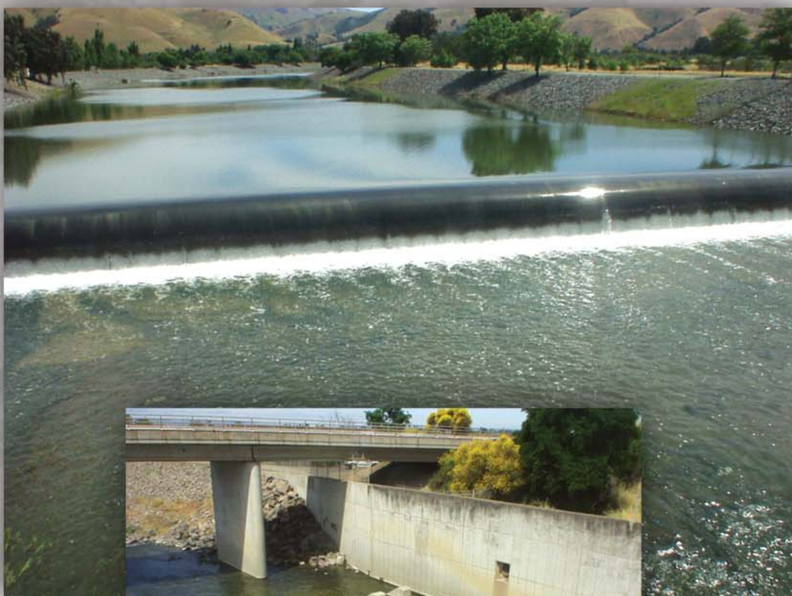
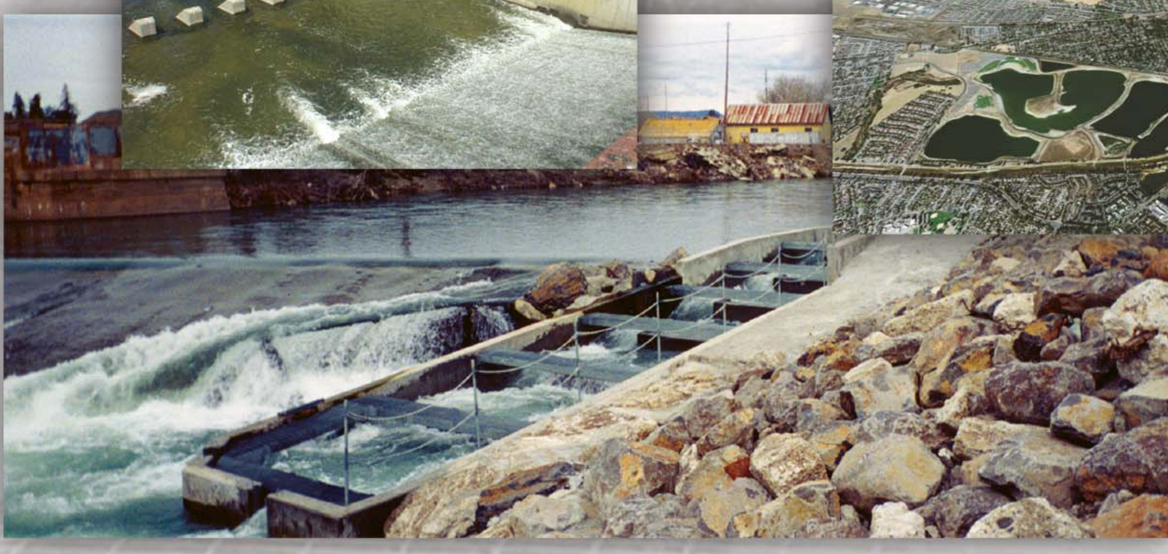
ALTERNATIVES EVALUATION REPORT

LOWER ALAMEDA CREEK/BART WEIR FISH PASSAGE ASSESSMENT





Alameda County Flood Control & Water Conservation District

December 14, 2006

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Introduction

In 1972, a grade stabilization structure was constructed across the Alameda Creek Flood Control Channel. The structure is referred to as the BART (Bay Area Regional Transit) Weir. The purpose of the structure is to protect the foundation elements of the Union Pacific Railroad (UPRR) and BART bridge crossings from scour and loss of stability. Since both rail crossings were designed to be supported by shallow foundations, i.e. piers atop spread footings, maintaining the geostructural integrity of subgrade beneath the footings is paramount. In addition to the weir, the channel was also armored to maintain streambed stability within the reach. The responsibility of ownership, operation, and maintenance of this flood control system was dedicated to the Alameda County Flood Control and Water Conservation District (ACFC&WCD) upon its completion.

At the same time the weir complex was being constructed, the Alameda County Water District's (ACWD) Middle Rubber Dam was built immediately upstream of the BART Weir. The purpose of this facility is to impound and divert raw water into ACWD's adjacent groundwater recharge reservoirs to offset the flood control project's adverse impacts on the Niles Cone Groundwater Basin. The combination of the weir and water supply facilities significantly affected the hydraulic gradient of the creek within this localized reach and compounded the vertical offset between upstream and downstream water surface elevations. When the dam is inflated and in service, the overall water surface differential across the collective facilities is approximately 22-feet. This drop is comprised of 9-feet at the weir plus 11-feet at the rubber dam plus 2-feet at the rock weir downstream of BART Weir.

Prior to implementation of the flood control and water supply improvements, the U.S. Army Corps of Engineers (USACOE) determined that Alameda Creek and its tributaries did not sustain a viable anadromous fishery. Considerations for both upstream and downstream fish migration were therefore not included in the design of the structures. Since that time, anecdotal reports and actual field trappings suggest the contrary, as steelhead, Coho, and Chinook salmon have all been observed within the tailrace of the weir (Kidd, 2006).

In response to environmental concerns and the listing of steelhead within the respective ESU, a Technical Advisory Committee was created in 1999. The Committee is comprised of the ACFC&WCD, the ACWD, regulatory agencies, special interest groups, and various other stakeholders. The primary objectives of the group are to restore access to former spawning habitat upstream of several artificial barriers in Lower Alameda Creek and to contribute to the overall population recovery of anadromous species within the watershed. Subordinate but important goals are keeping upstream water supply capabilities whole and making certain flood control functions are not compromised.

In the wake of the above Committee being formed, several studies have been launched to assess environmental conditions at the site along with the feasibility of various corrective alternatives aimed at achieving these objectives. In February of 2000, a report entitled, "An Assessment of the Potential for Restoring a Viable Steelhead Trout Population in the Alameda Creek Watershed," was published identifying the obstacles within Alameda Creek that obstruct the sustainability of a healthy steelhead population. The BART Weir complex was recognized as a barrier to upstream fish passage.

Two plausible options for improving fish passage at the BART Weir complex have been studied at a concept level. The first concept is a composite vertical slot/pool-and-weir fishway arranged to facilitate fish passage over the total 22-foot water surface differential at the complex. The second option is a roughened channel fishway designed to provide fish passage at the BART Weir only. The two concepts are markedly different in form and function and involve significantly different design approaches. The first alternative allows water supply operations upstream of the weir to continue as a result of maintaining the current operating capabilities of the Middle Rubber Dam. The second option is only viable when ACWD's dam is deflated and not in service. The basis and evolution of the two fish passage concepts are described below.

As part of a cooperative effort with the USACOE to restore a viable steelhead fishery in Alameda Creek under Section 1135 of the Water Resources Development Act of 1986, CH2M-Hill was retained in 2000 to develop the vertical slot fishway alternative as part of a series of system-wide restoration improvements. The overlying objectives of that study were to guide restoration efforts, improve communication between the involved parties, and conduct a feasibility level analysis for upstream and downstream protection and passage of steelhead. The goals of the effort were to identify a practicable method of facilitating fish passage while maintaining flood control and ACWD's methods of diverting raw water from Alameda Creek. The vertical slot fishway alternative was part and parcel to combined fish ladder and fish screen improvements at each of ACWD's three points of diversion from Alameda Creek. For a more detailed description of the causes leading up to the development of this fish passage alternative, the reader is directed to the document entitled, "Conceptual Fish Passage Designs & Cost Estimates for Lower Alameda Creek," CH2M-Hill, January 2001.

Subsequent to the above study, the Committee raised concerns regarding the efficiency of fish attraction and passage at high flows with a conventional fish ladder. The Committee agreed to evaluate an alternative technology termed "barrier *removal*" given its greater potential to facilitate fish passage at the subject site. It was originally envisioned the BART Weir be removed and the entire channel cross-section regraded, however this concept was deemed unfavorable as it would expose the existing bridge foundations and nullify the reason for which it was constructed. Hence the formulation of the roughened channel fishway concept which would provide a quasi-natural passage mechanism spanning only a portion of the overall channel width. The roughened channel fishway is described in the document entitled, "Conceptual Design and Feasibility of a Natural Fishway at the Fremont BART Weir, Alameda Creek, California," CEMAR/Far West/WRECO, September 2005. CEMAR/Far West/WRECO describe the roughened channel alternative as a superior fish passage alternative to the vertical slot fishway concept, considering ACWD's water supply operations at the Middle Rubber Dam could be economically reassigned to its Upper Rubber Dam facility. This premise has since been reconsidered by ACWD given operational flexibility, redundancy, and reliability of its overall water supply system are compromised, the cost of consolidating points of diversion upstream is extremely high ($2 mil more than original vertical slot ladder alternative), and the engineering requirements are complicated (ACWD, 2006).

These two alternatives each have advantages and shortcomings in view of project goals and objectives. Since the two alternatives are at a preliminary design level, the ACFC&WCD is interested in comparing the two alternatives, including recommended design changes, as a step toward selecting a preferred alternative. By applying a systematic approach, it is possible to identify the alternative that best achieves the outlined goals and objectives, while at the same time correlating cost with benefits. This document covers the following key elements, as described below, to achieve this purpose:

- Scope and purpose of evaluation
- Assessment of hydrology for which corrective fish passage measures should be designed
- Descriptions of alternatives considered and suggestions for improvement from former work
- System by which to appraise and compare alternatives based on a method of characteristics
- Detailed descriptions and comparisons of individual characteristics
- Summary of comparisons and scoring matrix
- Summary of recommended changes and analyses
- Concept level exhibits for each alternative
- Estimates of implementation costs for each alternative

Statement of Scope & Purpose

Since a formal alternative development process has not been conducted, the ACFC&WCD is interested in confirming the validity of two fish passage concepts proposed to date and comparing their associated strengths and weaknesses. Accordingly, a third-party review and evaluation has been requested to assist the District in advancing a solution that best meets a variety of design, economic, environmental, and operating criterion.

The focus of this document is to present the alternatives in an equal light and to provide information to the District to help determine which alternative best suits the project's objectives and goals. A method of comparison, weighting, and ranking is developed so a comparison can be made based on a total cumulative score approach. More importantly, the method is a means of understanding the strengths and weaknesses of the alternatives. The ranking procedure allows the Committee to see the sensitivity of each criterion in the comparison of options.

To adequately demonstrate the scope of each alternative, concept-level drawings have been developed for the two alternatives required within the scope of work. These exhibits are provided in Appendix A. The drawings serve as the basis for quantity take-offs and provide the foundation for developing and/or refining former cost estimates. As the concepts are not developed to a final stage and are based on a limited understanding of existing features and facilities, a contingency is included to conservatively account for the cost of potential unknowns and future design refinement. Due to market volatility in recent years, additional cost factors are included to err conservative in the projection of overall alternative budgets.

