to its steeper slope and ability to pass high flows, the overall structure is smaller and would be easier to construct.
- Note that while the footprint is smaller, the same foundation concerns addressed with the Rock Ramp alternative will apply to this alternative.
- No gated notches are necessary, and the overall dewatering needs for construction would be less due to the smaller footprint.

6.4.4 Opinion of Probable Construction Cost

An OPCC was developed for the Hardened Ramp alternative in a similar manner to the Rock Ramp (Section 6.3.4). Quantities were estimated as noted in Appendix C, Table C-3, with unit costs developed to be consisted in approach with all of the alternatives.

Including unlisted items, contingencies, and an allowance for engineering, permitting, and construction services, the OPCC for this alternative is $24 million in 2010 dollars. The largest unknown associated with this alternative is also the foundation needs and resulting structural system.

6.4.5 Evaluation of Hardened Ramp Alternative

6.4.5.1 Strengths

- Very good attraction flow over a wide range of flows.
- Multiple fish passageways.
- Relative ease of operation, minimal need for gate operation.
- Passes sediment.
- Will pass other species in addition to steelhead.
- No reduction in flood capacity of the existing dam.

6.4.5.2 Weaknesses

- Construction difficult for large, in-stream structure and cut through dam.

- Limited access to ramp by heavy equipment and personnel.
- Design approach for this slope size is untested.
- Fish rescues required when flow is cut off to the ramp.

6.4.6 Next Steps to Pursue Hardened Ramp

A physical model of this alternative is required to study hydraulic patterns and sediment movement through the system. At the current stage of development the need for a rubber dam between the rock ramp structure and the left bank of the Santa Clara River is uncertain. A physical model can help determine flow combinations that will allow sediment to be flushed from in front of the diversion intake while the rubber dam is raised, and determine a range of flows over which the flushing channel may be operated without the rubber dam and not have a negative effect on flows in the ramp.

A physical model or hydraulic measurements of a similar structure would confirm efficacy of fish passage. Review the USBR design and Ventura River project and any other projects utilizing this concept for efficacy of fish passage and other lessons learned.

A physical model could also help refine the orientation of the rock ramp to minimize negative impacts on the fluvial morphology of the river.

Additional borings and a geotechnical investigation are needed to confirm that bedrock is at the expected elevation and is suitable for founding the structure. Once the foundation needs are quantified, addition work should be done to optimize the design of the retaining walls and cutoff walls for this alternative.

6.5 ALTERNATIVE 8 – NATURE-LIKE FISHWAY

6.5.1 Description of Nature-Like Fishway

The new Nature-Like Fishway consists of an entrance structure, nature-like fishway, and exit structure. Auxiliary water at the entrance will be provided by two intake screens through a buried pipeline. The facilities will be located around the left abutment surrounding the existing fish passage system. Crest gates will be added to the dam and the flushing channel to control flows into the fishway (Figure 6.5-1). All structures of this alternative were designed to have the same flood protection as the existing canal and fish ladder facilities. All facilities are the same as those of Alternative 2, New Vertical Slot Fishway, except the fish ladder and transport channel are replaced by a semi-natural channel. Descriptions of the facilities that are identical to those of Alternative 2 are in the following sections:

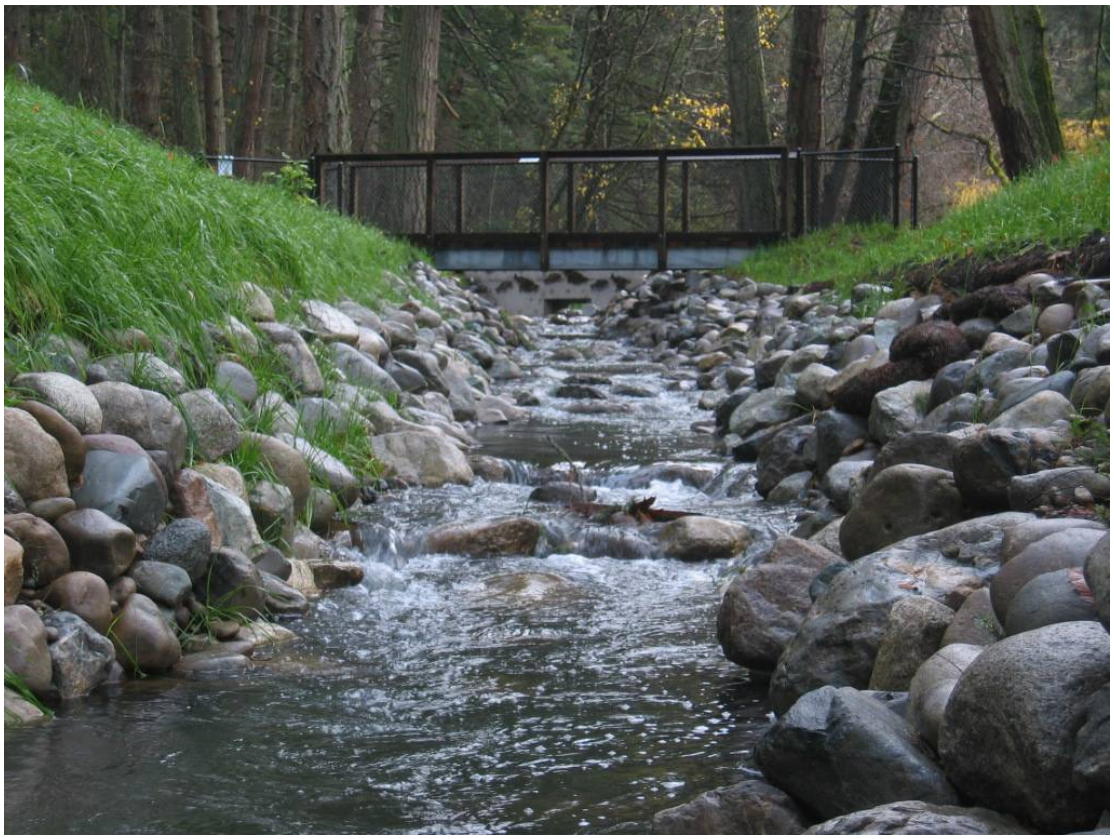


Figure 6.5-1. Nature-like fishway (Spanaway Cr. Washington State.)

Entrance structure: 6.2.1.1
Fishway exit: 6.2.1.4
Approach channel auxiliary water intake screen: 6.2.1.3.1
Canal intake auxiliary water screen: 6.2.1.3.2
Crest gate: 6.2.1.5
Optional auxiliary water arrangements: 6.2.1.7

Another difference is the routing of the auxiliary water pipes, which is described in subsections below.

This alternative is shown in Drawings 6.5-1 and 6.5-2. A nature-like fishway is shown in Figure 6.5-1. The fishway in the picture is close to the same dimensions and slope as the alternative described here.

The fishway design described here is somewhat based on working around the existing canal, diversion and fish screen. If major changes are made to any of these facilities, they could greatly affect the fishway layout. The concepts and scope would not be greatly affected though the scale and cost could be affected as described in Section 6.5.1.

6.5.1.1 Nature-Like Fishway

A nature-like fishway will replace the ladder and transportation channel of Alternative 2. It uses rocks and other streambed material in a constructed channel that mimics a natural streambed. The general shape of the channel cross section is a trapezoid with an 8-ft wide base and 2H:1V side slopes. A 3-feet wide walkway is provided on each side of the channel for maintenance access. The stream banks provide an area for vegetation to grow around the channel. The channel, banks, and walkways are contained by concrete retaining walls, up to 25 feet high. The width of the fishway between the concrete walls is approximately 26 feet, requiring a wider trench than for the vertical-slot fish ladder. To provide maximum ambient lighting into the channel, where there is room, the upper portion of the walls will be earth slope at 2H:1V up to the ground surface.

Nature-like fishways require obtaining an appropriate mix of bed materials to produce a roughness so that a minimum flow depth of 1 foot can be maintained. Larger rocks are used to provide roughness elements to achieve the proper hydraulics and areas for fish to rest. Finer-sized material is used to fill voids between larger materials to minimize subsurface flow. Construction of a nature-like fishway is generally not recommended by NMFS for total lengths of passage exceeding 150 feet, however, the engineering principles are valid at longer passage lengths. The total length of the Nature-Like Fishway at the Freeman Dam is approximately 900 feet. The channel would be built in a series of chutes about 20-feet long and at 4.8% slope separated by 20' pools throughout the fishway. The series of chutes and pools mimics a natural channel, creates diversity of hydraulics and habitat, and creates resting pools throughout. The pools are vulnerable to being at least partially filled with sediment though.

For this alternative, the vertical slot fishway is replaced by a nature-like fishway with a 2.4 % slope (Figure 6.5-1). This slope is a conservative value for planning purposes and can likely be increased somewhat to decrease the channel length with further design work. The site layout and fishway width and depth somewhat limit the maximum slope (minimum length) of the fishway. The fishway crosses the canal downstream of the screens in the current design so there is no construction or on-going conflict of those facilities. Crossing in that location limits how much the length can be reduced. If the screens and/or canal headworks are reconstructed, there might be other options to shorten the fishway.

The fishway route is described beginning at the entrance pool and moving upstream. It would turn to the south along the left bank of the river for approximately 200 feet. The fishway walls would replace the existing retaining wall there. The fishway would then turn east and crossing the canal below the slide gate downstream of the canal screens. The fishway channel invert in this area varies from between 20 and 25 feet below the existing grade. The fishway crosses the canal just downstream of the canal control gate located downstream of the screens. As the fishway crosses the canal, the invert is approximately 8 feet below that of the canal and would be contained in an arch culvert constructed beneath the canal and the existing roadway.

After exiting the culvert, the fishway turns to the north paralleling the canal wall at the existing fish screens for about 200 feet (Drawings 6.5-1 and 6.5-2). The fishway then follows the hill slope along the existing fence line for another 340 feet before turning back towards the river and the fishway exit. The channel will then transition to a deeper, narrower channel to connect with the exit channel. The centerline of the channel will be directly beneath the existing hill slope in order to provide access to the existing facilities on the river-side of the fishway (see Section B on Drawing 6.5-2). As a result, the slope and fence line must be offset approximately 20 feet to the east. A new access road will be constructed along the new top of the slope on the east side of the fishway.

6.5.1.2 Exit Channel

At the end of the nature-like fishway, the channel transitions into an 8-feet wide concrete channel with a series of automatically controlled adjustable weirs and pools. The weirs are required to control flow into the fishway and dissipate the head from the variable water surface in the reservoir to the fixed water surface in the upstream end of the nature-like fishway. The weirs can be operated to provide the optimum flow to the fishway based on operational experience. They can be operated to temporarily add flow to the fishway to scour excess sediment from the fishway. Similar to the Vertical Slot Fishway, a sluice gate will be located at the exit to dewater the ladder.

6.5.2 Operation of Nature-Like Fishway

There will be a drop in the water surface of about 0.2 feet across the entrance gate when fully open, which is its normal position up to a river flow of about 5,000 cfs. The adjustable weirs at the exit will be operated automatically to control flow into the nature-like fishway. A water level sensor and computer will measure the water surface upstream and set the weirs to obtain the desired flow and flow depth at the head of the fishway at Station 9+50 (Drawing 6.5-2). Each weir would be set to take 25% of the drop from the pool just downstream of the exit gate to the head of the fishway channel.

The flow in the fishway channel will be about one foot deep and have an average velocity of about 2.5 fps. However, the large rocks in the channel will provide backwater resting pools and chutes throughout the fishway. The vegetation on the side of the channel will provide shade for the fishway. The travel time for water in the channel will be about six or seven minutes.

The weirs can be operated to provide the optimum flow to the fishway based on operational experience. The fishway flow can normally be between about 8 and 30 cfs. They can be operated to temporarily add flow to the fishway to scour excess sediment from the fishway. The channel can be widened slightly in the final design to take more flow if required. In that case it will also require additional as a minimum flow and considerable more deep excavation will be required.

If the crest gate at the flushing channel screen is lowered entirely, the fishway will be dewatered. Because of the diversity within the nature-like fishway, there should be pools for fish to hold in. Water should be pumped to the fishway to keep fish healthy. Because of the channel complexity, it will be difficult to remove and relocate fish upstream.

The operation of the auxiliary water system is the same as described for Vertical slot fishway in Section 6.2.3.1.

6.5.3 Construction Considerations

The construction considerations are the same as for Alternative 2 except for building the nature-like fishway (see Section 6.2.3). The slope of the nature-like fishway dictates its depth below existing ground. Its invert elevation will be 15-25 feet below the existing ground for the majority of its length. Use of a traditional trapezoidal cross section is not possible due to site constraints. Because of the requirement for natural light, it is necessary to reduce the height of the walls and set them back as much as possible. As a result, the slope around the fishway will be excavated at a 2:1 grade from the existing ground down to the top of the walls. This is particularly apparent in the area behind the canal screen, where re-grading of the roadway for access to existing facilities and the new intake screens is required. As a result, significant amounts of material will need to be excavated and removed from the site.

6.5.4 Opinion of Probable Construction Cost

An OPCC was developed for the Nature-Like Fishway alternative in a similar manner to the Vertical Slot Fishway described in Section 6.2.4. Quantities were estimated as noted in Appendix C, Table C-4, with unit costs developed to be consisted in approach with all of the alternatives.

Quantities for excavation, backfill, structural demolition, concrete, intake screens, piping, and other materials were estimated using the conceptual drawings prepared for this report and based on the structures and finished grades shown in the original construction drawings. For excavation it was assumed that the contractor will minimize the amount of trenching or shoring required and, therefore, will excavate down to elevation 165 between the fishway and the base of the new intake screens. Stability or reinforcement of existing facilities impacted by construction was not considered at this level of analysis.

Including unlisted items, contingencies, and an allowance for engineering, permitting, and construction services, the OPCC for this alternative is $28.1 million, in 2010 dollars. See Table C-4 in Appendix C for a line-item breakdown of material costs.

6.5.5 Evaluation of Nature-Like Fishway

6.5.5.1 Strengths

- Proven passage technology.
- Entrance flows can be directed in different directions into the tailwater to attract fish.
- Facilities are located on shore where access for inspection and maintenance is good.
- Entrance is near flushing channel gate which can be used to release additional attraction flows.
- Does not restrict the flood flow capacity of the dam.
- Construction is relatively easy – good access, foundation conditions are known.

6.5.5.2 Weaknesses

- Attraction flows in the entrance pool are limited.
- During high flows fish attracted to the flushing channel gate releases or crest gate flows might have difficulty finding the entrances.
- Sediment could deposit in the fishway channel changing characteristics of channel.
- Sediment may accumulate in the entrance pool at times.
- Fish might reject the shallow, narrow fishway channel.
- Depends on automatic weir gates to provide optimum flow for fish passage. This would reduce reliability of the system.

7. EVALUATION AND COMPARISON OF ALTERNATIVES

The alternatives were evaluated and compared by estimating how each of 19 desirable characteristics would be achieved by each alternative. These characteristics were used in two ways. They were considered in the development and evaluation of each alternative and then were used to compare each of the alternatives against the others. The comparison of alternatives was done with a Pugh comparison matrix described below.

Each of the 19 desirable facility characteristics is described in this section. There are nine fish passage characteristics, six operations and maintenance characteristics, and four others.

7.1 FISH PASSAGE CHARACTERISTICS.

7.1.1 Attraction of Adult Fish to Fishway – Low, Mid-low, Mid-high, and High Flows

Attraction is the guidance of fish to find the migration pathway over the dam, whether it is a fishway or a rock ramp. It includes attraction to the vicinity of the fishway and passage into the fishway entrance. Attraction into the fishway is evaluated with respect to four ranges of river flows applied to each alternative. These make up four characteristics. Table 7.1-1 shows those ranges as well as other relevant flows for comparison.

Table 7.1-1. Ranges of flows evaluated.

Flow Range Descriptions	Flows
Low flow range	40 – 500cfs
Mid-low flow range	500 – 2,000 cfs
Mid-high flow range	2,000 – 6,000 cfs
High flow range	Over 6,000 cfs

The reasoning for selecting these flow ranges was described in Section 3.4. Fishway attraction is the key component to minimizing migration delay. It could account for a high proportion of the success of fish passage and it is often the most difficult to predict during design. This is because of variables such as behavior of individual fish, variable and changing hydraulic conditions below the dam and fishway entrance. Within the fishway structure, attraction depends on the fishway entrance flow, entrance location, and shape of entrance flow jet. Characteristics of the tailwater that affect attraction are bathymetry, attraction to the area or distraction or competition from other flows. All of these characteristics are considered in the design and evaluation of alternatives.

The fishway entrance flow is crucial. It is made up of the flow in the fishway plus any additional auxiliary flow that is added for attraction. When a fishway has greater flow, it is generally more attractive. Exceptions to this are when the extra flow creates excess drops and/or velocity. In those cases, fish might be attracted to the fishway but are not able to enter it.

The ratio of fishway entrance flow to the high fish passage river flow is often used as a design guide. Ratios of fishway flow five to ten percent of total river flow are often applied. The ratio of momentum (equivalent to the product of flow rate and velocity) has also been used. Simple ratios alone do not account for the other attraction considerations listed above.

Simply using just the entrance flow does not account for other hydraulic conditions that can attract fish to the vicinity of the fishway. For example, in the case of the vertical slot fishway, flow from the existing flushing channel sluice gate can attract fish to the vicinity of the gate, which is immediately adjacent to the fishway entrances. Figure 7.1-1 is a schematic of flows during a river flow below VFDD of 6,000 cfs. The purpose of the figure is only to demonstrate how attraction effectiveness is calculated.

The flushing channel sluice gate flow adds to the attraction effectiveness of the entrance. To be most effective, the energy and turbulence need to be well controlled to make use of that flow to guide fish to the fish ladder entrance area without obscuring the entrance gate(s) with excessive turbulence. The portion of the sluice gate and crest gate flows from Table 6.2-1 that are effective, in the Panel's judgment, in attracting fish to the fishway entrance were added to the fishway entrance flows to calculate the total attraction flow. The same was done for each alternative.

Figure 7.1-2 shows the percentages of the flows in the downstream channel that are considered to be effective fishway attraction flows for each of four alternatives and the existing fishway. The fishway flows are from the flow summary tables for each alternative in Section 6. The attraction effectiveness of each fishway component used by the Panel is summarized in Table 7.1-2. For example, all of the flow within the ramps or fishway entrances is effective for attraction because it all leads fish to the passage pathway. The effectiveness of attraction of flow from the sluice varies from zero to 0.5 (1.0=100% effective). It is less than one because it does not lead directly to a passage corridor. The sluice flow overwhelms the entrance flow of the existing fishway at moderate and high flows so its effectiveness is scored zero. The sluice in the 6% hardened ramp is close to the fishway entrance and is located between the entrance and the bank so no fish can be blocked on the opposite side of the sluice flow from the entrance. The attraction effectiveness of the sluice in that case is therefore judged to be 0.5.

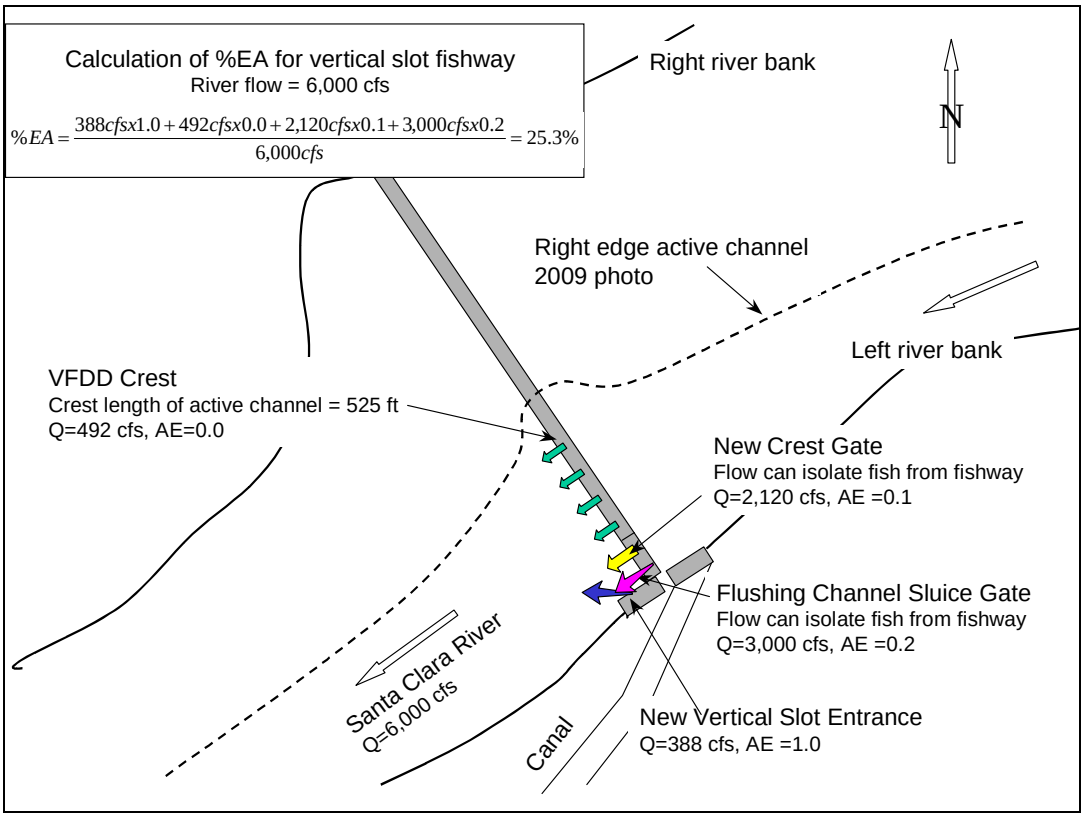


Figure 7.1-1. Example of calculation of effective attraction. Vertical Slot Fishway at downstream river flow of 6,000 cfs.

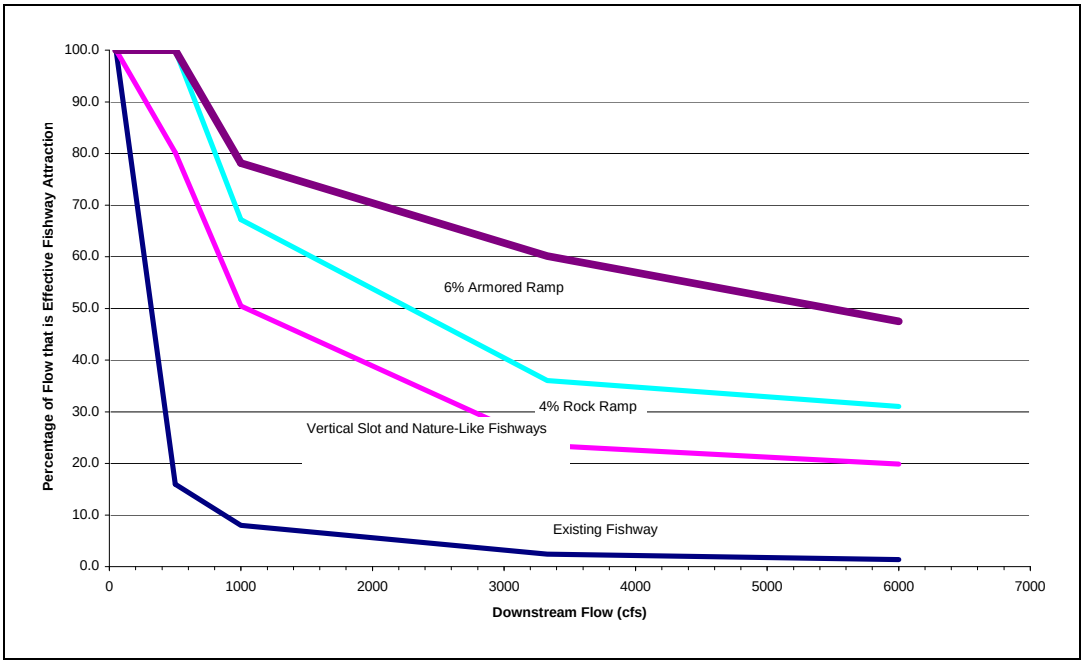


Figure 7.1-2. Percent of downstream flow that is effective fishway attraction flow.

Table 7.1-2. Attraction effectiveness of fishway and dam components used to derive values in Figure 7.1-2.

	Attraction Effectiveness	Explanation
Existing Fishway		
Sluice Gate	0.4	Sluice effectiveness is variable. Creates poor hydraulics at entrances but attraction effectiveness is chosen because sluice flow is limited to 150 cfs.
Dam Crest	0.0	
Vertical Slot and Nature-Like Fishways		
Sluice Gate	0.2	Sluice is close to fishway but isolates it from crest. Good dissipation will help.
Crest Gate	0.1	
Dam Crest	0.0	
4% Rock Ramp		
Sluice Gate	0.1	Sluice is remote from fishway.
Crest Gate	0.3	Gate can isolate fish from fishway.
Dam Crest	0.0	
6% Hardened Ramp		
Sluice Gate	0.5	Sluice is tight between fishway and bank so bank guidance is good.
Dam Crest	0.0	

There might be trade-offs in selecting the fishway entrance flow. The following are examples of such trade-offs:

- The rock ramp, with a high fishway flow, is likely more attractive than the left bank fishway options, which require an auxiliary water systems for attraction.
- On the other hand, the entrances of the left bank fishways have velocity almost twice that of the rock ramp, which therefore adds to the attraction of the fishways.
- Increasing the high flow in the rock ramp could cause the ramp to be wider and therefore shallower at low flows and thus increase the risk of stranding fish.
- An entrance made for a high flow may not create much attraction at low flow. The velocity might be low and/or the shape of the jet might not be appropriate. In this case, specific entrances for low and high flows might be used.
- A structure designed for a high flow may result in excessive deposition of sediment at low to moderate flows. For example, the entrance pools of the left bank fishways are designed to operate up to 400 cfs but must also operate down to about 40 cfs.

Weighting in the comparison matrix reflects the Panel's emphasis on passage at flows in the mid ranges. Scoring in the comparison matrix reflects that a large portion of the total river flow is contained within the rock ramp at all passage design flows so it becomes more attractive than the left bank fishways at higher flows. The scores for all of the fish passage characteristics in the dam removal alternative except monitoring are maximized.

Scoring of attraction at each flow range was by professional judgment. The Panel considered the entrance location, geometry, and lighting; entrance flow, ratio of entrance flow and its effectiveness to downstream flow; and tailrace flow patterns to compare and score alternatives.

7.1.2 Fish Access Out of Fishway

This characteristic describes physical access for fish from the fishway through any flow control section and out of the fishway. Access depends on the geometry and hydraulics of the exit and the area just upstream. Head differential, depth of flow at the exit, certainty of adequate flow passing into the fishway, and risk of fall-back are the primary considerations.

Generally, a minimum of four feet of water depth is preferred in fish passage channels for adult salmonids. As with all fishways, there is a low flow threshold at which they will perform adequately for fish passage. Low-flow barriers may exist downstream (i.e., critical shallow riffles) at flows below the low-flow capabilities of the fishway alternatives considered.

Fall-back is the characteristic of fish successfully passing the fishway, exiting the fishway, and then falling back over the dam, through the flushing channel, or into the canal.

The left bank fishways have slightly lower scores because their exits are nearer the canal intake, flushing channel, and dam crest and therefore have slightly less risk of fallback. All of the alternatives have some risk of deposition in the river channel blocking flow to the fishway exits. The Nature-Like Fishway has a flow control section different than the fishway itself and therefore a slight risk of fish rejecting it. The Rock Ramp and the Nature-Like Fishways have overflow weirs to control flow at the fishway exits. Those weirs might be difficult for lamprey to pass at high river flows.

7.1.3 Passage of Adult Steelhead and Lamprey through Fishway

Passage of adult fish through the fishway pertains to the certainty and efficiency of fish passage. The Rock Ramp has a slight uncertainty about fish passage because of the variability of rock placement and movement and how that might affect passage at low flow. The Vertical Slot

Fishway has the highest score because it is the most certain and has a long record of successful passage and research for steelhead and lamprey.

The Nature-Like Fishway scores slightly lower because there is some uncertainty whether steelhead will accept such a small channel after being accustomed to the scale of the Santa Clara River.

The physical safety of adult fish passing through the fishway is also included in this characteristic. Safety is possibly diminished when fish are expected to leap over weirs or are unintentionally induced to leap at other locations. Safety is diminished if fish might become stranded in the fishway when it is dewatered.

7.1.4 Attraction and Passage of Non-target Species

The target species for fish passage is adult steelhead. Lamprey have also been considered in the conceptual designs. There might be added ecological value in providing for or blocking passage of other species and life stages. No other non-target species have been specifically identified for passage but the Panel assumed if there are any, they would be weaker swimmers than steelhead.

Weaker swimmers could most easily pass through the Nature-Like Fishway. The next easiest alternative for passage of weak swimmers would be the ramp fishways. The Vertical Slot Fishway has the greatest uncertainty for passage of weak swimmers. To access the Nature-Like Fishway, the fish must pass through the entrance, which is optimized for steelhead. As mentioned above, a second entrance for weaker fish could be provided.

7.1.5 Safety of Juvenile Fish

This characteristic is the physical safety of juvenile fish passing downstream over the dam or through the fishway. It accounts for any risk of fish being passed into the downstream channel that does not flow to the ocean under the current flow regime. It also considers and risks of predation in an open, shallow channel, stranding in a fishway, injury in energy dissipation structure, and injury from spilling over dam crest.

Safety is increased in the left bank fishways because fish are more likely to enter the canal and be collected with the option of transporting them downstream. In evaluating safety, it was assumed that the screens in the canal protect fish so it does not include efficacy of the canal screens. Evaluation of that screen is not within the scope of this evaluation though a brief recommendation is made regarding it.

Smolts passing over the dam could become stranded in the channel downstream as flows are ramped down. Capabilities of releasing a minimum flow for volitional passage, monitoring smolts passing the facility, and preventing fish from passing when the flows recede below a low threshold would be favorable. To maintain 120 cfs below the losing reach of the Santa Clara, a flow of at least 200 cfs is needed just below VFDD. When the fishway flow is reduced to below a given threshold, say 250 cfs, a release of screened water downstream for a limited period of time could provide safe passage downstream to those fish that passed below the VFDD.

7.1.6 Potential for Fish Passage Evaluation or Biological Monitoring

This characteristic is the ability to add facilities for trapping and counting fish passage through the fishway to either assess performance of the fishway or to monitor populations. The primary objective of the project is to provide fish passage; there is no stated intent of doing population monitoring at this time. Other technologies (cameras, radio tracking) are available for facility evaluation. If continuing monitoring of fish passage is considered a priority for a ramp alternative the best means of achieving that goal can be determined in the design process.

The Vertical Slot and Nature-Like Fishway alternatives score relatively high because the fish will pass through confined spaces that can be modified to include trapping or monitoring facilities. The ramp alternatives score lower because there is no known practical way to monitor fish in such a wide, variable ramp in such turbidity and turbulence.

7.2 OPERATION AND MAINTENANCE CHARACTERISTICS

7.2.1 Simplicity of Fish Passage Operations

More complex and frequent operational demands result in greater uncertainty and risk due to improper operations or possible failure of equipment. Additional entrance gates, auxiliary water systems, and mechanical flow control weirs add to complexity but operations are still simple when these can be automated.

7.2.2 Sediment and Bed Load Management

The Santa Clara River has a high sediment load. Most of the fishways themselves are expected to be essentially self-maintaining. Sediment will continuously flush through the vertical slot and ramp fishways.

The Nature-Like Fishway will accumulate sediment, which will tend to fill pools. It can be flushed by temporarily adding water. The auxiliary water systems have risks of sediment accumulations especially when they are operated at flows lower than their capacities.

7.2.3 Debris Management

Fish ladders are vulnerable to debris. Debris can impair operations and performance if allowed to accumulate, thus compromising its passage effectiveness. This characteristic describes three characteristics; the likelihood and the consequence of debris accumulation at the exit of or within the fishway and the ease of dealing with it.

7.2.4 Certainty of Diversion

This is the certainty that the water diversion will function. There is little difference among the fishway alternatives and the dam removal alternative scores low.

7.2.5 Simplicity of Operation

Simplicity of operation relates to the simplicity of operating the diversion. There is little difference among the fishway alternatives and the dam removal alternative scores low.

7.2.6 Durability of Structure

This is risk of damage of the fish passage structure due to high flows or changes in the channel. The ramp options score lower than the left bank fishways because they are subjected to full river flood flows and debris. The hardened ramp is exposed to those flows whereas the rock ramp will be protected by a headgate. On the other hand, the roughness elements of the rock ramp could become dislodged.

7.3 OTHER CHARACTERISTICS

7.3.1 Minimize Geomorphic Impacts

Potential geomorphic impacts could affect channel stability, banklines, levees, other infrastructure, and habitats in the Santa Clara River. These effects could be due to a headcut migrating upstream or sediment released due to a headcut.

The VFDD was constructed with an objective of halting incision of a headcut. Removal of the dam therefore ranks low for this characteristic.

7.3.2 Public Safety

Public safety was considered but weighted low because the site is not accessible to the public and to favor fish passage objectives.

7.3.3 Aesthetics, Education

Specific alternatives could enhance aesthetic qualities of the site and provide educational opportunities. The Panel weighted this combined characteristic low in favor of fish passage objectives.

7.3.4 Permitting

There are two levels of permits involved. One level is compliance with HCP and Section 10 permitting. Any alternative that does not satisfy this level of permitting is fatally flawed. This level of permitting is therefore not included in this characteristic.

The second level is construction permitting. Standard provisions for instream work would be applied to any of the designs and might vary considerable among projects. Environmental compliance and regulatory permits such as the USACE 404, CDFG 1600, and Water Quality Control Board 401 permits would involve the same processes and efforts for each alternative but some alternatives are built primarily out of the flowing channel while others are in the channel and require substantial fill and dredging and major modifications to the dam itself.

The Panel weighted permitting low because it believes that permitting should not control the alternative selected at this level of analysis.

7.3.5 Effect on Flood Capacity

The effect of the projects on flood capacity was not included in the final scoring because any reduction of flood capacity is considered a fatal flaw.

7.4 COST

Construction cost, operation and maintenance cost, and certainty of cost factors are included in the comparison matrix but were not weighted by the Panel. The Panel cannot judge economic factors such as sources or availability of funds.

7.5 SUMMARY OF KEY CHARACTERISTICS FOR EACH ALTERNATIVE

Table 7.5-1 is a summary of key characteristics that vary significantly different among the alternatives as described in the evaluation of each alternative.

Table 7.5-1. Summary of key characteristics that vary significantly among alternatives.

	Vertical Slot Fishway	**Rock Ramp**	**Hardened Ramp**	**Nature-Like Fishway**
		Fish Passage		
Fish attraction; all design flow ranges	+ Entrance flows can be directed in different directions into the tailwater to attract fish + Entrance is near sluice gate which can be used to release additional attraction flows - Attraction flows in the entrance pool are limited - Fish attracted to the sluice gate releases or crest gate flows might have to cross those flows and have difficulty finding the entrances	+ Very good attraction flow over a wide range of river flows.	+ Very good attraction flow over a wide range of river flows	+ Entrance flows can be directed in different directions into the tailwater to attract fish + Entrance is near sluice gate which can be used to release additional attraction flows - Attraction flows in the entrance pool are limited - Fish attracted to the sluice gate releases or crest gate flows might have to cross those flows and have difficulty finding the entrances
Steelhead and lamprey passage through fishway	+ Proven passage technology - Narrow and deep transportation channel could hinder fish movement	+ Proven concept, although scale of project unprecedented to our knowledge. + Many diverse fish passage pathways + Designed for wide range of flows thus design is not optimal at the low fish passage flow	+ Multiple fish passageways - Design approach for this slope size is untested	+ Proven passage technology, although scale of project unprecedented to our knowledge - Fish might reject the shallow, narrow fishway channel
Attraction and passage of non-target species		+ Will pass other species in addition to Steelhead	+ Will pass other species in addition to steelhead	+ Will pass other species in addition to Steelhead

	Vertical Slot Fishway	Rock Ramp	Hardened Ramp	Nature-Like Fishway
		Operation and Maintenance		
Simplicity of fish passage operations	+ Facilities are located on shore where access for inspection and maintenance is good	+ Flexible operations with multiple flow routing paths + Possibly complex operations due to many flow paths - Ramp difficult to access for maintenance in wet season - Fish rescues will be required when flow is cut off to the ramp	+ Relative ease of operation, minimal need for gate operation - Ramp difficult to access with equipment in wet season - Fish rescues required when flow is cut off to the ramp	+ Facilities are located on shore where access for inspection and maintenance is good - Dependency on automatic weir gates reduces reliability
Sediment and bedload management	+ Sediment is easily passed through fishway - Sediment may accumulate in the entrance pool at times	+ Easily passes sediment	+ Passes sediment	+ Sediment is easily passed through fishway - Sediment may accumulate in the entrance pool at times - Sediment will likely deposit in the fishway channel changing fishway characteristics
		Other		
Construction	+ Construction is relatively easy – good access, foundation conditions are known	- Construction difficult for large, in-stream structure and cut through dam - Local availability of rock material uncertain	- Construction difficult for large, in-stream structure and cut through dam	+ Construction is relatively easy – good access, foundation conditions are known

7.6 COMPARISON MATRIX

The alternatives were compared using a Pugh comparison matrix. The matrix is used to describe and compare options. Its best use is to understand differences among alternatives and among stakeholder needs. It is not meant to necessarily select the preferred alternative. Though this tool results in a final relative score, the highest score may not represent the best option. Various stakeholders will likely weigh characteristics differently depending on their responsibilities, authority, and funding. Each stakeholder might therefore have a different final ranking of alternatives. Panel distributed the spreadsheet used to calculate the Pugh matrix. Interested parties are invited to change characteristics weights in their versions of the matrix and to question values in the Panel's scoring.

The matrix describes and weighs the importance of characteristics needed for a successful project. The score of how well a characteristic is achieved for each alternative is the product of the weighting factor and the score of how well that alternative satisfies the characteristic. The resulting weighted scores are then summed for each alternative to create a total score. The weights and scores for each alternative developed by the Panel are shown in Table 7.1-2. The first column lists the characteristics, and the second column indicates the weight applied to it. The weighting scale is from zero to ten with zero meaning the characteristic is of no importance and ten meaning it is essential to the success of the project.

Scores are also on a scale of zero to ten, with zero meaning the option does not at all satisfy the characteristic and ten meaning that it satisfies the characteristic to the point that it could not be further enhanced. The scores in Table 7.6-1 are normalized to 100 for easier interpretation so the highest overall normalized score and the highest fish passage normalized score are each 100.

It is helpful if different stakeholders weigh the options independently. Differences among stakeholder weights can lead to a better mutual understanding of pros and cons of each option and better understanding of the goals and needs of each stakeholder.

To fill out the matrix, change the weight values to reflect the needs you represent. Some characteristics must be weighted lower than others. Weights should total 100 so all characteristics cannot be highly important. Score each characteristic for all alternatives at once (complete each row in the matrix) so the alternatives are compared simultaneously for each characteristic. For clear differentiation among options, chose scores that differ significantly.

Table 7.6-1. Comparison matrix with Panel's weightings, scores, and totals.

Freeman Dam Fish Passage Alternative Comparison Matrix
9/12/2010

Characteristic	Wt 0 - 10	Existing Fishway		Vertical Slot Ladder		Nature-Like Fishway		4% Rock Ramp		6% Hardened Ramp		Dam Removal		Standard Deviation
		Score 0-10	Product	Score 0-10	Product	Score 0-10	Product	Score 0-10	Product	Score 0-10	Product	Score 0-10	Product	
Fish passage														
Fish attraction at high flow (above 6,000 cfs)	2	0.2	0	3.0	6	3.4	7	5.2	10	6.2	12	10.0	20	3.0
Fish attraction at mid-high flow (2,000 to 6,000 cfs)	6	0.4	2	4.6	28	4.4	26	8.0	48	8.2	49	10.0	60	12.5
Fish attraction at mid-low flow (500 to 2,000 cfs)	10	2.4	24	6.0	60	6.0	60	8.6	86	8.8	88	10.0	100	15.6
Fish attraction at low flow (40 to 500 cfs)	10	5.2	52	8.6	86	8.6	86	9.2	92	9.2	92	10.0	100	3.5
Fish access out of fishway	6	3.0	18	6.4	38	6.4	38	6.8	41	6.8	41	10.0	60	1.4
Passage of steelhead, lamprey through Fishway	10	3.6	36	8.8	88	8.2	82	7.8	78	7.0	70	10.0	100	7.5
Attraction and Passage of Non-Target Species	3	2.0	6	4.8	14	5.4	16	6.0	18	4.2	13	10.0	30	2.3
Safety of juvenile fish	8	4.8	38	7.8	62	7.6	61	6.0	48	6.4	51	10.0	80	7.1
Potential for Biological Monitoring	2	7.0	14	9.8	20	9.4	19	0.8	2	0.8	2	0.0	0	10.2
Operation and maintenance														
Simplicity of fish passage operations	5	5.8	29	6.4	32	6.0	30	5.0	25	7.2	36	10.0	50	4.6
Sediment and Bedload Management	6	5.0	30	5.8	35	4.8	29	8.2	49	8.4	50	9.6	58	10.7
Debris management	5	7.6	38	6.4	32	7.2	36	7.8	39	7.8	39	10.0	50	3.3
Certainty of diversion	10	7.6	76	7.8	78	7.8	78	8.4	84	8.4	84	6.8	68	3.5
Simplicity and ease of diversion	4	6.4	26	6.6	26	6.4	26	7.4	30	7.6	30	4.2	17	2.4
Durability of Structure	8	9.4	75	8.2	66	7.2	58	4.8	38	7.0	56	10.0	80	11.5
Other														
Minimize geomorphic impacts	5	8.0	40	8.0	40	8.8	44	7.2	36	7.2	36	0.0	0	3.8
Public safety	0	8.2	0	7.6	0	7.8	0	5.0	0	4.2	0	10.0	0	0.0
Aesthetics, Education	0	8.0	0	6.8	0	8.2	0	4.4	0	4.6	0	10.0	0	0.0
Permitting	0	10.0	0	8.6	0	8.6	0	7.2	0	7.0	0	5.0	0	0.0
Cost														
Construction														
Operation and maintenance														
Certainty of cost														
Total Score Normalized to 100			58		82		80		83		86		100	
Fish Passage Only Normalized to 100			35		73		72		77		76		100	

Review scores within the completed matrix to understand what issues and/or objectives drive the final ranking. Do not pretend the score totals are precise; totals that are close should be considered equal. Challenge the options. What can be changed in a concept to raise its final score and make it more acceptable?

The Panel used the matrix interactively and iteratively to develop consensus among the Panel members and to develop the best project alternatives possible. Scores were adjusted in the matrix to reflect changes in designs as they were developed. Strong differences among scores of Panel members or among alternatives were identified and challenged. Differences among Panel members might be based on different experiences of similar facilities or differences in understanding of the design or site conditions. Those differences were discussed and resolved so each score was close to consensus. The recorded scores are the averages of the Panel members. Large differences in scores among alternatives were challenged by attempting to improve the

designs with the low scores so they would be more competitive with higher scoring alternatives. At the conclusion of the study, the Panel members reviewed scores they provided previously and updated them based on any changes as a result of design changes, Panel discussion, and responses to comments.

The final results of the Panel's discussion and scoring of the Pugh comparison matrix are shown in Table 7.6-1 and Figure 7.6-1. Both the table and figure show sums of scores that are normalized to 100 for easier interpretation. The highest scoring alternative is dam removal with a normalized score of 100. The four alternatives developed in this study all score within eight percent of each other, from a score of 79 to 85. Considering the method of analysis, this slight range does not represent a significant difference. The ramp fishway alternatives scored slightly higher (score: 85 for the 6% and 83 for the 4% ramps) than the Vertical Slot Fishway (score: 81) and Nature-Like Fishway (score: 79). As a comparison, the existing fishway scored 59 overall and about half the scores of the other alternatives considering fish passage only. As any designs are carried forward, the scoring estimates can be improved.

The far right column of the table shows the standard deviation of the final scores for the two ramp and the two fishway alternatives. The relative standard deviations are an index that indicates where the primary differences are among the alternatives that drive the final results. For example, the values for the characteristics of fish attraction at the mid-low (S.D.=15.6) and mid-high (S.D.=12.5) flows are the most influential of all the characteristics in differences among the alternatives. Other relatively high values are durability of structure (S.D.=11.5), potential for biological monitoring (S.D.=10.2), and sediment and bedload management (S.D.=10.7).

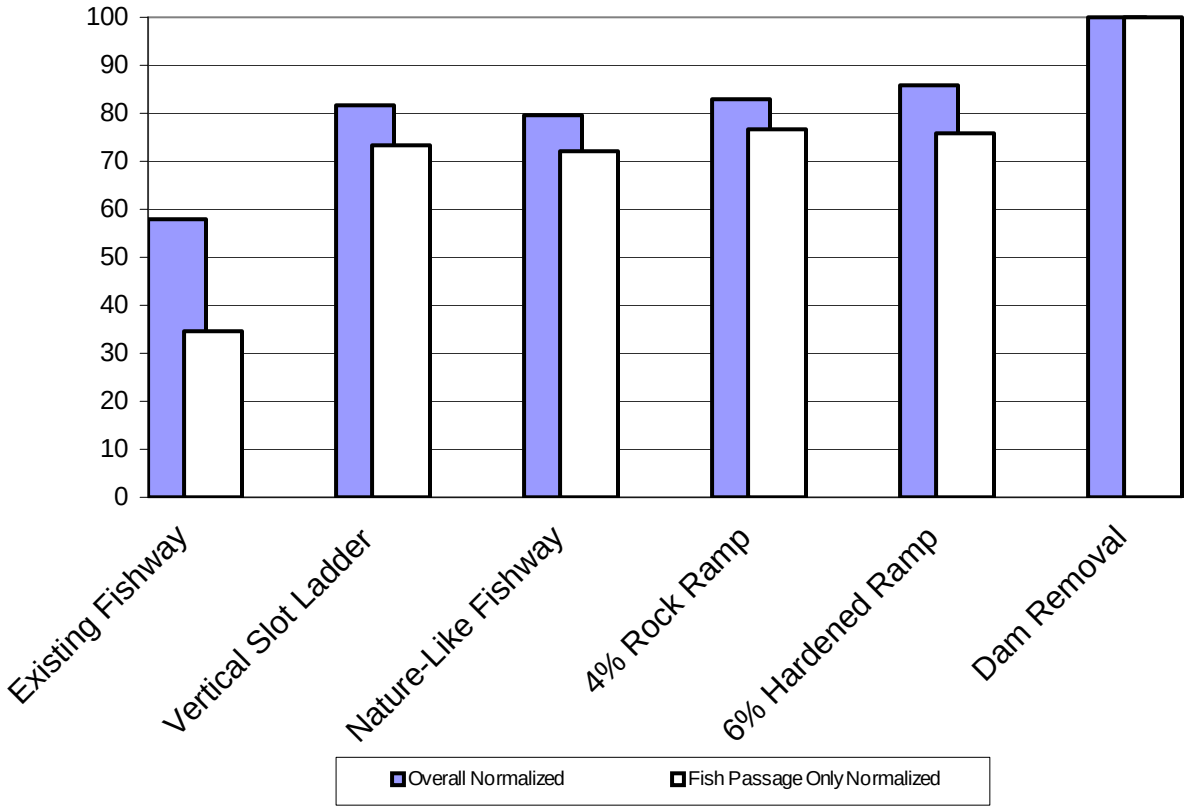


Figure 7.6-1. Normalized comparison matrix scores for five alternatives.

This page intentionally blank.

8. EXISTING FISH SCREENS

The Panel's scope of work addresses upstream passage only. However, the Panel observed that the existing fish screens appeared to not comply with current screening criteria and, to provide the best survival at the Vern Freeman Dam, mentions observations and thoughts concerning downstream passage. The Panel did not study downstream passage or the screens and only discussed the topic very briefly during site visits and deliberations. The comments here are based on these brief discussions and a report by MWH Americas (2006). The comments below are provided in Table 8.1-1 below that lists perceived deficiencies and possible solutions. Note that the comments are based on current NMFS guidelines that were developed after the 2006 MWH report. Further study should be undertaken to better define any improvements required. Possible screen modifications should be considered if the Vertical Slot Fishway or Nature-Like Fishway alternative are further developed since they are inter-related due to vicinity and layout. If the screens were reconstructed, the scale and cost of the Nature-Like Fishway might be reduced. The scale of the Vertical Slot Fishway might be reduced slightly but would not likely affect the cost. The ramp alternatives would not be affected.

Table 8.1-1. Screen deficiencies listed by MWH (2006).

Issue	Deficiency	Possible Solution
Approach velocity to the screen	High approach velocities were observed at areas on the screen face (hot spots)	Provide adjustable baffles behind the screens to even out approach velocities
Approach velocity to the screen	High approach velocities to the screens in general	Adjust gate operation if possible by lowering the drop across the head gates and increase the drop across the canal gates downstream. This will increase the depth on the fish screens.
Sediment deposition at the screen	Screens extend to the canal invert. Deposition could restrict screen cleaner movement.	Place screens on a 6- to 12-inch stem wall to provide some area for deposition.
Turbulence area and backflow through screens exist at upstream end of screens	Backflow through the screens requires higher approach velocities on the downstream portion of the screens.	Convert screens to vertical plates in line with the upstream wall
Screen cleaning system	The multiple brushes moving back and forth only a few feet only concentrate debris at the end of the brush stroke occluding portions of the screen face	Provide new cleaning system such as a brush stroke the entire length allowing debris to be pushed to the bypass.
Fish bypass	Bypass flows are small causing a slowing of sweeping flows along the screen face.	Increase bypass flows employing secondary screens and returning the secondary screen water to the canal downstream of the canal gates or river if the flows are high enough.
Bypass trap appears to be undersized for appropriate bypass flow		Expand trap enclosure to match appropriate screen bypass flow

9. CONCLUSIONS AND RECOMMENDATIONS

The Panel concludes that the final four fish passage alternatives appear, at this level of analysis and design, practical and effective for passing fish at VFDD and minimizing spawning risk.

The ascendograph analyses provided a tool for assessing steelhead spawning risk attributable to passage delay at VFDD. The Panel focused on the inflection of the total success curves in Modeling Scenarios No. 1 through No. 3 for recommending a passage window, whereas future broader considerations (e.g.; HCP) might be concerned with the actual number of successful days. No matter how effective fish passage structures are designed, constructed, and operated at VFDD, spawning success will depend on favorable streamflows.

The ascendograph analysis indicates that steelhead passage at VFDD when streamflows are less than 2,000 cfs will be important for maintaining total spawning success in all water years. Favorable passage at VFDD between 2,000 cfs and 6,000 cfs could still contribute significantly to annual spawning success in wetter water years, though the effects of very high turbidities on steelhead migration remain unresolved. Given the necessary design tradeoffs between providing optimal passage during low versus high streamflows, streamflows between 2,000 cfs and 6,000 cfs (and greater) did not dominate the engineering design for alternatives, but were nevertheless accommodated in each alternative's design. For design and evaluation of alternatives it is recommended that a range of passage streamflows from 45 cfs up to 6,000 cfs at VFDD be used to minimize loss of long-term annual spawning success within the Santa Clara River Basin.

Dam removal involves a myriad of considerations beyond the scope and purview of the Panel; however, it should be considered as an ultimate goal to maximize fish passage opportunities. Considering the highly variable hydrologic characteristics of the basin, edge of steelhead ecosystem, fragility of the stock, inherent delays caused by dams, dam removal would have the greatest chance of allowing and promoting restoration of Santa Clara River fish stocks. The Panel cannot develop the concept because it will involve many issues far beyond the scope and expertise of the Panel. The Panel concludes that the alternative of dam removal should be investigated as a long-term goal of the interested parties.

The four concepts developed for this report rank very close to each other in a comparison matrix developed by the Panel. The order of scoring from high to low, considering all project characteristics, was 6% Slope Hardened Ramp, 4% Rock Ramp, Vertical Slot Fishway, and Nature-like Fishway. When just fish passage characteristics are considered, the order of the two

ramps is switched. Though the scores remain very close, the difference in total scores between the ramps and the left bank fishways increased. The four alternatives scored within 6% of each other, and, at this level of detail and precision, they should be considered to have equal scores.

Conceptual-level opinions of probable construction costs were estimated, with the primary goal to allow comparison between alternatives. The costs of the four alternatives have been reviewed for consistency and can be compared to each other to get an idea of relative costs among alternatives. Significant unknowns for each cost estimate have been noted in Section 6, and should be examined closely with development of any alternative. In addition, the costs are very conceptual and should not be used for budgeting purposes.

With respect to the four alternatives and considering the costs and the evaluation results in Section 7, the Panel recommends that additional work be focused on the development of the Vertical Slot Fishway and the Hardened Ramp alternatives. The Vertical Slot Fishway is preferred over the Nature-like Fishway due to its proven performance for passing steelhead and sediment, and the fact that the two alternatives share many similar features except for the passage route. The Hardened Ramp is preferred over the Rock Ramp due to its simplicity of operation without adding crest gates, its ability to withstand flood flows without risk of failure, its shorter passage route and time, and its lesser cost. These two remaining alternatives offer unique solutions that would both offer distinct passage improvements and varying risks of development.

In addition to the upstream passage issues, the Panel concludes that the existing screen structure is deficient and should be upgraded. If updates are desired, the project would benefit from a coordinated planning and design effort for the upstream and downstream passage features. The scale of the upstream passage solution would be similar to the designs shown herein; however, the overall layout for the ladder alternatives could be refined to consolidate the ladder and fish screens.

Next steps and information needs are identified in Section 6 for specific alternatives. The Panel recommends that next steps include the consideration of these alternatives in future discussions, such as the HCP. To better differentiate the alternatives would require further study and gathering more field data, chiefly geotechnical data and better rating curves for upstream and downstream areas of the dam. Further study would involve deeper engineering analyses consisting of additional hydraulic analyses and modeling, more refinement to the structural design based on the geotechnical data, additional and more detailed drawings, and operational studies coordinating the diversion and fish passage operations.

10. REFERENCES

Bates, K. 1992. Fishway Design Guidelines for Pacific Salmon. Washington Department of Fish and Wildlife, Olympia, Washington.

California Department of Fish and Game (CDFG). 2003. Fish Passage Evaluation at Stream Crossings. Part IX in California Salmonid Stream Habitat Restoration Manual.

California Department of Fish and Game (CDFG). 2009. Fish Passage Design and Implementation. Part XII in California Salmonid Stream Habitat Restoration Manual.

MWH Americas. 2006. Final Appraisal Report, Fish Screen Facility at the Freeman Diversion.

National Marine Fisheries Service (NMFS). 2001. Guidelines for Salmonid Passage at Stream Crossings. NMFS, Southwest Region, Long Beach, California.

National Marine Fisheries Service (NMFS). 2008a. Final Biological Opinion to the U. S. Bureau of Reclamation, Sacramento, California for the action of "Approve United Water Conservation District's Proposal to Operate the Vern Freeman Diversion and Fish-Passage Facility." Administrative Record File # 151422SWR01PR6149. NMFS, Southwest Region, Long Beach, California. July.

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

Simons, Li and Associates, Inc. 1985. Final Report – Hydraulic, Erosion and Sedimentation Analysis of the Freeman Diversion Project. January 30, 1985.

Thomas R. Payne and Associates. 2005. Assessing Passage of Steelhead over Riffles in the Lower Santa Clara River, Draft Final Report to the United Water Conservation District.

U.S. Bureau of Reclamation (USBR). 2010. Draft Report: Robles Diversion Dam – Left Bank Fishway. U.S. Bureau of Reclamation, Technical Service Center, Denver, Colorado.

United Water Conservation District (UWCD). Memo from M. McEachron to Fish Passage Panel (12-23-08). Subject: Total River flow calculation at the Freeman Diversion.

United Water Conservation District (UWCD). Memo from M. McEachron to Fish Passage Panel (11-05-09). Subject: Description of the Freeman Operations.

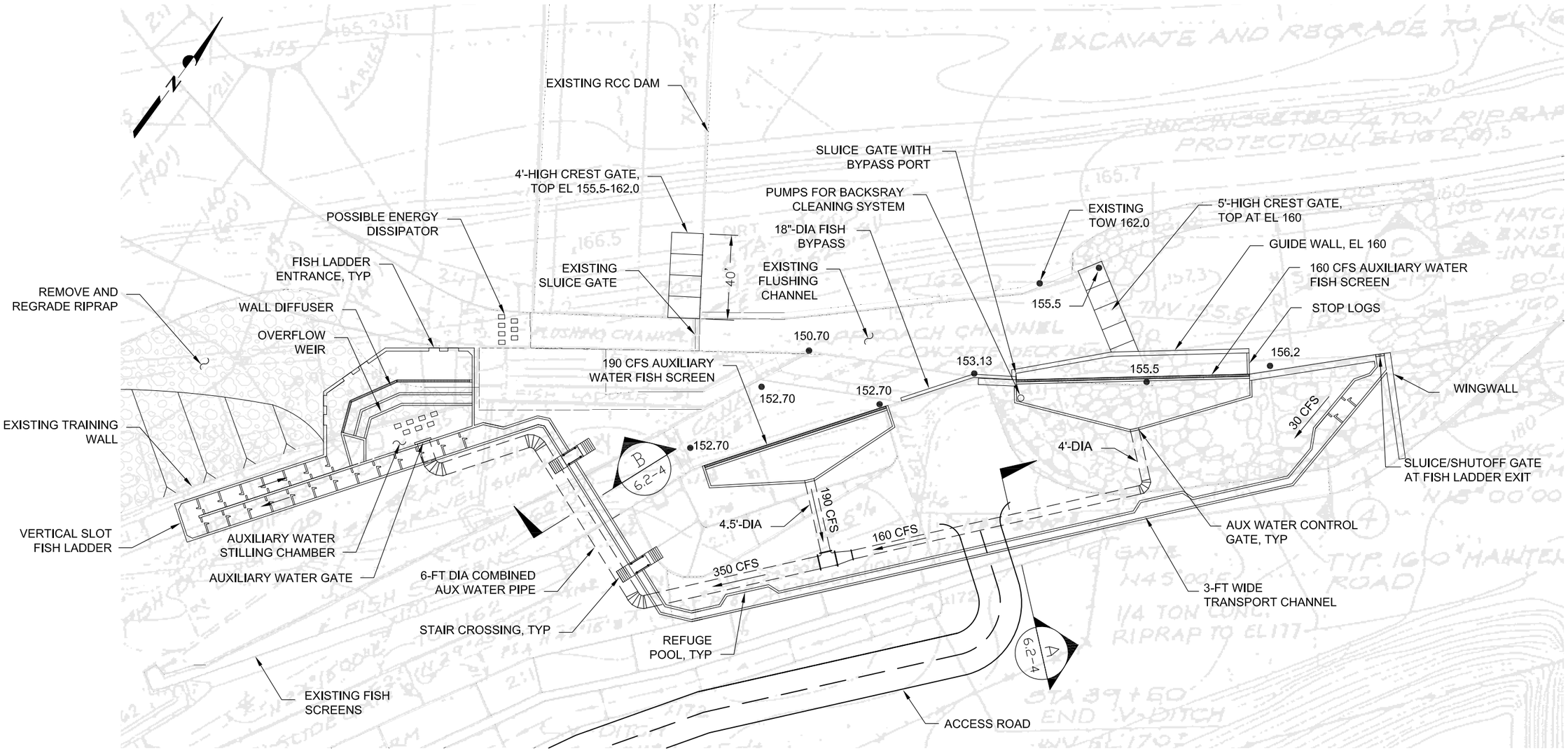
United Water Conservation District (UWCD). Information from M. McEachron to Fish Passage Panel (11-05-09): Discussion of flows over the crest of the Freeman Diversion.

United Water Conservation District (UWCD). Information from M. McEachron to Fish Passage Panel (11-05-09): A brief description of downstream water levels.

Ventura County Watershed Protection District (VCWPD). 2006. Santa Clara River 2006 Hydrology Update – Phase I, From Ocean to County Line. December.

DRAWINGS

This page intentionally blank.



NOTE:
1. ALL ELEVATION CALLOUTS ARE EXISTING.

PRELIMINARY DESIGN PHASE

NOT FOR CONSTRUCTION

This document is an interim document and not suitable for construction. As an interim document, it may contain data that is potentially inaccurate or incomplete and is not to be relied upon without the express written consent of the preparer.

0 25 50
SCALE: 1" = 50'

0 1"
BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

MWH

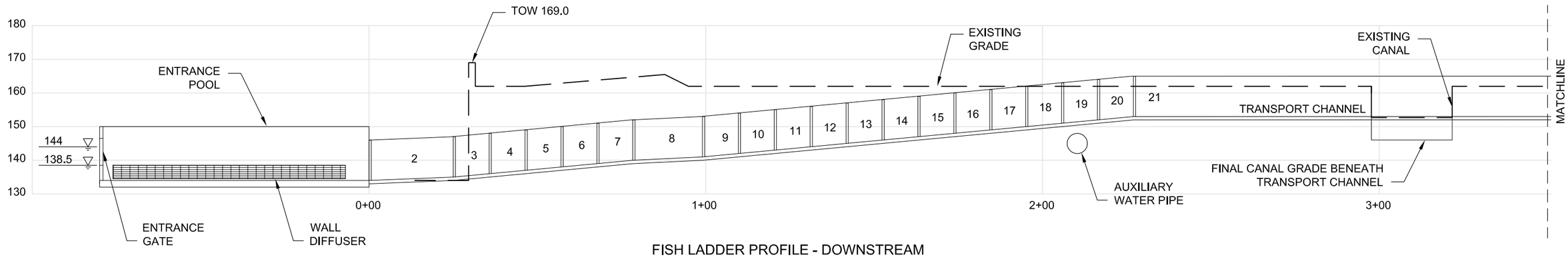
VERN FREEMAN DIVERSION DAM
FISH PASSAGE IMPROVEMENTS PANEL

ALTERNATIVE 3A -
VERTICAL SLOT FISHWAY
PLAN

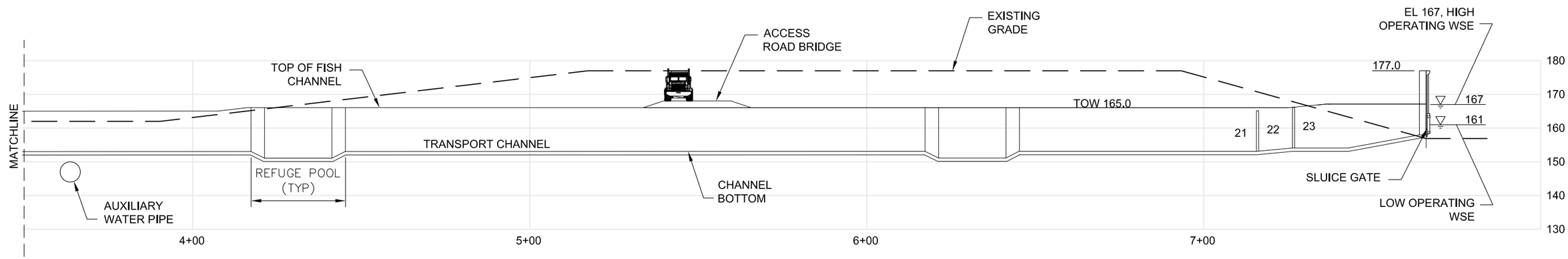
DATE: SEPT 3, 2010

DRAWING: 6.2-1

REV: -



FISH LADDER PROFILE - DOWNSTREAM



FISH LADDER PROFILE - UPSTREAM

PRELIMINARY DESIGN PHASE

NOT FOR CONSTRUCTION

This document is an interim document and not suitable for construction. As an interim document, it may contain data that is potentially inaccurate or incomplete and is not to be relied upon without the express written consent of the preparer.

0 15 30

SCALE: 1" = 30'

0 1"

BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

MWH

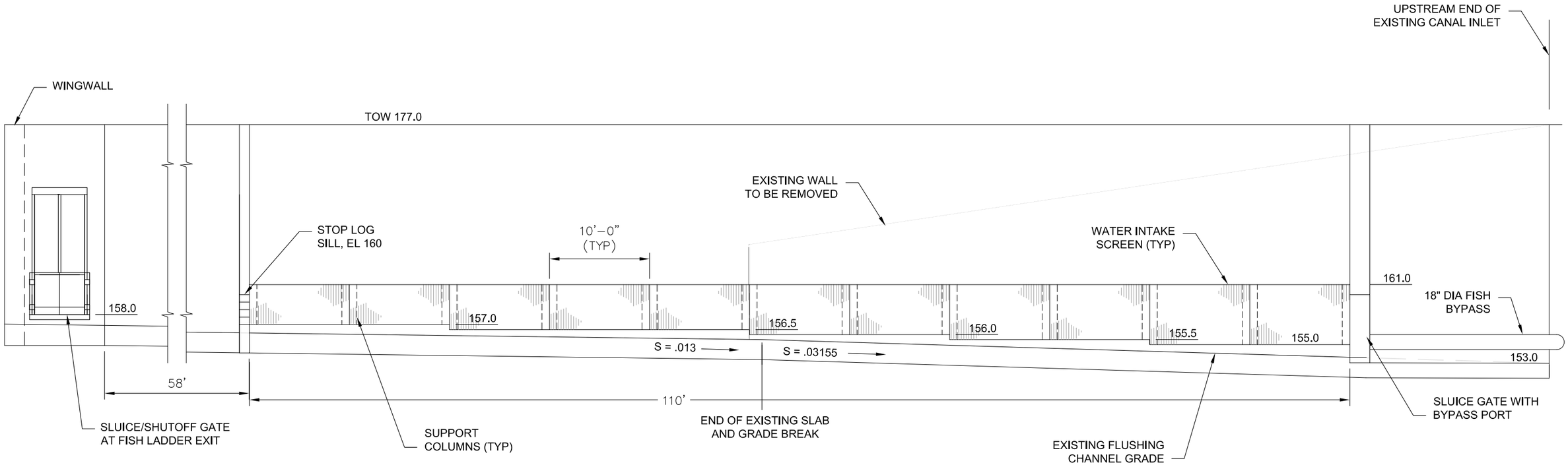
VERN FREEMAN DIVERSION DAM
FISH PASSAGE IMPROVEMENTS PANEL

ALTERNATIVE 3A -
VERTICAL SLOT FISHWAY
PROFILE

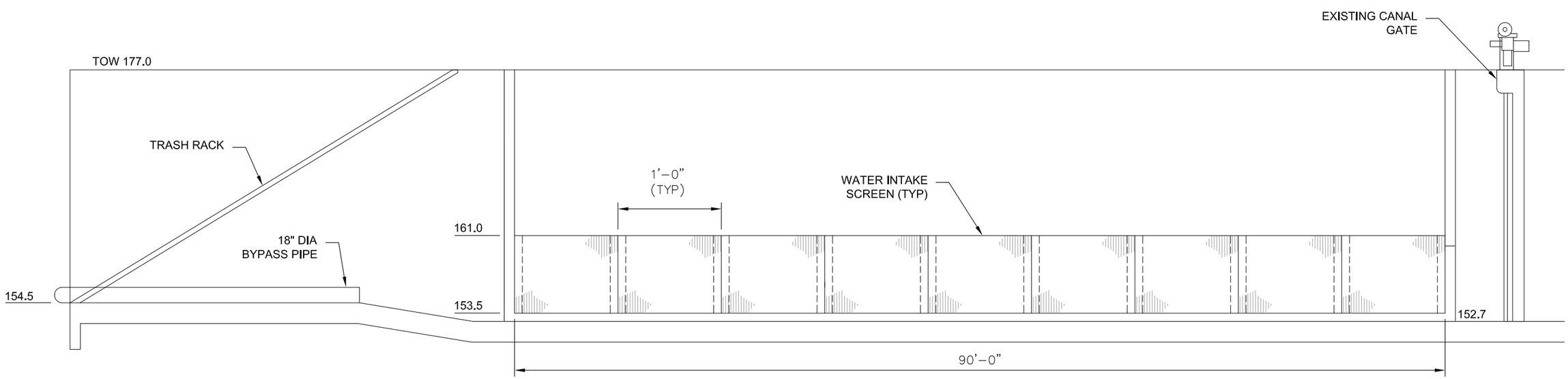
DATE: JULY 16, 2010

DRAWING: 6.2-2

REV: -



FLUSHING CHANNEL INTAKE SCREEN



CANAL INTAKE SCREEN

NOTE:
1. THIS DRAWING ALSO APPLIES TO ALTERNATIVE 8: NATURE-LIKE FISHWAY

PRELIMINARY DESIGN PHASE

NOT FOR CONSTRUCTION

This document is an interim document and not suitable for construction. As an interim document, it may contain data that is potentially inaccurate or incomplete and is not to be relied upon without the express written consent of the preparer.

0 5 10
SCALE: 1" = 10'

0 1"
BAR MEASURES ONE INCH
ON ORIGINAL DRAWINGS

MWH

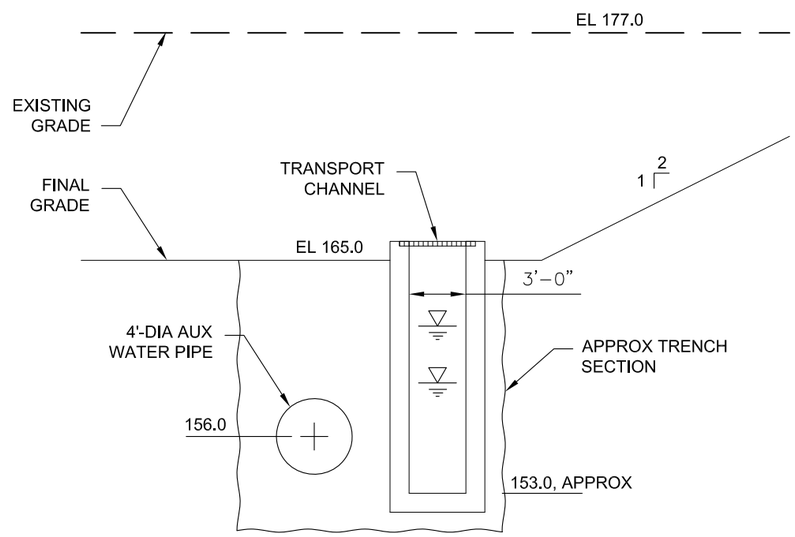
VERN FREEMAN DIVERSION DAM
FISH PASSAGE IMPROVEMENTS PANEL

ALTERNATIVE 3A -
VERTICAL SLOT FISHWAY
INTAKE SCREENS PROFILES

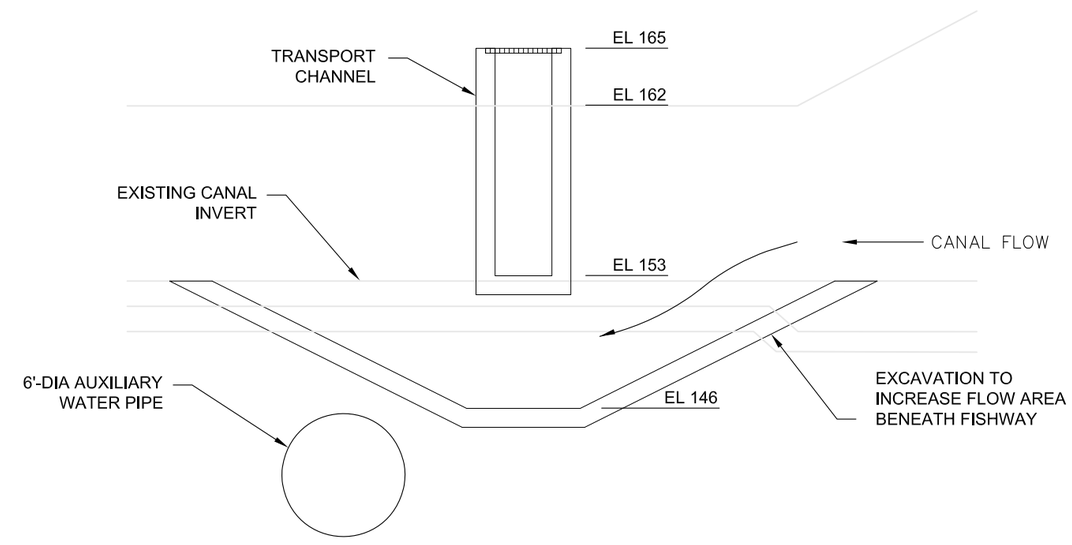
DATE: SEPT 3, 2010

DRAWING: 6.2-3

REV: -



SECTION A 6.2-1
1/8"=1'-0"



SECTION B 6.2-1
1/8" = 1'-0"

PRELIMINARY DESIGN PHASE

NOT FOR CONSTRUCTION

This document is an interim document and not suitable for construction. As an interim document, it may contain data that is potentially inaccurate or incomplete and is not to be relied upon without the express written consent of the preparer.

0 5 10
SCALE: 1/8" = 1'-0"

0 1"
BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

MWH

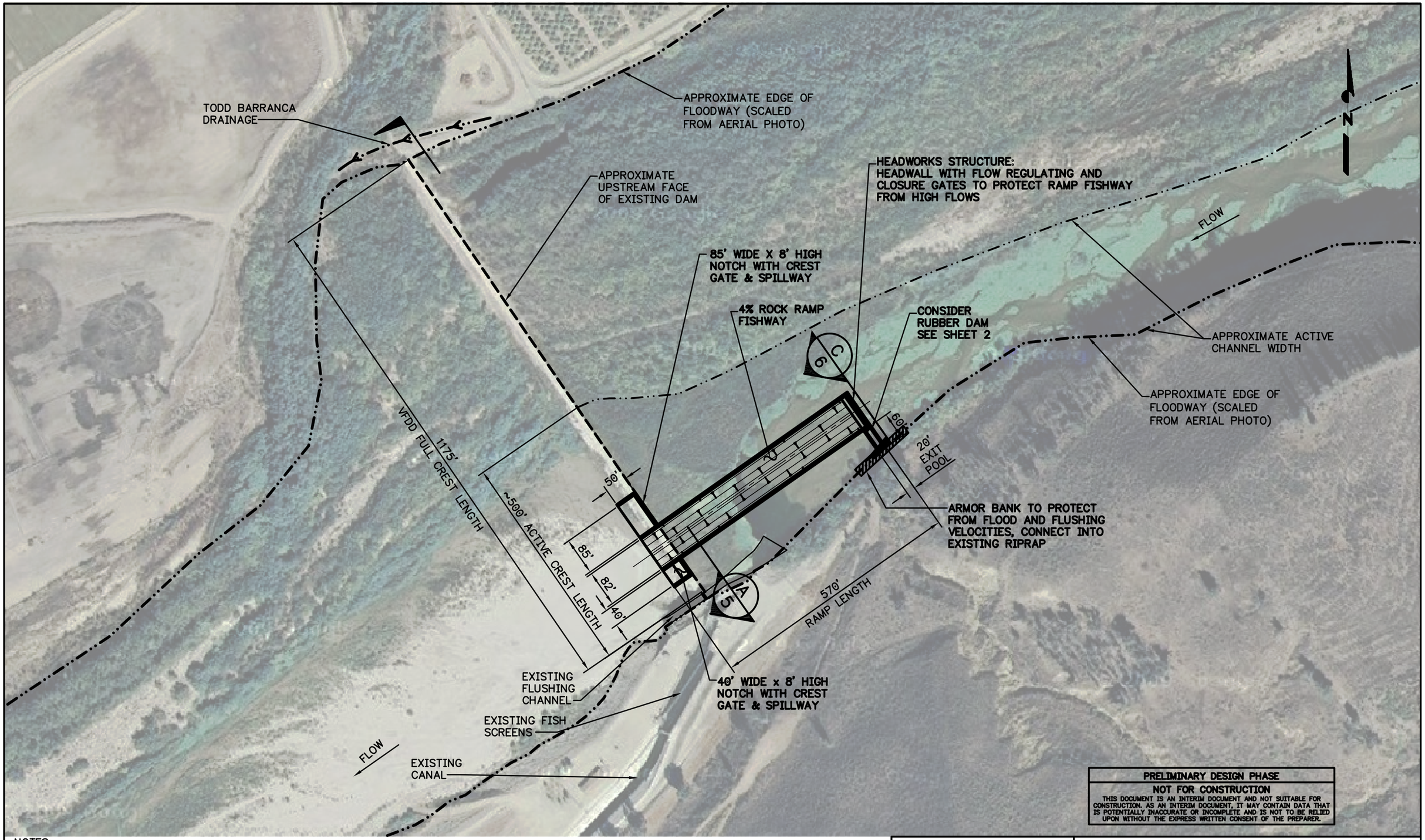
VERN FREEMAN DIVERSION DAM
FISH PASSAGE IMPROVEMENTS PANEL

ALTERNATIVE 3A -
VERTICAL SLOT FISHWAY
SECTIONS

DATE: JULY 28, 2010

DRAWING: 6.2-4

REV: -



NOTES:

1. CONCEPT SHOWN IS PRELIMINARY, TO COMMUNICATE FUNCTIONAL INTENT OF ALTERNATIVE. ADDITIONAL REFINEMENT OF CONCEPT IS NEEDED FOR FLOOD PROTECTION, SLUICING AND GATE DESIGN, INCLUDING HYDRAULIC MODELING.
2. CONCEPT SHOWN PROVIDES FISH PASSAGE AT FLOWS FROM 50 TO OVER 6,000 CFS.