The tools described above and the deliverables furnished within this study lay the groundwork for providing the District with the information to advance a preferred alternative to the final design stage. For the sake of objectivity, the draft version of this document was distributed to Committee constituents for review and comment. Accordingly, the weighting and cumulative scoring of alternative characteristics has been subjected to the influence of involved parties. Using this approach supports a heightened confidence level that the results of this study are consistent with a comprehensive and equitable decision-making process, taking into account the interests and opinions of the Committee. A consolidated list of paraphrased review comments and responses to those comments is made available for review in Appendix B of this report. In addition, copies of actual review comments received are included as well.

Fish Passage Hydrology

An important task in fish passage design is estimating the flows at which fish passage should be provided. Fish passage design is generally tied to the hydrologic characteristics of the particular watercourse. Selection of the design flow is typically determined in view of the actual migration period of the target species and life stages, statistical flow recurrence intervals, and acceptable risk that might result from delay due to hydraulic conditions that hinder passage. Since the window of in-migration for adult fall-run salmon and steelhead in Lower Alameda Creek is presumed to historically fall between the months of December and May, the alternatives are evaluated with respect to the hydrologic record within these months.

Fish sightings at the barrier in question are also useful in establishing reasonable fish passage design flows. According to sample information provided by Far West Engineers (Refer to Appendix C), fish sightings have been made at the BART Weir when daily mean flows were as low as 5 cfs in Alameda Creek (Per USGS Union City Gage #1180700, February 5 and 6 of 1999/January 20 of 2000) to as much as 1,360 cfs (Per USGS Union City Gage #1180700, January 24 of 2000). Based on field observations, sightings are reported to predominantly occur between a flow range from 100 cfs to 700 cfs, per the CEMAR/Far West/WRECO report. The Alameda Creek Alliance states that nine years of observations and rescue operations suggest steelhead reach the BART Weir when flows are between 250 cfs and 400 cfs following the descending limb of the hydrograph (Miller, 2006). This information shall be further considered in the final design stage of the preferred fish passage alternative.

Fish passage design flow is evaluated based on high and low limits. The low fish passage design flow is the lowest streamflow at which the fishway must operate optimally. Normally a statistical analysis comparable to that used for the high fish passage design flow is appropriate. Since the low flow in Alameda Creek is typically controlled as a release from the rubber dam, a statistical analysis of historical flows may not be appropriate. Instead, for each fishway alternative considered here, a minimum flow at which it is expected to operate favorably is stated. For each fishway to operate properly, the minimum passage flow would need to be conveyed during the migration period and should be consistent with releases being made at ACWD's Upper and Lower Rubber Dam diversions. This document is not intended to quantify minimum required creek or bypass flow requirements for upstream and downstream fish passage or survival according to CDFG Code 5937. A broader assessment of the overall watercourse should be conducted to that end. Nevertheless, the fishway should be operable and effective at allowing fish passage at the lowest flow conditions in the watercourse when fish are able to navigate up the creek.

Conversely, the high fish passage design flow is typically defined as the greatest flow in the river or stream at which passage must be optimized. The high fish passage design flow is generally selected as the upper limit at which fish are actually migrating naturally, and/or the threshold in which greater flows occur so infrequently there is little consequence. Considering the latest 50-year period of record of available hydrologic data, a reasonable high fish passage design flow can be determined.

California Department of Fish and Game (CDFG, 1998) recommends, *"Fishways should be designed to pass fish during at least 90 percent of the flow conditions that will be encountered."* For culverts CDFG and NOAA Fisheries (2001) recommend a high fish passage design flow equal to the mean daily flow that is exceeded only 1% of the time. According to the report entitled, "Fishway Design Guidelines for Pacific Salmon," by Ken M. Bates (2000), *"A variety of design flow criteria have been suggested or used. Gebhards and Fisher (1972) suggested an allowable migration delay of 6 consecutive days for salmon and trout. Dryden and Stein (1975) recommend that a 7 day impassable period should not be exceeded more than once in the design period of 50 years, and that a 3-day impassable period should not be exceeded during the average annual flood."*

An alternative approach as set forth in the reference, "Introduction to Fishway Design," authored by C. Katapodis (1998) is commonly used as well. The reference states, *"A delay period of less than three (consecutive) days in annual spawning migrations is usually accepted for several freshwater species. Delays longer than three (consecutive) days may be acceptable with a 1:10 year frequency. These two criteria are used whenever sufficient data exists to estimate the maximum flow that is likely to prevail at the time of fish migration."*

Once the high fish passage design flow has been established, the appropriate high fishway design flow (flow through the fishway) can be estimated. A high fishway design flow of about 10% of the high fish passage design flow has generally been found to produce adequate attraction into fishways of comparable hydraulic conditions. This has proven to be the case where a fishway entrance is located near the passage barrier, and the barrier is perpendicular to the channel. At a 10% ratio, in-migrants do not experience excessive delays in their attempt to locate the fishway.

The U.S. Geological Survey (USGS) has maintained a stream flow gage at Niles Canyon (#11179000) several miles upstream of the subject site since the late 1800's. According to average daily data over a 50-year period of record (July 1956 through July 2006), the 90% exceedance flow is estimated to be 180 cfs. In other words, stream flow was measured to be greater than or equal to 180 cfs for less than 10% of the time considered. This is consistent with the findings by CEMAR/Far West/WRECO (2005).

The 10% exceedance flow during the upstream migration period of the target species, generally considered to be December through April for coastal watercourses in the region, is estimated to be 530 cfs. Upstream water supply re-operations in 1993 reduced the flow being measured at the gage in contrast to former operating conditions as described by CEMAR/Far West/WRECO. Therefore flows before 1993 were supposedly higher than they would be today, and the estimated design flow could be potentially influenced.

In 15 years out of the 50-year record reviewed, there have been periods of more than seven (7) consecutive days when stream flow exceeded 530 cfs, and a total of 13 events since 1993. Further consideration of the high fish passage design flow is therefore warranted. It is recommended a collaborative process be conducted with regulatory agency officials to establish **concurrence on high fish passage design flow prior to final design**.

At a project coordination meeting on July 24, 2006, Mr. George Heise (CDFG) suggested that the high fish passage design flow be in the range of 350 cfs to 450 cfs. Based on flow records, fish observations, and CDFG recommendations, we assume a high fish passage design flow of 450 cfs is appropriate. Accordingly, we targeted 45 cfs as the minimum high fishway design flow for attraction and passage efficacy. On the other hand, for the roughened channel alternative a maximum design flow of 800 cfs is considered per the CEMAR/Far West/WRECO document since the entrance is located a considerable distance downstream of the BART Weir. For this option it is important the capacity of the fishway be great enough to convey all streamflow when adult fish have been observed in the system. This ensures the in-migrants will not bypass the fishway entrance and otherwise stage at the apron of the BART Weir.

Regardless of alternative, the end result should be compatible with flow capabilities of the proposed upstream and downstream fish passage improvements at ACWD’s Upper and Lower Rubber Dam projects (ACWD, 2006). The alternatives should be considered in light of ACWD’s obligation to provide passage conditions down to 20 cfs at its Lower Rubber Dam per NOAA requirements (ACWD, 2006) and the nominal 25 cfs fishway design flow proposed at its Upper Rubber Dam (CH2M-Hill, 2006). Final design flows will also need to be coordinated with flow studies planned by the Committee involving investigations of historical hydrology and biological assessments of the low flow requirement in Alameda Creek.

Description of Alternatives

The BART Weir complex consists of multiple obstructions impeding or prohibiting fish passage. Starting below the complex and moving upstream, a rock weir is followed by an energy dissipating apron, a gravity concrete weir (BART Weir), roughly 100-feet of open channel, and the ACWD inflatable middle dam. The original scope of this study was to evaluate and compare variations of two previously developed alternatives aimed at facilitating fish passage at these structures. These alternatives are termed the ***reduced vertical slot fishway*** (modified from that described by CH2M-Hill [2001]) and the ***roughened channel*** (natural fishway as described in the 2005 CEMAR/Far West/WRECO report).

To equalize the passage objectives of the two previously developed alternatives, the *reduced vertical slot fishway* needed to be reconfigured to provide passage at the BART Weir only and not over the entire complex. The hybrid fishway concept presented by CH2M-Hill (2001) served as the basis for the reduced vertical slot fishway. That design was reduced in scale and modified accordingly. In this study, the reduced vertical slot offers an equivalent passage route as the roughened channel alternative.

Detailed descriptions of the two alternatives and recommended modifications are provided below.

Additionally, the ACFC&WCD requested at the workshop on July 24, 2006 the original ***extended vertical slot fishway***, as it was described in the 2001 CH2M-Hill report, be included in the comparison. That fishway is included in this study as a third alternative. This is the only option evaluated that provides passage over the entire BART Weir complex with the middle rubber dam inflated. Since it has a different passage objective and because operation of the middle rubber dam has other environmental and water supply consequences, the extended vertical slot fishway cannot be compared directly to the two alternatives above. Some refinement of the original concept is recommended in this study to simplify the alternative.

Lastly, a fourth alternative is suggested. A ***pool-and-chute fishway*** was not applicable or considered in the CH2M-Hill feasibility study because it is a fish ladder type tailored to a lesser overall water surface differential. Since the fish passage objective in this evaluation is to address fish passage at the Bart Weir only, this fish ladder style has been considered as it can reduce construction costs while providing high fish passage effectiveness. A more detailed description of this alternative is provided below.

Alt 1 – Reduced Vertical Slot Fishway

Vertical slot fishways are a commonly used design for adult salmonids throughout the West Coast and have proven very successful for adult steelhead. Their greatest advantage is they are self-operating over a wide range of streamflows. That means they are functional regardless of streamflow and water level changes. Their greatest disadvantage is they take only a small portion of the flow during high flows so attraction of fish into the fishway is diminished.

The reduced vertical slot fishway is based on the CH2M-Hill design (2001), but with a reduced footprint, scale, and total head differential to be accommodated for fish passage over the BART Weir only.

A concept-level drawing of the configuration and alignment of this fishway is provided in Appendix A. This alternative involves a guide channel and low weir to provide adequate depth and hydraulic conditions for fishway access at the donwnstream face of the BART Weir. The low weir and an entrance transition pool create sufficient depth for passage in that area. An additional weir at the crest of the BART Weir is required to divert water to the fishway and to create adequate depths for fish passage over ACWD's inflatable dam when it is not in operation.

The fishway is designed to operate effectively over a fishway flow range of 20 cfs to 50 cfs. The hydraulics of the fishway are appropriate for passage through this range in correlation to the fish passage design flow established earlier in this report. Below 20 cfs, the fishway is still passable but depths are less than optimal, primarily upstream of the fishway. The fishway continues to operate optimally at streamflows greater than the fish passage design flow but attraction to it is diminished. The fishway's capacity can be increased, if needed, by deepening the structure or increasing slot widths at the baffles.

This alternative can be extended in the future if ACWD's inflatable dam is later determined to be an indispensable element of water supply infrastructure. The reduced vertical slot could be extended to essentially become the extended vertical slot as described below.

Alt 2 – Roughened Channel Fishway

The roughened channel fishway is a relatively steep channel lined with random rock and boulders producing high boundary roughness and hence restricting velocities to a prescribed level for the target species. It is similar to a natural cascade channel or "engineered riffle" and emulates the diversity and complexity of a natural channel for fish passage. It is a rigid engineered channel designed and constructed for reliability and longevity.

This option was previously described by CEMAR/Far West/WRECO (2005). Passage is provided only over the BART weir by this alternative. A concept-level drawing showing the recommended configuration and alignment is provided in Appendix A.

Our evaluation includes specific design recommendations. It should be configured with a reduced-width triangular cross-section, an upstream weir for directing flow into the fishway, and a substantial channel transition needed to assure adequate flow enters the fishway. We suggest a retaining wall as a more practical and reliable method for containment of the southeast or left side of the fishway.

The fishway is designed to operate and be passable over an approximate flow range of 50 cfs to 800 cfs. The higher upper fishway design flow is required with this style of fishway because the entrance into it is so far downstream from the physical/hydraulic barrier. Below 50 cfs, the fishway might still be passable but depths are uncertain and may be inadequate.

This fishway alternative cannot be readily extended to provide future passage of the Middle Rubber Dam if needed.

Alt 3 – Extended Vertical Slot Fishway

This option was previously described by CH2M-Hill (2001). Passage is provided over the BART weir and the middle rubber dam, whether inflated or deflated. The extended vertical slot is the only alternative that functions when the rubber dam is inflated. Operation of the Middle Dam has other environmental and water supply implications that are not considered here. This alternative should therefore not be evaluated in direct comparison with the other alternatives solely on its fish passage attributes.

Some modifications are recommended here for a simplified and more practical design. We recommend the pool-and-weir segment of fishway with the flow control weirs originally described by CH2M-Hill be simplified to a vertical slot design throughout for consistency and to avoid unneeded complexity. The vertical slot fishway is self-adjusting with respect to upstream and downstream water levels and therefore requires no control elements to maintain performance within operating design parameters.

Like the *reduced vertical slot fishway*, this alternative is designed to operate satisfactorily over a fishway flow range of 20 cfs to 50 cfs. The hydraulics of the fishway are appropriate for passage through this range in correlation to the fish passage design flow established earlier in this report. Below 20 cfs, the fishway is still passable but depths are less than optimal, primarily upstream of the fishway. The fishway continues to operate optimally at streamflows greater than the fish passage design flow but attraction to it is diminished. The fishway's capacity can be increased, if needed, by deepening the structure or increasing slot widths at the baffles.

The fishway will be inlet controlled and will convey the design fishway flow regardless of creek flow. A gate will be operated to switch fishway exits when the rubber dam is either inflated or deflated.

Alt 4 – Pool-and-Chute Fishway

A pool and chute fishway operates over a much broader flow range than other fishways and it is well suited for the short drop over the BART Weir. It would be located near the center of the BART Weir to align it with the channel downstream.

The pool-and-chute ladder was developed in the last decade and has been used for passage of adult steelhead and other adult salmonids at low-head barriers on the West Coast. The explanation of the pool-and-chute is more extensive here because it has not been considered or described in previous reports.

A pool-and-chute fishway is a cross between a pool-and-weir fishway and a roughened chute. It is made up of a concrete structure located within the stream channel and partitioned by a series of weirs with vee-shaped cross-sections and notches at the apex of each vee.

The fish passage corridor is defined as the non-overflow area along the walls of the fishway that provide resting areas and good holding and upstream passage conditions. Because the baffle is sloped toward the center of the ladder, the flow at the outer-width limits is restricted and the downstream pool is calm compared to the center section of the fishway that is streaming and turbulent.

At low flow, the fishway performs as a pool-and-weir fishway. The flow plunges over each weir and dissipates in each pool. At high flow, a streaming flow condition exists down the center of the fishway where the bulk of the flow passes. Plunging flow and good fish passage conditions can be maintained through a "passage corridor" at the edges of the pools. The economy of the concept is achieved by exceeding the usual fishway pool volume criteria based on energy dissipation in each pool, thus reducing the depth of the ladder and the volume of the pools while taking a greater flow in contrast with other fishway types. The configuration of the pool-and-chute accommodates a much greater range of flows than its vertical slot counterparts, thereby improving detection/attraction and self-cleaning operations. A pool-and-chute fish ladder suiting the site conditions and hydrology can be configured to operate effectively from a few cubic feet per second to several hundred cfs with good fish passage operating conditions throughout.

This style of fishway is also good at passing debris since the fishway is substantially submerged at highest flows. The open design encourages debris to wash over the weirs and out of the fishway.

Application of the fishway is limited because of limited hydraulic verification. Bates (2000) recommends that the concept not be applied where the total drop exceeds about six feet until the concept is more thoroughly tested. It is not clear that uniform flow conditions at high flows have been achieved in the modeling and prototypes so far tested. Higher velocities, flow instabilities and downstream channel impacts may be created with greater heads. In addition, with such high velocities, even minor disturbance of the desired flow patterns by dimensional error in design or construction or by debris can potentially cause flow instabilities throughout the fishway. The geometry of the BART Weir is within the range of conditions recommended for its application, therefore the pool-and-chute fishway is suggested as an option.

This fishway style is not conducive to extending in the future if ACWD’s inflatable dam is later determined a necessity.

Hydraulic Capabilities of Alternatives

To better understand hydraulic characteristics of the four alternatives relative to flow in Alameda Creek, Table 1 is provided below. This data illustrates how the fishway alternatives will operate with respect to varying hydrologic conditions within the creek.

The low flow capability is the estimated lowest fishway flow suitable for adult steelhead passage. Low flow barriers within Alameda Creek might exist at flows higher than these low flows, but these low flows are still relevant because the Alameda Creek channel is highly manipulated and could be modified in the future to provide better passage at low flows. NOAA has suggested a low fish passage design flow of 20 cfs at the Lower Rubber Dam (ACWD, 2006).

The high flow capability is the estimated upper capacity of the fishway at which point flow begins to bypass the fishway and competing flow begins to occur at the entrance. Flow through each fishway will increase slightly above this upper limit in proportion to the mutual rise in creek flow.

As explained earlier, the general rule is the high fishway design flow should be at least 10% of the high fish passage design flow in Alameda Creek. As long as the flow relationship is equal to or greater than this limit, delays and difficulty of migrants discovering the fishway are considered acceptable. The more the range is deviated from, the greater the risk of delay and difficulty of fish locating and negotiating the fishway.

Table 1. Summary of Fishway Operating Capabilities

Alternative	Low Flow Capability	High Flow Capability (Compliant with Design Criteria)		
	Fishway Flow (cfs)	Fishway Flow (cfs)	Creek Flow (cfs)	Percentage of Creek Flow in Fishway
No. 1 - Reduced Vertical Slot	20	50	500	10%
No. 2 - Roughened Channel	50	800[2/]	800	100%
No. 3 - Extended Vertical Slot	20	50	500	10%
No. 4 - Pool-and-Chute[1/]	10	150	1,500	10%

[1/] Flow range for this ladder type approximated.
[2/] Not known if fishway is actually negotiable by adult steelhead at this flow rate.

In response to Committee request, Table 2 is also provided below to portray fishway response to the range of flows in which fish are presumed to most likely be migrating in Alameda Creek (Miller, 2006), or 250 cfs to 400 cfs.

Table 2. Fishway Operations at Select Flows

Alternative	Creek Flow at 250 cfs		Creek Flow at 400 cfs	
	Fishway Flow (cfs)	Percentage of Creek Flow in Fishway	Fishway Flow (cfs)	Percentage of Creek Flow in Fishway
No. 1 - Reduced Vertical Slot	40	16%	47	12%
No. 2 - Roughened Channel	250	100%	400	100%
No. 3 - Extended Vertical Slot	40	16%	47	12%
No. 4 - Pool-and-Chute[1/]	100	40%	110	28%

[1/] Flow range for this ladder type approximated.

These flows are approximate. A more thorough hydraulic analysis should be completed as part of the final design of the selected alternative. The high design fishway flows for the pool-and-chute and roughened channel fishways could be modified considerably depending on the height of the dam crest sill and width of the fishways. The design flows of the vertical slot fishways could likewise be increased as needed by increasing slot widths and structure depths.

Comparison of Alternatives

Process of Comparison

The four alternatives are compared using a weighted decision matrix or Pugh Method. This is a common decision-support tool allowing decision-makers to make compare alternatives by evaluating, rating, and comparing them. There are four basic steps to a Pugh Method matrix as it applies to this study.

1. General fishway and project characteristics are chosen and are weighted based on their relative importance.
2. Each option is evaluated by how well it is expected to achieve each characteristic.
3. Each option is scored for each characteristic as the product of the weight and the evaluation.
4. The scores are summed for each option for comparison with the other alternatives.

The matrix should be used as a tool rather than an answer. It should be used to explain the strengths, weakness, and differences among the alternatives rather than as just a simple comparison. Though the matrix provides a final relative score by which alternatives can be compared, the highest score may not represent the best option. Interested parties will likely weigh characteristics differently depending on their roles, responsibilities, and authority with respect to the project. Each entity might therefore have a different final ranking of alternatives.

The comparison of the reduced vertical slot, roughened channel, and pool-and-chute fishways is straightforward. These facilities will pass fish over the BART Weir with the assumption that either ACWD's middle rubber dam is deflated during the migration window or an additional upstream passage mechanism is provided to circumvent this barrier when inflated. Evaluation of a supplemental fishway is not included within this exercise. Evaluation of the extended vertical slot is unique since passage is provided over both the BART Weir and the rubber dam, regardless of whether the rubber dam is inflated or deflated. It should not be compared directly to the other alternatives.

This method of comparison provides an opportunity to look for possible improvements in the designs. The characteristics used for evaluating and comparing the alternatives are discussed in detail below. Any low-scoring characteristic can be further investigated to see if a modification to the design could raise the ranking score.

Independent reviewers can modify the weights and resulting scores to reflect their interests. The descriptions and evaluations in this document include some recommendations for design changes and/or further analysis of the previous CH2M-Hill (2001) and CEMAR/Far West/WRECO (2005) designs. To make comparisons on an equal basis, the evaluations of those previous designs are made with the assumption that the recommendations offered in this report are incorporated into their final designs.

The comparisons and recommendations for improvements are based on professional judgments and a collective experience of over 40-years designing, evaluating, and constructing fish passage projects for all fishway types considered in this evaluation. The comparisons have been made "blind" meaning the cumulative scores were not calculated until after all fishways were evaluated and characteristics weighted appropriately.

The basis for analyzing the alternatives are supplemented by concept-level drawings and cost estimates provided in the appendices. Exhibits are developed for Alternatives No. 1 and No. 2 per the original scope of work. Exhibits and updated cost estimates of Alternative No. 3 are included in the appropriate appendices as provided by ACWC&FCD and ACWD. Since Alternative No. 4 is voluntarily offered for consideration, drawings or cost estimates are not provided for this alternative.

Characteristics Compared

As explained above, a Pugh comparison matrix was used to compare how alternatives meet all conditions and objectives deemed important to involved parties. Parameters are explained below. Scoring for each parameter is included in brackets for each alternative. Associated weighting and ranking values as presented in the detailed schedule of Appendix D. The evaluations are broken down into six general categories; fish passage, operation and maintenance, water supply, design and construction, flood control, and other. The assessments were presented to ACFC&WCD, ACWD, and CDFG at a workshop on July 24, 2006 and have been modified somewhat based on those discussions.

Fish Passage

The foremost objective of this project is to provide upstream passage for adult steelhead over the BART Weir. Passage is broken into the characteristics described below for the purpose of comparison and evaluation of components.

Attraction of adult steelhead to fishway

An important key to fish passage is attraction of fish into the fishway. It could account for a high portion of the success of fish passage and it is often the most difficult to predict during the design phase. Fishway attraction depends on the entrance location, entrance flow, shape of entrance flow jet, and distraction or competition from other flows. Attraction into the fishway is evaluated with respect to the entire fish passage design flow ranges applied to each alternative.

Reduced Vertical Slot [7] According to standard engineering practice and as explained earlier in this report, the selected fishway design flow (20 cfs to 50 cfs) will adequately attract immigrants to the entrance during a majority of the migration period. However, because the operating flow range of this fishway is limited, competing flow over the weir will diminish its effectiveness during higher flows when fish have previously been observed in the proximity of the weir.

Attraction into the vertical slot option is scored lower because attraction to the entrance competes with flow over the weir crest when creek flow exceeds roughly 45 cfs. Since the high fish passage design flow (450 cfs) over the weir is only about 2.0 cfs/ft of weir length, the competition is not considered to be a significant issue. In addition, Alameda Creek is not overly wide at the site meaning opportunity for delay will be short. In-migrants will not have to travel far to locate the fishway entrance. Attraction to the fishway will continue to degrade at flows higher than 450 cfs.