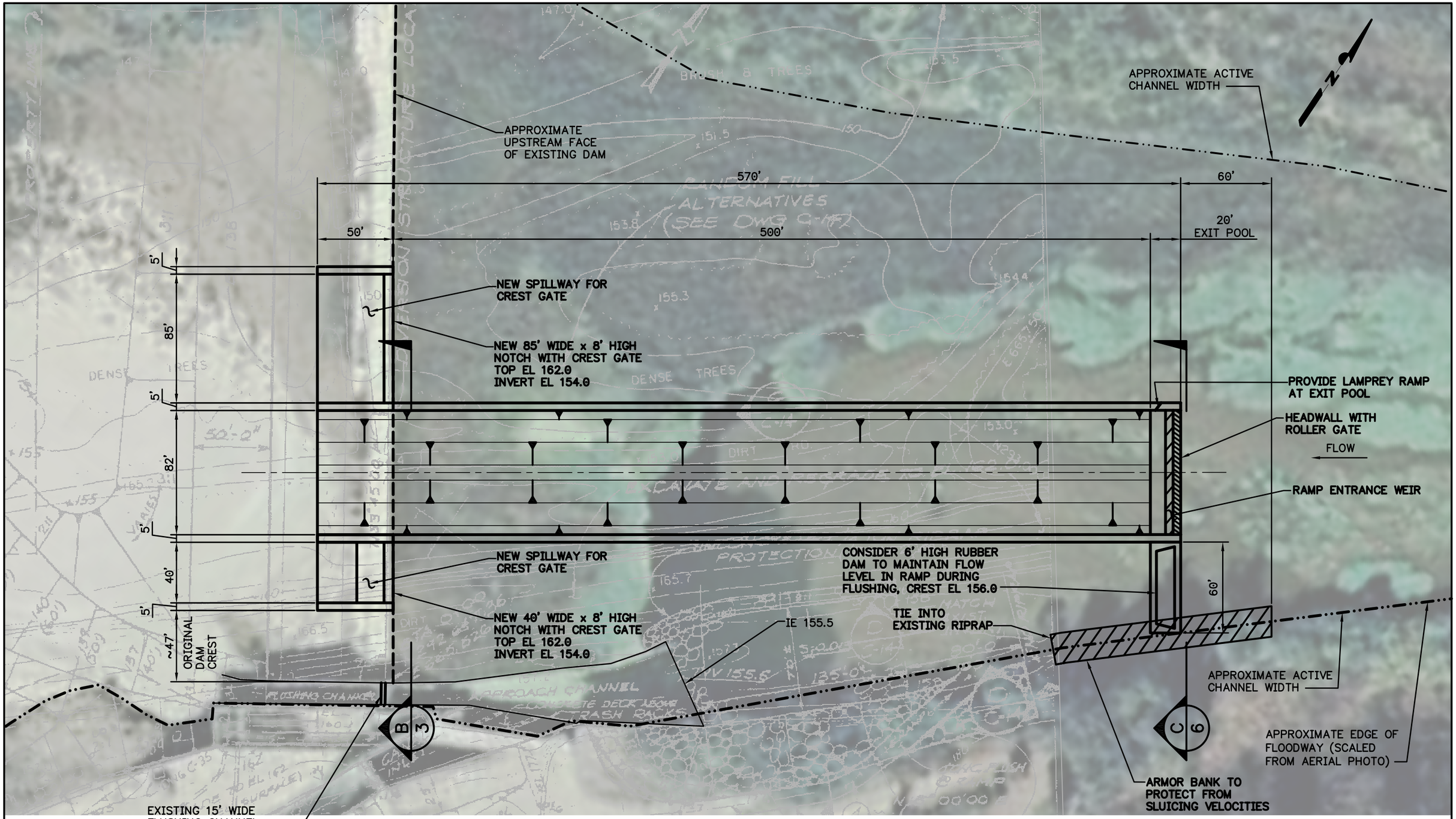
0 100 200
SCALE: 1" = 200'
0 1"
BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

Resource Consultants, Inc.
REDMOND, WA 98052
PHONE: (425) 556-1288

VERN FREEMAN DIVERSION DAM
FISH PASSAGE PANEL

ALTERNATIVE 6A – PARTIAL WIDTH 4% ROCK RAMP OVERALL SITE PLAN

DATE: AUG 6, 2010
DRAWING: 6.3–1
REV: 1



PRELIMINARY DESIGN PHASE

NOT FOR CONSTRUCTION

THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.

0 10 60

SCALE: 1" = 60'

0 1"

BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

Resource Consultants, Inc.
REDMOND, WA 98052
PHONE: (425) 556-1288

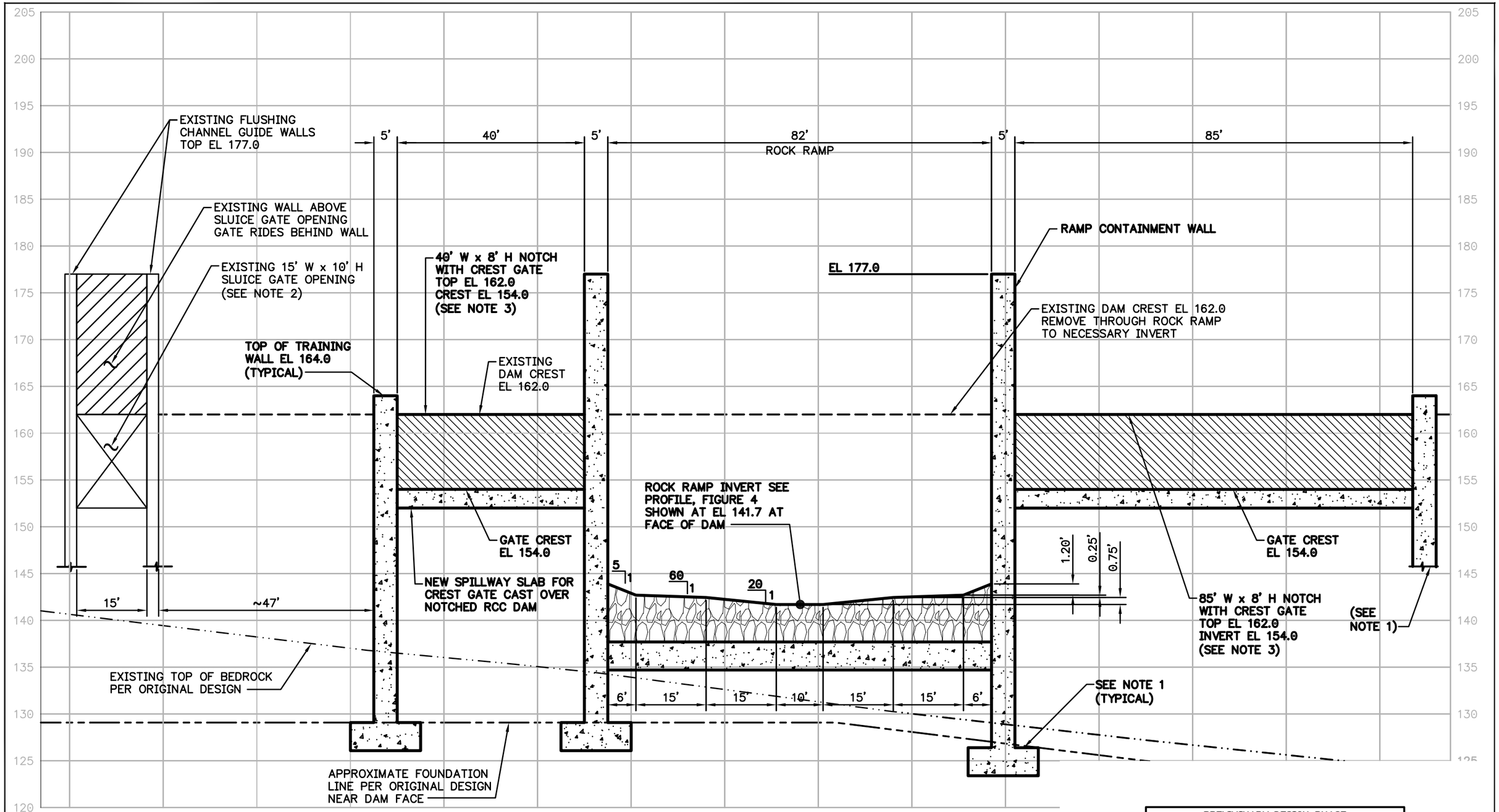
VERN FREEMAN DIVERSION DAM
FISH PASSAGE PANEL

ALTERNATIVE 6A – PARTIAL WIDTH 4% ROCK RAMP SITE PLAN

DATE: AUG 6, 2010

DRAWING: 6.3–2

REV: 1



PRELIMINARY DESIGN PHASE

NOT FOR CONSTRUCTION

THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.

NOTES:

1. WALL THICKNESS AND FOOTING DETAIL SHOWN FOR CONCEPT ONLY. WALL AND FOUNDATION DESIGN REQUIRE ADDITIONAL INFORMATION AND ANALYSIS. ASSUME NEED TO TIE INTO BEDROCK.
2. SLUICE CAPACITY AT POOL EL 162.0 APPROX. 2,700 CFS.

TYPICAL SECTION, ROCK RAMP – EXAGGERATED SCALE TAKEN AT FACE OF DAM LOOKING DOWNSTREAM (B/2)

0 5 10
SCALE: 1" = 10'
VERTICAL SCALE

0 10 20
SCALE: 1" = 20'
HORIZONTAL SCALE

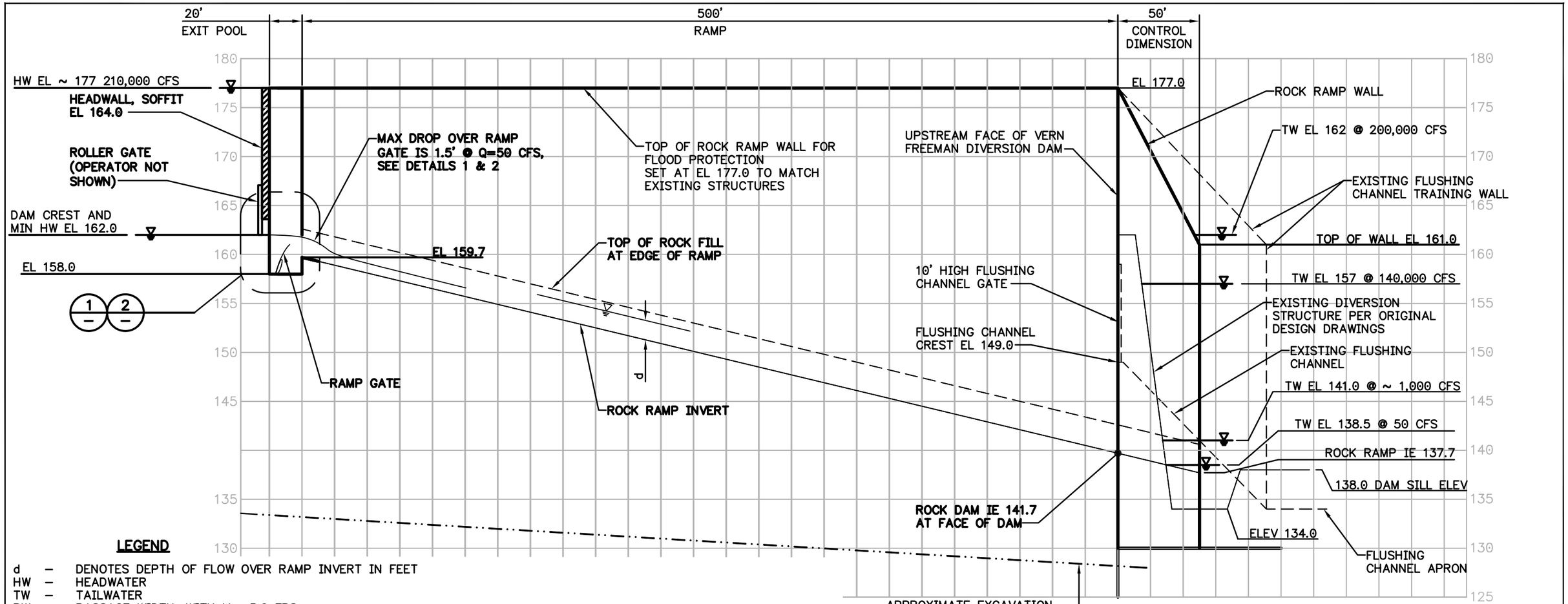
0 1"
BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

Resource Consultants, Inc.
REDMOND, WA 98052
PHONE: (425) 556-1288

VERN FREEMAN DIVERSION DAM
FISH PASSAGE PANEL

ALTERNATIVE 6A – PARTIAL WIDTH 4% ROCK RAMP TYPICAL RAMP SECTION

DATE: AUG 6, 2010
DRAWING: 6.3–3
REV: 1



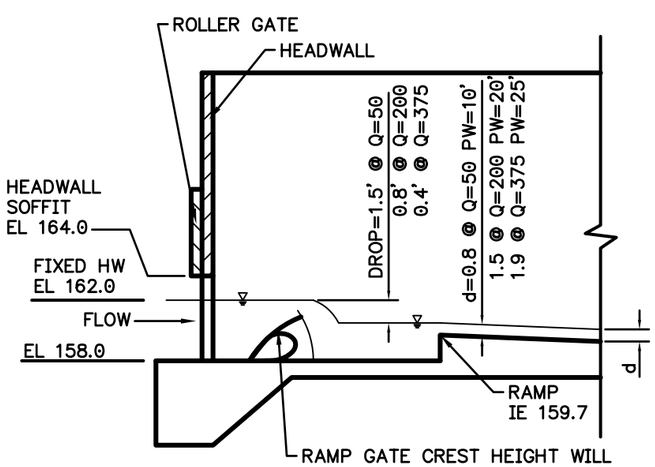
℄ PROFILE OF 4% ROCK RAMP

0 10 60
SCALE: 1" = 60'
HORIZONTAL SCALE

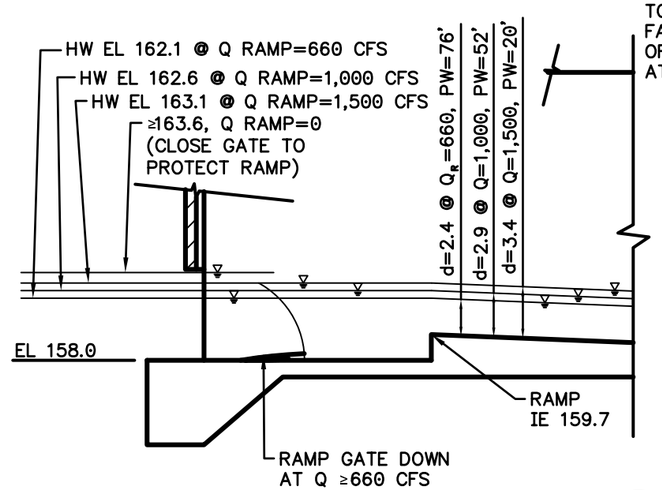
0 1 6
SCALE: 1" = 6'
VERTICAL SCALE

LEGEND

d – DENOTES DEPTH OF FLOW OVER RAMP INVERT IN FEET
HW – HEADWATER
TW – TAILWATER
PW – PASSAGE WIDTH, WITH V ≤ 5.6 FPS



DETAIL 1
HEADWORKS STRUCTURE SCHEMATIC
RAMP GATE CONTROLLING LOW FLOW (50 TO 660 CFS)
(NOT TO SCALE)



DETAIL 2
HEADWORKS STRUCTURE SCHEMATIC
RAMP GATE DOWN FOR 660 ≤Q ≤ 1500 RAMP FLOW
(NOT TO SCALE)

0 1"
BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

PRELIMINARY DESIGN PHASE
NOT FOR CONSTRUCTION
THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.

NOTES:

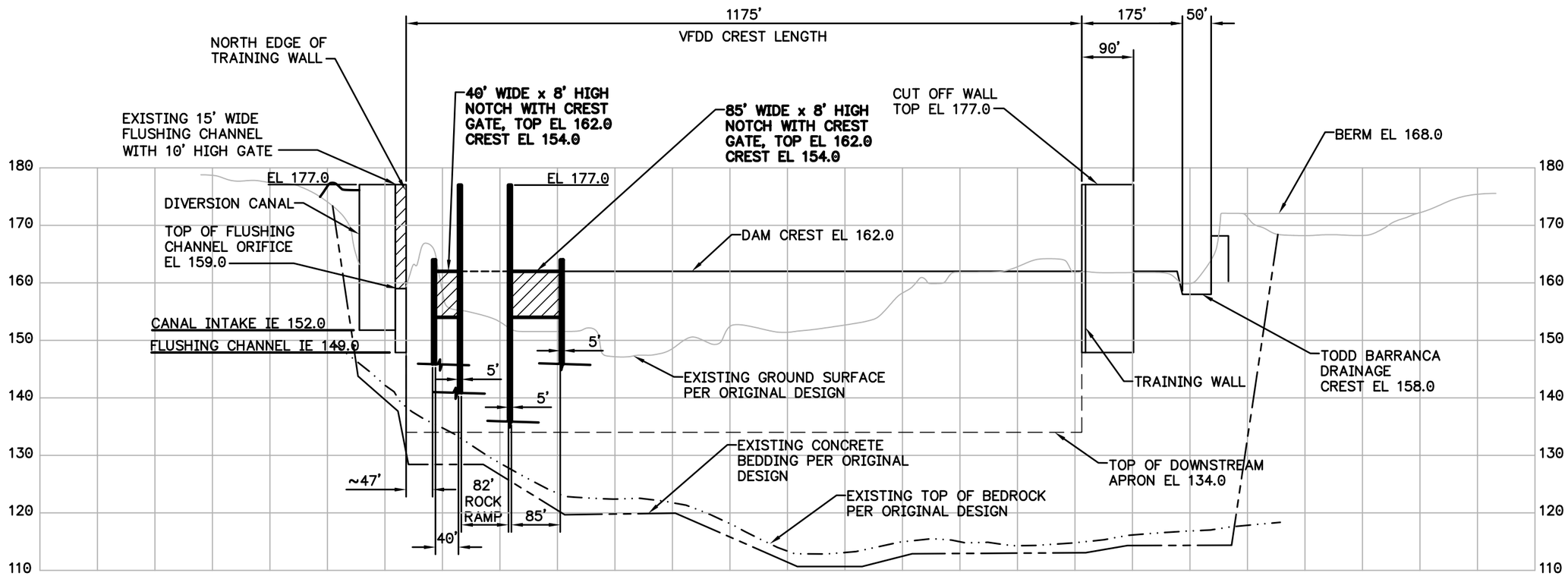
1. LOCATION SET WITH ROCK RAMP ENTRANCE 50' DOWNSTREAM OF FACE OF DAM.
2. BEDROCK ELEVATIONS PROVIDED FROM ORIGINAL DESIGN PLANS, BEDROCK TILTS APPROXIMATELY AS SHOWN, PER 1987 BORING DATA, ADDITIONAL INFO NEEDED.
3. FOUNDATIONS NOT SHOWN, ADDITIONAL ENGINEERING WILL BE REQUIRED FOR THIS ALTERNATIVE.

Resource Consultants, Inc.
REDMOND, WA 98052
PHONE: (425) 556-1288

VERN FREEMAN DIVERSION DAM
FISH PASSAGE PANEL

ALTERNATIVE 6A – PARTIAL WIDTH 4% ROCK RAMP PROFILE

DATE: AUG 6, 2010
DRAWING: 6.3–4
REV: 1



SECTION A/1

VIEW AT UPSTREAM FACE OF DAM LOOKING DOWNSTREAM – ALTERNATIVE 6A

0 100 200
SCALE: 1" = 200'
HORIZONTAL SCALE

0 10 20
SCALE: 1" = 20'
VERTICAL SCALE

NOTES:

1. DAM FEATURES, EXISTING GROUND AND FOUNDATION DATA FROM DAMES & MOORE DESIGN DRAWINGS DATED 2/6/89 (ADDENDUM 3), SHEET C–1.
2. FOUNDATIONS FOR ROCK RAMP WALLS AND GATE WALLS NOT SHOWN.
3. CONSIDER POTENTIAL FOR SCOUR AND UPLIFT WITH FUTURE INVESTIGATIONS.

PRELIMINARY DESIGN PHASE

NOT FOR CONSTRUCTION

THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.

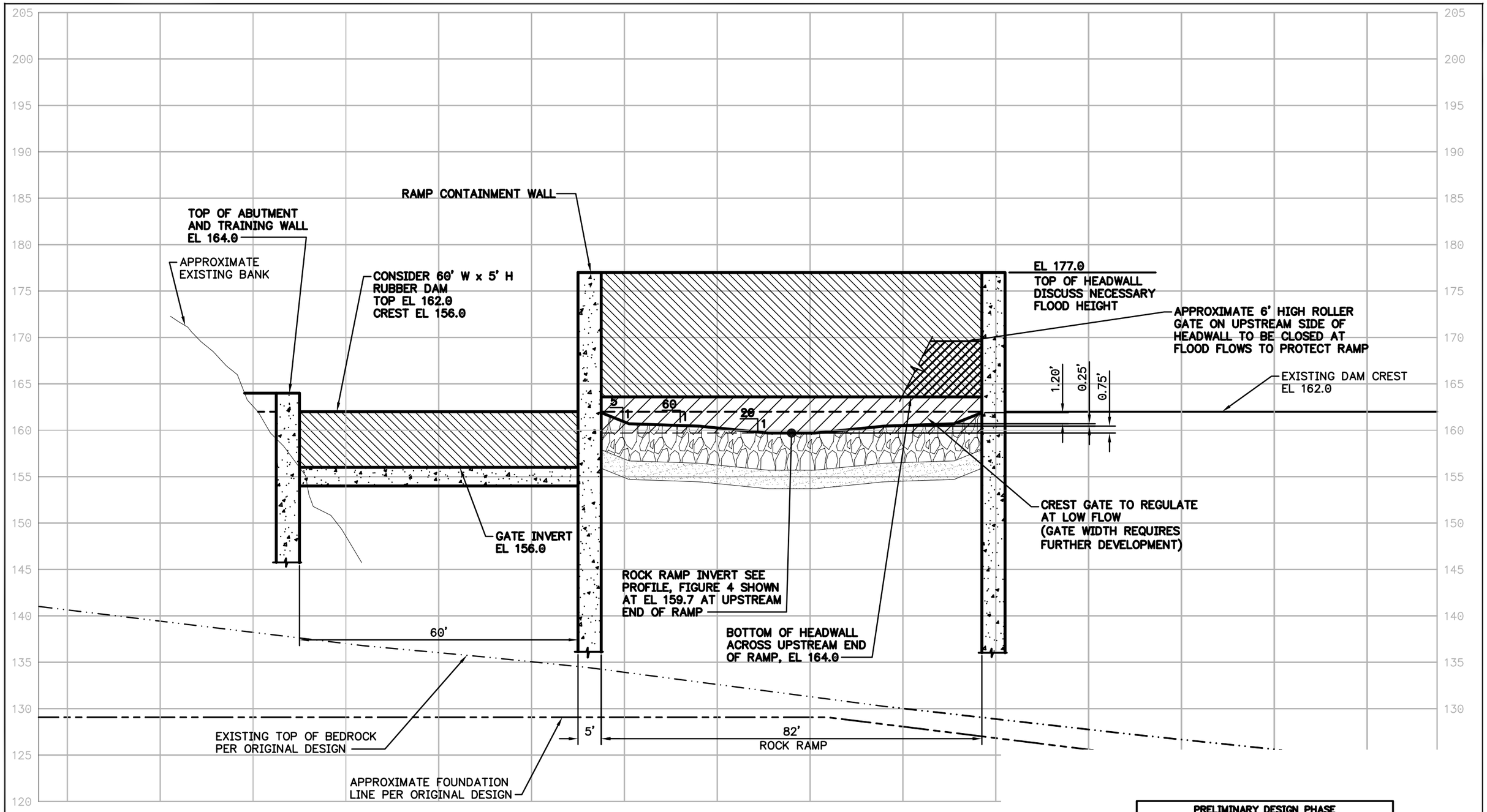
0 1"
BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

Resource Consultants, Inc.
REDMOND, WA 98052
PHONE: (425) 556–1288

VERN FREEMAN DIVERSION DAM
FISH PASSAGE PANEL

ALTERNATIVE 6A – PARTIAL WIDTH 4% ROCK RAMP ELEV VIEW OF DAM LOOKING DS

DATE: AUG 6, 2010
DRAWING: 6.3–5
REV: 1



NOTES:

1. WALL THICKNESS SHOWN FOR CONCEPT ONLY. WALL AND FOUNDATION DESIGN REQUIRE ADDITIONAL INFORMATION AND ANALYSIS.

SECTION C/2
TAKEN AT UPSTREAM FACE OF RAMP LOOKING DOWNSTREAM – EXAGGERATED SCALE

0 5 10
SCALE: 1" = 10'
VERTICAL SCALE

0 10 20
SCALE: 1" = 20'
HORIZONTAL SCALE

0 1"
BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

PRELIMINARY DESIGN PHASE

NOT FOR CONSTRUCTION

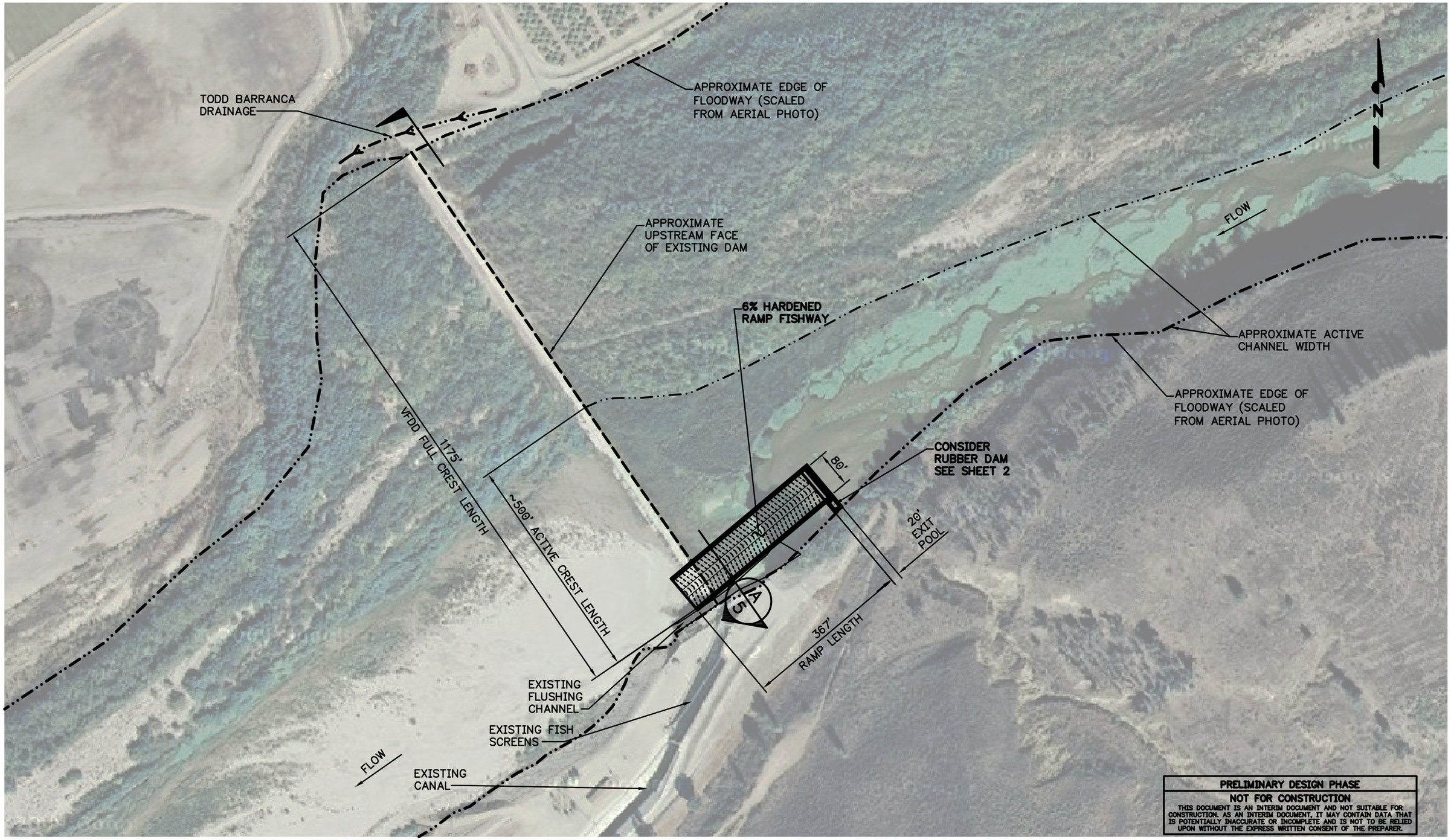
THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.

Resource Consultants, Inc.
REDMOND, WA 98052
PHONE: (425) 556-1288

VERN FREEMAN DIVERSION DAM
FISH PASSAGE PANEL

ALTERNATIVE 6A – PARTIAL WIDTH 4% ROCK RAMP SECTION AT RAMP HEADWORKS

DATE: AUG 6, 2010
DRAWING: 6.3–6
REV: 1



NOTES:

1. CONCEPT SHOWN IS PRELIMINARY, TO COMMUNICATE FUNCTIONAL INTENT OF ALTERNATIVE. ADDITIONAL REFINEMENT OF CONCEPT IS NEEDED FOR FLOOD PROTECTION, SLUICING AND GATE DESIGN, INCLUDING HYDRAULIC MODELING.
2. CONCEPT SHOWN PROVIDES FISH PASSAGE AT FLOWS FROM 50 TO OVER 6,000 CFS.

0 100 200
SCALE: 1" = 200'

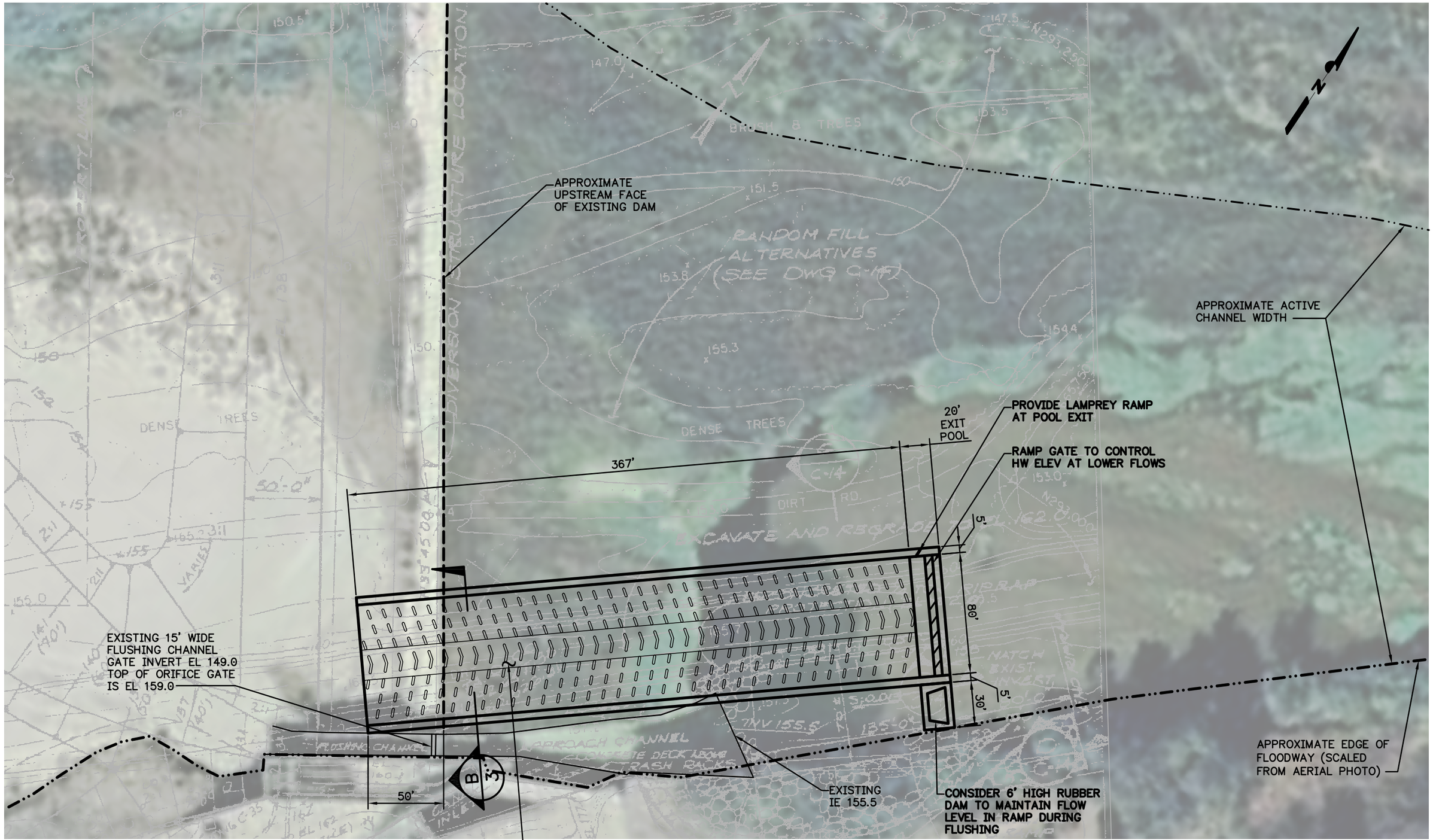
0 1"
BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

Resource Consultants, Inc.
REDMOND, WA 98052
PHONE: (425) 556-1288

VERN FREEMAN DIVERSION DAM
FISH PASSAGE PANEL

ALTERNATIVE 6B – PARTIAL WIDTH 6% HARDENED RAMP OVERALL SITE PLAN

DATE: AUG 6, 2010
DRAWING: 6.4–1
REV: 1



PRELIMINARY DESIGN PHASE

NOT FOR CONSTRUCTION

THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.

0 10 60

SCALE: 1" = 60'

0 1"

BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

Resource Consultants, Inc.
REDMOND, WA 98052
PHONE: (425) 556-1288

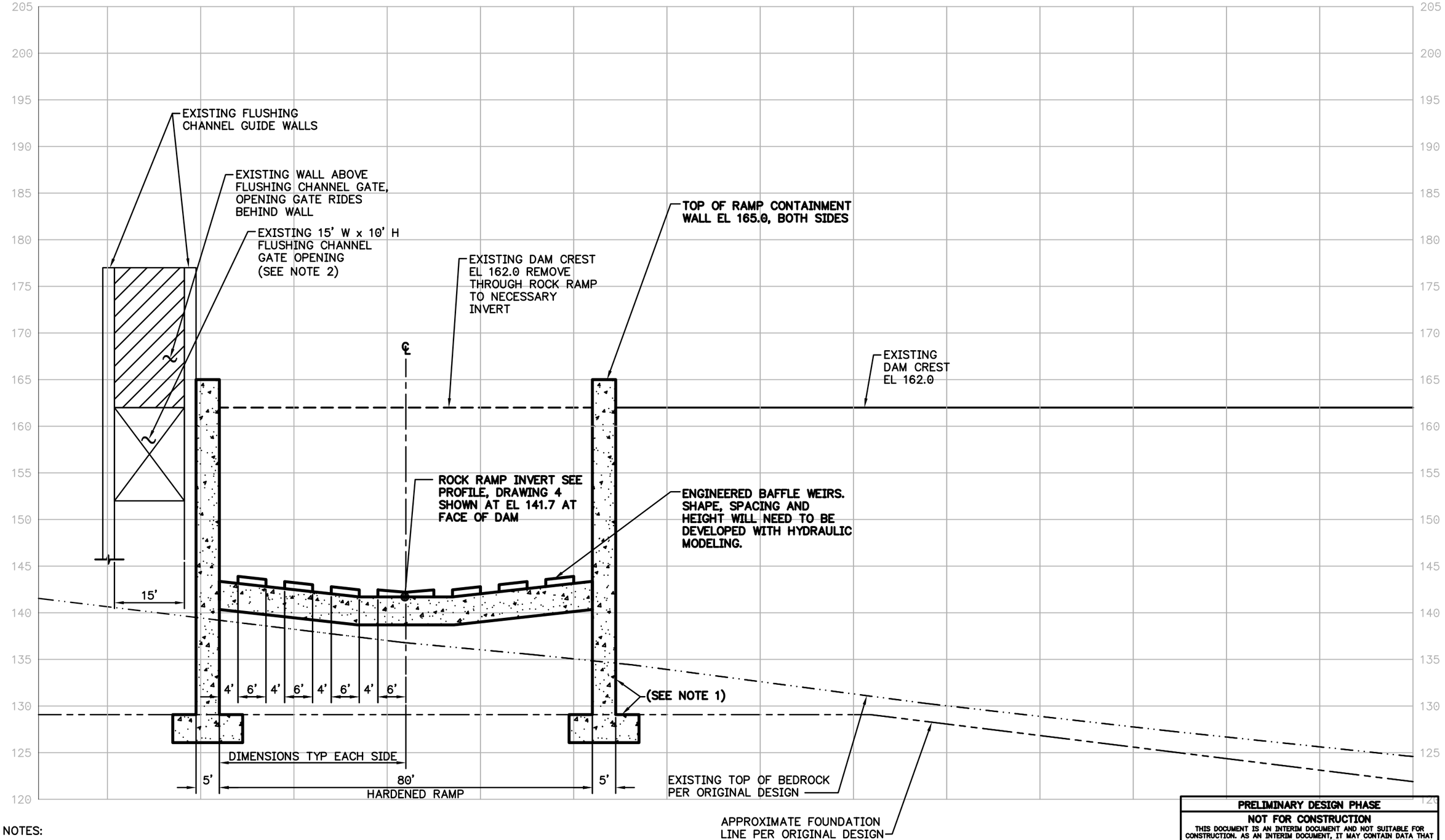
VERN FREEMAN DIVERSION DAM
FISH PASSAGE PANEL

ALTERNATIVE 6B – PARTIAL WIDTH 6% HARDENED RAMP SITE PLAN

DATE: AUG 6, 2010

DRAWING: 6.4–2

REV: 1



PRELIMINARY DESIGN PHASE

NOT FOR CONSTRUCTION

THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.

NOTES:

1. WALL THICKNESS SHOWN FOR CONCEPT ONLY. WALL AND FOUNDATION DESIGN REQUIRE ADDITIONAL INFORMATION AND ANALYSIS.
2. FLUSHING CHANNEL GATE CAPACITY AT POOL EL 162.0 APPROX. 2,700 CFS.