The vertical slot entrance is a tall narrow slot similar to the fishway vertical slots. It is therefore self-operating and will maintain a velocity that will attract fish. Because of its tall narrow shape the jet is more rapidly dissipated than would be a more concentrated jet. It is recommended that the entrance shape be optimized in the final design.

Attraction will be improved with the recommendations as described in the **Fish Access** characteristic below. The recommendation would increase the fishway design flow and attraction

Roughened Channel [10] The roughened channel ranks highest of all four alternatives for this characteristic because all creek flow, up to the maximum design flow of 800 cfs for this alternative, would be conveyed within the fishway. This fishway would provide a single-source passage route when migration presumably occurs. Designing at a lesser flow rate could cause some fish to miss the fishway entrance and be delayed at the weir apron. This would require particular attention if the option is advanced to the final design stage.

Extended Vertical Slot [7] Attraction characteristics are identical to the reduced vertical slot.

Pool and Chute [9] Attraction into the pool-and-chute would be very good since a high percentage of creek flow would be routed through the fishway under the design flow range considered. The pool and chute would have a lower flow capacity at the high fish passage flow than the roughened channel. Attraction to the fishway would continue to degrade at creek flows higher than 450 cfs.

Fish Access Into and Out of Fishway

This characteristic pertains to physical access into and out of the fishway. Depth of flow is the only limitation for these designs. Generally, a minimum depth of four feet is preferred in fish passage channels for adult salmonids. Appropriate measures are required to facilitate access into the fishway entrance and out of the exit.

Assurance that the adequate flow will pass into the fishway, assuming normal maintenance is performed, is also covered by this characteristic. 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 riffles, braided channels, broad shallows) below the low-flow capabilities of the alternatives considered. The downstream channel is manipulated extensively and it could be modified in the future to enhance passage at lower flows.

Reduced Vertical Slot [6] Attraction to the fishway necessitates location of the entrance as near the physical/hydraulic barrier as possible. In this case, the entrance is located at the downstream sloping face of the BART weir within the energy-dissipating apron. A combined low-flow guide channel, weir, and entrance pool (See Appendix A) are considered per the CH2M-Hill Report to prevent shallow, high-velocity sheet flow over the apron. The system will provide appropriate hydraulics to allow in-migrants access to the entrance. The weir will back up water to provide roughly four feet of depth at the entrance and will produce velocities consistent with adult salmonid swimming capabilities. The weir notch will concentrate flow to the right bankline thus improving access and fishway discovery. Access will be improved by the suggested pool cut into the apron to provide fish a deeper path to the fishway entrance. With the fishway entrance lowered to the same elevation as this pool, access is significantly improved.

Fish must also exit the fishway into the creek channel where water depth is typically shallow. A full channel-width weir is suggested at the fishway exit to produce an upstream pool and provide adequate depth upstream for fish to continue their travel over the deflated ACWD dam. A transition pool is also necessary to provide an adequate flow/depth relationship in the ladder by setting its invert deeper than the creek thalweg. This pool will provide the necessary transition of flowlines from creek thalweg to fishway. Alternatively, a channel could be excavated into the bed from the fishway exit to the sill of the rubber dam. The upstream end of the channel would be located just below a low sill with a notch located on the apron of the rubber dam and as suggested by CH2M-Hill.

Roughened Channel [8] The exit of the roughened channel is downstream of the ACWD dam and has similar design considerations as those described for the reduced vertical slot fishway above. In this case, since the design flow is so much greater (800 cfs), a significant channel transition is required to transition from fishway to creek channel while maintaining uniform flow area and velocities throughout. The transition will make up the difference between the roughened channel invert and the creek thalweg. A full channel-width weir is needed to force creek flow up to 800 cfs into the roughened channel and to provide adequate depth upstream for passage over the deflated ACWD dam. The height of the weir dictates the distribution of flow between the fishway and the creek.

At the opposite end of the fishway, the entrance is located downstream of the Bart Weir complex and daylights within the existing creek channel. Access and attraction into this fishway option are determined to be the best of all options considered.

Due to supposed downstream grade control, it is presumed there is little risk the downstream channel will erode in the future. However there is some risk this could occur, as evidenced by the 4-foot scour hole below the BART Weir complex. If this alternative is advanced further, the probability and extent of future downstream erosion should be investigated to ensure a “hanging entrance” is not produced over time.

Extended Vertical Slot [8] Provisions for access into the fishway and attraction at its entrance are identical as those for the reduced vertical slot. This is the only alternative offering egress from the fishway upstream of the rubber dam when inflated. Accordingly, this option has provisions for exiting within the deep forebay of the dam. When the dam is deflated, alternate exit provisions will exist similar to the reduced vertical slot above.

Pool and Chute [6] Access considerations for the pool-and-chute are similar to those for the reduced vertical slot. A weir and guide channel would likewise be required from the downstream tailwater pool to the apron. Since a high-velocity jet is produced at the entrance of this fishway type, considerable downstream pool volume is required to dissipate the energy. With the ladder entrance located at the upstream limit of the apron, sufficient space exists to form a good energy dissipating pool. A full channel width weir would also be required at the upstream exit of the fishway for passage over the deflated ACWD rubber dam.

Passage of adult steelhead through fishway

Passage of adult steelhead through the fishway pertains to the certainty and efficiency of fish passage.

Passage and flow designs vary among the alternatives and other locations in Alameda Creek slated to receive fish passage improvements. As long as the collective passage improvements maintain similar ranges of fish passage design flows, no one particular fishway style needs to be applied at each location.

Reduced Vertical Slot [10] The vertical slot fishways score the highest of all options for this characteristic given the considerable positive experience of this style of fishway for passage of steelhead and other species of adult fish throughout the West Coast.

Roughened Channel [8] There is less experience in the design and construction of large roughened channel fishways. Since there is some randomness in the materials and design, there is some uncertainty in performance and passage effectiveness, especially at the higher end of the passage flow range. The channel should be configured with a triangular cross section to concentrate flow toward its center and maintain necessary water depth during low flows. A liner is also recommended to prevent subsurface flow. Placement and the ability to reposition boulders offers convenient flexibility in the field toward optimizing hydraulic conditions for fish passage.

Extended Vertical Slot [10] The performance of this option is the same as for the reduced vertical slot. The original design included a pool-and-weir fishway in the upper segment. There is some risk that steelhead will delay or reject the change in hydraulics within the fishway. We recommend a vertical slot ladder throughout. An extended vertical slot ladder will eliminate the need for the control gates on the upper three weirs.

Pool and Chute [7] There is less experience with design and operation of pool and chute fishways than the vertical slot type. Passage at high flows depends on there being a passage corridor within the fishway adjacent to a high velocity, high turbulence streaming flow. There is a small risk that passage for some individual fish may be unsuccessful or delayed during high flows.

Attraction and passage of non-target species

The target species for fish passage is adult steelhead, however there is ecological value in providing for or blocking passage of other species and life stages. No other species have been specifically identified for passage, though lamprey, Sacramento sucker, Sacramento pikeminnow, hardhead, prickly sculpin, and hitch have been observed near the site. There might be value of upstream passage of salmonid juveniles since there is no rearing habitat in the vicinity.

CDFG (Atkinson, 2006) suggests that carp and striped bass be blocked from upstream passage if it can be done without compromising adult steelhead passage. The objective of blocking these fish is to minimize predation on steelhead smolts in the channel upstream.

There are several ways to block fish; height and velocity barriers are the most common. If there is a distinctive difference in swimming or leaping ability between species, undesirable fish might be blocked and steelhead passed. Gates could easily be installed on the vertical slot entrances to create a velocity barrier. Structures could also be built within the vertical slot fishways for the same purpose. These features would likely compromise passage of steelhead to some extent and we have therefore not included such a feature in our recommendations or evaluation.

<u>Reduced Vertical Slot [3]</u> The vertical slot fishway is less desirable for passing weak species or juvenile salmonids. A relative high velocity (8 fps) and narrow slot dimensions (12 inches) through the vertical slots prevent weaker fish from either swimming or leaping from one pool to the next.

<u>Roughened Channel [8]</u> The diversity of hydraulic conditions within the roughened channel makes it potentially suitable for passage of some weaker and juvenile fish.

<u>Extended Vertical Slot [3]</u> Attraction and passage of other species is similar to the vertical slot fishway.

<u>Pool and Chute [3]</u> Hydraulic conditions within the fishway are good for passage of a variety of species and sizes of fish up to a moderate flow. Fish that do not leap will not use the fishway.

Safety of Adult Fish

This characteristic is the physical safety of adult fish passing through the fishway. Safety of fish is split into two characteristics; safety of adult fish and safety of juvenile fish.

<u>Reduced Vertical Slot [8]</u> Fish in the vertical slot are safer since the fishway is enclosed and access is more difficult. There is some risk of poachers building a fish trap within the fishway and not being visible from the outside. Fish will be exposed as they enter and exit the fishway through shallow areas. The apron and weir crest modifications described in **Fish Access** will reduce that risk.

<u>Roughened Channel [5]</u> Fish in the roughened channel are exposed to slightly greater risk of predation and poaching. The exposure is presumed to be slightly higher than in the creek channel downstream

because flow is confined to the fishway, which is narrower than the stream channel, and boulders allow access for avian predators and poachers to get close to the fish. Any poaching activity would be very visible. Fish will also be exposed as they exit into a shallow area just above the BART weir though the sill described in **Fish Access** will reduce that risk.

<u>Extended Vertical Slot [9]</u> Safety of fish within the fishway is no different than the vertical slot fishway. Fish will be exposed as they enter the fishway over the shallow apron. The apron sill described in **Fish Access** will reduce that risk. Fish exit into a deep pool above the rubber dam.

<u>Pool and Chute [7]</u> Though the fishway is open, fish are protected by the depths of the pools and the cover of turbulent water. Fish could be poached from within the fishway but any activity there would be very visible.

Safety of Juvenile Fish

This characteristic is the physical safety of juvenile fish passing downstream over the dam or through the fishway. Juvenile are likely safer in any of the fishways than they are passing over the dam where they are easily preyed upon or injured.

<u>Reduced Vertical Slot [4]</u> Juvenile fish in the vertical slot are safer than in other fishways since the fishway is enclosed and access is more difficult.

<u>Roughened Channel [6]</u> Fish in the roughened channel are exposed to slightly greater risk of predation than in the vertical slot fishways. On the other hand, since the flow capacity of the roughened channel is substantially greater than the vertical slots, fewer fish would be exposed to the dam crest.

<u>Extended Vertical Slot [5]</u> Safety of juvenile fish is the same as for the reduced vertical slot.

<u>Pool and Chute [7]</u> Though the fishway is open, fish are protected by the depths of the pools and the cover of turbulent water. The flow capacity is fairly high so many fish are prevented from being exposed on the face of the dam.

Potential for Fish Passage Evaluation or Biological Monitoring

This characteristic is the ability evaluate passage through the fishway and to assess hydraulic performance in light of design criteria. There is no stated intent of doing such an evaluation of the fishway at this time.

Biological monitoring is also part of this characteristic. The monitoring component could be to monitor fish escapement and population in Alameda Creek. This site could be a valuable population monitoring opportunity. It would be good to have the possibility for some entity to install a camera to count fish or a trap to look for marked fish. Such a task could be done at this site or at the upper weir fishway, assuming it is a barrier at least at the same range of flows and access, and that the footprint of that fishway would accommodate a monitoring facility.

Reduced Vertical Slot [8] A portion of the vertical slot has access, geometry, and flow characteristics suitable for the installation of a monitoring trap or bio-mass monitoring instrument. This fishway is the easiest of all four alternatives for conducting a hydraulic performance evaluation.