TYPICAL SECTION, HARDENED RAMP – EXAGGERATED SCALE (B/2)
TAKEN AT FACE OF DAM LOOKING DOWNSTREAM

0 5 10
SCALE: 1" = 10'
VERTICAL SCALE

0 10 20
SCALE: 1" = 20'
HORIZONTAL SCALE

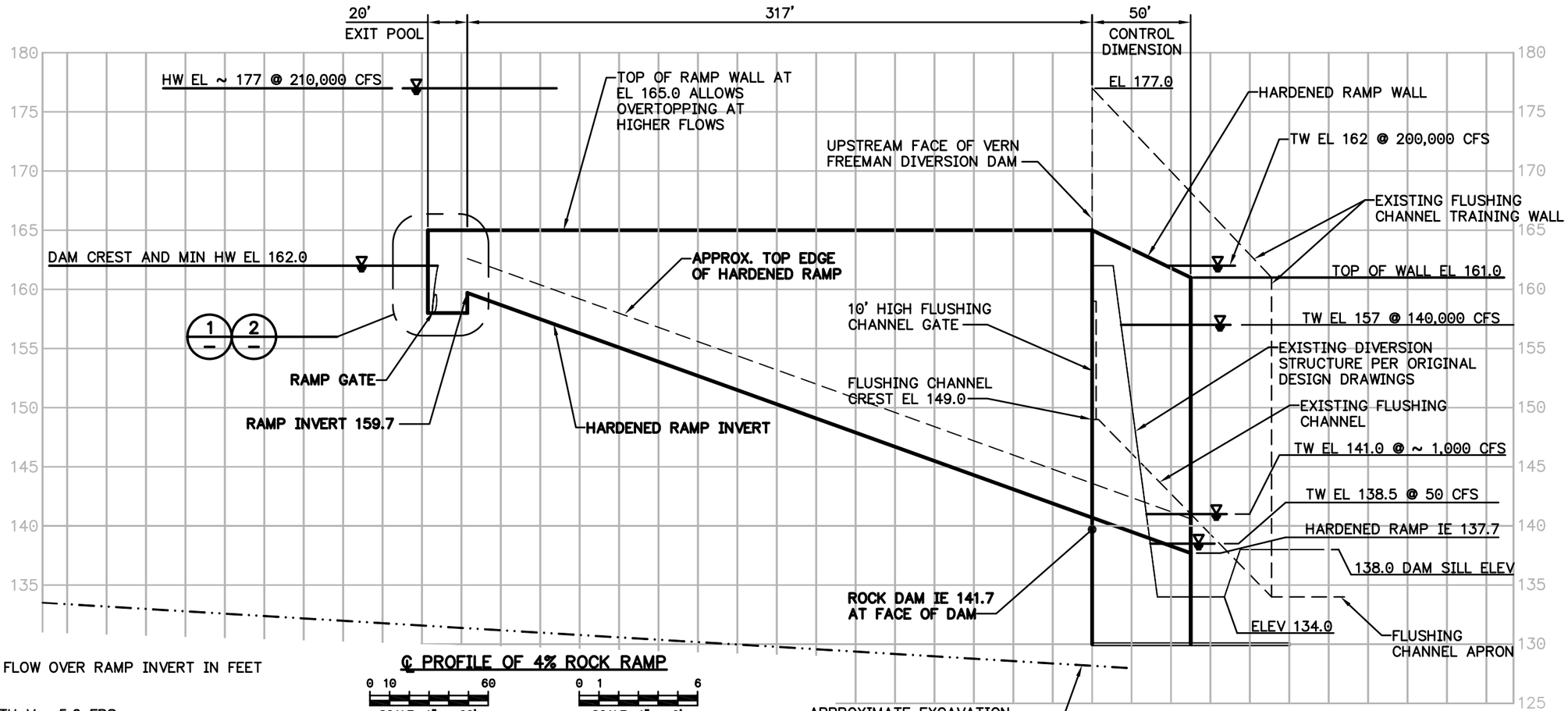
0 1"
BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

Resource Consultants, Inc.
REDMOND, WA 98052
PHONE: (425) 556-1288

VERN FREEMAN DIVERSION DAM
FISH PASSAGE PANEL

ALTERNATIVE 6B – PARTIAL WIDTH 6% HARDENED RAMP TYPICAL RAMP SECTION

DATE: AUG 6, 2010
DRAWING: 6.4–3
REV: 1



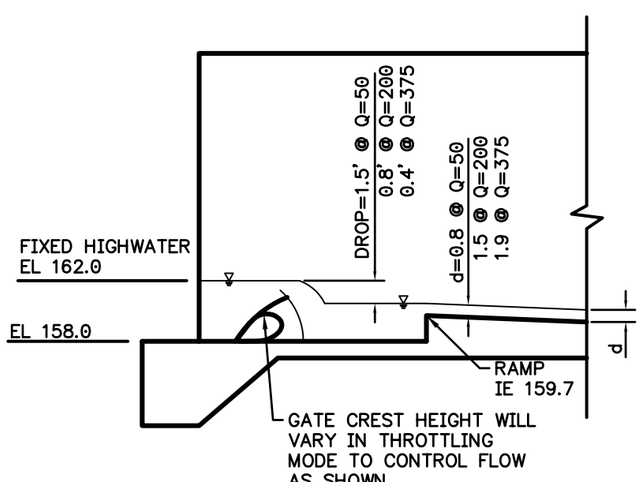
℄ PROFILE OF 4% ROCK RAMP

0 10 60
SCALE: 1" = 60'
HORIZONTAL SCALE

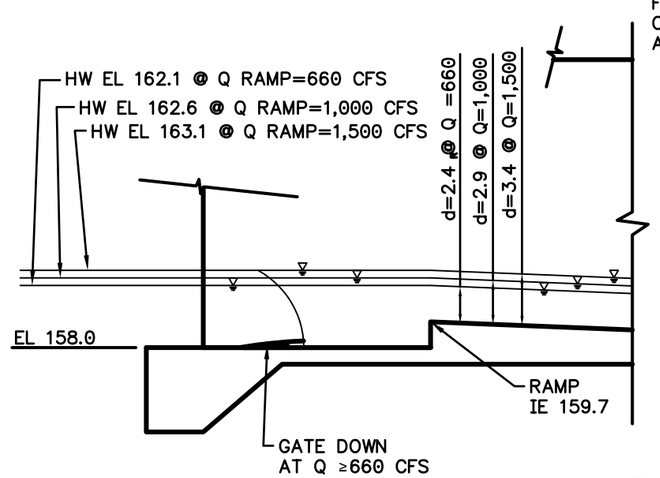
0 1 6
SCALE: 1" = 6'
VERTICAL SCALE

LEGEND

d – DENOTES DEPTH OF FLOW OVER RAMP INVERT IN FEET
HW – HEADWATER
TW – TAILWATER
PW – PASSAGE WIDTH, WITH V ≤ 5.6 FPS



DETAIL 1
HEADWORKS STRUCTURE SCHEMATIC
RAMP GATE CONTROLLING LOW FLOW (50 TO 660 CFS)
(NOT TO SCALE)



DETAIL 2
HEADWORKS STRUCTURE SCHEMATIC
RAMP GATE DOWN FOR Q ≥ 660 CFS
(NOT TO SCALE)

0 1"
BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

PRELIMINARY DESIGN PHASE
NOT FOR CONSTRUCTION
THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.

NOTES:

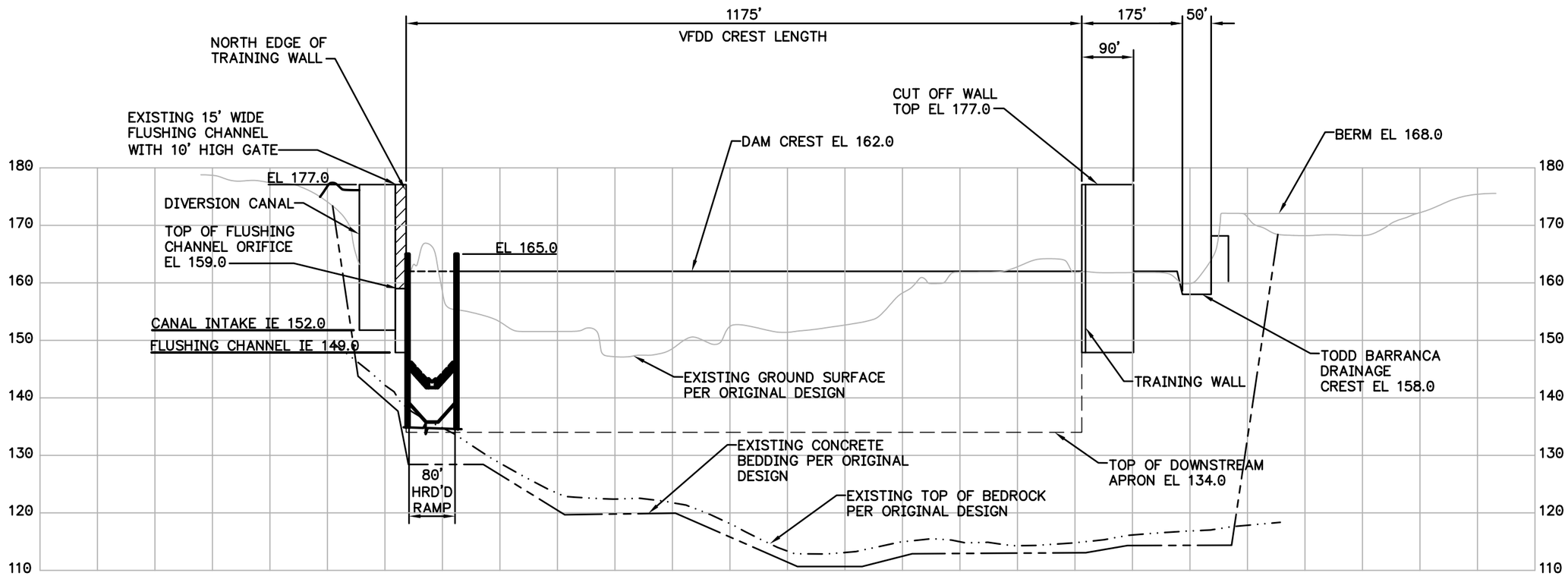
1. LOCATION SET WITH HARDENED RAMP ENTRANCE 50' DOWNSTREAM OF FACE OF DAM.
2. BEDROCK ELEVATIONS PROVIDED FROM ORIGINAL DESIGN PLANS, BEDROCK TILTS APPROXIMATELY 1 TO 2% UPSTREAM AS SHOWN, PER 1987 BORING DATA, ADDITIONAL INFO NEEDED.
3. FOUNDATIONS NOT SHOWN, ADDITIONAL ENGINEERING WILL BE REQUIRED FOR THIS ALTERNATIVE.
4. RAMP HYDRAULIC DESIGN AND CONTROL GATE NEEDS FURTHER DEVELOPMENT IN CONJUNCTION WITH FLOOD GATE AND HYDRAULIC MODELING.
5. WATER SURFACE ELEVATIONS ARE ESTIMATES AND CAN BE DETERMINED THROUGH MODELING.

Resource Consultants, Inc.
REDMOND, WA 98052
PHONE: (425) 556-1288

VERN FREEMAN DIVERSION DAM
FISH PASSAGE PANEL

ALTERNATIVE 6B – PARTIAL WIDTH 6% HARDENED RAMP PROFILE

DATE: AUG 6, 2010
DRAWING: 6.4–4
REV: 1



SECTION VIEW AT UPSTREAM FACE OF DAM – ALTERNATIVE 6B (A/1)

0 100 200
SCALE: 1" = 200'
HORIZONTAL SCALE

0 10 20
SCALE: 1" = 20'
VERTICAL SCALE

NOTES:

1. DAM FEATURES, EXISTING GROUND AND FOUNDATION DATA FROM DAMES & MOORE DESIGN DRAWINGS DATED 2/6/89 (ADDENDUM 3), SHEET C–1.
2. FOUNDATIONS FOR ROCK RAMP WALLS AND GATE WALLS NOT SHOWN.

PRELIMINARY DESIGN PHASE

NOT FOR CONSTRUCTION

THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.

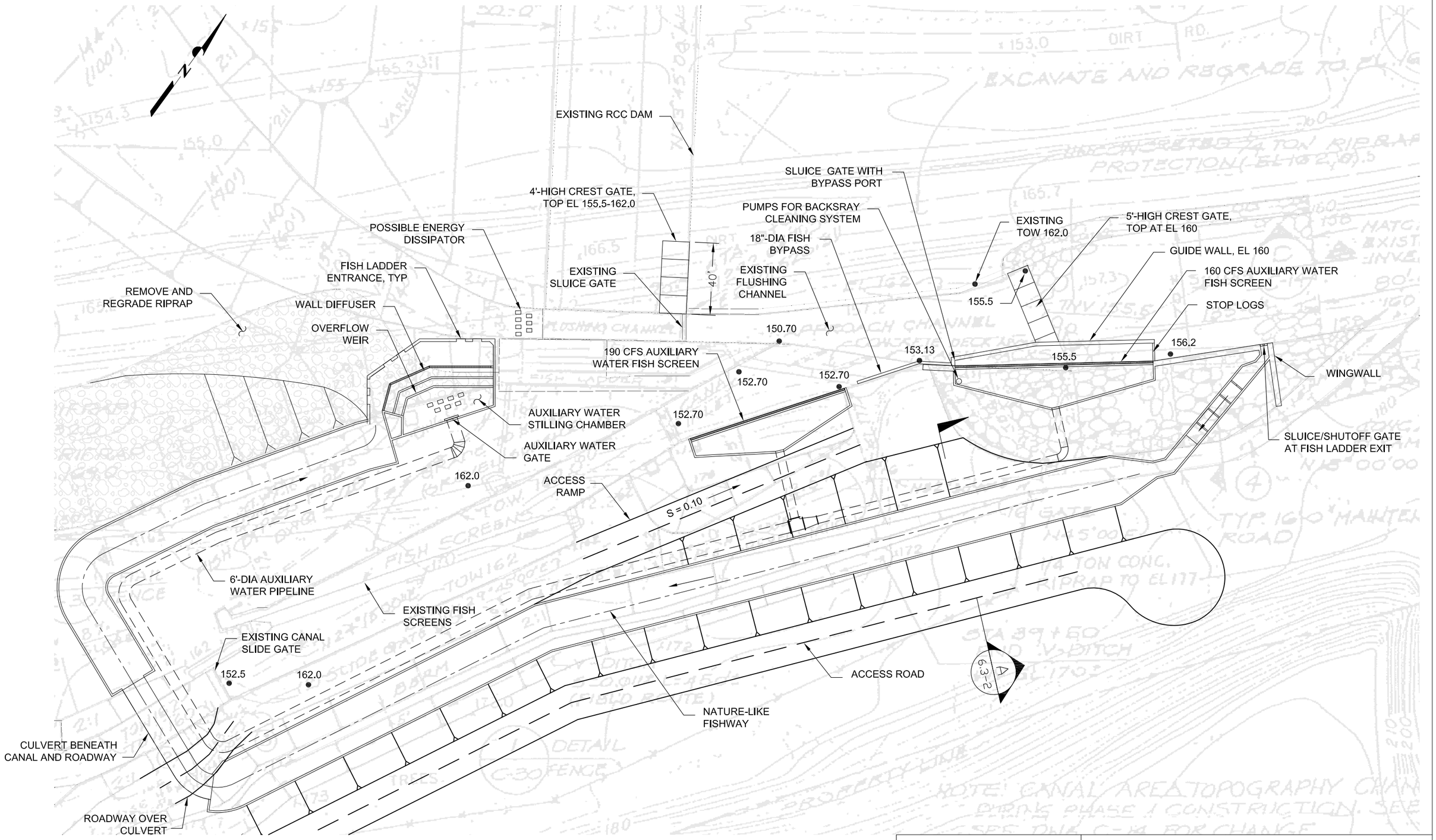
0 1"
BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

Resource Consultants, Inc.
REDMOND, WA 98052
PHONE: (425) 556–1288

VERN FREEMAN DIVERSION DAM
FISH PASSAGE PANEL

ALTERNATIVE 6B – PARTIAL WIDTH 6% HARDENED RAMP ELEV VIEW OF DAM LOOKING DS

DATE: AUG 6, 2010
DRAWING: 6.4–5
REV: 1



NOTES:
1. ALL ELEVATION CALLOUTS ARE EXISTING.
2. SEE DRAWING 6.2-3 FOR INTAKE SCREEN ELEVATIONS.

PRELIMINARY DESIGN PHASE

NOT FOR CONSTRUCTION

This document is an interim document and not suitable for construction. As an interim document, it may contain data that is potentially inaccurate or incomplete and is not to be relied upon without the express written consent of the preparer.

0 25 50
SCALE: 1" = 50'

0 1"
BAR MEASURES ONE INCH ON ORIGINAL DRAWINGS

MWH

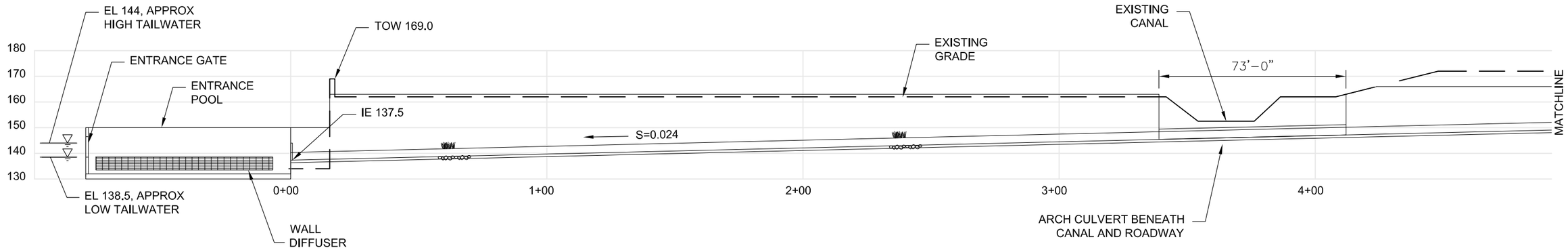
VERN FREEMAN DIVERSION DAM
FISH PASSAGE IMPROVEMENTS PANEL

ALTERNATIVE 8 -
NATURE-LIKE FISHWAY
PLAN

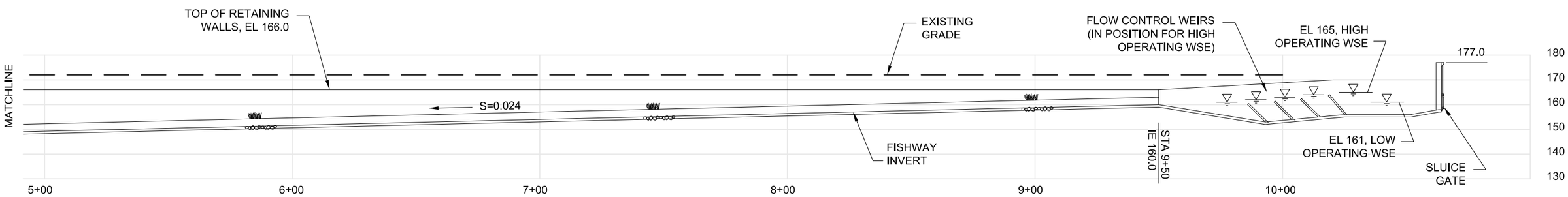
DATE: SEPT 3, 2010

DRAWING: 6.5-1

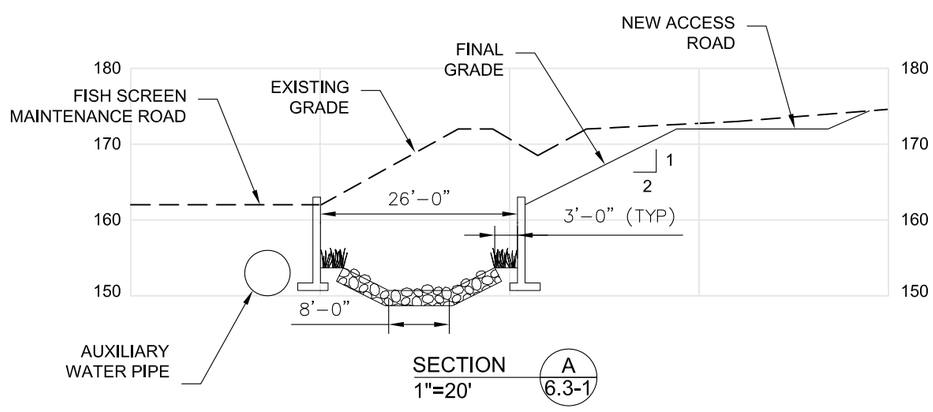
REV: -



NATURE-LIKE FISHWAY PROFILE - DOWNSTREAM
1"=40'



NATURE-LIKE FISHWAY PROFILE - UPSTREAM
1"=40'



SECTION A 6.3-1
1"=20'

PRELIMINARY DESIGN PHASE

NOT FOR CONSTRUCTION

This document is an interim document and not suitable for construction. As an interim document, it may contain data that is potentially inaccurate or incomplete and is not to be relied upon without the express written consent of the preparer.

0 1"
BAR MEASURES ONE INCH
ON ORIGINAL DRAWINGS

MWH

VERN FREEMAN DIVERSION DAM
FISH PASSAGE IMPROVEMENTS PANEL

ALTERNATIVE 8 -
NATURE-LIKE FISHWAY
PROFILE AND SECTION

DATE: JULY 22, 2010
DRAWING: 6.5-2
REV: -

APPENDIX A

Correspondence

This page intentionally blank.

Appendix A – Correspondence Index

Date	From	To	Subject
August 20, 2010	Rodney R. McInnis U.S. Department of Commerce, NOAA, NMFS	Dr. Terry Roelofs	NMFS Comments on Draft VFDD Fish Passage Conceptual Design Report.
August 19, 2010	Catherine McCalvin United Water Conservation District	Dr. Terry Roelofs	UWCD Comments on Draft VFDD Fish Passage Conceptual Design Report.
June 23, 2010	Chris E. Yates U.S. Department of Commerce, NOAA, NMFS	Dr. Terry Roelofs	No subject line – Design flow commentary, ESA considerations for alternatives, upper and lower design flow recommendations for Operative Standard.
June 22, 2010	U.S. District Court for the Central District of California		Order modifying release date of Fish Panel report stated in Settlement Agreement from August 1, 2010 to September 15, 2010.
June 9, 2010	Steven R. Howard United Water Conservation District	Nica Knite, California Trout	Monthly Update Regarding Compliance with Paragraph C (1) of the Settlement Agreement between California Trout and United Water Conservation District.
May 7, 2010	Rodney R. McInnis U.S. Department of Commerce, NOAA, NMFS	Dr. Terry Roelofs	No subject line – Clarify misunderstanding related to 2/25/10 NMFS letter. Reiterate importance of weighting review of each alternative by ability to promote meaningful fish-passage window over range of flow magnitudes and durations. Request that alternatives analysis consider how operation of VFDD affects performance of any alternative under consideration.
February 25, 2010	Chris E. Yates U.S. Department of Commerce, NOAA, NMFS	Dr. Terry Roelofs	No subject line – NMFS comments on Alternative Development Status Report prepared by the Fish Panel. Dated February 3, 2010.
February 23, 2010	E. Michael Solomon United Water Conservation District	Dr. Terry Roelofs	UWCD Comments on Freeman Fish Passage Panel Memo Dated 02-03-10 “Brainstorm Workshop and Alternative Development Status Report.”
December 16, 2009	E. Michael Solomon United Water Conservation District	Dr. Terry Roelofs and VFD Fish Passage Panel	Memorandum – Comments on the flow guidelines by NMFS for the Fish Panel.

Date	From	To	Subject
November 16, 2009	Rodney R. McInnis U.S. Department of Commerce, NOAA, NMFS	Michael Solomon	No subject line – NMFS comments on recommended process by panel to develop long-term passage improvements for endangered steelhead, NMFS recommendation for upper and lower passage-design flows.
June 10, 2009	Rodney R. McInnis U.S. Department of Commerce, NOAA, NMFS	Michael Solomon	No subject line – NMFS concerns with proposed process to guide identification of improvements for the fish-passage facility at VFDD.
March 13, 2009	E. Michael Solomon United Water Conservation District	Dr. Terry Roelofs	No subject line – Court Order approving the stipulation between the District and CalTrout.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802- 4213

August 20, 2010

In response, refer to:
2010/04053

Terry Roelofs, Ph.D.
120 Pacific Lumber Camp Road
Freshwater, California 95503

Dear Dr. Roelofs:

NOAA's National Marine Fisheries Service (NMFS) hereby extends general comments on the Panel's draft Vern Freeman Fish Passage Conceptual Design Report (draft report). Specific comments are presented in the spreadsheet matrix, which is attached to this letter. The general and specific comments are decidedly not exhaustive, but instead focus on a few key topics that warrant mention at this time.

The Panel's findings corroborate available evidence that the existing fish-passage facility at the Vern Freeman Diversion Dam (diversion dam), including the fish ladder, is not an adequate system for passage of endangered steelhead (*Oncorhynchus mykiss*). The findings bring an end to several years of disagreement regarding the adequacy of the existing facility and, perhaps more importantly, identify alternatives for improving passage conditions for endangered steelhead. In reviewing the features of each alternative, and based on knowledge of regional steelhead behavior and ecology, river dynamics and sediment transport, NMFS expects that either of the two ramp alternatives would represent the superior alternative, that is the alternative that would be consistent with the intent of the Panel's design standard to promote or approximate unimpeded passage conditions for endangered steelhead over a broad range of flows, including high flows. Comment 1

There are clear advantages to the capabilities of the partial-width rock ramp and hardened ramp. Chief among these involve the degree of attraction that would be provided over a wide range of flows and, based on NMFS' interpretation of the alternatives, the magnitude and duration of the fish-passage window. As described more fully in the Panel's draft report, with the exception of the dam-removal alternative, the other alternatives are not capable of promoting a similar degree of attraction flow or magnitude and duration of fish-passage window. As stated in previous NMFS correspondence, the capability of an alternative to promote or approximate unimpeded passage conditions for endangered steelhead is particularly relevant to the current proceedings given requirements of the U.S. Endangered Species Act (ESA) and United Water Conservation District's (United) stated intention of operating the diversion dam in compliance with Section 10(a)(1)(B) of the ESA.

By contrast, the nature-like fishway and vertical slot fishway alternatives do not seem well suited to allow reasonable attainment of the design standard, especially when one considers attraction to the fishway entrance. Capabilities of these two alternatives for producing attraction flows are limited in terms of magnitude, relative to the ramp alternatives. Flow from sources other than the fishway entrance (e.g., sluice-gate releases or crest-gate flows) have the potential to mask detection of the entrance, particularly during periods of elevated flows when adult steelhead are expected to be migrating. The limited attraction capabilities and potential for masking detection of the fishway entrance are features of the existing fish-passage facility and should be avoided as United moves forward with remediating the existing effects of the diversion dam on passage conditions for endangered steelhead. Comment 2

The partial-width rock ramp and hardened ramp alternatives appear capable of harmonizing the pattern and magnitude of discharges characteristic of "wet" water-year types in the Santa Clara River and the migratory behavior and ecology of endangered steelhead. While the Santa Clara River is generally flashy, during periods of persistent or heavy rainfall, runoff in the river can remain elevated (e.g., in excess of 3,000 cfs) and exhibit a protracted rate of decline on the falling limb of the hydrograph, as review of the historical hydrologic record indicates. Such events are not infrequent and produce migration opportunities for endangered steelhead in the lower river. As a result, the selected alternative must be capable of providing passage of endangered steelhead over a broad range of flows, particularly high flows.

The ecological function and value of moderately high flows (e.g., 2,000 to 6,000) for passage of steelhead through the lower Santa Clara River appear to have been underestimated in the methods that are the basis of the draft report. The draft report appears to place emphasis on flows of 2,000 cfs or less, and the weights assigned to the design flows are skewed toward the lower-range flows. These features have the potential to allocate greater weight to alternatives that operate at the lower flow range rather than the moderately high flow range. This is counterintuitive because, in part, the discussion during the meeting of August 9, 2010, lead NMFS to believe that the Panel recognizes the importance of the moderately higher flows to the migratory behavior and ecology of steelhead in southern California. Allocating a proper balance (weighting) to the flow categories, in particular the moderately high flows, would more accurately represent the function and value of the flow categories to steelhead migration and potentially increase distinction among the alternatives. In this regard, NMFS recommends that a weight of 10, rather than 6, be assigned to the moderately high flow category. Comment 3

It is NMFS' intention that the selected alternative must be capable of meeting the life history and migratory requirements of juvenile migrants as well as adults. Accordingly, the final report should include a more thorough comparison of the capabilities of the partial-width rock ramp and hardened ramp to facilitate passage of juvenile steelhead. Comment 4

While NMFS appreciates the willingness of the Panel to specify a new design standard, the subject standard was defined after the Panel had scored each alternative in the Pugh matrix. As described in the draft report, this new standard includes two important criteria: (1) promoting or approximating unimpeded passage conditions for adult steelhead in the lower Santa Clara River, and (2) a steelhead-passage window (i.e., fish-passage design flow) of 45 to at least 6,000 cfs. Given the implications of these specific criteria, applying the new design standard as a basis to evaluate the alternatives has the potential to change the final scores for each alternative, perhaps altering the final recommendations of the Panel. Comment 5

Thank you for the opportunity to comment on the draft report. NMFS greatly appreciates the efforts of the Panel for appraising the performance of the existing fish-passage facility, and identifying alternatives for improving passage conditions for endangered steelhead in the lower Santa Clara River.

Please contact Darren Brumback at (562) 908-4060 if you have a question regarding these comments or if you would like additional information.

Sincerely,

Rodney R McInnis

Rodney R. McInnis
Regional Administrator

Attachment

cc: Mike Solomon, United Water Conservation District
Nica Knite, California Trout
Mary Larson, California Department of Fish and Game
Roger Root, U.S. Fish and Wildlife Service
Copy to: 151422SWR2008PR00506

This page intentionally blank.

NOAA's National Marine Fisheries Service comments on Panel's draft Vern Freeman Fish Passage Conceptual Design Report

NMFS	Fig 2.2-1	Page 2-9	It is stated that the, "downstream bypass flows will vary depending on percolation rates below the dam". What data were used in this analysis?
NMFS	Fig 2.2-2	Page 2-10	How will sediment management change with the various alternatives? For instance, under current operations, the fish ladder is not operated when the turbidity is > 3,000 ntu - will this operation criteria remain?
NMFS		Page 3-1	What is the scientific basis for the statement that during dry water years, "Inconsequential or significant migratory delay at VFDD might make little difference to annual spawning success"?
NMFS		Page 3-1	An explicit statement should be made regarding how the range, or window of spawning stream flows derived from the Ascendograph analysis, was used in evaluating fish passage opportunities at VFDD.
NMFS	Fig 3.1-1	Page 3-2	At present, stream flow is labeled on a secondary y-axis but no datum is shown, which is a bit confusing. If the shaded curve is the stream flow then perhaps make it darker (or add a dotted pattern to the fill) to make it stand out a bit more.
NMFS		Page 3-3	What criteria are used to determine the success of egg incubation, fry emergence, intra-gravel oxygen flow and energy expenditure? Is it simply the flow depth or magnitude at a point in the watershed? If so, this should be stated explicitly, as well as a discussion of how such simplifying assumptions influence the overall interpretation of the results.
NMFS		Page 3-4	It is our understanding that the model would initially be developed with a single end location and that additional runs would be completed to test the sensitivity of the results. Have additional analyses been carried out and if so, will they be included in the final report? One concern is how to interpret results from the ascendograph analysis, which were drawn from a location ~60 miles from the Ocean, at which point there may have been other suitable spawning locations that were bypassed.
NMFS	Sec 3.2-2	Page 3-6	How were the input parameters for the ascendograph developed? Presumably these values were derived from the literature but no references are cited in this section.
NMFS		Page 3-15	What was the reason that the SLOW migration had more successful migration days in 3/4 of the Water Years (WY 2001,2003 and 2006) in comparison to the FAST migration scenario? This seemed counterintuitive.
NMFS	Fig 3.2-9	Page 3-18	How were the passage flow barriers determined?
NMFS		General Ascendograph Comments	Overall, the ascendograph method is an innovative approach to assessing migration delay and the spawning risk associated with fish passage issues at VFFD. These are both poorly understood processes in the Santa Clara River (and elsewhere) and the ascendograph offers a first-cut at establishing the importance of both spawning risk and migration delay at VFDD. As stated previously, NMFS has certain reservations regarding the interpretation of the results, primarily related to several assumptions and the fact that only a single run was completed over the year that the Panel conducted their analysis. If the results were to be used in determining a meaningful flow range, a more rigorous sensitivity analysis should be completed. Without additional scenarios the overall results and the error associated with various assumptions remain difficult to interpret.

NMFS	Section 4.2	Page 4-3	It is stated that, "'The 95% mean daily exceedance flow during the fish migration period (January to May) is approximately 50 cfs…". We do not have issue with a flow of ~50 cfs as the lower design flow but were curious what gage data were used in this calculation? USGS at Montalvo?
NMFS	Table 4.2-1	Page 4-4	How was a weighting of 6 determined for the mid-high flow range?
NMFS	Table 4.2-1	Page 4-4	How were the flow range categories (i.e. low, mid-low, mid-high and high flow) developed? It appears that they were derived via a combination of flow exceedance analyses, consideration of fishway flows and the ascendograph analyses, though a more explicit description of the methods used in this analysis is warranted.
NMFS	Section 7.1.5	Page 7-6	Is there any more information on how the alternatives performed in terms of safety for juvenile fish? As it stands now, the section is fairly brief.
NMFS	Sec. 6.3	Page 6-17	Quantify and/or qualify the statement "the rock ramp would need to be closed to high flows to protect substrate". What river discharge is considered high flow, as referenced? The statement indicates the rock ramp would be closed and not function as fish passage under such flows, yet Table 6.3-1 suggests it will be operational up to 18,900 cfs. Subsequent text further suggests that flows will be managed/maintained at 1,500 cfs or less in the rock ramp to protect substrate.
NMFS	Sec. 6.3.2	Page 6-23	Reference or define "when fish passage is not required" in context with this paragraph.
NMFS	Sec. 6.4.1.1	Page 6-31	The last sentence of the first paragraph states that fish passage is not required when flows are greater than 6,000 cfs. This statement is not consistant with the Design Standard (Page 1-2) and appears to mischaracterize the design flow categories, where flows greater than 6,000 cfs may be considered less critical for design criteria/performance due to frequency of occurrence, but not excluded. Please delete "when fish passage is not required".
NMFS	Sec. 7.1.1	Page 7-1	For text and Table 7.1-1, see above comments to Table 4.2-1
NMFS	Table 7.5	Page 7-9	Table 7.5-1 *Summary of Key Characteristics for each Alternative* presents Fish attraction at high flows, but does not include the other flow categories.
NMFS	Table 7.5	Page 7-10	Table 7.5-1: This Table does not include all Characteristics used in Comparison Matrix ((Table 7.6-1). While the title suggests this table may only summarize the "key" characteristics, lower weighted characterisitcs (Attraction and passage of non-target species - 3) are discussed, yet higher weighted characteristics (Fish attraction categories - 10) are not.
NMFS	Sec. 7.6	Page 7-12	Reference to Table 7.1-2 should be Table 7.6-1.
NMFS	Table 7.6-1	Page 7-14	Simplicity of fish passage operations: As briefly discussed during the August 9 meeting and upon further review of the draft report, the relative high scoring of the Vertical Slot Ladder does not appear reflective of the overall complexity of this alternative or consistent with the description of this characteristic provided on page 7-7.
NMFS	Sec. 9	Page 9-1	The statement in reference to dam removal, "It would be a long-term project and could not likely be accomplished in a time frame necessary for recovery of steelhead" should be deleted. The time frame for recovering endangered southern California steelhead has not, and likely cannot, be accurately predicted at this time.

From: Terry Roelofs [mailto:troelofs@reninet.com]
Sent: Thursday, August 19, 2010 2:59 PM
To: kozmo@aquakoz.com; Dennis.E.Dorratcague@us.mwhglobal.com; jonathon.mann@hdrinc.com; dpostlewait@r2usa.com; Bill@mcbaintrush.com; Steve.Thomas@noaa.gov; bill.trush@gmail.com
Subject: Fwd: comments on report

Greetings All:

United Water's comments - expect to get NMFS tomorrow or later today, CalTrout on Tuesday.

Terry

From: Catherine McCalvin <cmccalvin@unitedwater.org>
To: Terry Roelofs <troelofs@reninet.com>
CC: Mike Solomon <msolomon@unitedwater.org>, Steve Howard <steveh@unitedwater.org>, John Dickenson <johnd@unitedwater.org>, Murray McEachron <murraym@unitedwater.org>, Linda Purpus <lindap@unitedwater.org>, Jim Kentosh <jimk@unitedwater.org>
Date: Thu, 19 Aug 2010 09:33:12 -0700
Subject: comments on report

Hi Terry,

Attached is the spreadsheet with UWCD's comments.

Feel free to contact me if you have any questions.

Catherine

Catherine McCalvin
Lead Environmental Scientist
United Water Conservation District
106 N 8th Street, Santa Paula, CA 93060
(805) 525-0621, ext 133

This page intentionally blank.

UWCD Comments on
Draft VFDD Fish Passage Conceptual Design Report
(dated August 19, 2010)

Comment By	Document Section (Para #)	Context (or Paragraph#, Sentence#)	Comment	Suggested text
UWCD	1.2	Last paragraph before "Design Standard" section	Because the settlement agreement refers to the "operative standard", United prefers that the report continue to use that terminology.	..."operative standard"...is equivalent to "design standard"...
UWCD	1.2	1st paragraph of "Design Standard" section	"...success of steelhead trout in the Santa Clara River that equals or approaches unimpeded migration rates through the river corridor."	Replace "through the river corridor" with "past the Freeman Diversion Dam."
UWCD	2.1.2 (page 2-8)	last paragraph on page 2-8	The Santa Clara River bed had been degrading since at least the mid-1950s. This was caused by a combination of artificial channelization and in-river mining activities. Halting degradation above the diversion was one of two primary project goals (the other being harvesting additional yields to combat groundwater overdraft). UWCD backfilled the upstream area up to the crest of the dam in order to both eliminate beach erosion concerns and California Division of Safety of Dams jurisdiction.	
UWCD	2.2 (page 2-9)	first paragraph on page 2-9, Typo	"They typically turn out is for eight..."	Typically, the diversion is turned out for...
UWCD	Sec. 3	General	The ascendograph uses the upper Sespe as the targeted spawning site. The documentation of steelhead at this site is very sparse if at all. How do the final results compare when using a site much closer to the ocean that has a much better recorded history of Steelhead for example the Santa Paula Creek site. A paragraph summarizing how a closer site may affect your results would be helpful. Additionally what would happen if it was even further away and less assessable due to a flashier system like Piru Creek?	
UWCD	Sec. 3	general	We understand that many of the components that went into the model were based on the panels personal expertise and knowledge. It would be helpful to refrence all the assumptions made to a study or as personel estimate.	
UWCD	3.2.2	A 50-day Egg Incubation Period	A 30-day egg incubation period. The ascendograph used conservative values for the variables used in the model. It would be interesting to see what a 30 day incubation period would look like. Santa Clara River temperatures are higher than what would be considered for 50 day incubation.	N/A
UWCD	3.2.3 (page 3-19)	general	Scenario # 2 assumes if fish encounters flows in excess of the design flow, it would expire in 3 to 5 days. This is problematic because the scenario allows for fish to move into the system at high flows (in excess of 12,000 cfs) when in reality fish are likely not entering the system then. Page 6-33 of the draft report even states that "During high flows (greater than 12,000cfs) steelhead are likely not actively moving upstream ....." In combination, these conditions inflate the number of unsuccessful fish at the dam than what would occur in reality.	If the panel feels that migration halts at elevated flows then either the model run scenario # 2 should clarify the results to state that the delay values are over estimated due to the natural delays in the river or a model run could be done with fish migration halting on their own in natural conditions and then progressing when those flows have subsided.
UWCD	3.2.4 (Page 3-26)		The conclusions drawn here need to consider the unique geology and the historical information of this section of the river (forebay). Historical accounts stated that in the summer the forebay would dry up, leaving a dry a barren floodplain. It had no riparian corridor due to the natural percolation in the river with or without pumping. Currently and probably historically 50 cfs thins out to flow only a couple of inches deep in this reach. If the panel wishes to keep this section in the report, we would be glad to share all of our historical documentation, geological reports, pumping data, historical percolation studies and modeling results that discuss this section of the river.	
UWCD	Figure 3.2-1		It's hard to distinguish between red and orange on the map	

UWCD Comments on
Draft VFDD Fish Passage Conceptual Design Report
(dated August 19, 2010)

Comment By	Document Section (Para #)	Context (or Paragraph#, Sentence#)	Comment	Suggested text
UWCD	Fig. 3.2.7 and 3.2.8	Graphs	The graphs show the total successful days based on the "Fast Migration Baseline" and the "Slow Migration Baseline" The results show that a fish in 2003 would be more successful at the slow migration rates than the faster migration rates. If correct, please provide and explanation why.	
UWCD	6.1	last paragraph on page 6-1	"Dam removal will result in channel stability…"	Dam removal more likely will result in channel instability at least for some period
UWCD	6.1	general	Issues which are understandably beyond the Panel's scope are real. The social and water management challenges with the dam removal option cannot be overstated. Adding some numbers may help provide some perspective on why this alternative is complicated from a water supply angle.	United has diverted an average of 78,000 AF per year since the diversion was built in 1991. During this time Lake Piru has provided an average annual available storage of 29,000 AF. More than half of this water is delivered to the upper basins leaving the Freeman Diversion with about 15,000 AF on average. This would represent an 80% loss in diversions to an already over drafted basin. Additionally water reliability would go down because the diversions could no longer rely on the upper basins drainage via rising groundwater during the droughts. The diverted yield from the Santa Clara (non-Piru) watershed helps support the water needs of a population of over 200,000 and a globally important agricultural resource which produces $1B in annual economic benefit.
UWCD	6.1 (page 6-2)	"advantages" bullets 2&3	As mentioned in the disadvantages, the head cutting could be a problem with bank erosion and other morphology changes, this head cutting may also create or make worse current barriers in Santa Paul Creek and as far up as the Sespe. Additionally the channel has been confined throughout the river. This constriction would likely not allow the river to ever re-stabilize to its historic conditions.	Delete both items and/ or include also in "disadvantages"
UWCD	6.1 (page 6-2)	"disadvantages" bullet 4	Head cutting will have very serious consequences, and it is very unlikely that the river would regrade to pre-dam conditions. Pre-dam riverbed conditions were seriously unstable and that the river has been channelized with only a fraction of its ancestral flood plain remaining. Head cutting would very likely extend to the next upstream hardened features and result in relocating the passage issues to Santa Paula and Sespe Creek(s). The process of extending head cutting will have significant impacts of the riparian habitats.	Delete "Over the long term…"
UWCD	6.1 (page 6-3)	last paragraph says"...fish passage at VFDD costs more than a dam removal…	The statement regarding relative costs is not necessary.	Delete sentence.
UWCD	6.2.1.2 (3rd paragraph)	"The ladder goes through the existing retaining wall…"	Elsewhere it is indicated that this wall is to be removed.	The ladder goes through the location of the existing retaining wall.
UWCD	6.2.2.5	Typo at end of 2nd paragraph	"…as it is currently."	…currently done.
UWCD	6.3.1.3	Question(s)	Is an 82 ft. wide roller gate being suggested? Or would there be a series of bays?	

UWCD Comments on
Draft VFDD Fish Passage Conceptual Design Report
(dated August 19, 2010)

Comment By	Document Section (Para #)	Context (or Paragraph#, Sentence#)	Comment	Suggested text
UWCD	6.3.2.2	last paragraph states "…operated continuously throughout the fish passage season…"	Continuous seasonal operation is not practical. Natural passage opportunities often only occur in separate pulses separated by low flow periods.There will likely be many years that the ladder will be shut off between upstream migration events, and when we are no longer able to maintain a suitable migration corridor for smolts. Many years, this may be during the peak of the smolt migration season. The panel should evaluate this project expecting that the ladder will be shut off during these times.	
UWCD	6.3.3.1	first paragraph - Materials Required	Local rock is presently available, but it is of low density (Caltrans standards typically need to be waived to accept local rock.) Other high density sources must come from the far side of Los Angeles County.	
UWCD	6.2.3.2	1st paragraph states "…sandstone bedrock layer…"	Bedrock at the site(s) is soft siltsone.	
UWCD	6.4.1.1	2nd to last paragraph states "…river flows greater than 6000 cfs…"	Delete "…when fish passage is not required."	Consider instead adding "The effects on passage at higher flows in unknown."
UWCD	6.4.2.2		Discussion of fall-back in ramp alternatives appears more rigorous than the same discussion for the technical fishway alternatives. It seems the exit for fishways is nearer the flushing channel than the exit for the ramps. Wouldn't fallback risk be worse for the technicall fishway exit?	
UWCD	6.4.5	both Strengths & Weaknesses sections	The hardened ramp could even increase flood capacity. We are unsure as to why ramp access is difficult. As shown it should be a simple system of ladders to reach the dewatered ramp floor from the existing roller gate platform. Perhaps this supperior access (relative to 4% rock-ramp) this could be seen as a strength.	
UWCD	6.4.6	Typo "…rock ramp…" on last sentence of first paragraph	Delete "rock" from rock ramp.	
UWCD	6.5	Stranding Survey Potential for Alternatives	This alternative could have a high potential for stranding during ramp-downs and shut-downs. Fish could become impinged in rock crevices and be difficult to rescue.	N/A
UWCD	6.5.5.2	Suggested additional text	This alternative could become damaged during flood events even with gates. It is imperative that any new facility can withstand 100,000+ cfs with huge debris flows.	Potentially vulnerable to flood events
UWCD	Table 6.2-1		Value for first row in column labeled "Fish Ladder Flow" appears incorrect (50 cfs in the first row). Should this be 31 cfs?	
UWCD	Figure 7.1-2		It appears that the panel estimated the total attraction flow of the existing fishway to be around 80cfs. Please revise to show that the Ladder is capable of 40 cfs, the auxiliary 80 cfs, and in the past few years we have augmented the attraction with the sluice gate with another 150 cfs. That would bring a total attraction of 270 cfs. So at 1000 cfs in the river the graph should be showing around 27% attraction. If the rating system on page 7-14 was based on the incorrect attraction flows please revise.	
UWCD	7.1.1	Typo in first bullet on page 7-4	...an\ auxillary water systems for attraction.	Delete "an"
UWCD	7.1.2	First sentence of 4th paragraph	Does not appear to follow… lower scores because of less risk of fallback?	Replace "less" with "greater"
UWCD	7.1.6	Passage Monitoring	This will be crucial to understanding success of any new facility. Didson could be used downstream and maybe physical trapping at the exit (?) for the rock ramp designs.	N/A

Comment By	Document Section (Para #)	Context (or Paragraph#, Sentence#)	Comment	Suggested text
UWCD	7.1.6	Passage Monitoring	We encountered a problem with flow and smolts going over the dam during our first year of smolt bypass flows. United maintained minimum diversions of 40 cfs and maintained 120 cfs at the downstream end of the losing reach of the river. There was on average ~60 cfs surface water loss which means a total of 200 cfs was released at the dam. That 200 cfs was either both flowing through the fish ladder and auxiliary canal (~90 cfs) and over the dam (~110 cfs) or just over the dam (200 cfs). We need to have control of smolts passing the Freeman Diversion facility when we end the bypass flows. The problem is that smolts migrating over the dam could become stranded as flows are ramped down. We need to be able to release the required flow for volitional passage but be able to monitor smolts passing the facility and be able to stop fish from passing when the flows recede below what is favorable. In other words, is there a way to release up to 250 cfs to the lower river while controlling the bypass flow from the facility and not losing control of flow so fish can remain above the dam and then be trapped and relocated?	N/A
UWCD	Table 7.5-1	under characteristic of flood impacts (page 7-11)	Flood impacts for the rock ramp show a + and then state that head works restrict flood capacity. Shouldn't the impact be scored as a negative?	change "+" to "-"
UWCD	Table 7.5-1	Operation & Maintenance	Rock Ramp - Proposed flood gate between fush channel and ramp may make access difficult./ Hardened Ramp – Why is access considered difficult for this alternative? A ladder from existing roller gate platform is feasible.	
UWCD	General		It seems that either of the two ramp alternatives would allow for the existing ladder to remain in operation. Improvements suggested in the documentation could be included (larger turning pools with rest areas, improvements to entrance, exit and auxillary water system). Two passage facilities, with the flushing channel between, might be advantageous.	

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802- 4213

June 23, 2010

In response refer to:
2010/02792:DB

Terry Roelofs, Ph.D.
120 Pacific Lumber Camp Road
Freshwater, California 95503

Dear Dr. Roelofs:

The purpose of this letter is threefold. First, NOAA's National Marine Fisheries Service (NMFS) reiterates the necessity of adopting relevant design flows for improving the existing passage conditions for endangered steelhead (*Oncorhynchus mykiss*) at the Vern Freeman Diversion Dam (VFDD). Second, NMFS briefly outlines requirements of the U. S. Endangered Species Act (ESA) that should be considered when developing the fish-passage alternatives for the VFDD. Third, NMFS recommends an upper and lower design flow for promoting passage conditions consistent with the principles of the ESA and, therefore, the "operative standard." This letter concludes with a comparison of the NMFS-recommended design flows and the preliminary design flows recently discussed by the Fish Panel (panel).

Briefly reiterating the necessity of defining and adopting relevant design flows appears warranted because although design flows have been discussed[1,2] and the panel identified ranges of flows[3] for preliminary design consideration, NMFS' involvement in planning meetings and review of work products suggests design flows have not been explicitly defined and adopted as such. Generally, design flows are needed to guide the creation of physical features to meet hydraulic criteria, and provide the basis to quantify or qualify anticipated performance with respect to proposed operations and maintenance of the facility. Passage conditions for endangered steelhead through the VFDD will depend on selection of appropriate design flows.

The relevance of the ESA and related provisions to the ongoing development and selection of fish-passage alternatives (and basis for the operative standard) is underscored by United Water Conservation District's (United) effort to develop a Habitat Conservation Plan (HCP) and application for an incidental take permit (permit) under Section 10 of the ESA. Design and implementation of fish passage at the VFDD in concert with proposed operations and maintenance are critical components of this HCP and permit process. Additionally, NMFS' issuance of an incidental take permit is considered a Federal action, which requires NMFS to conduct formal consultation and prepare a biological opinion in accordance with Section 7 of the ESA. In light of the foregoing, the sections of the ESA that have relevance to the development and selection of any fish-passage alternative include the following:

[1] NMFS, November 16, 2009: Letter from Rodney R. McInnis to Michael Solomon.
[2] United,December 16, 2009: Memorandum from Michael Solomon to Terry Roelofs.
[3] Fish Panel, February 26, 2010: Vern Freeman Diversion Dam – Fish Panel Meeting Notes.

A. Section 10(a)(2)(B)(iii): The applicant will, to the maximum extent practicable, minimize and mitigate the impacts of such takings.

B. Section 7(a)(2): Each Federal agency shall, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species[4].

NMFS recommended provisional design flows in a letter of November 16, 2009. The goal of the analysis that informed these design flows was to assess the range of flow conditions at which migratory steelhead would potentially be able to reach the VFDD facilities. The results of the analysis found that the maximum velocity criteria (Thompson, 1972)[5] was not exceeded at flows up to 12,930 cfs, which is a flow with a return period of about 2-years on the Santa Clara River. During subsequent fish-panel meetings, it has been suggested that the 2-year event is too high in terms of an upper fish-passage limit, based upon fish-passage design considerations and the ascendograph analyses. NMFS continues to maintain that steelhead should be capable of reaching the VFFD at flows up to a 2-year event. However, NMFS recognize that flows of this magnitude may not be sustained for extended durations.

To assess the magnitude and duration of smaller runoff events on the Santa Clara River, NMFS analyzed the relative and cumulative frequency of flows ranging from 45 to 13,000 cfs, calculated in 1,000 cfs intervals. A discharge value of 45 cfs was used as a lower bound for migration opportunities based upon NMFS' previous analysis of fish-passage conditions on the Santa Clara River. Results shown in Figure 1 (see appendix) indicate that the relative frequency of flow events is right-skewed with approximately 90% of the flows ranging from 45-3,000 cfs. Based on these findings, providing volitional fish passage over the flow range of 45 to 3,000 cfs would conceivably capture many fish-passage opportunities and should be a priority of any fish passage design. However, Figure 1 also shows that 95% of the flows analyzed are between 45 to 5,000 cfs, and therefore NMFS recommends a flow of 5,000 cfs as the upper design limit.

It is noteworthy that NMFS' recommended upper design flow of 5,000 cfs is within the mid-high range recently presented by the panel and appears to be within the design capacity of the alternatives as discussed during the June 1, 2010, meeting. NMFS recognizes that the effectiveness of any fishway design to meet hydraulic criteria over the range of recommended design flows may not be uniform. In this regard NMFS recommends that the panel assess the relative performance of conceptual design alternatives, including operation and maintenance aspects, over the recommended design flow range (45 cfs to 5,000 cfs). It is expected that this assessment would be based on the categories identified by the panel during the February 26, 2010 meeting and outlined in the Fish Passage Alternative Comparison Matrix (matrix) provided at the June 1, 2010, meeting: 50-500 cfs, 500-2,000 cfs, 2,000-6,000 cfs, and >6,000 cfs. NMFS believes that the matrix, along with the panel's quantitative and qualitative rationale, will inform

---

[4] The destruction or adverse modification standard assesses whether, with implementation of the proposed Federal action, critical habitat would remain functional to serve the intended conservation role for the species. The term *conservation* means to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to the ESA are no longer necessary.

[5] Thompson, K. E., 1972. Determining stream flows for fish life. Proceedings of the instream flow requirements workshop. Pacific Northwest River Basins Commission, Portland, Oregon, 31-50.

discussions of potential performance trade-offs relative to design-flow magnitude, ultimately for identifying a design-flow range that will promote optimal performance, and selecting a preferred conceptual design.

Please contact Darren Brumback at (562) 980-4060 if you have any questions concerning this letter.

Sincerely,

for Chris E. Yates
Assistant Regional Administrator
for Protected Resources

cc: Michael Solomon, United Water Conservation District
Nica Knite, California Trout
Roger Root, U.S. Fish and Wildlife Service
Mary Larson, California Department of Fish and Game
Copy Admin. File: 151422SWR2008PR000506

Appendix

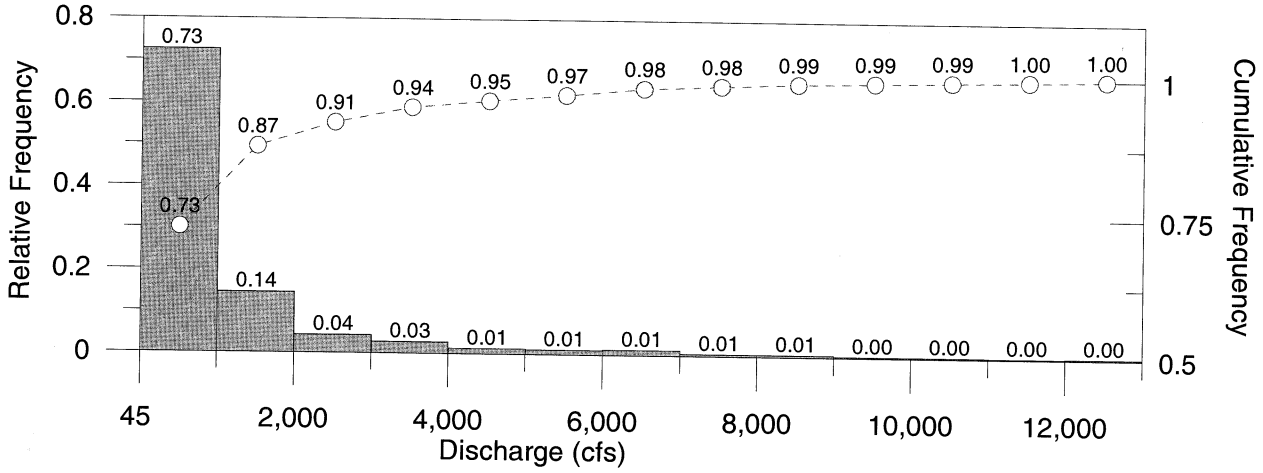


Figure 1. Relative and cumulative frequencies of mean daily flow events at the Montalvo gage on the Santa Clara River (1928-2004) during the steelhead migration window (January 1st – May 31st).

ELLISON FOLK (SBN 149232)
HEATHER M. MINNER (SBN 252676)
SHUTE, MIHALY & WEINBERGER LLP
396 Hayes Street
San Francisco, CA 94102
Tel: (415) 552-7272
Fax: (415) 552-5816

H. SINCLAIR KERR, JR. (SBN 61713)
CHEROKEE MELTON (SBN 243265)
KERR & WAGSTAFFE LLP
100 Spear Street, Suite 1800
San Francisco, CA 94105
Tel: (415) 371-8500
Fax: (415) 371-0500

Attorneys for Plaintiff
California Trout, Inc.

E-FILED: **6/22/10**

UNITED STATES DISTRICT COURT

FOR THE CENTRAL DISTRICT OF CALIFORNIA

CALIFORNIA TROUT, INC., a California Non-Profit Corporation, Plaintiff, v. BUREAU OF RECLAMATION; UNITED WATER CONSERVATION DISTRICT. Defendants.	Case No: CV09-0312 GHK FMOx **[~~PROPOSED~~] ORDER MODIFYING DATE SPECIFIED IN THE SETTLEMENT AGREEMENT** **Courtroom: 650** **Judge: Hon. George H. King**

Pursuant to the stipulation of the parties, it is hereby ordered that the time for release of the Fish Panel report set forth in paragraph C.4 of the settlement agreement shall be changed from August 1, 2010 to September 15, 2010.

DATED: 6/22/10

Honorable George H. King
United States District Judge

UNITED WATER CONSERVATION DISTRICT
"Conserving Water Since 1927"

June 9, 2010

Nica Knite
California Trout
PO Box 7797
San Diego, CA 92167

Reference: Monthly Update Regarding Compliance with Paragraph C (1) of the Settlement Agreement between California Trout and United Water Conservation District.

Dear Nica:

This is the fifth monthly update regarding compliance with stipulations outlined in paragraph C (1) of the settlement agreement between California Trout, Inc. and United Water Conservation District. This letter describes the activities that pertain to adult steelhead bypass flows downstream of the Freeman Diversion from May 1 to May 30, 2010. This letter is the final monthly update regarding adult steelhead bypass operations for 2010.

Fish Ladder Operation

The fish ladder was not operated during the month of May due to low flow conditions in the Santa Clara River. The fish ladder operations during the 2010 migration season ended on April 19. The results of the fish passage monitoring activities for 2010 indicate that no adult steelhead passed the Freeman Diversion Fish Ladder.

Bypass Flow Monitoring

Bypass flow releases did not occur in May.

Conclusions

Based on extensive migration monitoring that occurred in 2010 at the Freeman Diversion Fish Passage Facility, we are confident that no adult steelhead migrated up the Santa Clara River this year. Our passive detection system (infrared beam trigger) and camera/software upgrade are extremely effective, and with the addition of Didson monitoring next year, the effectiveness of this system will be unmatched especially in a dynamic river system such as the Santa Clara River. It is not at all surprising that no adult steelhead returned this year. The adults that we would expect to return in 2010

would most likely be from the 2008 downstream migrants. We counted 133 smolts in 2008, and 81 were surgically implanted with acoustic and PIT tags by Elise Kelley as part of a study of smolt survival in estuary. Naturally low smolt survival rates could certainly have been exacerbated by the effect of surgeries. We counted 160 smolts in 2009 and hopefully some of these fish will survive to return in 2011.

Please feel free to contact me should you have any questions regarding these activities.

Sincerely,

Steven R. Howard
Fisheries Biologist
United Water Conservation District
106 N. 8th Street
Santa Paula, California 93060
805-671-9569
steveh@unitedwater.org

cc: Ellison Folk, Shute, Milhaly & Weinberger LLP
Michael Solomon, United Water Conservation District
Anthony Trembley, Nordman, Cormany, Hair & Compton LLP
Chris Yates, National Marine Fisheries Service

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802- 4213

2010/01924:AS

MAY 7 2010

Terry Roelofs, Ph.D.
120 Pacific Lumber Camp Road
Freshwater, California 95503

Dear Dr. Roelofs:

The purpose of this letter is threefold. First, NOAA's National Marine Fisheries Service (NMFS) would like to clarify an apparent misunderstanding related to NMFS' letter of February 25, 2010. Second, NMFS wishes to reiterate the importance of weighting the review of each alternative by its ability to promote a meaningful fish-passage window over a range of flow magnitudes and durations. Lastly, NMFS continues to recommend that the alternatives analysis consider how operation of the Vern Freeman Diversion Dam affects the performance of any alternative that is under consideration. Each of these points of clarification are described more fully below.

The notes from the February 26, 2010 meeting provide the inaccurate perception that NMFS does not view the alternative to remove the diversion dam (Alternative 1) as a viable option for improving steelhead passage conditions in the lower Santa Clara River. This is an incorrect perception because NMFS does view this as an alternative that warrants further consideration, as stated in NMFS' letter of February 25, 2010. As a matter of clarification, the subject letter recommends that the panel members refine this alternative in a way that would allow United Water Conservation District to divert water from the Santa Clara River at current levels, which the alternative, as currently defined, cannot apparently accomplish. Therefore, NMFS continues to recommend that Alternative 1 be retained for consideration by the panel as a means to improve passage conditions for endangered steelhead.

NMFS' letter of February 25, 2010, requested that the alternatives analysis should consider (1) the range of flows in which an alternative would operate to promote passage conditions, and (2) the resulting duration of the fish-passage window. We recognize that an analysis of the range of flows in which an alternative would operate is underway and we look forward to viewing the results from this analysis when available. With regard to the duration of the fish-passage window, the meeting notes do not indicate whether the panel will consider this issue in the context of the alternatives analysis. Such consideration is important for NMFS to develop an understanding of the appropriateness of any alternative for promoting meaningful passage conditions for endangered steelhead in the lower river. Indeed, the limited migration opportunities that steelhead naturally encounter at the southern extent of its geographic range is reason enough to warrant such consideration, as explained in NMFS' February 25, 2010, letter.

The manner of operating the Vern Freeman Diversion Dam can preclude endangered steelhead from migrating upstream past the diversion. For instance, during periods of elevated flows, United Water Conservation District reports that the fish ladder is frequently not operated. Similarly, operating the flushing channel has the potential to preclude steelhead from passing the diversion dam. Accordingly, the alternatives analysis must consider how United's operation of the diversion dam would affect the ability of any alternative to improve passage conditions for endangered steelhead in the lower river. However, the meeting notes provides no indication that the panel is considering how the operations affect performance of the alternatives.

Please contact Darren Brumback at (562) 980-4060 if you have any questions concerning this letter or if you require additional information.

Sincerely,

For Rodney R. McInnis
Regional Administrator

cc: Mike Solomon, United Water Conservation District
Nica Knite, California Trout
Mary Larson, California Department of Fish and Game
Roger Root, U.S. Fish and Wildlife Service
Copy to: 151422SWR2008PR00506

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

In response refer to:
T/SWR/2008/08370:DB

FEB 25 2010

Terry Roelofs, Ph.D.
120 Pacific Lumber Camp Road
Freshwater, California 95503

Dear Dr. Roelofs:

Thank you for providing a copy of the February 3, 2010, Brainstorm Workshop and Alternative Development Status Report (report), prepared by the "Fish Panel" (panel) for the Vern Freeman Diversion Dam. The attached comments represent NOAA's National Marine Fisheries Service's (NMFS) views on the report. NMFS greatly appreciates this opportunity to be involved in the work of the panel and looks forward to continued collaboration in this regard.

Please contact Darren Brumback at (562) 980-4060 or via email at Darren.Brumback@noaa.gov if you have any questions concerning NMFS' comments.

Sincerely,

for Chris E. Yates
Assistant Regional Administrator
for Protected Resources

Attachment

cc: Mike Solomon, United Water Conservation District
Nica Knite, California Trout
Mary Larson, California Department of Fish and Game
Roger Root, U.S. Fish and Wildlife Service
Copy to: 151422SWR2008PR00506

This page intentionally blank.

Comments of NOAA's National Marine Fisheries Service on the Brainstorm Workshop and Alternative Development Status Report

February 25, 2010

The following comments represent NOAA's National Marine Fisheries Service's (NMFS) views on the Brainstorm Workshop and Alternative Development Status Report (report), prepared by the "Fish Panel" (panel) for the Vern Freeman Diversion Dam (diversion dam). Our comments are organized into three categories: general comments, alternative comparison matrix, and conceptual design alternatives.

General Comments

We are grateful to the panel for their concerted effort to identify ecologically meaningful alternatives for improving migration conditions in the lower Santa Clara River for endangered steelhead (*Oncorhynchus mykiss*). As the panel undoubtedly recognizes, this task is not without challenge, owing to the necessity of considering issues that have particular influence on alternatives development. Such issues involve ensuring the current level of water deliveries to downstream users, the river's high sediment-transport capacity and widely fluctuating discharge, and the life history and habitat requirements of steelhead. Although accounting for these issues does not appear insurmountable, defining alternatives that properly balance the issues represents a key challenge. In this regard, our review of the report suggests that while the panel has made noteworthy strides, the current alternatives would greatly benefit from further consideration and refinement.

For instance, while the alternative to remove the diversion dam (alternative 1) would conceivably account for the limited migration opportunities that steelhead naturally experience in southern California, and promote properly functioning habitat characteristics and condition in the lower river, the alternative appears to have the incidental effect of precluding United from diverting surface water at current levels from the Santa Clara River. This alternative is understandably not acceptable to United, as confirmed in the meeting of February 8, 2010. The conceptual framework for this specific alternative is an example where the panel should develop the necessary elemental aspects that would properly balance the issues, which we expect would inspire reasonable consideration of the revised alternative in the future.

Another issue that appears to deserve further balancing involves the limited migration opportunities that steelhead naturally encounter at the southern extent of its geographic range. The limited migration opportunities are a function of regional rainfall, which can be infrequent and intense. Because the resulting pattern of migration opportunities is restricted, the preferred or selected alternative must be capable of providing passage over a broad range of flows, including high flows. However, the report does not indicate how the limited migration opportunities have been accounted for, consistently, in the development of the different alternatives.

We did not locate a criterion in the report that clearly indicates how the panel would evaluate the capability of an alternative for meeting tenets of the U.S. Endangered Species Act (ESA). How an alternative relates to the migratory behavior and ecology of steelhead has an administrative context because we will evaluate the consistency of the preferred or selected alternative with the ESA. Recall that during the August 26, 2009, fish-panel meeting, and in a subsequent letter of November 16, 2009, we addressed concerns regarding the concept of "unimpeded migration conditions." In doing so, we identified an upper and lower passage-design flow and recommended the panel consider this design flow when assessing the fish-passage capability of the diversion dam (and existing facility) and, of particular relevance to the current effort, when developing alternatives. Yet the report gives no indication that the alternatives have been, or will be, tempered by such consideration. While we acknowledge that United disagrees with our recommended design flow, we continue to recommend a passage design flow as an integral component to appraise the merits of an alternative.

Alternative Comparison Matrix

Generally, the proposed comparison matrix has the potential to provide an effective means of identifying the initial strengths and weaknesses of the conceptual design alternatives. The comments and questions below are intended to advance the evaluation process, improve our understanding of the individual evaluation characteristics, and highlight those specific areas that would benefit from additional consideration.

NMFS understands that the matrix is intended for the panel's use in evaluating individual alternatives relative to the identified characteristics rather than developing a numeric score for comparing alternatives at this time. The panel will then use this to refine elements of the alternatives, where necessary, to improve the score of the individual characteristic(s). We assume that the description of the characteristics will be refined by the panel to include appropriate detailed narrative to support individual scoring during the evaluation of design alternatives.

In addition to a description of the individual elements of each alternative, a clear understanding of the operational scenarios seems critical for properly informing the evaluation process. As of the February 8, 2010, meeting the panel had not been provided a detailed description of the diversion dam operations. A detailed description of United's current and anticipated operations, including actual scenarios, seems critical for the panel's ability to develop, assess and refine fish-passage design alternatives at the diversion dam. The water operation description should include: a) the timing, duration, and rates of diverted flows from the Santa Clara River relative to total river flow, and b) the timing, duration and magnitude of flushing channel operations, including an estimated volume of sediment erosion and deposition upstream of the diversion dam.

With regard to the specific characteristic involving the "attraction of fish to fishway,"as we stated during the meeting of February 8, 2010, we would like to see the terms "low," "moderate," and "high flows" refined in the future to include approximate flow magnitudes corresponding to each category. We recognize that the panel has not reached

this point in their analysis yet, but establishing the magnitude of these flows is a crucial component of evaluating the various alternatives. At a minimum, a method for developing and assessing these flow categories should be defined. In addition to quantifying the flow terms, the range of flows in which an alternative would operate to promote passage conditions, and the resulting duration of the fish-passage window, should be assessed (see Figure 1 for an example). This information should be integrated with other information generated from the matrix to assess the overall strength and weakness of the alternatives.

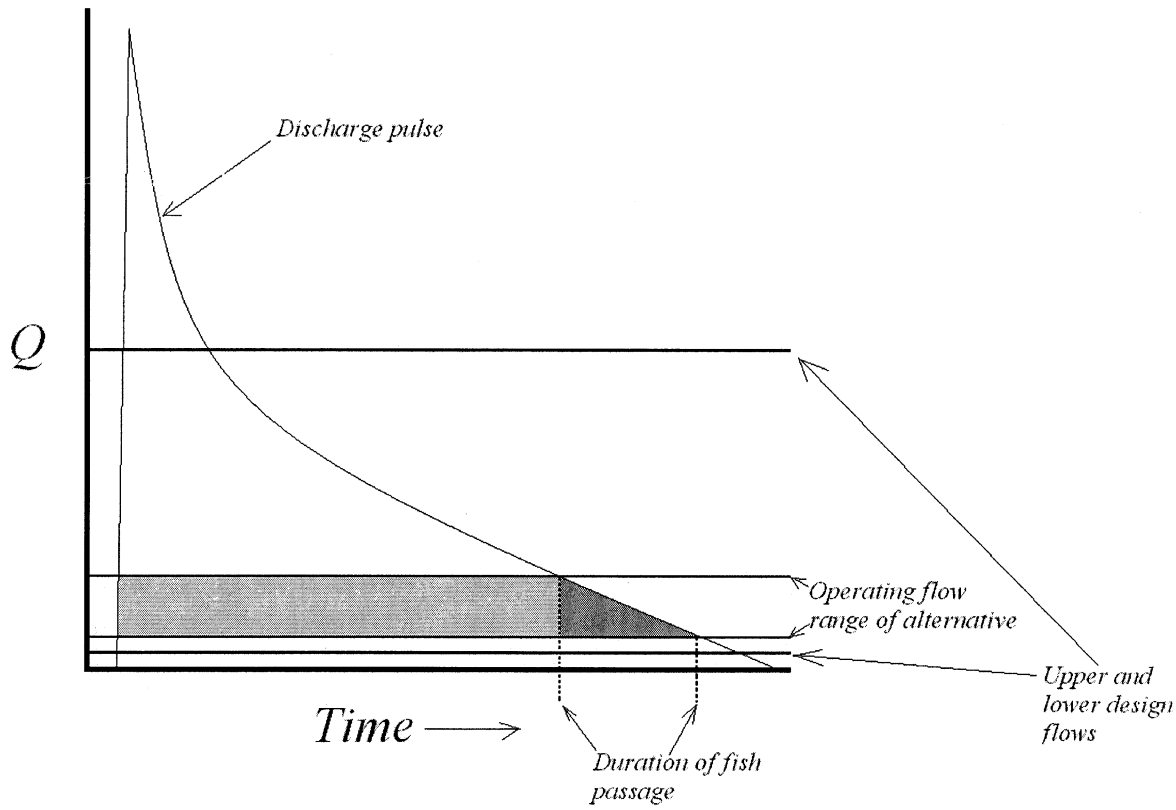


Figure 1.—Hypothetical example showing the duration of the fish-passage window resulting from the range of flows in which an alternative would "operate," relative to an expected discharge pulse (i.e., period of rainfall-induced elevated flows) and upper and lower design flows.[1]

With regard to the specific matrix characteristic that involves passage of steelhead and lamprey through the fishway, how would the panel assess the performance of each alternative in the context of this characteristic? Will the analysis qualify or quantify migration delay for each of the alternatives? The performance of any individual alternative seems intrinsically linked to a specific flow magnitude, again highlighting the importance of defining the upper and lower flow in consideration.

[1] Because the preferred or selected alternative must provide passage over a broad range of flows, including flows that are higher than design flows observed in northerly landscapes, a reasonable design flow may be closer to the 2-year recurrence interval.

With regard to the sediment and bedload management characteristic, does this character incorporate the manner in which the operation of the existing flushing channel influences the potential migratory behavior of steelhead? How will the current operations influence the ability of steelhead to locate the fishway entrance and contribute to potential delays or cessations of migration downstream of the facility as a result of increased water velocities, turbulence, and sediment transport?

Conceptual Design Alternatives

The proposed alternatives generally warrant further development and review with the exception of Alternative 9 (Trap and Haul) and Alternative 10 (Improvements to existing fishway). With regard to Alternative 9, trap and haul of steelhead is not scientifically sound and does not comport with NMFS' primary management objective of providing volitional passage for this endangered species. Collecting and then relocating steelhead can only be considered in the context of rescue operations and research. With regard to Alternative 10, we agree with the panel's assessment that the existing fishway is not an adequate fish passage system on its own, and views the purpose of this alternative as improving performance of the existing fish ladder to serve as a potential component of Alternatives 5 and 6 (Rock Ramp). More specific comments on the alternatives are presented as follows.

Alternative 1: Dam removal and pipeline from Lake Piru.—This alternative appears to be viable for meeting the project objectives of providing volitional fish passage for endangered steelhead and a reliable water source for United, but the alternative would preclude United from diverting surface water directly from the Santa Clara River. While this alternative has ecological merit, the underlying conceptual framework should be developed to afford United the ability to meet existing water-management objectives. Alternative 1 should be expanded to address identified data needs and uncertainties.

Alternative 2: Replace VFDD with a new inflatable dam near Hwy 101.—In general, this alternative creates the potential for moving the existing fish-passage problem farther downstream. Additionally, potential effects of this alternative that need to be considered include the creation of a thermal barrier to migration, increased predation, and effective attraction of emigrating steelhead to the impoundment outlet (ladder).

Alternative 3: Left bank vertical slot ladder around diversion with notch in dam.—Does the gated notch (partial or full-depth) replace the existing flushing channel and gate? How does this alternative ameliorate the effects of the existing flushing channel operations on attraction to the ladder entrance, such as induced sediment-laden flows and high velocity and turbulent flows? While not specifically stated, the partial notch (element B1) appears to function for sediment transport and flow concentration only, whereas the full notch (element B2) functions to provide fish passage at higher flows when the diversion is not operating.

Alternative 4: Full depth notch in dam with new technical fishway.—See Alternative 3 comments. Additionally, the rate of sediment erosion and deposition upstream of the diversion dam when the notch is closed, and subsequent effects of flushing, needs to be considered. The assessment should consider potential physical (skin and gill abrasion) and behavioral (delay or cessation of migration) effects to steelhead from induced sediment pulses.

Alternative 5 and 6: Full and partial active channel width rock ramp with dam crest modifications.—The estimated or assumed average velocities across the full rock ramp range from 3 to 9 ft/s for flows of 8 to 2,600 cfs, whereas the velocities for the partial rock ramp range from 3 to 9.5 ft/s for flows of 8 to 1,000 cfs. Guidelines for Salmonid Passage at Stream Crossings (NMFS-SWR, 2001) and Anadromous Salmonid Passage Facility Design (NMFS-NWR, 2008) identify hydraulic design criteria of 2.0 ft/s for culverts greater than 300 feet. The California Salmonid Stream Habitat Restoration Manual (2009) identifies the overall channel slope for rock ramps as less than or equal to 4 percent and suggests that, for long ramps, the pools be interspersed to address elevation differences greater than 5 feet and to reduce the risk of creating an "exhaustion barrier." These references and design parameters should be incorporated in the assessment and revision of Alternatives 5 and 6.

Alternative 8: Left bank nature-like fishway.—See comments on Alternatives 3 and 4.

This page intentionally blank.

UNITED WATER CONSERVATION DISTRICT

"Conserving Water Since 1927"

February 23, 2010

Dr. Terry Roelofs
120 Pacific Lumber Camp Road
Eureka, CA 95503-9439

Subject: UWCD comments on Freeman Fish Passage Panel Memo dated 02-03-10 "Brainstorm Workshop and Alternative Development Status Report"

Dear Dr. ~~Roelofs~~ Terry,

This is written to provide our observations regarding the details included in the subject memorandum and to thank you and the panel for its efforts to date. In general we found that some interesting ideas were presented, and while it cannot be known how these concepts will play out against yet-to-be-developed functional criteria (discharges, turbidity levels, etc…), the alternatives certainly provide a backdrop for beginning further discussion.

It is evident from some of the suggested alternatives the panel has been allowed to work independently to date. However, it appears imperative now for NMFS and UWCD staffs to begin working more closely with the panel to assist in informing the process to a successful and beneficial conclusion, if we are to comply with our obligations under the Endangered Species Act (ESA) and meet our August 1, 2010 deadline set in our recent settlement with Caltrout.

GLOBAL COMMENTS

We generally find that the purpose of the task is inadequately described. The stated goal is to define alternatives for initial evaluation. However, the necessary criteria for evaluating the alternatives have not been developed to date. It is therefore impossible to determine if alternatives meet any yet-to-be developed criteria.

Discussion should be drafted describing how both the exercise's overall goal and/ or each specific alternative is expected to assist the facility in meeting the requirements of the Endangered Species Act (ESA), NMFS' July 2008 Biological Opinion, and UWCD's water resource responsibilities. These should remain the metric with which all proposals are weighed.

Some of the alternatives express a general misunderstanding of UWCD's non-Freeman facilities and operations. We intend to provide additional information regarding the Freeman Diversion's relationships with other UWCD facilities and programs by separate transmittal(s). For the

106 N. 8th Street • Santa Paula, California 93060 • Phone (805) 525-4431 • FAX (805) 525-2661 • www.unitedwater.org

purpose of these comments we wish to share at least the following: UWCD owns and operates conjunctive use (surface and ground water) facilities for the primary purpose of protecting productive aquifers associated with the Santa Clara River. The panel is aware of many of the unique characteristics of the Santa Clara River. UWCDs programs have been developed from over eighty years of observations. Santa Felicia Dam stores winter storm runoff from Piru Creek for later controlled releases which both percolate in the Santa Clara River groundwater basins and are diverted for conjunctive use on the Coastal Plain. The Freeman Diversion provides riverbed stabilization which allows the diversion of winter-spring storm flows from the Santa Clara River's undammed tributaries for conjunctive uses on the Coastal Plain. The elevation at which the Freeman stabilizes the Santa Clara Riverbed was carefully chosen to provide only enough head to drive the existing treatment (screening and de-silting) and distribution system below the diversion. Diverted water is distributed by canal and pipeline to three existing spreading grounds and to direct delivery to two irrigation water delivery systems. One of the spreading grounds is coincident with a well field, the extractions from which are disinfected and boosted for municipal potable uses. All of this is done to reduce pumping in the pressure aquifer portion of the coastal plain in an attempt to eliminate seawater intrusion and other water quality issues.

SPECIFIC COMMENTS

The following comments are offered for each of the specific alternatives presented in the memorandum.

A. Alternative 1 (*Remove Freeman + pipe from Santa Felicia*)

This alternative will not meet water resource goals. The yield of Freeman is not associated with the operation Santa Felicia Dam. Rather, the Freeman's water rights are to specific volumes and flows originating from the uncontrolled tributaries to Santa Clara River. Please note that occasionally, during spills, Piru Creek is also uncontrolled. In California, once water is stored for more than thirty days it is considered "foreign in time" to the watercourse. Accordingly, the portions of Santa Felicia's controlled releases that make it to Freeman are not natural waters.

Piping of water from Santa Felicia will reduce volumes released into the natural stream course and would be expected to have effects on recharge to upstream groundwater basins. The environmental effects of piping flows out of river also could be severe and could impact proposed future Santa Felicia operations (FERC License issues) regarding steelhead passage.