Roughened Channel [2] The roughened channel would be much more difficult to evaluate; there are no vertical walls, flow is distributed through a number of pathways, a trap would be susceptible to debris and flood flows, and the fishway is located away from the bankline so it is not easily accessible for construction or operation. However, a quantitative approach could be provided to estimate passage effectiveness. Using a velocity profiler and performing velocity surveys throughout the water column at selected transects, velocity distribution and hydraulic conditions could be measured and evaluated with respect to swimming characteristics.

Extended Vertical Slot [9] Potential for evaluation is slightly better than the reduced vertical slot because there is more space for a trap/instrument and access is easier. The same method for conducting a hydraulic performance evaluation at the reduced vertical slot fishway would apply.

Pool and Chute [4] The pool and chute would be slightly easier to evaluate than the roughened channel because it is contained within concrete walls. Access and hydraulic evaluations would be more difficult than the vertical slot fishways.

Operation and Maintenance

Fishway Flow Control

A fishway with good flow control is one that is self-operating and needs little to no intervention for proper flow control, operating conditions, and performance.

Reduced Vertical Slot [10] A benefit of vertical slot fishways is that, if designed correctly, they operate at optimum condition through the entire range of fish passage design flows without a need for operational adjustment. Flow will self-adjust within the fishway commensurate with varying depth in Alameda Creek.

Multiple entrances are shown in the design. Multiple entrances are often provided with the intent of opening and closing specific entrances to accommodate varying tailwater conditions through the range of fish passage flows. Since even at the expected high fish passage flow the unit discharge is about 2.0 cfs/ft, it is expected only a single entrance will be used for attraction. From the standpoint of fish preference, it makes sense to construct at least two entrances to allow flexibility in determining which entrance is most effective based on field observations. If the recommendation for deepening a portion of the apron is implemented, the deepening and the entrance location must be coordinated and may lead to a single entrance in the final design.

Roughened Channel [10] As this is a quasi-natural open channel, no flow control operations are needed for the roughened channel.

Extended Vertical Slot [10] The benefits of this alternative are the same as for the reduced vertical slot fishway. It is recommended the design be modified from the CH2M-Hill report as a continuous vertical slot fishway for its entire length. This will greatly facilitate operations and improve reliability by omitting actuated slide gates.

The fishway exit would be manually switched between two gates when the dam is inflated or deflated. When the dam is deflated the upper portion of the fishway must be inspected and any stranded fish moved out of the fishway.

Pool and Chute [10] No flow control operations are needed for the pool and chute.

Required Operating Flow

The required operating flow is the minimum flow required in the channel and fishway for the fishway to operate. Again, the minimum operable limit is assumed to be above that required for passage through the channel downstream of the project.

Reduced Vertical Slot [7] Flow requirements through a vertical slot fishway is certain. It depends on the depth of the fishway and width of the slots. Depending on water levels within the creek, the fishway will operate in accordance with industry standard design criteria from roughly 20 cfs with 4-feet of depth in the ladder to roughly 50 cfs with 7-feet of depth in ladder. Flow in the creek below this limit will result in impassable conditions at the ladder’s exit.

Roughened Channel [5] A minimum flow is required to maintain optimum hydraulic conditions within the fishway. That flow is estimated be in the order of 50 cfs due to a minimum depth constraint in the creek channel upstream of the fishway. Flow in the creek below this limit will result in impassable conditions at the fishway's exit.

It is recommended the cross-section of the fishway be configured with a triangular cross section to optimize conditions at low flow and therefore minimize the low flow requirement.

Extended Vertical Slot [7] Flow requirements are the same as for the reduced vertical slot fishway alternative.

Pool and Chute [9] There are no low flow limitations of the pool and chute. It can operate effectively with flows down to a few cfs.

Sediment and Bed Load Management

Alameda Creek has a high load of transported sediment. The fishways themselves are expected to be essentially self-maintaining. Sediment will continuously flush through the fishways. There might be some sediment accumulation at the entrances and exits of some of the designs.

Reduced Vertical Slot [8] Sediment is not expected to deposit within the fishway nor affect its performance. Due to the full-height vertical slots at the fishway baffles, the vertical slot fishway is more self-maintaining than pool-and-weir type fish ladders. Some sediment may accumulate at the fishway inlet and transition pool. The proposed sluice gates at the exit can be manually operated to produce higher velocity flow at the invert of the exit structure and assist with moving accumulated material downstream through the ladder. They also serve to isolate the fishway for personnel admittance should access be needed for maintenance. A small amount of sediment might accumulate in the fishway entrance pool but higher stream flows will wash it out so it is not a hindrance to passage.

Roughened Channel [9] No sediment is expected to accumulate in the roughened channel. It should be relatively self-maintaining.

Extended Vertical Slot [9] Since it is recommended the entire fishway be configured as a vertical slot style throughout, sediment will not accumulate within the fishway. A small amount of sediment might accumulate in the approach channel to the fishway entrance but higher stream flows will wash it out so it is not a hindrance to passage.

Pool and Chute [9] No sediment is expected to accumulate in the pool and chute fishway.

Debris

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

Debris management will be the only substantial operational demand of these fishways. To compare the alternatives we estimated a range hours of debris inspections and removal required for each alternative. Normal debris maintenance should include inspections of the fishway weekly and after floods during the fish passage season and monthly otherwise. We assumed a crew size and means of observing the fishways as described in each of the descriptions below.

Reduced Vertical Slot [7] Debris will accumulate at the fishway trashrack and need to be removed after flood events. With a trash rack in place large debris will not be transported into fish ladder. The trash racks should be sized with consideration of manual cleaning in mind.

Small debris may pass through the trash racks and could become lodged in slots of the vertical slot fishway, which could affect passage.

Inspection of the slots would be done by walking down the deck of the fishway and observing the slots through the deck grating. A pike pole would be used to clear slots of any debris. Minimum inspection would be after floods and monthly.

Estimated annual debris maintenance is 116 to 216 hours.

Roughened Channel [5] Large debris could become stranded in the roughened channel and could affect flow and passage through the fishway. Because access for regular maintenance is poor, debris would not likely be removed regularly and could accumulate. Large pieces would likely have to be removed but cutting into pieces. At low flow even accumulations of small debris could be an issue at specific points within the channel. Since the fishway is wider and there are multiple passage corridors, the risk of fish blockage is less than for the vertical slots.

Inspection could be done by direct observation from overhead. We assume inspections are done remotely by camera. Closer inspections would be conducted if accumulations of debris are seen. Minimum inspection would be after floods and monthly.

Estimated annual debris maintenance is 165 to 279 hours. It's considerably greater than for the vertical slots because a two-person crew is necessary for safety and access to the fishway is difficult.

Extended Vertical Slot [8] Debris issues are similar to the vertical slot fishway. This option scores slightly higher than the reduced vertical slot fishway because the trash rack can be larger given the exit structure in the impoundment upstream of the ACWD dam. The structure would also be more accessible for debris removal.

Debris maintenance would be the same as for the reduced vertical slot though the area to be observed would be greater when the rubber dam is in operation. Estimated annual debris maintenance is 116 to 216 hours.

Pool and Chute [5] Debris issues are similar to the roughened channel alternative. Access to the pool and chute is more difficult than the roughened channel but access on the fishway is easier.

Debris maintenance would be similar as for the roughened channel though the area to be observed would be less and access is easier because of the concrete walls. Estimated annual debris maintenance is 65 to 150 hours.

- ***Durability of Structure***

Reduced Vertical Slot [10] Durability/longevity of the cast-in-place concrete fishway is high. The structure footprint is entirely within the structures of the existing rubber dam and BART Weir. The structure cross-section is very strong. Common concrete design and construction methods would be used and would be well controlled.

Roughened Channel [6] There is some risk that individual boulders in the roughened channel could become dislodged. Anchorage of the boulders may be needed in the design but could affect the desired flexibility of repositioning and relocating the boulders.

The fishway cross-section is thin and it extends beyond the existing structure footprint. There is also some risk that the channel seal could fail and cause excess leakage from the fishway.

Extended Vertical Slot [10] Durability/longevity of the cast-in-place concrete fishway is high. Most of the structure footprint is within the structures of the existing rubber dam and BART Weir. Common concrete design and construction methods would be used and would be well controlled.

Pool and Chute [8] Durability/longevity of the cast-in-place concrete fishway is high. The structure footprint is entirely within the structures of the existing rubber dam and BART Weir. Common concrete design and construction methods would be used and would be well controlled.

Design and Construction

Construction Complexities

Complexities of construction include the extent of work, access and spatial constraints, depths of excavations, public and construction personnel safety, disturbance to existing improvements, conflicts with and selective demolition of existing structures, bypassing and dewatering, cofferdamming requirements, and allowable duration of construction. These complexities are also reflected in the construction cost estimates provided in Appendix E.

Reduced Vertical Slot [5] Cofferdamming and dewatering is less difficult than the roughened channel as the footprint of the fish ladder alternative is smaller. Disturbance to existing structures and magnitude of demolition would likewise be less. Deep excavations are needed adjacent to the high retaining wall and both the BART and the UPRR crossing piers and abutments and structural connections to those facilities may be required.

Roughened Channel [4] Construction of the roughened channel includes more in-stream construction and a larger footprint; construction extends 200 feet further downstream than the other options. A notch will be cut into the weir crest. Selection of boulders and their placement into the roughened channel are critical elements of the success of this option. Placement is not a standard construction practice and is not easy to specify. It is recommended that a source of boulders be located for the contractor and that the design engineer assist in supervising placement.

Extended Vertical Slot [4] Construction complexities are similar to the reduced vertical slot fishway. Construction of the extended segment will require an excavation through or underneath the abutment of the rubber dam, as well as cofferdamming and dewatering in the forebay. Preventing interference with the ACWD's on-going diversion operations would be complicated.

Pool and Chute [8] Construction of the pool and chute includes the least amount of in-stream construction and relatively the same size footprint as the reduced vertical slot. Construction will involve similar issues as the reduced vertical slot fishway though excavations will likely be shallower. Access, bypassing and dewatering would be complicated given the location be sited in the center of the channel.

Certainty of Structural Design

There will have to be high certainty of the final structural design. This characteristic describes the complexities of the design and the certainty that components won't fail. The complexity of any of the designs might be exacerbated by the fact that the Hayward Fault passes just upstream of the structure.

Reduced Vertical Slot [9] Certainty in the design of cast-in-place concrete is high. Structural complexities of cutting into the weir apron and crest and tying to the adjacent retaining wall need further investigation. Construction of the vertical slots is complex but can be simplified by re-using custom forms or pre-cast elements.

Roughened Channel [6] As mentioned previously, boulder placement is not a standard construction practice and is not easy to specify. The design may require trade-offs between passage of fish (diversity of boulders) and stability (large boulders). There is some uncertainty in the stability of individual boulders and their anchorages. There is some uncertainty in the grouted rock fill required to line the roughened channel.

Since this alternative is thin in cross-section and extends well beyond the footprint of the existing structures, there is added complexity to the structural and seismic design.

Extended Vertical Slot [9] Structural considerations are similar to the reduced vertical slot fishway with some added exposure or risk around the abutment of the rubber dam.

Pool and Chute [9] Certainty in the design of cast-in-place concrete is high. Structural complexities of cutting into the weir apron and crest need further investigation.

Flood Control

Affect on flood control

This characteristic describes the impacts to the hydraulic stream profiles upstream of the BART Weir. Regardless of alternative, the proposed full-width upstream weirs needed to direct flow into the fishways are expected to have the governing effect on flood control impacts. Impacts from the fishway configurations themselves are expected to have very little effect.