Removing the Freeman Dam will remove the stabilizing effects of the structure on the Santa Clara Riverbed. The future geomorphologic conditions and changes in riparian habitat would need to be carefully analysed. The spatial and temporal destabilize of sediment upstream could extend beyond Santa Paula and even Sespe confluence. Neighboring properties would be affected. Existing river encroachments (channelization) may result in permanently degraded thalweg through the affected reach.

B. Alternative 2 (*Replace Freeman with downstream rubber dam*)
UWCD's present system is able to use gravity in a significant way. Lowering the elevation of the diversion will require very large volumes of water to be pumped to existing demand elevations. The proposal will require new average power demands of approximately 2,800,000 kW-Hr per year in pumping energy (55,000 AF x 50 feet). Recent changes in NEPA and CEQA require project proposals to consider the carbon footprint of the proposed activity.

Little is known about the geotechnical conditions of the proposed rubber dam site. This would have to be fully explored prior to advancing this concept. Our experience with alluvial foundations in the Santa Clara River has been disastrous.

The proposal needs to consider likely significant negative environmental effects. Besides the effects discussed above with respect to the removal of the Freeman's stabilization elements, this proposal needs also consider the effects of the proposed new features, including a new fish ladder and pump screening (smolts) as well as of impoundment effects on riparian habitat and geomorphic processes. The text indicates that the proposal will somehow reduce upstream passage delay at low and moderate river flows. We cannot see how this would be true.

C. Alternative 3 (Left Bank Vertical Slot with Notch)
The text describes a proposed notch in the dam, which is not shown in diagrams, and then states that the proposal leaves the dam intact. The existing sluiceway (a gated notch) has proven effective at concentrating low and moderate river flows to left bank. We are unsure as to why more sluicing is necessary. Additional concerns with notching are described in our comments to Alternative 4, below.

Sluicing flows have been thought to mask the attraction flows at the existing fish ladder entrance. Additional discharge could exacerbate this issue. The assumed entrance problems described in NMFS' Biological Opinion remain unaddressed by leaving entrance intact.

Ladder clogging issue will relate to operational schedule and trash-rack design. The dimensions appear large for the range of flows discussed in the text, but we have not checked this.

We concur that crossing the diversion canal could form "invert siphon." The panel should consider crossing diversion channel downstream of fishscreens (where there is a lower diversion water surface). Alternatively, the panel could consider combining the proposed diversion canal "invert siphon" with various fish screen and flushing works modifications.

The new exit proposals require significant excavation in bedrock.

The document should more clearly explain the desirability of a screened auxiliary water source. We understand such flows would not be any more "fish friendly" for adult migrants, but that is it less likely to harm smolt (?) The panel should consider modifications to the fishscreen bay to allow for screened auxilary water to be sourced from the right of the diversion channel.

In the Alternative 3a sketch, the proposed ladder footprint necessitates relocating project control center, a hub from which all power and control conduit radiate.

D. Alternative 4 (Full depth notch)
Headcutting will destabilize riparian habitat upstream. What are the spatial and temporal limits to this?

The panel should consider the potential for undermining or otherwise destabilizing existing features.

There are several undesirable environmental and administrative issues with creating any impoundment above the dam. One administrative issue is that the entire structure would then become subject to California Division of Safety of Dams' jurisdiction. Approval of the modification may be denied. An impoundment may also cause severe environmental issues, including unnatural habitat for exotic life and artificial increases in turbidity early in each year's operations.
The text appears to indicate that additional passage improvements are also necessary.

E. Alternative 5 (Full channel rock ramp – downstream construction)
It is unclear as to proposed width and elevation of the proposed "notch." The existing freeman crest was constructed to the lowest elevation to provide head for water to pass through UWCD's non-freeman facilities. Lowering the water surfaces will marginalize and perhaps even render all existing features useless. One could consider leaving the proposed ramp crest at 162 and instead raising the remaining portions of the crest. This might require consideration of improvements to upstream levees.

The panel should consider options for gating proposed thalweg channel and should discuss potential fish stranding as a result of flushing operations.

We have grave concerns regarding geotechnical and hydraulic issues. The hydraulic edge effects would be expected to cause unusual erosion. The fluctuating river thalweg at toe of improvement could result in the ramp being inaccessible. The bedrock becomes deeper downstream of Freeman, making successful founding difficult and costly. An alluvial foundation would be subject to undermining and subgrade liquefaction during

large storm events leading to a high likelihood of losing the entire improvement during a large flood.

F. Alternative 6 (Partial width rock ramp – upstream construction)
The proposal indicates that the ramp would have vertical sidewalls. The panel should consider hydraulic effects in the ramp during high flows (spilling over sidewalls). The panel should consider the dynamic effects (loads and erosion) from spilling over vertical sidewalls.

Accordingly, the panel may wish to consider laying back to sloping sidewalls, perhaps to 0.8:1, which matches the slope of the existing dam's face. One possible construction method could involve both the ramp and walls being of RCC founded on bedrock.

Keeping the perimeter at a constant elevation of 162 effectively doubles the crest length of the dam and provides more discharge at the toe of the ramp, similar to a single-cell labyrinth weir. This ought to provide abundant attraction flows without the need for notching below elevation 162. The panel may wish to consider non rectangular form, in plan-view. (Narrower at the top).
This geometry could be designed to achieve equal depth/ velocity along the rise of the ramp for any given headwater. The ramp could be shaped to take first/ last flows from left bank area that is affected by existing flushing channel. This should allow the existing features to keep the river on the left bank. The panel should consider gate schemes for proposed lowered thalweg channel.

The panel might consider placing ramp toe near or adjacent to the existing flushing channel which should eliminate need for right side sluice works (see comments to Alternative 4 above). The existing flushing channel would then provide attraction flows between two independent passage features (Rock ramp on the north and existing (or improved) ladder on the south.

G. Alternative 7 (= Alternative 3. B.)
Our comments are described under Alternative 3, above.

H. Alternative 8 (Left bank nature-like fishway)
The inclusion of a dam notch appears unnecessary and results in the requirement to pump flow into the passage device, otherwise this proposal appears very similar to Alternatives 3 and 7.

I. Alternative 9 (Trap and haul facilities)
Addresses exit concerns, but does not appear to address entrance issues. Our comments regarding notching the dam are included in several locations above.

J. Alternative 10 (Improve existing fishway)

The memorandum would follow more logically if this Alternative were discussed prior to the other technical fishway alternatives. The document should include a discussion of the advantages/ disadvantages of *denil ladders* in relation to vertical slot, pool and weir or nature-like fishways (technical passage facilities). Without this information, it will be difficult to explain to our Board of Directors and constituents why an investment into another passage alternative is warranted.

Changes to the existing facilities could accomplish each of design criteria suggested by the other technical fishway alternatives. These might include: 1) Modify entrance features, 2) Modify exit features, 3) Modify auxiliary water intake, 4) Notching dam, etc… The text should explain specific issues with the existing facilities and explore repair options. We request the panel consider the enclosed document which summarizes possible improvements to the existing denil fishway.

The text should also explain the ways in which the other technical passage alternatives reduce or eliminate the disadvantages of the existing facilities bulleted on page 38. How do alternatives 3, 7 and 8 address the stated disadvantages?

i. Inadequate attraction water
ii. Entrance conditions during flushing operation
iii. Improved exit conditions appear desirable. There are several options for improvement to the existing features, including elimination of the baffled section, crossing the diversion canal and exiting at the location proposed in alternatives 3, 7 and 8.
iv. Limitations to headwater operating range. Can this be improved with additional baffles, exit gates and/ or length of channel?
v. High turbulence in turning pools. There is room to modify these both horizontally and vertically.
vi. Excessive O&M requirements. Elaborate how this is different than alternatives 3, 7 and 8.

REJECTED OPTIONS

The reasons provided for rejecting the various options appear sound.

ADDITIONAL OPTIONS NOT DISCUSSED

Extending existing diversion canal and relocate dam upstream would offer a lower total height (approx. 10-12 ft. high) in which passage features could be built-in. However, the laterally steep bedrock/ alluvium interface (sloping to the north) could lead to a steep scoured channel below dam which could form a new barrier to upstream migration.

Provide improvements suggested in the technical passage options and modify the denil sections to an alternative technology. (See attached document entitled "Alternative Fishway Improvements.")

CONCLUSION

We continue to support the panel's independent efforts to ensure there are unbiased analyses of, and economically feasible solution(s) to, fish passage at the Freeman Diversion. However, it is also clear that our long experience with the Santa Clara River, and unique knowledge of our water resource facilities and operations, must be considered to arrive at viable passage solutions. Viable solution(s) must ensure the minimum: 1) the Freeman Diversion continues to meet the District's purposes, 2) the standard should have actual significance for steelhead and other species to be covered by our Habitat Conservation Plan, 3) UWCD must obtain an ESA section 10 permit, when all is said and done, and 4) any alternative(s) or solution(s) must be reasonable and economically feasible.

We understand that the panel is planning a teleconference of Friday, February 26, 2010. We can be available should you wish to provide a call-in time for additional open discussion of these comments.

Again, we commend the panel on its efforts and look forward to the development of criteria from which we can weigh and modify these and other options. We intend to develop more specific items of information for the panel's future use.

Very truly yours,

E. Michael Solomon,
General Manager

cc. Chris Yates, NMFS
Nica Knite, Caltrout

This page intentionally blank.

UNITED WATER CONSERVATION DISTRICT
"Conserving Water Since 1927"

MEMORANDUM

DATE: December 16, 2009

TO: Terry Roelofs and VFD Fish passage Panel

FROM: E. Michael Solomon, General Manager

Subject: **Comments on the flow guidelines by NMFS for the Fish Panel**

Prior to your December 22nd conference call, United Water Conservation District would like to share its comments and concerns regarding the guidelines that NMFS has recently developed for the upper and lower design flows at the Freeman Diversion fish ladder. The letter by NMFS's was dated November 16, 2009. Overall we had found that the criteria lacked any biological basis and does not consider other variables that are unique to the Santa Clara River. These variables include high suspended solids, flashy flows with steep recessions and high water velocities that are expected to affect the migration behavior of this species such as delayed river entry, delayed migration and reduced migration rates.

NMFS recommended that the fish ladder be operational between flow ranges of 12,930 cfs down to 45 cfs. The upper range was based on determining a 2 year occurrence of the storm peaks for each year. NMFS did not cite any standards when developing this method. An internet search did not reveal any other design criteria for fish ladders that used peak flows. Additionally the proposed design criteria conflicts with the guidelines that were set forth by NMFS in the Biological Opinion for the Freeman Diversion. The B.O. identified a standard used by NMFS of a 5% and 95% exceedance of average daily flows when fish are expected to migrate. The flow range criteria from the B.O. reveal flows that were much different than the latest guidelines. In recent discussions with NMFS's staff after they performed additional analysis, they had determined that the lower flow limit in the B.O. would not work, thus their proposed amended guidelines. According to the Fish Panel's flow duration curves the 5% exceedance would be approximately 2,000 cfs for the months of January through May 31st. The standards outlined in the B.O. agree with the guidelines used in the "Anadromous Salmonid Passage Facility Design" (NMFS northwest Region, Feb. 2008). I recently met with Chris Yates (NMFS) to discuss our concerns and he is working with his staff to pull together some information on mean daily flows of various durations and magnitudes. They will then analyze the frequency of how often they occur. Both UWCD and NMFS are working cooperatively on these issues in an effort to get a revision to the design flows to the panel. We are working together to narrow down the differences.

We have shared with NMFS our concerns with both of these analyses as they do not take into consideration variables such as local hydrology, turbidity, ladder location and velocities that do affect steelhead migration behavior. Published primary literature and unpublished literature have demonstrated that these variables can have an effect on time at river entry and migration rates including delayed migration when steelhead are holding in the lower river until conditions are favorable for safe migration upstream. Below is a brief discussion of the factors that should be included in any analysis to estimate when steelhead would be expected at the fish ladder. A more detailed description of each factor is forthcoming.

Hydrology:

NMFS used the peak of the largest storm for each year to determine the exceedance values. This river system is very flashy compared to the larger anadromous streams in the Pacific Northwest. The values at the peak of a storm only happen for an instant. One of our concerns is duration of the flows, the identified flow criteria would only occur once every two years for less than one minute. The peaks of the storms quickly subside. If the same analysis that NMFS did on the peaks of the storms is done using average daily flows instead of instantaneous peak flows, the 2 year exceedance for the peak discharges is about 3,400 cfs or about ¼ of their design flow. Again, there is no biological basis for this flow either, other factors must be considered.

Turbidity:

When river discharge at Montalvo is at the recommended design high flow of 12,930 cfs, the suspended solids would be expected to exceed 24,000 mg/L. This level is based on local suspended solid concentrations in the Santa Clara River and is considered to be lethal to steelhead with an exposure time of 1 hour based on a study by Newcomb and Jensen (1996). It would not be reasonable to assume that steelhead would be at the ladder under such conditions. Additionally it would not be reasonable to assume that they have even started to migrate into the river at this point. Studies show that steelhead avoid suspended solids at levels much less than what are considered lethal. Unpublished observations on the Mad River show delay in fish migration between 400-500 ntu and no movement above 500 ntu. The 500 ntu threshold observed in the Mad River would equate to approximately 575 mg/l of suspended solids in the Santa Clara River based on turbidity/suspended solid relationship developed on this river. If steelhead are expected to die at one hour of exposure at 22,026 mg/l and steelhead migration might cease at levels over 575 mg/l, the recommended passage flow design criteria submitted by NMFS does not fit the biological requirements for fish passage. Data of these unpublished observations need to be reviewed to understand the flow/velocity/turbidity relationship.

Both Chris and I agree that we should consider and determine the design flows first before we begin discussions to address the possible impact of turbidity.

Ladder Location:

The fish ladder is located approximately 11 miles upstream of the estuary. In Prior correspondence NMFS determine that steelhead would be expected at the Freeman Diversion from 3 to 12 days after the peak of a storm. The NMFS prior study was based on actual migration rates in the Carmel River which determined that steelhead would take from 3 to 12 days to reach the diversion. This study was also used in the B.O. for Casitas in the Ventura River. This estimate coincides well with migration rates of 2 to 4 miles per day. Factors such as turbidity

will have an effect on migration rates and time at entry in the estuary and increase the number of days it will take steelhead to reach the diversion.

Velocities for Migration Rates:

While NMFS recognized that velocities at flows of up to 12,930 cfs are below the limit that steelhead can successfully migrate upstream, what was not discussed was the additional time that would be expected to migrate in such high velocities.

In summary the Fish Passage Panel proposed a method to help estimate the potential delays that may be unique to this river by incorporating the ascendograph analysis. This model may help determine when fish should be expected at the Freeman Diversion and at what flows they may encounter when they arrive by incorporating all variables that affect steelhead migration. It has always been UWCD belief that we need to attain as much knowledge as possible before we make costly decisions. We encourage the Fish Passage Panel to pursue their model in order for us to come up with the best ladder design possible. Certainly UWCD also anticipates that the Fish Passage Panel will independently evaluate its own flow criteria that it believes is warranted for this unique river system.

As I have mentioned, we have discussed the above concerns with NMFS staff and both agencies are working together to resolve the differences and should provide the panel with updated information in the near future.

If you have any questions regarding this memorandum please call or e-mail me. If you have any questions on NMFS' November 16th letter please contact Chris Yates.

Cc: Chris Yates

Nica Knite

This page intentionally blank.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

November 16, 2009

Michael Solomon
United Water Conservation District
106 N. 8th Street
Santa Paula, California 93060

Dear Mr. Solomon:

The purpose of this letter is twofold. First, NOAA's National Marine Fisheries Service (NMFS) comments on the draft September 22, 2009, process recommended by the fish panel to develop long-term upstream passage improvements for endangered steelhead (*Oncorhynchus mykiss*) at the Vern Freeman Diversion Dam. Second, NMFS identifies an upper and lower passage-design flow and recommends the panel consider this design flow to assess the fish-passage capability of the diversion dam (and existing facility) and develop designs that would promote passage conditions for endangered steelhead accordingly.

Comment on the Recommended Process

Shortly after the August 26, 2009 fish-panel meeting that included United Water Conservation District (United), California Trout, and NMFS, representatives from United and NMFS, along with direction from a panel member, considered the type of data and issues that were to inform development of an ascendograph for assessing the risk of migration delay. Involvement in this effort allowed NMFS the opportunity to clearly understand the mechanics of the approach for deriving an ascendograph and, in particular, how one goes about defining the data that serves as input to the methodology. Prior to this occasion, NMFS did not possess the degree of understanding that was ultimately obtained.

Based on NMFS' involvement in this effort, NMFS questions the application of the approach to the current situation confronting the fish panel. The lack of a clearly defined ascendograph methodology, including provisions for guarding against the subjectivity that is inherent in the approach, continue to represent principal NMFS concerns. As such, the reliability of the results produced from the final analysis is unclear as is the manner in which the results derived from this analysis would be translated into a clear and confident articulation of the true migration delay that steelhead experience at the Vern Freeman Diversion Dam. The assessment simplifies complex factors that are known to influence migratory behavior and ecology. Accordingly, NMFS continues to question the application of this specific process to the current situation.

Passage-Design Flows

During the August 26, 2009, fish-panel meeting, NMFS spoke to United's concern regarding the concept of promoting or approximating unimpeded migration conditions for steelhead at the Vern Freeman Diversion Dam. In addressing this concern, NMFS stated that an upper and lower passage flow can be defined (i.e., passage-design flows) and used as a means for determining whether passage conditions at the Vern Freeman Diversion Dam meet the foregoing concept and, therefore, the tenets of the Endangered Species Act. In this context, the passage-design flows can guide an appraisal of the capability of the existing diversion dam (and facility) to allow passage of endangered steelhead and, if necessary, inform the development of modifications to improve passage conditions for this species.

Recently, NMFS applied an approach to determine upper and lower discharge magnitudes that migratory steelhead are expected to frequently encounter on the lower Santa Clara River. The approach and results are described more fully as follows. Results from this analysis are presented with the specific aim of identifying provisional passage-design flows that can guide the work of the fish panel.

Approach.—To determine the upper and lower fish passage flows, NMFS conducted two sets of analyses. The first involved a statistical flood frequency analysis of the flows in the mainstem of the Santa Clara River. This specific analysis was performed to establish the magnitude of frequently occurring peak flows (return period ~1.0 years) as well as the magnitude of small floods (on the order of 1.5 to 2-year return period). The second analysis involved using a hydraulic model (HEC-RAS) to investigate water-column depth and velocity values at upper and lower flows identified as expected fish passage flows in the flood frequency analysis. Hydraulic model predictions were compared to the minimum depth and maximum velocity criteria for migratory adult steelhead developed by Thompson (1972)[1], to determine whether the initial estimates of the upper and lower flows were realistic in terms of providing passage opportunities for endangered steelhead.

With regard to assessing flood frequency, annual peak flow data from the USGS gage at Montalvo (USGS gage number #11114000) from 1932 – 2005 were used to perform a flood frequency analysis by fitting the data to a Log-Pearson Type III distribution (USGS, 1982)[2]. Flows of selected return periods are shown in Table 1 and Figure 1 (enclosure to this letter). The calculated exceedance probabilities were used to select flows in the upper and lower range of discharge values that are expected to be experienced by migratory steelhead in any given year. For the low-flow limit, discharge magnitudes with an exceedance probability between 99 – 99.5% were selected, while flows with an exceedance probability between 50 – 67% were chosen to represent the higher flows. The specific flow magnitudes and return intervals of the twelve selected flows used in the hydraulic analysis are shown in bold in Table 1 (enclosure).

---

[1] Thompson, K. E., 1972. Determining stream flows for fish life. Proceedings of the instream flow requirements workshop. Pacific Northwest River Basins Commission, Portland, Oregon, 31-50.

[2] U.S. Interagency Advisory Committee on Water Data, 1982, Guidelines for determining flood flow frequency, Bulletin 17-B of the Hydrology Subcommittee: Reston, Virginia, U.S. Geological Survey, Office of Water Data Coordination, 183 p.

With regard to the hydraulic modeling, the upper and lower flows identified in the flood frequency analysis were in turn used as input discharge values into a HEC-RAS hydraulic model. The HEC-RAS model of the Santa Clara River used in this study extends from the Pacific Ocean to the Los Angeles County Line. The model was developed and verified by Stillwater Sciences and the URS Corporation (URS Inc., 2006)[3], and the cross-section geometry was based on digital topographic data from LiDAR surveys performed in February and March of 2005. The goal of the hydraulic modeling was to develop an understanding of whether a particular flow magnitude was realistic in terms of providing suitable migratory conditions for adult steelhead. Based on the criteria outlined by Thompson (1972), a minimum depth of 0.6 ft was adopted to represent a lower limit that fish could migrate upstream over shallow riffles. Similarly, a velocity of 8.0 ft/s was used as a maximum velocity at which steelhead could successfully migrate upstream (Thompson, 1972). For the purposes of this analysis, the predicted maximum depth at each cross-section was used and no attempt was made to calculate the extent of the cross-sectional area satisfying the minimum depth criteria as originally proposed by Thompson (1972). All velocity values are cross-sectionally-averaged, therefore lower velocity zones along the channel margins are not captured at the resolution of this modeling approach though are likely to exist.

Results and Provisional Passage Flow Recommendations.—Hydraulic model predictions indicate that 64% of the modeled transects between the Pacific Ocean and the Vern Freeman Diversion Dam should provide minimum passage depths at a flow of 45 cfs (Table 2) (enclosure). Flow magnitudes between 105 – 327 cfs are required for the minimum depth criteria to be satisfied at over 90% of the transects within the reach (Table 2). The velocity values in this same reach remain below the maximum velocity of 8.0 ft/s at nearly all of the modeled transects at flows up to 17,710 cfs (Table 2).

The minimum depth criterion was met at roughly 64 – 91% of the lower Santa Clara River at flows ranging from 45 - 105 cfs. While migratory steelhead may encounter portions of the river where the depth falls below 0.6 ft., they should be able to access a large portion of the lower Santa Clara River at these flow magnitudes. This expectation is supported by recent empirical evidence provided by United's biologists, who observed an adult steelhead in the fish passage facility forebay on March 4, 2009 (UWCD, 2009)[4]. Santa Clara River flows preceding this observation were 96 and 98 cfs below the Vern Freeman Diversion Dam for approximately two days and ranged from 22 to 170 cfs at the downstream critical riffle for the previous seven days. Given the expectation for passage opportunities to exist at these flows, NMFS recommends using a conservative lower flow of 45 to 105 cfs.

Steelhead are expected to migrate upstream during a flow of 12,930 cfs (2-yr flood) and potentially higher, based upon the maximum velocity criteria of Thompson (1972). The feasibility of getting steelhead through the fish passage facilities at the Vern Freeman Diversion Dam will likely be dictated by the ability of the structure to function at such flows, as well as the magnitude of peak velocities at the structure itself. Further evaluation by the engineers on the technical panel will be required to evaluate inclusion of this flow as an upper passage limit.

---

[3] URS Corporation Inc., 2006. Santa Clara River Parkway Floodplain Restoration Feasibility Study: Water Resources Investigations. Prepared for the California State Coastal Conservancy, Oakland, California, 119 p.

[4] United Water Conservation District, 2009. 2009 Freeman Diversion Fish Ladder Bypass Flow Operations. Santa Paula, California, 19 p.

In summary, NMFS recommends that future work by the fish panel involving the assessment of fish passage at the Vern Freeman Diversion Dam facilities consider the use of a provisional low flow of 45 to 105 cfs and an upper flow of 12,930 cfs as the passage-design flow. Please contact Darren Brumback (562) 980-4060 if you have a question concerning this letter or if you require additional information.

Sincerely,

for Rodney R. McInnis
Regional Administrator

cc: Terry Roelofs, Panel Facilitator
Mary Larson, California Department of Fish and Game, Long Beach
Administrative File#: 151422SWR2008PR00506

Enclosure
Supplemental Tables and Figures

Table 1. Frequency of Annual Peak Flow on the Santa Clara River at Montalvo gage. Dishcarge values shown in bold were used to assess the upper and lower ranges of the fish passage flows.

Exceedance Probability	Return Interval (yr)	Discharge (cfs)	Lower Confidence Level (5%) (cfs)	Upper Confidence Level (95%) (cfs)
0.995	1.005	**105**	**45**	**201**
0.99	1.01	**181**	**85**	**327**
0.95	1.05	737	421	1,154
0.90	1.11	1,477	921	2,176
0.80	1.25	3,266	2,220	4,563
0.67	1.50	**6,541**	**4,688**	**8,920**
0.5	2	**12,930**	**9,489**	**17,710**
0.43	2.33	16,910	12,420	23,390
0.20	5	42,780	30,500	63,380
0.10	10	74,710	51,340	117,500
0.04	25	128,900	84,690	216,700
0.02	50	178,600	113,900	313,600
0.01	100	235,400	146,300	429,300
0.005	200	299,000	181,400	564,000
0.002	500	392,800	231,800	770,400

Table 2. Calculated percentage of cross-sections meeting the minimum depth and maximum velocity criteria over a range of potential fish passage flows.

Lower Discharge (cfs)	Transects Meeting Min. Depth Criteria (%)	Upper Discharge (cfs)	Transects Meeting Max. Velocity Criteria (%)
45	63.8	4,688	100.0
85	86.2	6,541	100.0
105	91.4	8,920	100.0
181	93.1	9,489	100.0
201	93.1	12,930	96.6
327	98.3	17,710	96.6

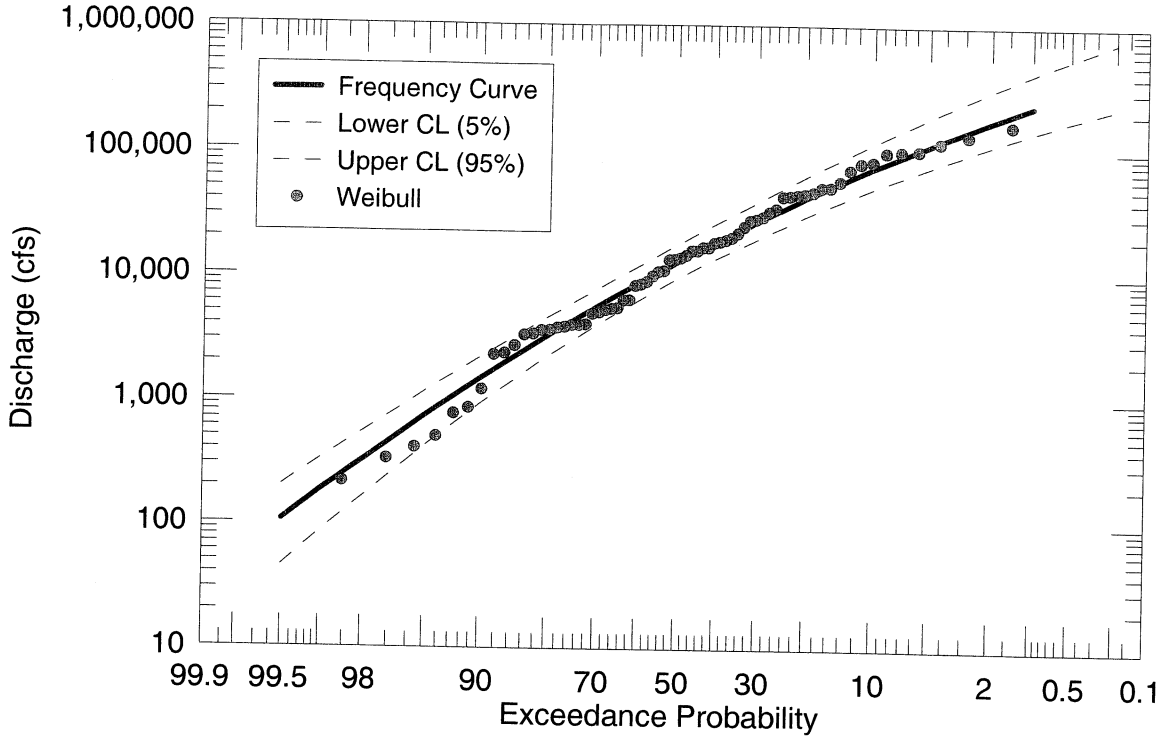


Figure 1. Flood frequency curve (solid line) for the Montalvo stream gage on the Santa Clara River from 1932 - 2005. The upper and lower confidence intervals are plotted as dashed lines bounding the flood frequency curve. Individual annual flow peak magnitudes and their corresponding exceedance probability, using the Weibull plotting function, are shown as circles.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

In response, refer to:
1991/00317:DB

June 10, 2009

Michael Solomon
United Water Conservation District
106 N. 8th Street
Santa Paula, California 93060

Dear Mr. Solomon:

NOAA's National Marine Fisheries Service (NMFS) reviewed the panel's recommended process[1] to guide identification of improvements for the fish-passage facility at the Vern Freeman Diversion Dam. NMFS recognizes the dedication and hard work of the panel in addressing the fish passage issue and appreciate the difficulty of this task. In this letter we outline our specific concerns with the proposed process.

Defining Required Passage Conditions at the Vern Freeman Diversion Dam

If the stated goal of the recommended process (pp. 5) is intended to serve as the fish-passage design objective, the goal should more closely agree with the design objective defined in NMFS' letter of March 3, 2008. NMFS continues to recommend adopting the referenced design objective because it captures standards or requirements defined in the U. S. Endangered Species Act (ESA), which involve ensuring that an action or activity would not jeopardize the continued existence of a listed species, or result in the destruction or adverse modification of designated critical habitat for the species. NMFS will apply these specific standards when processing United Water Conservation District's application for an incidental take permit under Section 10 of the ESA, as well as the following issuance criteria:

- The applicant will, to the maximum extent practicable, minimize and mitigate the impacts of taking, and
- The taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild.

[1] "*Vern Freeman Diversion Dam Fish Panel Recommended Process to Develop Long Term Upstream Fish Passage Improvements Draft – May 18, 2009*" and "*Assessing the Significance of Migration Delay in Steelhead and Pacific Lamprey Spawning Success at Vern Freeman Diversion Dam, Santa Clara River.*"

Because the stated goal has the potential to rely on an underestimate of the true unimpaired migration rate (described more fully below) to guide development of one or more facility improvements, efforts to attain the goal may introduce an amount of migration delay that does not approximate unimpeded migration rates through a freshwater migration corridor. In this regard, the stated goal is not expected to resolve the principal problem precluding endangered steelhead from migrating freely, without delay (i.e., an amount of delay that does not exceed what the species would experience in a mainstem habitat) past the Vern Freeman Diversion Dam (VFDD).

Application of the migration risk delay assessment to the proceedings is not ideally suited for producing the requisite information to inform development of the target passage conditions and improvements for the diversion dam, for two principal reasons. First, the assessment is based on one or more assumptions that simplify complex biotic and abiotic factors known to influence migratory behavior and ecology. The simplifying assumptions increase the potential that unreliable estimates of migration delay would be obtained. Second, determining an acceptable level of migration delay, based on time of arrival at spawning grounds, has the potential to introduce a level of delay into the design of the improvements that is not representative of the unimpaired migration rates steelhead exhibit in an unobstructed freshwater migration corridor. Instead, the panel should focus on estimates of steelhead migration rates in an unobstructed Santa Clara River mainstem, representing a broad range of river discharge, to guide development of the target passage conditions and improvements at the diversion dam.

Evaluation of the Performance of the Steelhead Passage

The recommended process does not include provisions to ensure the overall performance of the steelhead passage at the diversion dam would be properly considered and evaluated. As NMFS states in previous written correspondence, the overall performance of the steelhead passage, not performance of the fish ladder or fish in the ladder, is the principal problem challenging migration of steelhead past the diversion dam (contrary to page 1 of Attachment A, NMFS is not aware of any information that corroborates "successful upstream adult steelhead passage through the fish ladder at Vern Freeman Diversion Dam...has been documented"). Because the recommended process does not appear to apply a sufficient amount of consideration to the performance of the fish passage, relative to the disproportionate level of effort implied for evaluating the existing fish ladder, the recommended process has the potential to omit a scope of review necessary to resolve the main issue affecting steelhead migration.

The Value-Engineering Approach

NMFS has experience applying the value-engineer approach in the context of developing fish-passage design, and this experience indicates certain applications of the approach can lead to selection of an alternative that is not commensurate with the life history and habitat requirements of endangered steelhead. Although NMFS understands the panel proposes to loosely follow a traditional value-engineering approach, there still remains a concern that the recommended approach has the potential to divert focus away from the critical need to select a project alternative that would allow attainment of an ecologically meaningful fish-passage objective (i.e., best performing fish passage ideas and solutions, as stated in the recommended process).

In summary, NMFS strongly recommends the panel focus on evaluating fish passage at VFDD in the context of the migration corridor where it exists. This is essential since this will be the standard by which we will evaluate any future HCP applicants. We believe it would be helpful to have the NMFS and United technical team members meet directly with your panel to discuss these concepts.

Thank you for the opportunity to provide NMFS' views on the recommended process. Please contact Darren Brumback at (562) 980-4060 if you have a question concerning this letter.

Sincerely,

for Rodney R. McInnis
Regional Administrator

cc: Terry Roelofs, Panel Facilitator
Mary Larson, California Department of Fish and Game
File Copy: 151422SWR2001PR6149

This page intentionally blank.

UNITED WATER CONSERVATION DISTRICT

"Conserving Water Since 1927"

March 13, 2009

Dr. Terry Roelofs
120 Pacific Lumber Camp Road
Eureka, CA 95503-9439

Dear Dr. Roelofs:

Enclosed for the panel's information is a copy of the Court Order approving the stipulation between the District and CalTrout. The District has agreed to incorporate into its current (2009) Interim Operations Plan the operational criteria set forth in Reasonable And Prudent Alternative 2.a. from NMFS' July 2008 Final Biological Opinion. This stipulation and order is intended to apply to the current migration season, i.e. through May 31, 2009. Please note though, that the District is also currently working with NMFS technical folks, as part of our Habitat Conservation Plan application process (Section 10 of the ESA), on our interim operations plan. Therefore, our operating criteria is subject to additional changes/improvements based on these technical discussions with NMFS.

As you will also note, the stipulation and order provides that the District and CalTrout will meet and discuss in good faith the panel's objectives and timeline. I believe that all of the parties sincerely desire that the panel move forward with its independent work in as expeditious manner as feasible, consistent with panel members' professional standards. In that light, it would be very helpful for our discussions if you could provide us at your earliest convenience with a current status report, including a description of the panel's activities to date, the panel's objectives and anticipated next steps, and its timeline. We intend to provide copies of the report to all interested parties, including CalTrout and NMFS.

106 N. 8th Street • Santa Paula, California 93060 • Phone (805) 525-4431 • FAX (805) 525-2661 • www.unitedwater.org

UNITED WATER CONSERVATION DISTRICT

Please call me if you have any questions. I realize that this request may create an additional burden for you and the panel, but a current report will be of great assistance in discussions between the parties. Thank you in advance for your help.

E. Michael Solomon
General Manager

cc: Nica Knite, California Trout
Chris Yates, NMFS

Joel Mark, Esq. (State Bar #54049)
jmark@nchc.com
Anthony H. Trembley, Esq. (State Bar #110029)
atrembley@nchc.com
NORDMAN CORMANY HAIR & COMPTON LLP
1000 Town Center Drive, 6th Floor
P.O. Box 9100
Oxnard, CA 93031-9100
Telephone: (805) 485-1000
Facsimile: (805) 988-8387

Paul S. Simmons, Esq. (State Bar #127920)
psimmons@somachlaw.com
Jennifer T. Buckman, Esq. (State Bar #179143)
jbuckman@somachlaw.com
SOMACH SIMMONS & DUNN
813 Sixth Street, Third Floor
Sacramento, CA 95814
Telephone: (916) 446-7979
Facsimile: (916) 446-8199

Attorneys for Defendant
UNITED WATER CONSERVATION DISTRICT

E-Filed: **3/9/09**

UNITED STATES DISTRICT COURT

CENTRAL DISTRICT OF CALIFORNIA

CALIFORNIA TROUT, INC., a California Non-Profit Corporation, Plaintiff, vs. BUREAU OF RECLAMATION; UNITED WATER CONSERVATION DISTRICT, Defendants.	Case No. CV 09-312-GHK (FMOx) [~~PROPOSED~~] ORDER APPROVING STIPULATION RE: MOTION FOR PRELIMINARY INJUNCTION Date: March 9, 2009 Time: 9:30 a.m. Courtroom: 650 Judge: Honorable George H. King

Pursuant to the parties' Stipulation Re: Motion for Preliminary Injunction, and the Court having read and considered said Stipulation, and good cause

appearing, IT IS ORDERED that said Stipulation is approved:

1. Through May 31, 2009, Defendant United Water Conservation District (United) shall: incorporate into its January 16, 2009 "*Proposed 2009 Interim Operations Plan, Vern Freeman Diversion Dam and Fish Passage Facilities, Santa Clara River, Ventura County, California*" (Exhibit 109 attached to the Declaration of E. Michael Solomon in Opposition to Plaintiff's Motion for Preliminary Injunction) (hereinafter "Interim Plan") operational criteria identical to Reasonable and Prudent Alternative 2.a. (RPA 2.a.) contained on page 70 of the Final Biological Opinion dated July 23, 2008 issued to the U.S. Bureau of Reclamation by the National Marine Fisheries Service and denominated as Administrative Record File # 151422SWR01PR6149 (Exhibit 1 to Declaration of Heather M. Minner in Support of Plaintiff's Motion for Preliminary Injunction); and operate the Vern Freeman Diversion Dam and appurtenant facilities consistent with the Interim Plan as so modified.

2. Plaintiff California Trout, Inc. (CalTrout) will not assert to the National Marine Fisheries Service that the interim operation provided in paragraph 1 of said Stipulation is unreasonable or inappropriate for the time period covered by Paragraph 1 of this Order.

3. CalTrout and United shall meet and discuss in good faith the objectives and timeline for the work of the independent fish passage review panel, which has been convened by United.

4. CalTrout's Motion for Preliminary Injunction is hereby taken off calendar and, provided United complies with the provisions of this Order, shall not be re-noticed or re-filed prior to May 31, 2009.

///

///

///

///

///

///

///

5. Nothing in said Stipulation or this Order shall constitute an admission, or be relied upon in any subsequent proceeding in this case for any purpose other than enforcement of said Stipulation and this Order according to their terms. Further, nothing in said Stipulation or this Order shall establish precedent or be asserted in any administrative or adjudicatory context.

Dated: 3/6/09

This page intentionally blank.

APPENDIX B

Proposed 2009 Interim Operations Plan

This page intentionally blank.

UNITED WATER CONSERVATION DISTRICT

"Conserving Water Since 1927"

January 16, 2009

Chris Yates, Supervisor
Southern California Area Office
NOAA Fisheries
Protected Resources Division
501 W. Ocean Blvd., Suite 4200
Long Beach, CA 90802

Re: Proposed 2009 Interim Operations Plan

Dear ~~Mr. Yates~~ Chris:

I wish to thank you for making the presentation to the United Water Conservation District (United) Board of Directors on Wednesday. Your presentation was very helpful and an important step in our combined efforts to finalize a Habitat Conservation Plan (HCP) and for United to obtain an incidental take permit (ITP) for the operation of our facilities. The effort you put forth was important for building an atmosphere of cooperation and mutual respect between our two agencies.