Reduced Vertical Slot [7] No flood analysis has been done for hydraulic effects of the reduced vertical slot fishway option. The fishway, as designed, will effectively block roughly 60 square feet (3%) of the available flow area at the BART Weir crest during the 100-year event (per CEMAR/Far West/WRECO report existing conditions hydraulic model). The fishway will block roughly 1.5% of the flow area of the USACOE design flood. The fishway will block roughly the same percentages of the flow area at the downstream energy dissipating apron as well. ACFC&WCD has reportedly been told by USACOE representatives this option is not expected to not have a significant flood effect. A sill or weir at the downstream end of the apron is recommended and may have a greater effect on upstream flood elevations. It is not clear whether the USACOE considered that sill in their statement.

A low sill or weir is also recommended upstream of the BART Weir to provide additional depth in that area for fish to pass ACWD's Middle Dam. That sill may have an effect on upstream flood levels; the effect should be analyzed prior to design.

Roughened Channel [7] The CEMAR/Far West/WRECO conceptual design report includes the description of a HEC-RAS model of the roughened channel. The results show a rise of water level of 0.5-feet 75-feet upstream of the BART weir and about 0.2-foot 500-feet upstream during the 100-year flood event. These are likely within the error of the model. In fact the results show the water level being lowered by the project during the Corps of Engineers design flood. Flood effects for this option would have to be addressed prior to final design, but it is not expected to have a measurable effect. To be consistent with the above, the roughened channel concept is estimated to effectively block 20 square feet of the available flow area. This equates to 1.5% and 0.5% of the flow areas of the 100-year and USACOE design floods, respectively.

A weir is required upstream of the BART Weir to channel the design flow through the fishway and also provide additional depth upstream for fish passage over ACWD's Middle Dam. That sill may have an effect on upstream flood levels; the effect should be analyzed prior to design.

Extended Vertical Slot [7] This option will have a similar effect on flood capacity as the reduced vertical slot fishway through the subject reach. Again, the proposed weirs may affect flood levels and require further hydraulic analysis.

Pool and Chute [8] The flood considerations of a pool and chute are similar to the reduced vertical slot fishway alternative. Since this option involves no absorption of flow area, it ranks the highest of all four alternatives.

Other

Public safety

Reduced Vertical Slot [8] Access to the vertical slot fishway is limited as it would be covered by grating. The exit trashrack(s) and the relatively small size of the entrance ports or slots would make entry into the fishway difficult, if at all. Removable handrail and signage are recommended to deter loitering at the ladder and to provide fall protection.

Roughened Channel [4] The roughened channel fishway is exposed and access to it by the public is unrestricted though not easy. The fishway may attract people to enter it and possibly try to float down it. There is some risk of injury or drowning if a person is trapped between boulders.

Extended Vertical Slot [8] Access, safety, and liability are similar to the reduced vertical slot fishway.

Pool and Chute [3] The pool and chute fishway has the greatest concerns for public safety. Like the roughened channel it is exposed and accessible. Deep pools and plunging flow are more dangerous than the shallow flow through the boulders of the roughened channel.

Aesthetics, Education

Reduced Vertical Slot [5]

Roughened Channel [7] The roughened channel offers visual diversity in the Alameda Creek channel and gives a better opportunity for public education. The channel itself appears more natural than the other alternatives but it is constructed within a confined width of the Alameda Creek channel and would not necessarily appear like a natural channel. The fishway is visible from the levees and offers an opportunity for educational signing.

Extended Vertical Slot [6]

Pool and Chute [5] The pool and chute is also visible from the levees and offers an opportunity for educational signing.

The other alternatives would have more structural and engineered appearances, which is already characteristic of the site.

Permitting

Most of the permitting issues are included in other characteristics described and evaluated here. Standard provisions for instream work would be applied to any of the designs and will not tend to vary much. Environmental compliance and regulatory permits such as the USACOE 404, CDFG 1600, and Water Quality Control Board 401 permits would involve the same processes and efforts for each alternative.

Acceptability and preferences of specific designs by the permitting resource agencies are considerations that aren’t included elsewhere in this study. CDFG and NOAA provided comments to the draft report but gave no clear design preferences. Input from these entities should be obtained prior to final alternative selection and design.

In the meantime, a score of [5] was attributed to each alternative.

Comparison Summary Table

Each of the characteristics described above are weighted by their levels of importance and multiplied by how well each alternative achieves the characteristic. The resulting weighted scores are then summed for each alternative. Table D-1 in Appendix D shows the input weights and scores for each alternative. The first column lists the characteristics, and the second column indicates the weight applied to each option for each characteristic. The weighting scale is from 0 to 10 with 0 meaning the characteristic is of no importance and 10 meaning it is essential to the success of the project.

Scores are also on a scale of 0 to 10, with 0 meaning the option does not at all satisfy the characteristic and 10 meaning that it satisfies the characteristic to the point that it could not be further enhanced.

Table 3 below summarizes two sets of totals from Table D-1. The overall score is shown, and a second score considering only the fish passage characteristics is provided as well. The scores in Table 3 are normalized to 100 for easier interpretation so the highest overall score and the highest fish passage score are each 100.

The extended vertical slot is the only alternative that functions when the rubber dam is inflated. Operation of the Middle Dam has other environmental and water supply implications that are not considered here. That alternative is therefore not included in the comparison of the other alternatives.

Though this method results in a final relative score approach, the highest score may not represent the best option. Various entities will likely weigh characteristics differently depending on their responsibilities, authority, and funding. Each entity might therefore have a different final ranking of alternatives.

Table 3. Summary of Normalized Weighted Score Totals

Alternative	Overall Score	Score of Fish Passage Only
Reduced Vertical Slot	100	97
Roughened Channel	89	100
Pool and Chute	94	89

This is a preliminary summary based on the consultants' ranking of the options.

The permitting characteristic is preliminarily set at a score of 5 for all alternatives in lieu of stated preferences from the resource agencies. The scores also do not consider costs. Since the value of cost is subjective to the parties financing the project, implementation cost is not scored within the comparison matrix of Appendix D.

Values in the comparison matrix were reviewed to see if any individual parameters significantly affected the final rankings. The review of the matrix led to some of the design recommendations described above.

The reduced vertical slot fishway scores the highest (100) overall of the three alternatives compared. The second-ranked option is the pool and chute (94), though it ranks lowest when only the fish passage parameters are considered.

The roughened channel scores highest (100) when only the fish passage characteristics are considered, and the vertical slot scores slightly less (97).

If water supply operations were to continue at ACWD's point of diversion, the extended vertical slot fishway is the only alternative that would support this function while providing for good fish passage. The reduced vertical slot fishway would be more adaptable to being extended than the other two alternatives.

Summary of Recommended Changes and Analyses

Within the explanations of the alternatives and their characteristics, design changes have been recommended to the original designs described by CH2M-Hill (2001) and CEMAR/Far West/WRECO (2005). These recommendations are summarized below. In addition, consideration of a pool-and-chute fishway has been included in this study as a different style of fishway for the application.

Roughened Channel Fishway

- Investigate the probability and extent of future degradation of the downstream channel and design the roughened channel accordingly.
- Optimize the fishway cross-section of the fishway with a triangular cross section to create appropriate hydraulic conditions at lower flows.
- Investigate the flood effects of the recommended sill or weir.
- Provide a fishway operating plan.
- Select a source of boulders for the contractor and have the design engineer assist in supervising placement.
- Investigate the structural effect of notching the BART Weir for the fishway.

Vertical Slot Fishways – Reduced and Extended

- Optimize the shape of the entrance
- Lower the lower fishway floor roughly 2-feet to provide greater capacity and attraction.
- Cut a channel into the apron or construct a weir to provide a deeper path to the fishway entrance.
- Configure the fish ladder as a vertical slot for the entire fishway length (extended version) to provide better flow control and reduce the likelihood of sediment deposition.

- Cut a channel into the bed between the weir crest and the rubber dam or construct a low sill just above the weir to divert all flow at low flow to the fishway.
- Investigate the flood effects of the fishway.
- Provide a fishway operating plan.
- Investigate the structural effect of cutting the toe of the retaining wall away for placement of the fishway.

Implementation Costs

Estimates of probable implementation costs are provided in Appendix E for the *Reduced Vertical Slot Fishway* and *Roughened Channel Fishway* alternatives. The modifications recommended for these two alternatives in this report are accounted for in their respective estimates. Since the *Pool-and-Chute Fishway* alternative is suggested as a value-engineering option and not within the scope of work, an estimate has not been prepared for this option.

A cost estimate for the *Extended Vertical Slot* alternative was originally prepared by CH2M-Hill in 2001 and updated in 2006. A copy of that updated estimate is provided in Appendix E. The estimate does not include the recommendations mentioned in this report. By implementing the revisions suggested, the concept could be simplified and it stands to reason the overall cost of the alternative could be slightly reduced. All things considered, the updated CH2M-Hill cost estimate provides a conservative forecast of implementation cost for this alternative.

Since project cost is a basic element of alternative comparison, but the value of cost is entirely subjective to the parties financing the project, the cost factor is not scored as a characteristic within the comparison matrix. Values are simply provided in this report for informational purposes.

- **Reduced Vertical Slot Fishway: $1,890,000**
- **Roughened Channel Fishway: $2,424,000**
- **Extended Vertical Slot Fishway: $4,385,000**
- **Pool-and-Chute Fishway: TBD**

The budgeting-level cost estimates developed for each alternative include engineering and design, geotechnical investigation and laboratory testing, environmental compliance and permitting, bidding and contract award, surveying and staking, construction management, and materials testing. Additionally, all anticipated construction costs are accounted for including materials, labor and services, contract administration, mobilization and demobilization, sureties and insurance premiums, overhead and profit, and a 30-percent contingency to account for budgeting at a preliminary design level.

In general, the cost estimates are developed based on the preliminary design information gathered from former studies and the alternatives as presented in this report. The basis for estimating construction costs relies on data from cost indexes, vendors, and bid summaries from similar past projects. Generic construction activities and materials are based on either actual construction bids from past fish passage projects or unit pricing from RS Means 2006 Construction Cost Data. No attempt is made to predict competitive bidding influence, bidding climate, future labor market conditions, or value engineering possibilities.

The dynamic nature of material escalation, market conditions, and bidding climate are difficult to predict. These items are subject to many variables including natural disasters, demand by foreign markets, energy shortages, competitive bidding influence, contractor availability, etc. To some degree these uncertainties are covered by the 30-percent construction cost contingency. However, the contingency is primarily included to cover the cost of unknowns regarding final project geometry, complexion, and potential conflicts with existing structures, to name a few. The estimates do not account for significant conflicts with existing structures or radically unusual or unforeseen site conditions.

In accordance with Committee comment, several cost adjustment factors are added to provide a margin of safety in the estimates. Construction costs are based on index pricing from Sacramento-based projects. Due to inflated construction market conditions reported within the Bay area, a 10-percent city location multiplier is added to the construction subtotal to capture this (See RS Means City Cost Index/Location Factor relationship between Sacramento and San Francisco).

To account for annual price escalation, barring major unforeseen shifts in the construction market, two annual adjustment factors are included in the estimates to enable the ACFC&WCD to budget for the effects of time relative to when the project is let out to bid. Accordingly, a 4-percent annual inflation rate is applied to construction and engineering/construction management services. Minor professional services such as surveying and mapping, geotechnical, and environmental services are assumed to remain constant.

The second annual adjustment factor consists of a 15-percent material escalation multiplier. Due to the volatility of building materials pricing in recent years, it is difficult to predict project outlay. Upon review of market trend data, material and heavy construction costs appear to have steadily increased since mid-2004 but were fairly constant before that time. A greater confidence level can be gained for budgeting purposes by applying this escalation factor. The material escalation factor is based on trend data from the Federal Highway Administration index of federal-aid highway construction for the following construction types; earthwork, surfacing, and reinforced concrete structures. The data can be reviewed over a period of record from 1987 to the fourth quarter of 2005 at the following website:

http://www.fhwa.dot.gov/programadmin/pt2005q4.cfm

To improve estimate accuracy, it is common practice to review bid summaries from comparable projects constructed within a close proximity and time frame. Attempts to collect applicable cost information from recent fish passage projects within the vicinity of this Project (USACOE Guadalupe River Modifications/Zone 7 Water Agency Arroyos Mocho and Las Positas Fish Passage Projects) have proven to be unsuccessful. Bid schedules or schedules of values were unfortunately unavailable in a form that could be used to reflect appropriate unit costs for similar construction types and materials.

As a reality check, Wood Rodgers designed a fish screen and fishway project for the Casitas Municipal Water District that was solicited for bid in late 2003 and completed in early 2005. The southern California project involved a **400-linear foot**, 16-step vertical slot fishway (**700** cubic yards of concrete and **9,980** cubic yards excavation) comparable to the **480-linear foot**, 23-step *Extended Vertical Slot* fishway discussed in this report (**860** cubic yards of concrete and **2,780** cubic yards of excavation). Bids for the fishway component of the Casitas project ranged from approximately **$0.82 mil to $1.14** mil per the three general contractors who submitted bids. The cost of the upper/lower fish ladder from the CH2M-Hill estimate with 30% contingency, excluding general items to be consistent, is roughly **$2.55 mil**.

With respect to the *Roughened Channel* alternative, a **900-ft** long by **125-ft** wide roughened channel fishway was part of the Casitas project mentioned above. Bids came in between **$0.75 mil to $1.0 mil** for just the channel construction element of the project. The estimate for the *Roughened Channel* fishway herein (**400-ft** long by **60-ft** wide) with contingencies is roughly **$1.16 mil**, excluding the *General* cost component to be consistent.

Detailed cost estimates are presented in Appendix E to convey the detail of costs considered. The costs for design and construction management services are directly tied to the construction cost of the project. Industry standard percentages are applied to account for such services. Uniform allowances are applied for the following services; surveying and mapping, geotechnical services, environmental compliance, and permitting.

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APPENDICES

Appendix A

Concept Level Drawings

Appendix B

Committee Review Comments

Appendix C

Sample Fish Sighting Data

Appendix D

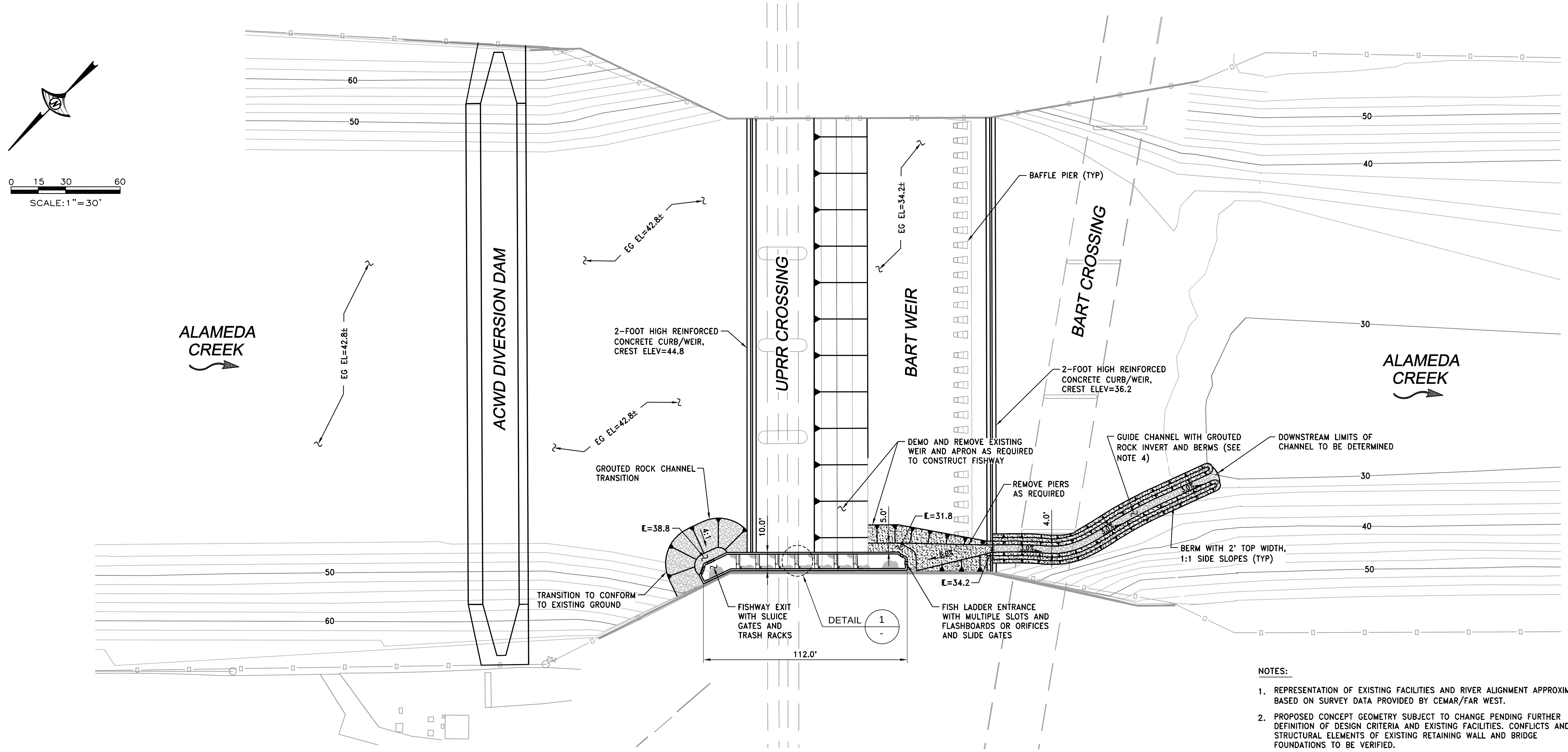
Scoring Matrix

Appendix E

Implementation Cost Estimates

APPENDIX A

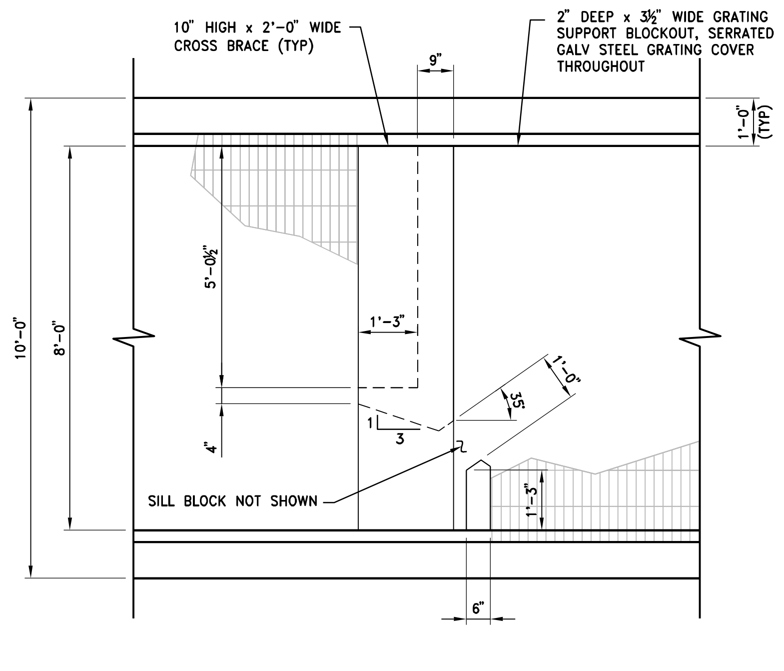
Concept Level Drawings



PLAN

NOTES:

1. REPRESENTATION OF EXISTING FACILITIES AND RIVER ALIGNMENT APPROXIMATE BASED ON SURVEY DATA PROVIDED BY CEMAR/FAR WEST.
2. PROPOSED CONCEPT GEOMETRY SUBJECT TO CHANGE PENDING FURTHER DEFINITION OF DESIGN CRITERIA AND EXISTING FACILITIES. CONFLICTS AND STRUCTURAL ELEMENTS OF EXISTING RETAINING WALL AND BRIDGE FOUNDATIONS TO BE VERIFIED.
3. REDUCED VERTICAL SLOT FISHWAY DESIGN BASED ON 40 CFS NOMINAL DESIGN CAPACITY, 6 FPS MAX VELOCITY, AND 1-FOOT DIFFERENTIAL AT BAFFLES. FLOW IN FISHWAY WILL VARY CONSISTENT WITH CREEK FLOW AND RELATED WATER SURFACE PROFILE.
4. GUIDE CHANNEL CAN BE INCISED INTO APRON UP TO FISHWAY ENTRANCE IN LIEU OF PROVIDING CURB/WEIR.



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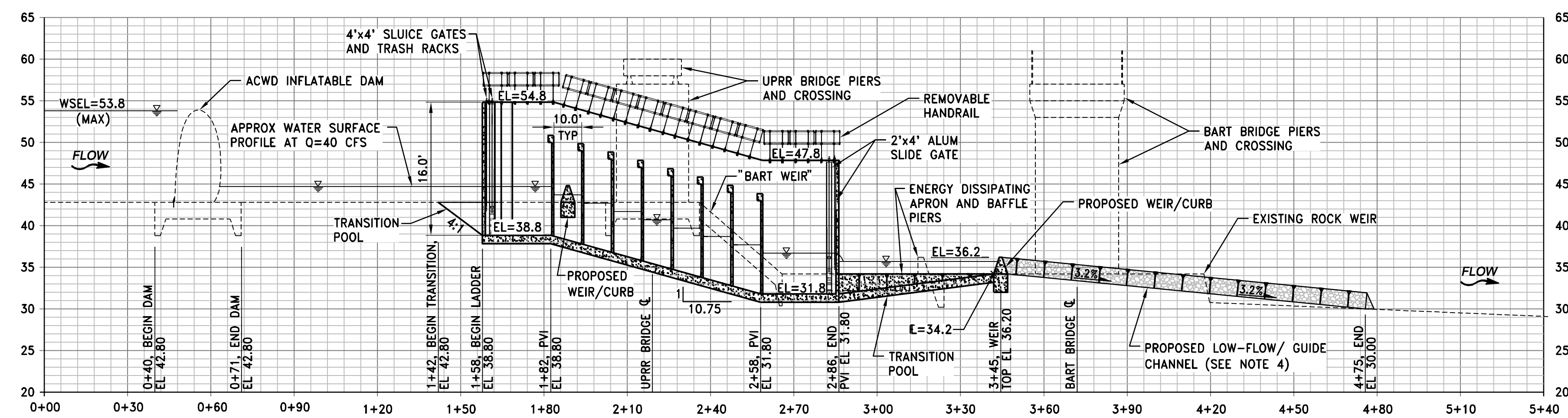

PROFILE
HORIZ SCALE: 1" = 30'
VERT SCALE: 1" = 10'

HALF-SIZE

WOOD-RODGERS INC.