In response to our discussion at the kick-off meeting for preparation of a United Water HCP, I am sending you a copy of our "Proposed 2009 Interim Operations Plan". The plan outlines interim operations for the Vern Freeman Diversion Dam and associated fish passage facilities located on the Santa Clara River in Ventura County, California. We have defined interim operations as those that will be in place while United works with the National Marine Fisheries Service (NMFS) to complete an HCP and ultimately obtain an incidental take permit. We envision that the appropriate long-term operating criteria for protection of species and water resources at the Vern Freeman Diversion would be described as part of a successful HCP and ITP process. The proposed 2009 interim operations plan incorporates recommendations made by NMFS personnel between 2001 and 2008. You will notice that within the plan we provide a figure that compares the proposed 2009 interim operations criteria to the operating criteria used for the 1991-2001 period (baseline operations). This comparison provides a good illustration of how some potential effects to Southern California steelhead could be reduced, as well as how some potential benefits could be achieved, by modifying the baseline operations. The plan also identifies potential modifications to the fish passage facilities. We are committed to evaluate and incorporate, as part of the ITP application process, additional conservation measures to

106 N. 8th Street • Santa Paula, California 93060 • Phone (805) 525-4431 • FAX (805) 525-2661 • www.unitedwater.org

UNITED WATER CONSERVATION DISTRICT

offset the potential effects of our operations. We look forward to your thoughtful evaluation and consideration of our proposed 2009 interim operations plan.

Sincerely,

Mike

E. Michael Solomon
General Manager

Proposed 2009 Interim Operations Plan

Vern Freeman Diversion Dam and Fish Passage Facilities
Santa Clara River, Ventura County, California

January 16, 2009

INTRODUCTION

This document provides a description of the proposed interim operating criteria for the Vern Freeman Dan and Fish Passage facility for the 2009 operating season. Where, for the purposes of this document, interim operations are those operations that will be in place while United Water Conservation District (United) is working with the National Marine Fisheries Service (NMFS) to develop a Habitat Conservation Plan and obtain an incidental take permit that will include the appropriate long-term operating criteria for both protection of the species and protection of water resources at the Vern Freeman Diversion. The proposed 2009 interim operations plan was developed from recommendations provided by NMFS personnel during the period between 2001 and 2008. It is based on data collected by United and others following listing of southern steelhead (*Oncorhynchus mykiss*) as Endangered under the Endangered Species Act in 1997. In contrast to the approved operating criteria that were used prior to 2001 (1991 -2001 Operating Criteria), the proposed plan was developed in consideration of the requirements for steelhead passage downstream of the diversion. Accordingly, the objective of the 2009 interim operations plan is to minimize potential impacts on steelhead by providing sufficient bypass flows over an extended period to maintain passage from the mouth of the Santa Clara River through the Vern Freeman Diversion fish ladder. The 2009 interim operations plan will be managed by a qualified-fisheries biologist that will be responsible for its implementation and collecting monitoring data to evaluate its effectiveness. The following sections present an overview of the operating criteria that was used between 1991 and 2001 and the proposed 2009 interim operations plan.

1991 – 2001 OPERATING CRITERIA

Between 1991 and 2001, the Vern Freeman Diversion Dam and its fish passage facilities were operated in accordance with U.S. Army Corps of Engineers Permit No. 86-116-TS that was issued in 1987. In regards to fish passage flows, the permit requires the following:

> "The flow release schedule is such that during the period February 15 to May 15, after each time river flow recedes to 415 cfs, a 40 cfs bypass flow through the fish ladder shall be maintained for a 48-hour period. The amount by which this reduces the full diversion capacity of 375 cfs shall not exceed on the average 500 af/yr using a 10 year base."

At the time that this operating criteria was developed, steelhead were not listed as Endangered and limited data was available regarding passage requirements for steelhead in the Santa Clara River downstream of the Vern Freeman Diversion Dam. Accordingly, these operating criteria did not specifically incorporate measures to ensure passage of steelhead downstream of the diversion. Figure 1 presents an illustrative example of bypass flows under the 1991-2001 operating criteria using a selected 2003 storm event.

PROPOSED 2009 INTERIM OPERATIONS PLAN

The proposed 2009 interim operations plan includes two primary components: 1) interim modifications to the fish passage facilities; and, 2) proposed 2009 interim operating criteria for the diversion and fish passage facilities. These components are described below.

Interim Fish Ladder Modifications (subject to change based on prioritized list of recommendations from the Vernon Freeman fish ladder review panel led by Dr. Terry Roelofs)

Where feasible, United will implement the following interim modifications to the fish passage facilities to enhance attraction and passage through the fish ladder. The proposed modifications include the following:

1) Installation of floodlights at the entrance of the fish ladder to enhance the attraction of steelhead into the ladder;

2) Removal of the false weir fish counter and installation of a Didson sonar fish detector at the entrance to the fish ladder (Note: A Didson sonar fish detector has been ordered and will be installed within the fish ladder; the false weir fish counter will not be removed until United is confident that the Didson is positioned and operating in an efficient and effective manner)

3) Modification of the trash rack by increasing the spacing between the bars;

4) Modification of the Denil weir plates in the fish ladder (pending the final recommendations of the fish passage review panel);

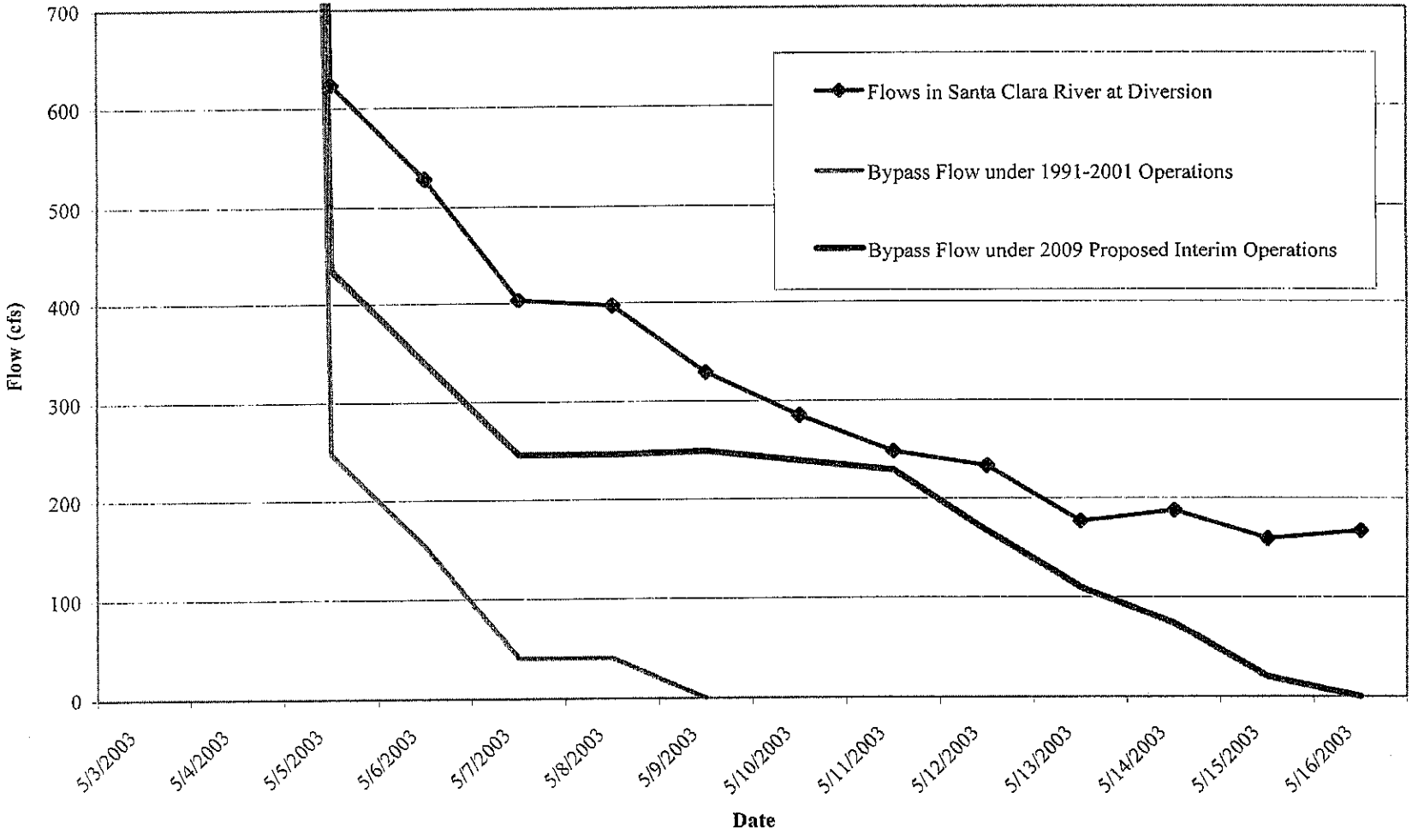
5) Removal of a 10-foot portion of the apron-lip of the diversion dam near the flushing channel; and,

6) Modification of the resting pools within the fish ladder (pending the final recommendations of the fish passage review panel. It should be noted that major concrete work would not likely be completed before the 2009 steelhead migration season.).

Proposed 2009 Interim Operating Criteria

As mentioned above, the proposed 2009 interim operating criteria were developed based on data collected by United and others following listing of steelhead as Endangered in 1997 and recommendations provided by NMFS and others during the period between 2001 and 2008. A detailed description is provided in detail below. In addition, United will monitor water depths below the diversion and adjust ramping flows to ensure that water levels do not decline at a rate exceeding 2-inches per hour. The additional ramping will be done in concurrence with the ramping rates that are included in the downstream bypass flows. Steve Howard, United's fisheries biologist, will provide responsible oversight of the fish passage operations specified in this plan. Monitoring data will be collected during the 2009 steelhead migration season and will be compiled into an annual monitoring report that will be submitted to NMFS and posted on the United website. During 2009, United will operate the Vern Freeman Diversion Dam and associated fish passage facilities as follows (for comparison, Figure 1 presents an illustrative example of bypass flows under the 1991-2001 operating criteria and the proposed 2009 interim operating criteria using a selected 2003 storm event):

Figure 1. Illustrative Example of Bypass Flows under 1991-2001 Operations and Proposed 2009 Interim Operations of the Vern Freeman Diversion Fish Passage Facilities Based on a Selected 2003 Storm Event



A. Several limiting criteria will apply to operating the fish ladder, as described below:

1) United's fisheries biologists will monitor the sand bar at the mouth of the estuary before storms. If the estuary has been sealed from the ocean by a sand bar for more than two weeks before a storm, and if a given storm does not breach the sandbar at the mouth of the estuary, then subsequent fish ladder releases need not be made after that storm. If the peak flows from such a storm were not able to breach the sandbar and maintain access to the river from the ocean, then subsequent fish ladder releases at reduced flow rates are also unlikely to breach the bar. However, when there is doubt as to the breaching of the sandbar, or if there is evidence that adult steelhead may be present in the estuary, the operation will err on the side of running the ladder and providing for upstream migration.

2) If, while the fish ladder is in operation, the estuary has become sealed off from the ocean by a sand bar or other obstruction for more than five days, a four day ramping down may be implemented as described below.

3) United will continue to operate and maintain a fish counter in the fish ladder, to count upstream migrating adults. Note: as discussed above in "Interim Fish Ladder Modifications – Section 2" United has ordered a Didson sonar fish detector to provide for a visual assessment of fish migration through the fish ladder. The Didson will be installed within the fish ladder, however, the false weir fish counter will remain in use until United is confident that the Didson is positioned and operating in an efficient and effective manner. Depending upon recommendations from the Expert Fish Ladder Review Panel, the false weir fish counter may be removed in the future.

4) The fish ladder may be shut down temporarily or on an emergency basis during abnormal conditions that could cause damage to the ladder, such as extensive debris or oil spills (since 1991 the fish ladder has been shut down on a few occasions due to unexpected conditions; in particular, after oil spills in the river). NMFS will be notified of any such shutdown.

5) Whenever the fish ladder is shut down while migration is feasible, it will be inspected by a fisheries biologist to ensure that no adults become stranded.

B. The fish ladder operating criteria described below will be implemented:

1) The upstream migration season for adult steelhead is defined to be January 1 through May 31.

2) During the peaks of storms, when river water turbidity exceeds 3,000 NTU's, all river water will flow through the flushing channel and/or over the crest of the dam. The fish ladder is not operated at these times to protect it from debris or damage.

3) A storm is considered to be large enough to allow upstream fish migration if the storm's peak 24-hour average flow exceeds 200 cfs over base flow. The peak 24-hour average flow is the highest 24-hour running average flow during the storm, measured at USGS Gage No. 11113000 at Sespe Creek near Fillmore.

4) During the period of December 1 through June 15, any water in the river that United is not able to divert due to water rights limitations or operational constraints, when turbidities are less than 3,000 NTU's, will be sent through the fish passage facilities with the following priorities: (a) the first 40 cfs through the fish ladder; (b) the next 80 cfs through the fish ladder auxiliary pipe, whenever United is diverting water or otherwise has water available in the fish screen bay (note: The auxiliary water pipe

does not typically have water available for transmission when United is not diverting water.); (c) flows exceeding 120 cfs, or 40 cfs if United is not diverting water, shall be allowed to flow over the crest of the dam or through the flushing channel. The release of water for fish under this provision will not reduce flows for fish required by other provisions of the operating criteria.

5) From January 1st to March 31st the fish ladder will be operated for up to 18 days after the peak of any storm large enough to allow upstream migration (increase of 200 cfs peak running 24-hour average over the base flow). From April 1st to May 31st (which includes the peak of the downstream migration) the ladder will be operated for up to 30 days after the peak of any storm large enough to meet the ladder initiation criteria. On the last four days of the operation of the ladder the flows will be reduced to 2/3 of the previous day's flow; on the last day a flow of 20 cfs will be provided. This ramping down scenario would occur during the 15th through the 18th days of the ladder operations after storms with a peak occurring from January through March, or on the 27th through the 30th days after storms with a peak occurring from April 1st through May 31st. These criteria are further defined and limited as follows:

a) The flow passing through or over the Freeman facilities during any such fish ladder operation, excluding ramping down flows, will be adequate to provide for a designated minimum discharge at the most critical riffle downstream of the Freeman diversion. The designated minimum discharge at the critical riffle will be defined as follows for storms with their peaks occurring from January 1st to March 31st.

Days of Fish Ladder Operation	Designated Minimum Flows at Critical Riffle (cfs)
1	160
2	160
3	160
4	160
5	160
6	160
7	160
8	150
9	140
10	130
11	120
12	110
13	100
13	90
14	80
15	2/3 of previous day*
16	2/3 of previous day*
17	2/3 of previous day*
18	20*

* Ramping down flow measured at the Freeman Diversion

The designated minimum discharge at the critical riffle will be defined as follows for storms with their peaks occurring from April 1st to May 31st.

Days of Fish Ladder Operation	Designated Minimum Flows at Critical Riffle (cfs)
1	160
2	160
3	160
4	160
5	160
6	160
7	160
8	160
9	160
10	160
11	160
12	160
13	160
14	160
15	160
16	160
17	160
18	160
19	150
20	140
21	130
22	120
23	110
24	100
25	90
26	80
27	2/3 of previous day*
28	2/3 of previous day*
29	2/3 of previous day*
30	20*

* Ramping down flow measured at the Freeman diversion

b) The critical riffle is that place in the mainstem river between Freeman and the estuary where steelhead would have the greatest difficulty passing during low flows. The total releases required to achieve these flows will be released from the fish ladder, through the auxiliary water pipe, and either through the flushing channel or over the crest of the dam.

c) United's fisheries biologists and hydrologists will monitor potentially limiting riffles downstream to ensure adequate passage for steelhead during the period for which flows are to be maintained at the designated flow. The location of the

most critical riffle will be determined as riverbed and flow conditions change. Written records shall be kept of these monitoring results. This work will be done under the oversight of an authorized fisheries biologist.

d) For the ladder operations from January through March: If, after a storm large enough to allow upstream migration, the total river flow drops to a level that, even with all water in the river passing downstream and none being diverted, cannot sustain the designated minimum flow over the critical riffle, then the amount of flow being released will be reduced to 2/3 of the previous day's flow for the next three days, after which time the fish ladder releases will run at 20 cfs for an additional 24 hours. During the ramping down period, United may divert water not being released downstream. The amount of ramping-down flow will be measured at the Freeman diversion, and not at the critical riffle.

e) If, during the ramping down period, natural flows decline faster than the specified 1/3 reduction in flows, so that it is impossible to maintain the specified 2/3 flow, then the natural flow will be used for that 24 hour period.

f) For the ladder operations from April through June: The shutdown criteria will be the same as the operations from January through March with the exception that after the first 12 days of ladder flow, the first 50 cfs in the river will be reserved for diversions for surface water deliveries to the seawater-intruded areas of the Oxnard Plain. The available water for the fish passage will be the total river flow less the 50 cfs diversion.

g) To provide continuity of passage between two subsequent storms that are close together, United will attempt to bridge significant storms with additional days of downstream releases, when feasible. During the ramp down of migration releases from the Freeman Diversion, if another major storm is predicted that would be large enough to create a potential migration event, United will attempt to bridge the two storms with additional water released from the dam.

h) If, during the prescribed fish ladder releases, another storm should occur, within 8 days of the initial storm, that exceeds the peak 24-hour average of the initial storm, then the prescribed fish ladder operating period will be restarted from the peak of the new storm, with the same criteria and limits defined for a single storm. If any storm that exceeds the 200 cfs peak criteria described in item # 3 above occurs after 8 days of the initial storm, then the ladder operation criteria will restart with the peak of the new storm.

i) If the peak of the storm measured at USGS Gage No. 11113000 at Sespe Creek near Fillmore is sufficient to trigger the ladder operations but the peak flow is not sufficient to allow a migration flow of 120 cfs across the critical riffle, the ladder operating criteria will not go into effect and United may divert the remainder of the storm.

j) If, on the last day of operation of the fish ladder, an adult steelhead is observed in the fish counter, the fish ladder operation will be extended for another day at the same flow. If subsequent fish are counted, the operating time will be extended again at the same flow, if necessary, until no adult steelhead has been counted for 24-hours.

6) After a storm large enough to allow upstream migration and trigger operation of the fish ladder, and when the total river flow is less than the prescribed fish ladder releases plus 375 cfs on the day United starts to divert water after the storm, United will ramp up its diversion rate as follows:

   On the first day United will divert up to ½ the remaining water after providing the necessary flows to maintain 160 cfs. This will be repeated on the second day as long as the total flows in the river are sufficient to maintain the minimum fish ladder flows required.

   The intent of this measure is to minimize lateral stranding of adult and juvenile steelhead downstream. It is important to note that during and after this ramping up of diversions; a minimum flow of 160 cfs will be provided downstream, adequate for both upstream and downstream steelhead migration. Therefore, this ramping should cause no longitudinal stranding.

7) The fish ladder entrance gates will be operated to optimize attraction of fish into the ladder. Selection of which, or both, gates are to be used will take into consideration the distribution of flows in the river. The fish exit gate will be operated to minimize head loss and turbulence in the fish ladder bay next to the exit gate, within limitations imposed by the fish counter.

8) So long as it provides the fish release flows described herein, United will continue to divert water within its existing water rights. The maximum diversion rate from the Santa Clara River is limited to 375 cfs. The maximum amount of water diverted from the river in any calendar year is limited to 144,000 AF.

9) Although United normally starts diverting river water when turbidity falls below 1,000 to 3,000 NTU's, that could limit migration of any adult steelhead attempting to migrate in highly turbid storm peaks. To minimize such effects, United will attempt to modify its operations to divert water as soon as possible after a storm.

10) On a trial-and-error basis, United will attempt to operate the fish ladder before water diversions start. The limiting factor is likely to be plugging of the current fish counter grates. Note: as discussed above in "Interim Fish Ladder Modifications – Section 2" United has ordered a Didson sonar fish detector to use in place of the current false weir fish counter. The Didson will be installed within the fish ladder, however, the false weir fish counter will remain in use until United is confident that the Didson is positioned and operating in an efficient and effective manner. Depending upon recommendations from the Expert Fish Ladder Review Panel, the false weir fish counter may be removed in the future. In the interim, if the fish counter grates become plugged, United may try to remove portions of the fish counter during the first day of the fish ladder operations. The results of this trial operation will be provided to NMFS.

11) During critical drought periods, when available groundwater storage space in the Oxnard Forebay is greater than 80,000 AF, as defined in Resolution No. 81-17 by the SWRCB, the fish ladder operating criteria will not change.

APPENDIX C

Cost Estimates

This page intentionally blank.

Table C-1
VERN FREEMAN DIVERSION DAM
FISH PASSAGE IMPROVEMENTS PANEL
OPINION OF PROBABLE CONSTRUCTION COST
Vertical Slot Fishway
September 2010

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	*Mobilization*	*10*	*PCT*		*$ 1,332,000*
2	*Dewatering and Temporary Cofferdams*	*1*	*LS*	*$ 750,000*	*$ 750,000*
3	*Site Restoration*	*1*	*LS*	*$ 150,000*	*$ 150,000*
	DEMOLITION				
4	*Retaining Wall, upstream left bank*	*83*	*CY*	*$ 1,200*	*$ 99,600*
5	*Retaining Wall, downstream left bank*	*171*	*CY*	*$ 1,200*	*$ 205,200*
6	*Retaining Wall, canal fish screen*	*207*	*CY*	*$ 1,200*	*$ 248,400*
7	*Notch in Dam Crest*	*1*	*LS*	*$ 500,000*	*$ 500,000*
8	*Canal Walls and Floor*	*1*	*LS*	*$ 100,000*	*$ 100,000*
	EARTHWORK				
9	*Excavation*	*32,000*	*CY*	*$ 20*	*$ 640,000*
10	*Haul Spoils Off Site*	*15,000*	*CY*	*$ 10*	*$ 150,000*
11	*Backfill*	*15,000*	*CY*	*$ 20*	*$ 300,000*
12	*Riprap removal and hual off site*	*2,600*	*CY*	*$ 100*	*$ 260,000*
13	*Riprap removal and replacement*	*2,800*	*CY*	*$ 150*	*$ 420,000*
	ENTRANCE STRUCTURE				
14	*Concrete, Slab*	*300*	*CY*	*$ 500*	*$ 150,000*
15	*Concrete, Walls*	*150*	*CY*	*$ 900*	*$ 135,000*
16	*Concrete, Weirs*	*41*	*CY*	*$ 1,200*	*$ 49,200*
17	*60"x60" Sluice Gates*	*6*	*EA*	*$ 30,000*	*$ 180,000*
18	*Wall Diffuser Panels*	*350*	*SF*	*$ 50*	*$ 17,500*
19	*Aux Water Shutoff Gate*	*1*	*EA*	*$ 100,000*	*$ 100,000*
20	*Blank Panels*	*900*	*SF*	*$ 150*	*$ 135,000*
21	*Grating and Supports*	*2,970*	*SF*	*$ 35*	*$ 103,950*
22	*Handrail*	*120*	*LF*	*$ 50*	*$ 6,000*
	FISH LADDER AND TRANSPORT CHANNEL				
23	*Concrete, Slab*	*300*	*CY*	*$ 500*	*$ 150,000*
24	*Concrete, Walls*	*650*	*CY*	*$ 900*	*$ 585,000*
25	*Concrete, Weirs*	*55*	*CY*	*$ 1,200*	*$ 66,000*
26	*48"x48" Sluice/Shutoff Gate at Exit*	*1*	*EA*	*$ 20,000*	*$ 20,000*
27	*Grating and Supports*	*3,780*	*SF*	*$ 35*	*$ 132,300*
	APPROACH CHANNEL INTAKE SCREEN				
28	*Concrete, Slab*	*160*	*CY*	*$ 500*	*$ 80,000*
29	*Concrete, Structural Walls*	*250*	*CY*	*$ 900*	*$ 225,000*
30	*Concrete, Retaining Walls*	*180*	*CY*	*$ 1,000*	*$ 180,000*
31	*Fish Screens*	*545*	*SF*	*$ 300*	*$ 163,500*
32	*Fish Screen Support Columns, Steel*	*13,000*	*LB*	*$ 2.40*	*$ 31,200*
33	*Flow Control Baffles*	*1,205*	*SF*	*$ 200*	*$ 241,000*
34	*Backwash Screen Cleaning System*	*1*	*LS*	*$ 400,000*	*$ 400,000*
35	*Sediment Control System*	*1*	*LS*	*$ 200,000*	*$ 200,000*
36	*Blank Panels*	*1,760*	*SF*	*$ 150*	*$ 264,000*
37	*4'x4' Auxiliary Water Gate*	*1*	*EA*	*$ 20,000*	*$ 20,000*
38	*3'x8' Sluice Gate*	*1*	*EA*	*$ 20,000*	*$ 20,000*
39	*18"-Dia Fish Bypass Pipe*	*55*	*LF*	*$ 150*	*$ 8,250*
40	*Grating and Supports*	*2,250*	*SF*	*$ 35*	*$ 78,750*
41	*Handrail*	*250*	*LF*	*$ 50*	*$ 12,500*
	CANAL INTAKE SCREEN				
42	*Concrete, Slab*	*120*	*CY*	*$ 500*	*$ 60,000*
43	*Concrete, Structural Walls*	*220*	*CY*	*$ 900*	*$ 198,000*
44	*Fish Screens*	*675*	*SF*	*$ 300*	*$ 202,500*
45	*Fish Screen Support Columns, Steel*	*12,000*	*LB*	*$ 2.40*	*$ 28,800*
46	*Flow Control Baffles*	*1,215*	*SF*	*$ 200*	*$ 243,000*
47	*Backwash Screen Cleaning System*	*1*	*LS*	*$ 400,000*	*$ 400,000*
48	*Sediment Control System*	*1*	*LS*	*$ 200,000*	*$ 200,000*
49	*Blank Panels*	*1,440*	*SF*	*$ 150*	*$ 216,000*
50	*4.5'x4.5' Auxiliary Water Gate*	*1*	*EA*	*$ 25,000*	*$ 25,000*
51	*Grating and Supports*	*1,800*	*SF*	*$ 35*	*$ 63,000*
52	*Handrail*	*200*	*LF*	*$ 50*	*$ 10,000*

Table C-1
VERN FREEMAN DIVERSION DAM
FISH PASSAGE IMPROVEMENTS PANEL
OPINION OF PROBABLE CONSTRUCTION COST
Vertical Slot Fishway
September 2010

	AUXILIARY WATER PIPELINE					
53	*4'-DIA Auxiliary Water Pipe*	*175*	*LF*	*$ 600*	*$*	*105,000*
54	*4.5'-DIA Auxiliary Water Pipe*	*35*	*LF*	*$ 700*	*$*	*24,500*
55	*6'-DIA Auxiliary Water Pipe*	*260*	*LF*	*$ 1,000*	*$*	*260,000*
	APPROACH CHANNEL MODIFICATIONS					
56	*5'-High Crest Gate, Approach Channel*	*1*	*LS*	*$ 200,000*	*$*	*200,000*
57	*Guide Wall*	*70*	*CY*	*$ 900*	*$*	*63,000*
	DAM MODIFICATION					
58	*6.5'-High Crest Gate, Notch in Dam Crest*	*1*	*LS*	*$ 250,000*	*$*	*250,000*
	ACCESS IMPROVEMENTS					
59	*Gravel Access Road*	*11,700*	*SF*	*$ 10*	*$*	*117,000*
60	*Stair Crossing, Pre-fabricated*	*2*	*LS*	*$ 30,000*	*$*	*60,000*
61	***ELECTRICAL & CONTROLS***	*1*	*LS*	*$ 800,000*	*$*	*800,000*
62	*UNLISTED ITEMS*	*20*	*PCT*		*$*	*2,220,600*
	SUBTOTAL (ROUNDED)				$	14,700,000
	CONTINGENCY	**25**	**%**		$	3,700,000
	TOTAL CONSTRUCTION COST				**$**	**18,400,000**
	ENGINEERING/CONSTRUCTION MGMT/PERMITTING	**30**	**%**		$	5,500,000
	TOTAL PROJECT COST				**$**	**23,900,000**
	TOTAL PROJECT COST (ROUNDED)				**$**	**23,900,000**

AACE International CLASS 5 Cost Estimate - Class 5 estimates are generally prepared based on very limited information, and subsequently have wide accuracy ranges. Typically, engineering is 0% to 10% complete. They are typically used for any number of business planning purposes, such as but not limited to market studies, assessment of initial viability, evaluation of alternate schemes, project screening, project location studies, evaluation of resource needs and budgeting, or long-range capital planning. Virtually all Class 5 estimates use stochastic estimating methods such as cost curves, capacity factors, and other parametric and modeling techniques. Expected accuracy ranges are from -20% to -50% on the low side and +30% to +100% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances. As little as 1 hour or less to perhaps more than 200 hours may have been spent preparing the estimate depending on the project and estimating methodology (AACE International Recommended Practices and Standards).

MWH OPCC Disclaimer - The client acknowledges that MWH has no control over costs of labor, materials, competitive bidding environments and procedures, unidentified field conditions, financial and/or market conditions, or any other factors likely to affect the OPCC of this project, all of which are and will unavoidably remain in a state of change, especially in light of the high volatility if the market attributable to Act of Gods and other market event beyond the control of the parties. Client further acknowledges that this OPCC is a "snapshot in time" and that the reliability of this OPCC will degrade over time. Client agrees that MWH cannot and does not make any warranty, promise, guarantee or representation, either express or implied. that proposals, bids, project construction costs, or cost of O&M functions will not vary significantly from MWH's good faith Class 5 OPCC.

Table C-2
VERN FREEMAN DIVERSION DAM
FISH PASSAGE IMPROVEMENTS PANEL
OPINION OF PROBABLE CONSTRUCTION COST
ALTERNATIVE 6A - 4% ROCK RAMP
September 2010

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	*Mobilization*	*1*	*LS*	*$ 3,500,000*	*$ 3,500,000*
2	*Dewatering and Water Handling*	*1*	*LS*	*$ 1,000,000*	*$ 1,000,000*
3	*VFDD Demolition and Notching (for gates and ramp penetration, incl disposal)*	*2,500*	*CY*	*$ 500*	*$ 1,250,000*
4	*40' L x 8' H Crest Gate*	*1*	*EA*	*$ 290,000*	*$ 290,000*
5	*40' Gate Sidewall, slab, and Spillway concrete*	*350*	*CY*	*$ 1,200*	*$ 420,000*
6	*85' L x 8' H Crest Gate*	*1*	*EA*	*$ 600,000*	*$ 600,000*
7	*85' Gate Sidewall, slab, and Spillway concrete*	*560*	*CY*	*$ 1,200*	*$ 672,000*
8	*82' Wide Ramp Excavation (allowance - depends on foundation needs)*	*35,000*	*CY*	*$ 30*	*$ 1,050,000*
9	*Foundation Preparation Allowance*	*1*	*LS*	*$ 2,000,000*	*$ 2,000,000*
10	*Backfill (sides of ramp walls)*	*5,000*	*CY*	*$ 20*	*$ 100,000*
11	*Concrete - 82' Wide Ramp Retaining Walls (allowance - depends on foundation)*	*5,300*	*CY*	*$ 1,200*	*$ 6,360,000*
12	*Concrete - slab & wall footings (allowance - depends on foundation)*	*5,900*	*CY*	*$ 800*	*$ 4,720,000*
13	*Riprap (d50 = 2.5') for surface of 82' Wide Ramp (assume 4' deep, no filter)*	*6,700*	*CY*	*$ 75*	*$ 502,500*
14	*Concrete - Headworks Structure (20' long w/ headwall, incl foundation allowance)*	*550*	*CY*	*$ 1,200.00*	*$ 660,000*
15	*6' High Roller Gate & Operator (assume 82' L)*	*1*	*EA*	*$ 500,000.00*	*$ 500,000*
16	*Ramp Gate (assume 4' H x 40' L Obermeyer)*	*1*	*EA*	*$ 250,000.00*	*$ 250,000*
17	*60' L x 6' H Rubber Dam (bladder, clamps, install, blower, piping)*	*1*	*LS*	*$ 200,000.00*	*$ 200,000*
18	*60' L Rubber Dam Foundation and Abutment, and cutoff wall*	*350*	*CY*	*$ 1,000.00*	*$ 350,000*
19	*Riprap for Bank Armoring and Scour Protection*	*2,000*	*CY*	*$ 75.00*	*$ 150,000*
20	*Electrical and Controls*	*1*	*LS*	*$ 800,000*	*$ 800,000*
21	*Site restoration*	*1*	*LS*	*$ 100,000.00*	*$ 100,000*
22	*UNLISTED ITEMS*	*20*	*PCT*	*n/a*	*$ 2,547,000*
	SUBTOTAL (ROUNDED)				$ 28,000,000
	CONTINGENCY	**25**	**%**		$ 7,000,000
	TOTAL CONSTRUCTION COST				**$ 35,000,000**
	ENGINEERING/CONSTRUCTION MGMT/PERMITTING	**30**	**%**		$ 10,500,000
	TOTAL PROJECT COST				**$ 45,500,000**
	TOTAL PROJECT COST (ROUNDED)				**$ 46,000,000**

AACE International CLASS 5 Cost Estimate - Class 5 estimates are generally prepared based on very limited information, and subsequently have wide accuracy ranges. Typically, engineering is 0% to 10% complete. They are typically used for any number of business planning purposes, such as but not limited to market studies, assessment of initial viability, evaluation of alternate schemes, project screening, project location studies, evaluation of resource needs and budgeting, or long-range capital planning. Virtually all Class 5 estimates use stochastic estimating methods such as cost curves, capacity factors, and other parametric and modeling techniques. Expected accuracy ranges are from -20% to -50% on the low side and +30% to +100% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances. As little as 1 hour or less to perhaps more than 200 hours may have been spent preparing the estimate depending on the project and estimating methodology (AACE International Recommended Practices and Standards).

R2 OPCC Disclaimer - The client acknowledges that R2 has no control over costs of labor, materials, competitive bidding environments and procedures, unidentified field conditions, financial and/or market conditions, or any other factors likely to affect the OPCC of this project, all of which are and will unavoidably remain in a state of change, especially in light of the high volatility if the market attributable to Act of Gods and other market event beyond the control of the parties. Client further acknowledges that this OPCC is a "snapshot in time" and that the reliability of this OPCC will degrade over time. Client agrees that R2 cannot and does not make any warranty, promise, guarantee or representation, either express or implied. that proposals, bids, project construction costs, or cost of O&M functions will not vary significantly from R2 good faith Class 5 OPCC.

This page intentionally blank.

Table C-3
VERN FREEMAN DIVERSION DAM
FISH PASSAGE IMPROVEMENTS PANEL
OPINION OF PROBABLE CONSTRUCTION COST
ALTERNATIVE 6B - 6% HARDENED RAMP
September 2010

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	*Mobilization*	*1*	*LS*	*$ 1,800,000*	*$ 1,800,000*
2	*Dewatering and Water Handling*	*1*	*LS*	*$ 750,000*	*$ 750,000*
3	*VFDD Demolition and Notching (for gates and ramp penetration, incl disposal)*	*1,700*	*CY*	*$ 500*	*$ 850,000*
8	*80' Wide Ramp Excavation (allowance - depends on foundation needs)*	*25,000*	*CY*	*$ 30*	*$ 750,000*
9	*Foundation Preparation Allowance*	*1*	*LS*	*$ 1,500,000*	*$ 1,500,000*
10	*Backfill (sides of ramp walls)*	*3,000*	*CY*	*$ 20*	*$ 60,000*
11	*Concrete - 80' Wide Ramp Retaining Walls (allowance - depends on foundation)*	*2,300*	*CY*	*$ 1,200*	*$ 2,760,000*
12	*Concrete - slab & wall footings (allowance - depends on foundation)*	*3,900*	*CY*	*$ 800*	*$ 3,120,000*
13	*Concrete - engineered roughness elements*	*200*	*CY*	*$ 1,500*	*$ 300,000*
14	*Concrete - Headworks Structure (20' long, incl foundation allowance)*	*370*	*CY*	*$ 1,200.00*	*$ 444,000*
16	*Ramp Gate (assume 4' H x 40' L Obermeyer)*	*1*	*EA*	*$ 250,000.00*	*$ 250,000*
17	*30' L x 6' H Rubber Dam (bladder, clamps, install, blower, piping)*	*1*	*LS*	*$ 160,000.00*	*$ 160,000*
18	*30' L Rubber Dam Foundation and Abutment, and cutoff wall*	*200*	*CY*	*$ 1,000.00*	*$ 200,000*
19	*Riprap for Bank Armoring and Scour Protection*	*800*	*CY*	*$ 75.00*	*$ 60,000*
20	*Electrical and Controls*	*1*	*LS*	*$ 500,000*	*$ 500,000*
21	*Site restoration*	*1*	*LS*	*$ 75,000.00*	*$ 75,000*
22	*UNLISTED ITEMS*	*20*	*PCT*	*n/a*	*$ 1,358,000*
	SUBTOTAL (ROUNDED)				$ 14,900,000
	CONTINGENCY	**25**	**%**		$ 3,725,000
	TOTAL CONSTRUCTION COST				**$ 18,625,000**
	ENGINEERING/CONSTRUCTION MGMT/PERMITTING	**30**	**%**		$ 5,590,000
	TOTAL PROJECT COST				**$ 24,215,000**
	TOTAL PROJECT COST (ROUNDED)				**$ 24,000,000**

AACE International CLASS 5 Cost Estimate - Class 5 estimates are generally prepared based on very limited information, and subsequently have wide accuracy ranges. Typically, engineering is 0% to 10% complete. They are typically used for any number of business planning purposes, such as but not limited to market studies, assessment of initial viability, evaluation of alternate schemes, project screening, project location studies, evaluation of resource needs and budgeting, or long-range capital planning. Virtually all Class 5 estimates use stochastic estimating methods such as cost curves, capacity factors, and other parametric and modeling techniques. Expected accuracy ranges are from -20% to -50% on the low side and +30% to +100% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances. As little as 1 hour or less to perhaps more than 200 hours may have been spent preparing the estimate depending on the project and estimating methodology (AACE International Recommended Practices and Standards).

R2 OPCC Disclaimer - The client acknowledges that R2 has no control over costs of labor, materials, competitive bidding environments and procedures, unidentified field conditions, financial and/or market conditions, or any other factors likely to affect the OPCC of this project, all of which are and will unavoidably remain in a state of change, especially in light of the high volatility if the market attributable to Act of Gods and other market event beyond the control of the parties. Client further acknowledges that this OPCC is a "snapshot in time" and that the reliability of this OPCC will degrade over time. Client agrees that R2 cannot and does not make any warranty, promise, guarantee or representation, either express or implied. that proposals, bids, project construction costs, or cost of O&M functions will not vary significantly from R2 good faith Class 5 OPCC.

This page intentionally blank.

Table C-4
VERN FREEMAN DIVERSION DAM
FISH PASSAGE IMPROVEMENTS PANEL
OPINION OF PROBABLE CONSTRUCTION COST
Nature-Like Fishway
September 2010

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	*Mobilization*	*10*	*PCT*		*$ 1,571,000*
2	*Dewatering and Temporary Cofferdams*	*1*	*LS*	*$ 2,000,000*	*$ 2,000,000*
	DEMOLITION				
3	*Retaining Wall, upstream left bank*	*83*	*CY*	*$ 1,200*	*$ 99,600*
4	*Retaining Wall, downstream left bank*	*171*	*CY*	*$ 1,200*	*$ 205,200*
5	*Retaining Wall, canal fish screen*	*207*	*CY*	*$ 1,200*	*$ 248,400*
6	*Notch in Dam Crest*	*1*	*LS*	*$ 500,000*	*$ 500,000*
	EARTHWORK				
7	*Excavation*	*60,000*	*CY*	*$ 20*	*$ 1,200,000*
8	*Haul Spoils Off Site*	*44,000*	*CY*	*$ 10*	*$ 440,000*
9	*Backfill*	*16,000*	*CY*	*$ 20*	*$ 320,000*
10	*Riprap removal and hual off site*	*2,600*	*CY*	*$ 100*	*$ 260,000*
11	*Riprap removal and replacement*	*2,800*	*CY*	*$ 150*	*$ 420,000*
	ENTRANCE STRUCTURE				
12	*Concrete, Slab*	*300*	*CY*	*$ 500*	*$ 150,000*
13	*Concrete, Walls*	*150*	*CY*	*$ 900*	*$ 135,000*
14	*Concrete, Weirs*	*41*	*CY*	*$ 1,200*	*$ 49,200*
15	*60"x60" Sluice Gates*	*6*	*EA*	*$ 30,000*	*$ 180,000*
16	*Wall Diffuser Panels*	*350*	*SF*	*$ 300*	*$ 105,000*
17	*Aux Water Gate (Energy Dissipation Valve)*	*1*	*EA*	*$ 100,000*	*$ 100,000*
18	*Blank Panels*	*900*	*SF*	*$ 150*	*$ 135,000*
19	*Grating and Supports*	*330*	*SY*	*$ 60*	*$ 19,800*
20	*Handrail*	*120*	*LF*	*$ 50*	*$ 6,000*
	NATURE-LIKE FISHWAY				
21	*Channel Riprap*	*1,600*	*CY*	*$ 50*	*$ 80,000*
22	*Concrete, Walls*	*1,750*	*CY*	*$ 900*	*$ 1,575,000*
	FISHWAY EXIT				
23	*Concrete, Slab*	*50*	*CY*	*$ 500*	*$ 25,000*
24	*Concrete, Walls*	*140*	*CY*	*$ 900*	*$ 126,000*
25	*Concrete, Weirs*	*10*	*CY*	*$ 1,200*	*$ 12,000*
26	*48"x48" Sluice/Shutoff Gate at Exit*	*1*	*EA*	*$ 20,000*	*$ 20,000*
27	*Grating and Supports*	*100*	*SY*	*$ 60*	*$ 6,000*
	APPROACH CHANNEL INTAKE SCREEN				
28	*Concrete, Slab*	*160*	*CY*	*$ 500*	*$ 80,000*
29	*Concrete, Structural Walls*	*250*	*CY*	*$ 900*	*$ 225,000*
30	*Concrete, Retaining Walls*	*180*	*CY*	*$ 1,000*	*$ 180,000*
31	*Fish Screens*	*545*	*SF*	*$ 300*	*$ 163,500*
32	*Fish Screen Support Columns, Steel*	*6.5*	*TON*	*$ 2,400*	*$ 15,600*
33	*Flow Control Baffles*	*1,205*	*SF*	*$ 200*	*$ 241,000*
34	*Backwash Screen Cleaning System*	*1*	*LS*	*$ 300,000*	*$ 300,000*
35	*Sediment Control System*	*1*	*LS*	*$ 200,000*	*$ 200,000*
36	*Blank Panels*	*1,760*	*SF*	*$ 150*	*$ 264,000*
37	*4'x4' Auxiliary Water Gate*	*1*	*EA*	*$ 20,000*	*$ 20,000*
38	*3'x8' Sluice Gate*	*1*	*EA*	*$ 20,000*	*$ 20,000*
39	*18"-Dia Fish Bypass Pipe*	*55*	*LF*	*$ 150*	*$ 8,250*
40	*Grating and Supports*	*250*	*SY*	*$ 60*	*$ 15,000*
41	*Handrail*	*250*	*LF*	*$ 50*	*$ 12,500*
	CANAL INTAKE SCREEN				
42	*Concrete, Slab*	*120*	*CY*	*$ 500*	*$ 60,000*
43	*Concrete, Structural Walls*	*220*	*CY*	*$ 900*	*$ 198,000*
44	*Fish Screens*	*675*	*SF*	*$ 300*	*$ 202,500*
45	*Fish Screen Support Columns, Steel*	*6.0*	*TON*	*$ 2,400*	*$ 14,400*
46	*Flow Control Baffles*	*1,215*	*SF*	*$ 200*	*$ 243,000*
47	*Backwash Screen Cleaning System*	*1*	*LS*	*$ 300,000*	*$ 300,000*
48	*Sediment Control System*	*1*	*LS*	*$ 200,000*	*$ 200,000*
49	*Blank Panels*	*1,440*	*SF*	*$ 150*	*$ 216,000*
50	*4.5'x4.5' Auxiliary Water Gate*	*1*	*EA*	*$ 25,000*	*$ 25,000*
51	*Grating and Supports*	*200*	*SY*	*$ 60*	*$ 12,000*
52	*Handrail*	*200*	*LF*	*$ 50*	*$ 10,000*

Table C-4
VERN FREEMAN DIVERSION DAM
FISH PASSAGE IMPROVEMENTS PANEL
OPINION OF PROBABLE CONSTRUCTION COST
Nature-Like Fishway
September 2010

	AUXILIARY WATER PIPELINE					
53	*4'-DIA Auxiliary Water Pipe*	*175*	*LF*	*$ 600*	*$*	*105,000*
54	*4.5'-DIA Auxiliary Water Pipe*	*35*	*LF*	*$ 700*	*$*	*24,500*
55	*6'-DIA Auxiliary Water Pipe*	*675*	*LF*	*$ 1,000*	*$*	*675,000*
	APPROACH CHANNEL MODIFICATIONS					
56	*5'-High Crest Gate, Approach Channel*	*1*	*LS*	*$ 200,000*	*$*	*200,000*
57	*Guide Wall*	*70*	*CY*	*$ 900*	*$*	*63,000*
	DAM MODIFICATION					
58	*6.5'-High Crest Gate, Notch in Dam Crest*	*1*	*LS*	*$ 250,000*	*$*	*250,000*
	ACCESS IMPROVEMENTS					
59	*Gravel Access Road*	*11,700*	*SF*	*$ 10*	*$*	*117,000*
60	*Roadway Over Culvert*	*1,200*	*SF*	*$ 10*	*$*	*12,000*
61	*Access Road Easement*	*1*	*LS*	*$ 10*	*$*	*10*
60	*UNLISTED ITEMS*	*20*	*PCT*		*$*	*2,617,900*
	SUBTOTAL (ROUNDED)				$	17,300,000
	CONTINGENCY	**25**	**%**		$	4,300,000
	TOTAL CONSTRUCTION COST				**$**	**21,600,000**
	ENGINEERING/CONSTRUCTION MGMT/PERMITTING	**30**	**%**		$	6,500,000
	TOTAL PROJECT COST				**$**	**28,100,000**
	TOTAL PROJECT COST (ROUNDED)				**$**	**28,100,000**

AACE International CLASS 5 Cost Estimate - Class 5 estimates are generally prepared based on very limited information, and subsequently have wide accuracy ranges. Typically, engineering is 0% to 10% complete. They are typically used for any number of business planning purposes, such as but not limited to market studies, assessment of initial viability, evaluation of alternate schemes, project screening, project location studies, evaluation of resource needs and budgeting, or long-range capital planning. Virtually all Class 5 estimates use stochastic estimating methods such as cost curves, capacity factors, and other parametric and modeling techniques. Expected accuracy ranges are from -20% to -50% on the low side and +30% to +100% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances. As little as 1 hour or less to perhaps more than 200 hours may have been spent preparing the estimate depending on the project and estimating methodology (AACE International Recommended Practices and Standards).

MWH OPCC Disclaimer - The client acknowledges that MWH has no control over costs of labor, materials, competitive bidding environments and procedures, unidentified field conditions, financial and/or market conditions, or any other factors likely to affect the OPCC of this project, all of which are and will unavoidably remain in a state of change, especially in light of the high volatility if the market attributable to Act of Gods and other market event beyond the control of the parties. Client further acknowledges that this OPCC is a "snapshot in time" and that the reliability of this OPCC will degrade over time. Client agrees that MWH cannot and does not make any warranty, promise, guarantee or representation, either express or implied. that proposals, bids, project construction costs, or cost of O&M functions will not vary significantly from MWH's good faith Class 5 OPCC.

APPENDIX D

Panel's Response to Comments Received on the July 30, 2010 Draft Report

This page intentionally blank.

Appendix D contains the Panel's response to comments received on the July 30, 2010 Draft Report. Written comments were received from UWCD and NMFS, and copies of their comments are located in Appendix A. During the review period, CalTrout communicated by phone that they agree with the NMFS written comments, and will defer to NMFS for their comments (pers. comm. Nica Knite to Terry Roelofs, August 31, 2010).

The Panel compiled all of the written comments into a matrix and assigned numbers to each specific comment for reference. Five comment numbers were also assigned to the NMFS transmittal letter, as annotated in Appendix A. The Panel discussed all of the comments during multiple calls, and prepared responses. The responses are noted in the following response matrix, along with a brief description of actions performed for the final report.

This page intentionally blank.

Draft Report Comment Response Matrix

Com-ment #	From	Document Section (Para #)	Context	Comment	Suggested Text (from reviewer)	Panel Response
1	NMFS	Letter, Comment 1	Attraction flow	NMFS expects that either of the two ramp alternatives would represent the superior alternative, that is the alternative that would be consistent with the intent of the Panel's design standard to promote or approximate unimpeded passage conditions...over a broad range of flows, including high flows.	-	Comment noted.
2	NMFS	Letter, Comment 2	Attraction flow	Flow from sources other than the fishway entrance (e.g., sluice-gate releases or crest-gate flows) have the potential to mask detection of the entrance, particularly during periods of elevated flows when adult steelhead are expected to be migrating. The limited attraction capabilities and potential for masking detection of the fishway entrance are features of the existing fish-passage facility and should be avoided as United moves forward...	-	Comment noted. We've encountered this in other designs. Attraction effectiveness addresses this.
3	NMFS	Letter, Comment 3	Moderately high flows	The ecological function and value of moderately high flows...appear to have been underestimated... NMFS recommends that a weight of 10, rather than 6, be assigned to the moderately high flow category.	-	The Pugh matrix spreadsheet was provided to the Group so that all parties may modify weights and ratings as they believe is appropriate. See Section 4.3 for an explanation of the values.
4	NMFS	Letter, Comment 4	Juvenile passage	the final report should include a more thorough comparison of the capabilities of the partial-width rock ramp and the hardened ramp to facilitate passage of juvenile steelhead.	-	Panel assumes downstream passage is intended with this comment, and considered comment in final scoring. All alternatives provide safe downstream juvenile passage, assuming proper design of hydraulic features, and would be similar to natural downstream conditions.

Draft Report Comment Response Matrix

Com-ment #	From	Document Section (Para #)	Context	Comment	Suggested Text (from reviewer)	Panel Response
5	NMFS	Letter, Comment 5	Pugh Matrix	...applying the new design standard as a basis to evaluate the alternatives has the potential to change the final scores for each alternative, perhaps altering the final recommendations of the Panel.	-	At the August 9, 2010 meeting in Los Angeles, NMFS expressed the opinion that the Operative Standard should have quantifiable metrics based on design standards currently used for fish passage facilities. The four alternatives developed for the draft report were designed to meet current standards for fish passage design; therefore, weights of characteristics, and ratings for each alternative in the Pugh comparison matrix were originally based on the design standard. Panel members revisited their individual weightings and ratings of each alternative for the final report.
6	NMFS	Fig 2.2-1	Page 2-9	It is stated that the, "downstream bypass flows will vary depending on percolation rates below the dam". What data were used in this analysis?	-	The referenced text is from a UWCD memo dated 11/05/2009 describing operations so the question will have to be answered by UWCD. The Panel reasons that downstream flows will not likely vary based on percolation rates but that flows will more likely to be established depending on percolation rates.

Draft Report Comment Response Matrix

Com-ment #	From	Document Section (Para #)	Context	Comment	Suggested Text (from reviewer)	Panel Response
7	NMFS	Fig 2.2-2	Page 2-10	How will sediment management change with the various alternatives? For instance, under current operations, the fish ladder is not operated when the turbidity is > 3,000 ntu - will this operation criteria remain?	-	Sediment management will likely be very similar between all alternatives with all alternatives designed to operate at high turbidities because they are separated from the canal and will not cause high sediment loads to the canal or diversion facilities. So the existing operation constraint of not providing fish passage when turbidity is higher than 3,000 NTUs will not remain with the new alternatives. Design features are included in all of the alternatives to enhance or maintain sediment management opportunities (e.g., silt flushing to maintain open conveyances). Sediment transport performance through specific components may vary between alternatives (e.g., the ramps and nature-like fishway may retain residual sediment deposits that require monitoring or maintenance) but not likely to the point that there will be significant management differences among the alternatives.
8	NMFS	-	Page 3-1	What is the scientific basis for the statement that during dry water years, "Inconsequential or significant migratory delay at VFDD might make little difference to annual spawning success"?	-	The farther south, the more sporadic the streamflows particularly in early winter. Although we generally assign a periodicity window for spawning for all water years, there are often many years when this window experiences no streamflows (or barely flowing conditions) early within the 'spawning window'. Under these conditions, passage delay at VFDD would have little consequence on spawning success at the modeled destination. Our design window does not ignore Dry years, using 45 cfs as the lower design streamflow.

Draft Report Comment Response Matrix

Com-ment #	From	Document Section (Para #)	Context	Comment	Suggested Text (from reviewer)	Panel Response
9	NMFS	-	Page 3-1	An explicit statement should be made regarding how the range, or window of spawning stream flows derived from the Ascendograph analysis, was used in evaluating fish passage opportunities at VFDD.	-	Page 3-1 is an introduction to the goals of the risk assessment. The conclusion of the risk assessment are summarized in a new Section 3.4.
10	NMFS	Fig 3.1-1	Page 3-2	At present, stream flow is labeled on a secondary y-axis but no datum is shown, which is a bit confusing. If the shaded curve is the stream flow then perhaps make it darker (or add a dotted pattern to the fill) to make it stand out a bit more.	-	This figure is only illustrative of the ascendograph process, and the shaded area is a hypothetical hydrograph.
11	NMFS	-	Page 3-3	What criteria are used to determine the success of egg incubation, fry emergence, intra-gravel oxygen flow and energy expenditure? Is it simply the flow depth or magnitude at a point in the watershed? If so, this should be stated explicitly, as well as a discussion of how such simplifying assumptions influence the overall interpretation of the results.	-	Yes, flow magnitude inundating the redd was the criterion. Changing the minimum incubation streamflow did affect the number of successful days, but it did for the reference condition of no delay as well.
12	NMFS	-	Page 3-4	It is our understanding that the model would initially be developed with a single end location and that additional runs would be completed to test the sensitivity of the results. Have additional analyses been carried out and if so, will they be included in the final report? One concern is how to interpret results from the ascendograph analysis, which were drawn from a location ~60 miles from the Ocean, at which point there may have been other suitable spawning locations that were bypassed.	-	The ascendograph only models one destination in a given run. We used the farthest destination to really challenge the design window (i.e., make it conservatively wide) for passage during all likely annual hydrographs at VFDD. For the HCP, the ascendograph can be used to evaluate individual prescribed annual hydrographs for many destinations including those discussed previously (e.g., 1 mi up West Sespe Creek).

Draft Report Comment Response Matrix

Com-ment #	From	Document Section (Para #)	Context	Comment	Suggested Text (from reviewer)	Panel Response
13	NMFS	Sec 3.2-2	Page 3-6	How were the input parameters for the ascendograph developed? Presumably these values were derived from the literature but no references are cited in this section.	-	The input paramters were developed by Trush, United staff, and local observations. We chose conservative estimates for parameters that would require a wide window in passage design streamflows at VFDD. A monitoring plan should be constructed to provide empirical estimates. This could be done even before adult steelhead return.
14	NMFS	-	Page 3-15	What was the reason that the SLOW migration had more successful migration days in 3/4 of the Water Years (WY 2001,2003 and 2006) in comparison to the FAST migration scenario? This seemed counterintuitive.	-	It does seem counterintuitive.The SLOW migration provided more days within which to be successful, than the FAST migration. Under SLOW, a fish could better hold-out along the migration route (i.e., wait), then proceed when flows were favorable all within the maximum time allowed in the ascendograph model (i.e., more days allowed to succeed under SLOW than FAST). Perhaps a better label to the bundled parameters should have been Short-Timeframe (FAST) and Long-Timeframe (SLOW).
15	NMFS	Fig 3.2-9	Page 3-18	How were the passage flow barriers determined?	-	Barrier flows were estimated using the annual hydrographs and relationships between streamflow and riffle crest depths. Again, the estimates were conservative given the uncertainty.

Draft Report Comment Response Matrix

Com-ment #	From	Document Section (Para #)	Context	Comment	Suggested Text (from reviewer)	Panel Response
16	NMFS	-	General Ascendograph Comments	Overall, the ascendograph method is an innovative approach to assessing migration delay and the spawning risk associated with fish passage issues at VFFD. These are both poorly understood processes in the Santa Clara River (and elsewhere) and the ascendograph offers a first-cut at establishing the importance of both spawning risk and migration delay at VFDD. As stated previously, NMFS has certain reservations regarding the interpretation of the results, primarily related to several assumptions and the fact that only a single run was completed over the year that the Panel conducted their analysis. If the results were to be used in determining a meaningful flow range, a more rigorous sensitivity analysis should be completed. Without additional scenarios the overall results and the error associated with various assumptions remain difficult to interpret.	-	The Panel used the farthest destination to really challenge the ascendograph (i.e., make it conservatively wide) for establishing its recommended design window of passage streamflows. This provided the Panel with an analytical justification for its design window. Additional sensitivity analyses might have resulted in some adjustment of threshold streamflows among the 4 categories encompassing the overall 45 cfs to 6000 cfs range, e.g., the 500 cfs to 2000 cfs category might have been 500 cfs to 2500 cfs.
17	NMFS	Section 4.2	Page 4-3	It is stated that, "'The 95% mean daily exceedance flow during the fish migration period (January to May) is approximately 50 cfs…". We do not have issue with a flow of ~50 cfs as the lower design flow but were curious what gage data were used in this calculation? USGS at Montalvo?	-	This information referenced the NMFS letter of June 23, 2010 in which it states that the data is based on the USGS gage at Montalvo.
18	NMFS	Table 4.2-1	Page 4-4	How was a weighting of 6 determined for the mid-high flow range?	-	See section 4.3 for explanation.

Draft Report Comment Response Matrix

Com-ment #	From	Document Section (Para #)	Context	Comment	Suggested Text (from reviewer)	Panel Response
19	NMFS	Table 4.2-1	Page 4-4	How were the flow range categories (i.e. low, mid-low, mid-high and high flow) developed? It appears that they were derived via a combination of flow exceedance analyses, consideration of fishway flows and the ascendograph analyses, though a more explicit description of the methods used in this analysis is warranted.	-	See section 4.3 for explanation.
20	NMFS	Section 7.1.5	Page 7-6	Is there any more information on how the alternatives performed in terms of safety for juvenile fish? As it stands now, the section is fairly brief.	-	No other information. Scoring based on judgment. Explanation expanded in text.
21	NMFS	Sec. 6.3	Page 6-17	Quantify and/or qualify the statement "the rock ramp would need to be closed to high flows to protect substrate". What river discharge is considered high flow, as referenced? The statement indicates the rock ramp would be closed and not function as fish passage under such flows, yet Table 6.3-1 suggests it will be operational up to 18,900 cfs. Subsequent text further suggests that flows will be managed/maintained at 1,500 cfs or less in the rock ramp to protect substrate.	-	Flow in the rock ramp is limited to 1,500 cfs. At river flows greater than 18,900 cfs flow in the rock ramp can not be maintained at or below 1,500 cfs and still preserve a hydraulic drop at the flow control weir of one foot or less to enable fish passage. At flows greater than 18,900 cfs the rock ramp would be closed and fish passage would no longer be possible. The text was edited to reflect this statement.
22	NMFS	Sec. 6.3.2	Page 6-23	Reference or define "when fish passage is not required" in context with this paragraph.	-	Agree, text was changed to, "If there ever is a time when fish passage is not required..." Context is related to a future time when fish runs for target species are well enough defined that a consideration could be addressed to close the ladder in non-run seasons. Text also addressed in Section 6.4.2.

Draft Report Comment Response Matrix

Com-ment #	From	Document Section (Para #)	Context	Comment	Suggested Text (from reviewer)	Panel Response
23	NMFS	Sec. 6.4.1.1	Page 6-31	The last sentence of the first paragraph states that fish passage is not required when flows are greater than 6,000 cfs. This statement is not consistent with the Design Standard (Page 1-2) and appears to mischaracterize the design flow categories, where flows greater than 6,000 cfs may be considered less critical for design criteria/performance due to frequency of occurrence, but not excluded. Please delete "when fish passage is not required".	-	Agree, text edited.
24	NMFS	Sec. 7.1.1	Page 7-1	For text and Table 7.1-1, see above comments to Table 4.2-1	-	See response to Comments 18 and 19.
25	NMFS	Table 7.5	Page 7-9	Table 7.5-1 Summary of Key Characteristics for each Alternative presents Fish attraction at high flows, but does not include the other flow categories.	-	Description in Table 7.5-1 was meant to cover all flows. Clarified in table.
26	NMFS	Table 7.5	Page 7-10	Table 7.5-1: This Table does not include all Characteristics used in Comparison Matrix ((Table 7.6-1). While the title suggests this table may only summarize the "key" characteristics, lower weighted characteristics (Attraction and passage of non-target species - 3) are discussed, yet higher weighted characteristics (Fish attraction categories - 10) are not.	-	Table is meant to show only characteristics that vary significantly among alternatives. Clarified.
27	NMFS	Sec. 7.6	Page 7-12	Reference to Table 7.1-2 should be Table 7.6-1.	-	Agree, text edited.

Draft Report Comment Response Matrix

Com-ment #	From	Document Section (Para #)	Context	Comment	Suggested Text (from reviewer)	Panel Response
28	NMFS	Table 7.6-1	Page 7-14	Simplicity of fish passage operations: As briefly discussed during the August 9 meeting and upon further review of the draft report, the relative high scoring of the Vertical Slot Ladder does not appear reflective of the overall complexity of this alternative or consistent with the description of this characteristic provided on page 7-7.	-	Panel discussed comment and considered in final scoring.
29	NMFS	Sec. 9	Page 9-1	The statement in reference to dam removal, "It would be a long-term project and could not likely be accomplished in a time frame necessary for recovery of steelhead" should be deleted. The time frame for recovering endangered southern California steelhead has not, and likely cannot, be accurately predicted at this time.	-	Sentence removed.
30	UWCD	1.2	Last paragraph before "Design Standard" section	Because the settlement agreement refers to the "operative standard", United prefers that the report continue to use that terminology.	..."operative standard"…is equivalent to "design standard"…	Agree, text edited.
31	UWCD	1.2	1st paragraph of "Design Standard" section	...success of steelhead trout in the Santa Clara River that equals or approaches unimpeded migration rates through the river corridor.	Replace "through the river corridor" with "past the Freeman Diversion Dam."	Agree, text edited.

Draft Report Comment Response Matrix

Com-ment #	From	Document Section (Para #)	Context	Comment	Suggested Text (from reviewer)	Panel Response
32	UWCD	2.1.2 (page 2-8)	last paragraph on page 2-8	The Santa Clara River bed had been degrading since at least the mid-1950s. This was caused by a combination of artificial channelization and in-river mining activities. Halting degradation above the diversion was one of two primary project goals (the other being harvesting additional yields to combat groundwater overdraft). UWCD backfilled the upstream area up to the crest of the dam in order to both eliminate beach erosion concerns and California Division of Safety of Dams jurisdiction.	-	Comment noted and clarified in text.
33	UWCD	2.2 (page 2-9)	first paragraph on page 2-9, Typo	"They typically turn out is for eight…"	Typically, the diversion is turned out for...	Agree, text edited.
34	UWCD	Sec. 3	General	The ascendograph uses the upper Sespe as the targeted spawning site. The documentation of steelhead at this site is very sparse if at all. How do the final results compare when using a site much closer to the ocean that has a much better recorded history of Steelhead for example the Santa Paula Creek site. A paragraph summarizing how a closer site may affect your results would be helpful. Additionally what would happen if it was even further away and less assessable due to a flashier system like Piru Creek?	-	Several ascendograph runs were performed for Santa Paula Creek 9 miles upstream from its confluence with the Santa Clara River. These results were relayed at one of the Los Angeles meetings. This assumed fish passage facilities on Santa Paula Creek would be great in the future. The results had no effect on narrowing the 45 cfs to 6000 cfs window, but the overlap of storm events in individual water years was important. We did not model Piru Creek. Comment noted.

Com-ment #	From	Document Section (Para #)	Context	Comment	Suggested Text (from reviewer)	Panel Response
35	UWCD	Sec. 3	general	We understand that many of the components that went into the model were based on the panels personal expertise and knowledge. It would be helpful to reference all the assumptions made to a study or as personnel estimate.	-	Yes. The literature was not helpful for most parameters, especially the most important ones. This need, to apply a large dose of professional judgment, can be addressed in monitoring ... where very specific needs can be targeted. For example, developing a quantitative window of passage flows for Sespe Creek Canyon. For the HCP, considerably more sensitivity analyses will be needed for assessing the wide range in annual hydrographs that will likely be evaluated.
36	UWCD	3.2.2	A 50-day Egg Incubation Period	A 30-day egg incubation period. The ascendograph used conservative values for the variables used in the model. It would be interesting to see what a 30 day incubation period would look like. Santa Clara River temperatures are higher than what would be considered for 50 day incubation.	N/A	We did explore some range in incubation period. The number of successful days was sensitive to the minimum incubation streamflow, that gradually tapered-off into the summer, and a faster incubation period. However, the baseline scenario of no delay and scenarios with delay both seemed equally affected. For the HCP, a shorter incubation period may make a significant difference in recommending annual flow regimes.
37	UWCD	3.2.3 (page 3-19)	general	Scenario # 2 assumes if fish encounters flows in excess of the design flow, it would expire in 3 to 5 days. This is problematic because the scenario allows for fish to move into the system at high flows (in excess of 12,000 cfs) when in reality fish are likely not entering the system then. Page 6-33 of the draft report even states that "During high flows (greater than 12,000cfs) steelhead are likely not actively moving upstream ….." In combination, these conditions inflate the number of unsuccessful fish at the dam than what would occur in reality.	If the panel feels that migration halts at elevated flows then either the model run scenario # 2 should clarify the results to state that the delay values are over estimated due to the natural delays in the river or a model run could be done with fish migration halting on their own in natural conditions and then progressing when those flows have subsided.	Several scenarios similar to the one identified were explored, but had no effect on changing the design window's upper streamflow. However, in the HCP these model limitations should be revisited, if the ascendograph is used, to help assess annual instream flow releases.

Draft Report Comment Response Matrix

Com-ment #	From	Document Section (Para #)	Context	Comment	Suggested Text (from reviewer)	Panel Response
38	UWCD	3.2.4 (Page 3-26)	-	The conclusions drawn here need to consider the unique geology and the historical information of this section of the river (forebay). Historical accounts stated that in the summer the forebay would dry up, leaving a dry a barren floodplain. It had no riparian corridor due to the natural percolation in the river with or without pumping. Currently and probably historically 50 cfs thins out to flow only a couple of inches deep in this reach. If the panel wishes to keep this section in the report, we would be glad to share all of our historical documentation, geological reports, pumping data, historical percolation studies and modeling results that discuss this section of the river.	-	The 45 cfs lower design streamflow was considered to have a marginally passable riffle depth for a sand-bedded river. It was recommended to ensure that future recovery efforts (i.e., a restored groundwater table and surface baseflows) would not be thwarted by a passage facility that couldn't pass fish at these 'restored' baseflows.
39	UWCD	Figure 3.2-1	-	It's hard to distinguish between red and orange on the map	-	Comment noted.
40	UWCD	Fig. 3.2.7 and 3.2.8	Graphs	The graphs show the total successful days based on the “Fast Migration Baseline” and the “Slow Migration Baseline” The results show that a fish in 2003 would be more successful at the slow migration rates than the faster migration rates. If correct, please provide and explanation why.	-	Yes. Basically, the SLOW scenario gives the fish much more time in which to reach the spawning destination. The ascendograph modeling was more sensitive to the extended duration in which to be successful than sensitive to a higher daily average migration rate.
41	UWCD	6.1	last paragraph on page 6-1	Dam removal will result in channel stability…	Dam removal more likely will result in channel instability at least for some period	Agree, text edited.

Draft Report Comment Response Matrix

Com-ment #	From	Document Section (Para #)	Context	Comment	Suggested Text (from reviewer)	Panel Response
42	UWCD	6.1	general	Issues which are understandably beyond the Panel's scope are real. The social and water management challenges with the dam removal option cannot be overstated. Adding some numbers may help provide some perspective on why this alternative is complicated from a water supply angle.	United has diverted an average of 78,000 AF per year since the diversion was built in 1991. During this time Lake Piru has provided an average annual available storage of 29,000 AF. More than half of this water is delivered to the upper basins leaving the Freeman Diversion with about 15,000 AF on average. This would represent an 80% loss in diversions to an already over drafted basin. Additionally water reliability would go down because the diversions could no longer rely on the upper basins drainage via rising groundwater during the droughts. The diverted yield from the Santa Clara (non-Piru) watershed helps support the water needs of a population of over 200,000 and a globally important agricultural resource which produces $1B in annual economic benefit.	Water issues with dam removal were emphasized more for this alternative's description and evaluation. Most of the suggested text was not included because of a lack of logical location in this alternative's write-up. The percent of contribution from Lake Piru to the total diversion was listed in the text to emphasize the relative amount of sources available to VFDD. The Panel recognizes that a large-scale change in integrated, regional water management and land use planning is needed for this alternative to be viable.

Draft Report Comment Response Matrix

Com-ment #	From	Document Section (Para #)	Context	Comment	Suggested Text (from reviewer)	Panel Response
43	UWCD	6.1 (page 6-2)	“advantages” bullets 2&3	As mentioned in the disadvantages, the head cutting could be a problem with bank erosion and other morphology changes, this head cutting may also create or make worse current barriers in Santa Paul Creek and as far up as the Sespe. Additionally the channel has been confined throughout the river. This constriction would likely not allow the river to ever re-stabilize to its historic conditions.	Delete both items and/ or include also in "disadvantages"	Agree, text edited.
44	UWCD	6.1 (page 6-2)	“disadvantages” bullet 4	Head cutting will have very serious consequences, and it is very unlikely that the river would regrade to pre-dam conditions. Pre-dam riverbed conditions were seriously unstable and that the river has been channelized with only a fraction of its ancestral flood plain remaining. Head cutting would very likely extend to the next upstream hardened features and result in relocating the passage issues to Santa Paula and Sespe Creek(s). The process of extending head cutting will have significant impacts of the riparian habitats.	Delete "Over the long term…"	Agree, text edited.
45	UWCD	6.1 (page 6-3)	last paragraph says"...fish passage at VFDD costs more than a dam removal…	The statement regarding relative costs is not necessary.	Delete sentence.	Agree, text edited.
46	UWCD	6.2.1.2 (3rd paragraph)	“The ladder goes through the existing retaining wall…”	Elsewhere it is indicated that this wall is to be removed.	The ladder goes through the location of the existing retaining wall.	Agree, text edited.
47	UWCD	6.2.2.5	Typo at end of 2nd paragraph	“…as it is currently.”	…currently done.	Agree, text edited.

Draft Report Comment Response Matrix

Com-ment #	From	Document Section (Para #)	Context	Comment	Suggested Text (from reviewer)	Panel Response
48	UWCD	6.3.1.3	Question(s)	Is an 82 ft. wide roller gate being suggested? Or would there be a series of bays?	-	The 82 ft wide gate is described in context of the required span, and multiple gates with support piers would likely be required. The text has been revised to clarify this point.
49	UWCD	6.3.2.2	last paragraph states "…operated continuously throughout the fish passage season…"	Continuous seasonal operation is not practical. Natural passage opportunities often only occur in separate pulses separated by low flow periods. There will likely be many years that the ladder will be shut off between upstream migration events, and when we are no longer able to maintain a suitable migration corridor for smolts. Many years, this may be during the peak of the smolt migration season. The panel should evaluate this project expecting that the ladder will be shut off during these times.	-	Comment noted. Design focused on fish passage operational capabilities. Flow needs will be addressed in the HCP process. The text was edited to reflect this concern.
50	UWCD	6.3.3.1	first paragraph - Materials Required	Local rock is presently available, but it is of low density (Caltrans standards typically need to be waived to accept local rock.) Other high density sources must come from the far side of Los Angeles County.	-	Comment noted, and high density rock would be required. Text was edited to suggest further research on rock procurement, transport, and placement costs.
51	UWCD	6.2.3.2	1st paragraph states "…sandstone bedrock layer…"	Bedrock at the site(s) is soft siltstone.	-	Comment noted. Text edited.
52	UWCD	6.4.1.1	2nd to last paragraph states "…river flows greater than 6000 cfs…"	Delete "…when fish passage is not required."	Consider instead adding "The effects on passage at higher flows in unknown."	Agree, text was changed to, "If there ever is a time when fish passage is not required..." Context is related to a future time when fish runs for target species are well enough defined that a consideration could be addressed to close the ladder in non-run seasons.

Draft Report Comment Response Matrix

Com-ment #	From	Document Section (Para #)	Context	Comment	Suggested Text (from reviewer)	Panel Response
53	UWCD	6.4.2.2	-	Discussion of fall-back in ramp alternatives appears more rigorous than the same discussion for the technical fishway alternatives. It seems the exit for fishways is nearer the flushing channel than the exit for the ramps. Wouldn't fallback risk be worse for the technical fishway exit?	-	Fish exiting either of the ramp alternatives will find themselves in mid river channel and must negotiate high river velocities to reach the river's edge where velocities are lower and much migration occurs. Fish exiting the technical fishways will be exposed to lower river velocities along the river bank.
54	UWCD	6.4.5	both Strengths & Weaknesses sections	The hardened ramp could even increase flood capacity. We are unsure as to why ramp access is difficult. As shown it should be a simple system of ladders to reach the dewatered ramp floor from the existing roller gate platform. Perhaps this superior access (relative to 4% rock-ramp) this could be seen as a strength.	-	Agree, flood capacity could be increased with the ramp, and also with the crest gates associated with any of the alternatives. The access issue was clarified in text to consider personnel and equipment access.
55	UWCD	6.4.6	Typo "…rock ramp…" on last sentence of first paragraph	Delete “rock” from rock ramp.	-	Agree, typo corrected.
56	UWCD	6.5	Stranding Survey Potential for Alternatives	This alternative could have a high potential for stranding during ramp-downs and shut-downs. Fish could become impinged in rock crevices and be difficult to rescue.	N/A	Agree, text edited.
57	UWCD	6.5.5.2	Suggested additional text	This alternative could become damaged during flood events even with gates. It is imperative that any new facility can withstand 100,000+ cfs with huge debris flows.	Potentially vulnerable to flood events	Test was added to sections 6.2.1 and 6.5.1 to indicate that the design of both these alternatives provide the same flood protection as is currently provided to the existing canal and ladder facilities.
58	UWCD	Table 6.2-1	-	Value for first row in column labeled "Fish Ladder Flow" appears incorrect (50 cfs in the first row). Should this be 31 cfs?	-	Agree, text edited.

Draft Report Comment Response Matrix

Com-ment #	From	Document Section (Para #)	Context	Comment	Suggested Text (from reviewer)	Panel Response
59	UWCD	Figure 7.1-2		It appears that the panel estimated the total attraction flow of the existing fishway to be around 80cfs. Please revise to show that the Ladder is capable of 40 cfs, the auxiliary 80 cfs, and in the past few years we have augmented the attraction with the sluice gate with another 150 cfs. That would bring a total attraction of 270 cfs. So at 1000 cfs in the river the graph should be showing around 27% attraction. If the rating system on page 7-14 was based on the incorrect attraction flows please revise.	-	Entrance flow was wrongly estimated at 80 cfs; corrected to 120 cfs. Sluice flow was assumed up to 4,000 cfs similar to other alternatives; corrected to current condition of 150 cfs. Final calc: Q=80+40+0.4(150)=190. Figure updated.
60	UWCD	7.1.1	Typo in first bullet on page 7-4	...an\ auxiliary water systems for attraction.	Delete "an"	Agree, text edited.
61	UWCD	7.1.2	First sentence of 4th paragraph	Does not appear to follow… lower scores because of less risk of fallback?	Replace "less" with "greater"	Agree, text edited.
62	UWCD	7.1.6	Passage Monitoring	This will be crucial to understanding success of any new facility. Didson could be used downstream and maybe physical trapping at the exit (?) for the rock ramp designs.	N/A	Added comment that other means are available for evaluation of project.

Draft Report Comment Response Matrix

Com-ment #	From	Document Section (Para #)	Context	Comment	Suggested Text (from reviewer)	Panel Response
63	UWCD	7.1.6	Passage Monitoring	We encountered a problem with flow and smolts going over the dam during our first year of smolt bypass flows. United maintained minimum diversions of 40 cfs and maintained 120 cfs at the downstream end of the losing reach of the river. There was on average ~60 cfs surface water loss which means a total of 200 cfs was released at the dam. That 200 cfs was either both flowing through the fish ladder and auxiliary canal (~90 cfs) and over the dam (~110 cfs) or just over the dam (200 cfs). We need to have control of smolts passing the Freeman Diversion facility when we end the bypass flows. The problem is that smolts migrating over the dam could become stranded as flows are ramped down. We need to be able to release the required flow for volitional passage but be able to monitor smolts passing the facility and be able to stop fish from passing when the flows recede below what is favorable. In other words, is there a way to release up to 250 cfs to the lower river while controlling the bypass flow from the facility and not losing control of flow so fish can remain above the dam and then be trapped and relocated?	N/A	Passage monitoring is intended to deal with monitoring of upstream migrants. The comment made has to do with safety of downstream smolt migrants. The risk of stranding downstream migrants in the channel below VFDD and a possible solution are described in Section 7.1.5, safety of juvenile fish.
64	UWCD	Table 7.5-1	under characteristic of flood impacts (page 7-11)	Flood impacts for the rock ramp show a + and then state that head works restrict flood capacity. Shouldn't the impact be scored as a negative?	change "+" to "-"	Table is meant to show key differences among alternatives. No alternative negatively effects flood capacity. Flood impacts removed from table.

Draft Report Comment Response Matrix

Com-ment #	From	Document Section (Para #)	Context	Comment	Suggested Text (from reviewer)	Panel Response
65	UWCD	Table 7.5-1	Operation & Maintenance	Rock Ramp - Proposed flood gate between flush channel and ramp may make access difficult./ Hardened Ramp – Why is access considered difficult for this alternative? A ladder from existing roller gate platform is feasible.	-	Noted that poor access is for equipment.
66	UWCD	General	-	It seems that either of the two ramp alternatives would allow for the existing ladder to remain in operation. Improvements suggested in the documentation could be included (larger turning pools with rest areas, improvements to entrance, exit and auxiliary water system). Two passage facilities, with the flushing channel between, might be advantageous.	-	Comment noted. Utilizing the existing fishway during low flows was considered as an option for low flows for each ramp alternative, but moving operations between a ramp and the existing ladder would require shutting down the ramp which could result in fish strandings.