REGISTERED PROFESSIONAL ENGINEER TIMOTHY W. BULLER No. 60292 Exp. 6/30/08 CIVIL STATE OF CALIFORNIA

DATE: ________

CONCEPTUAL EXHIBITS FOR
ALAMEDA COUNTY FLOOD CONTROL DISTRICT
ALAMEDA CREEK/BART WEIR FISH PASSAGE
VERTICAL SLOT FISHWAY - PLAN & PROFILE
COUNTY OF ALAMEDA CALIFORNIA

WOOD RODGERS
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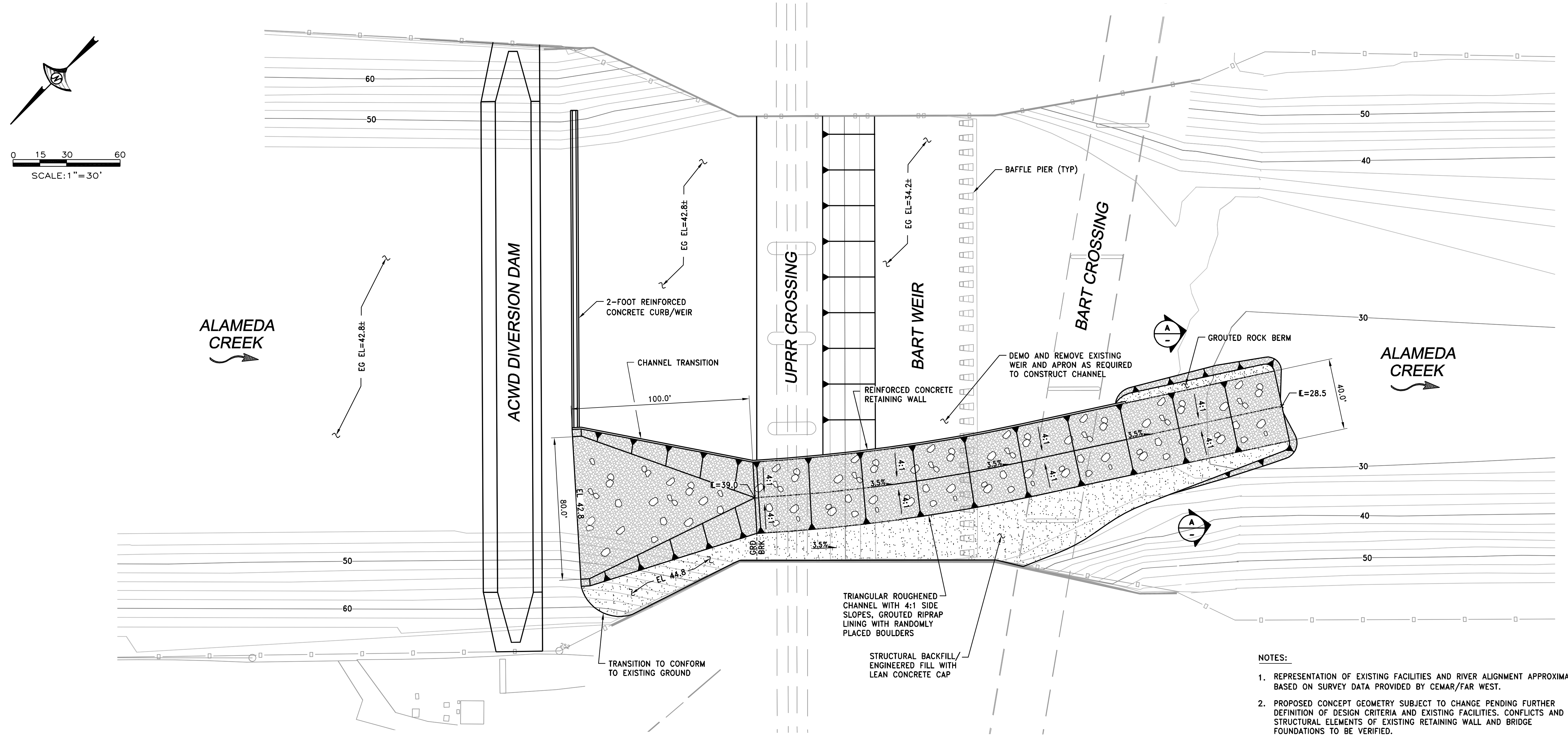
3301 C St. Bldg. 100-B Sacramento, CA 95816
Tel 916.341.7760 Fax 916.341.7767

DATE: 8/22/06
SCALE: AS SHOWN
DRAWN BY: T. BULLER
DESIGNED BY: T. BULLER
CHECKED BY: T. BULLER

NO.	DESCRIPTION	ENGR INIT	BY COUNTY APPROVED	DATE

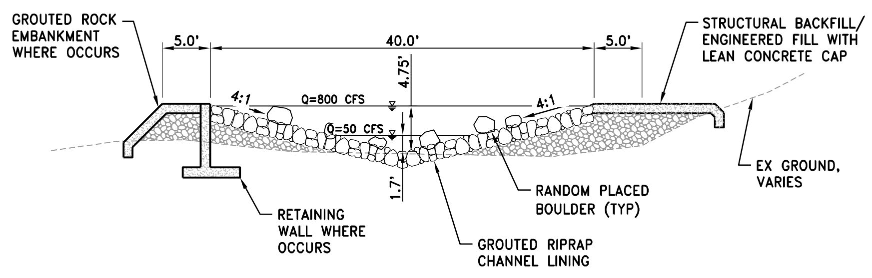
PROJECT NO. 8133.001
DRAWING A-1
SHEET 1 OF 2



PLAN

NOTES:

1. REPRESENTATION OF EXISTING FACILITIES AND RIVER ALIGNMENT APPROXIMATE BASED ON SURVEY DATA PROVIDED BY CEMAR/FAR WEST.
2. PROPOSED CONCEPT GEOMETRY SUBJECT TO CHANGE PENDING FURTHER DEFINITION OF DESIGN CRITERIA AND EXISTING FACILITIES. CONFLICTS AND STRUCTURAL ELEMENTS OF EXISTING RETAINING WALL AND BRIDGE FOUNDATIONS TO BE VERIFIED.
3. PROPOSED ROUGHENED CHANNEL FISHWAY DESIGN BASED ON 800 CFS MAX DESIGN CAPACITY, 50 CFS MIN DESIGN CAPACITY, 9 FPS MAX AVERAGE DESIGN VELOCITY, AND 0.055 ROUGHNESS COEFFICIENT.



A SECTION

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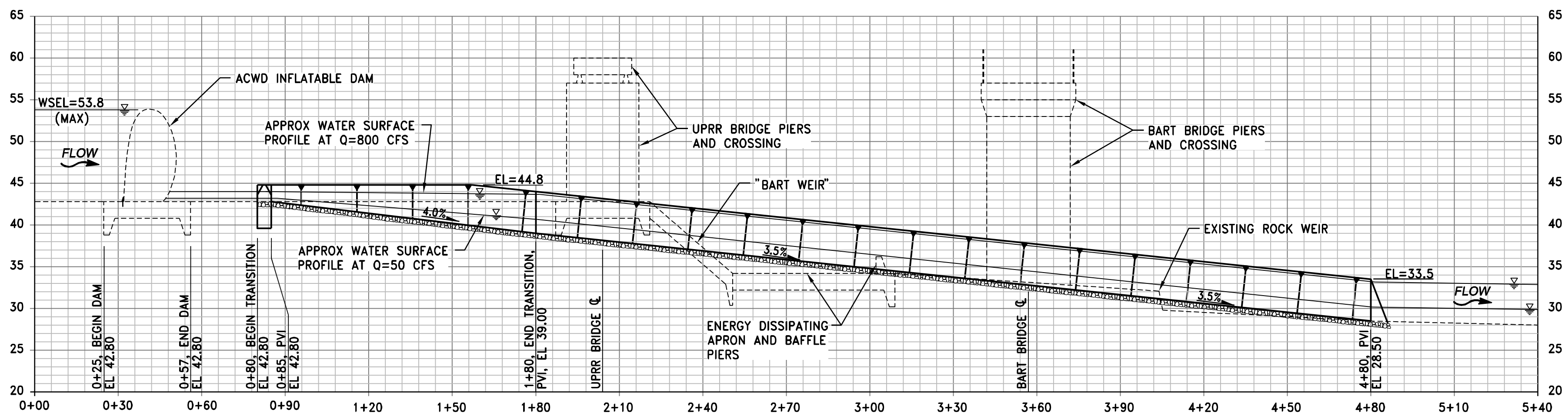

PROFILE

HORIZ SCALE: 1" = 30'
VERT SCALE: 1" = 10'

HALF-SIZE

WOOD-RODGERS INC.

REGISTERED PROFESSIONAL ENGINEER TIMOTHY W. BULLER No. 60292 Exp. 6/30/08 CIVIL STATE OF CALIFORNIA

DATE: ______

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CONCEPTUAL EXHIBITS FOR
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ROUGHENED CHANNEL - PLAN & PROFILE
COUNTY OF ALAMEDA CALIFORNIA

PROJECT NO. 8133.001
DRAWING A-2
SHEET 2 OF 2

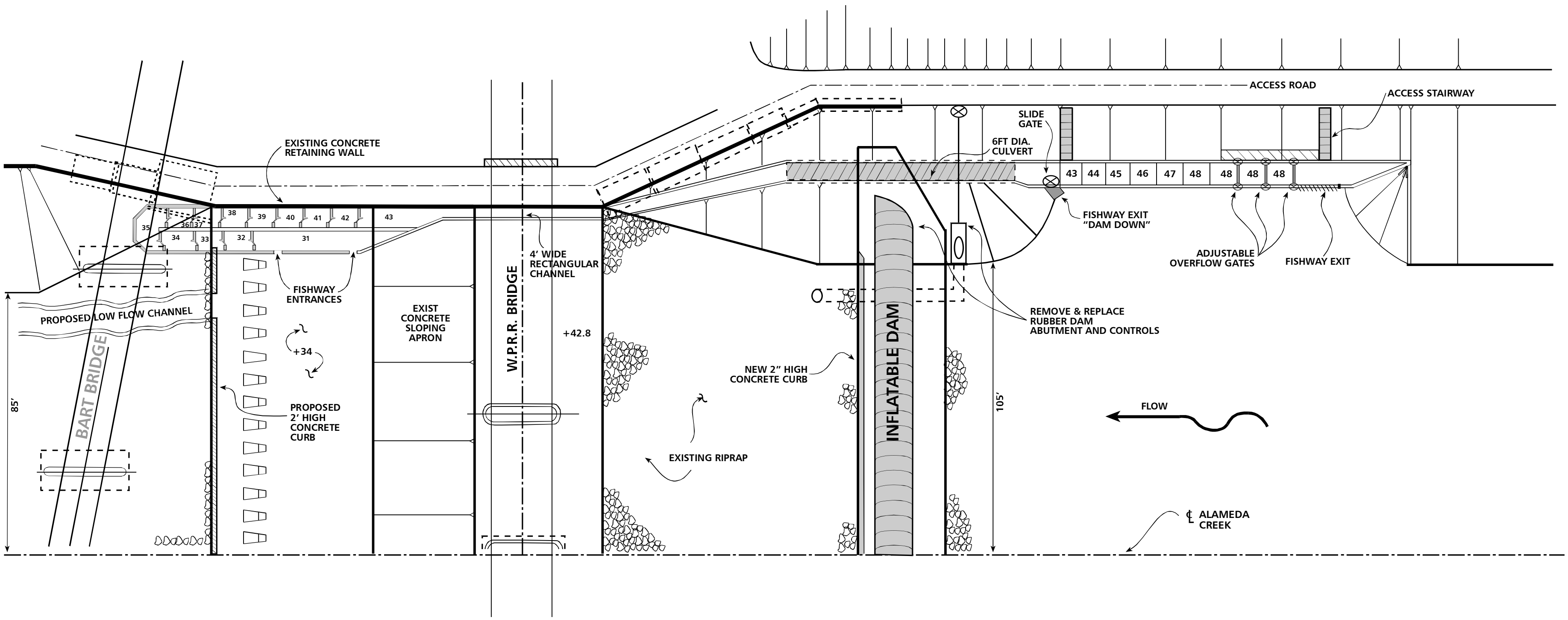

Figure 4-Plan

Proposed Fishway at B.A.R.T. WEIR and Middle Inflatable Dam

Alameda County Water District

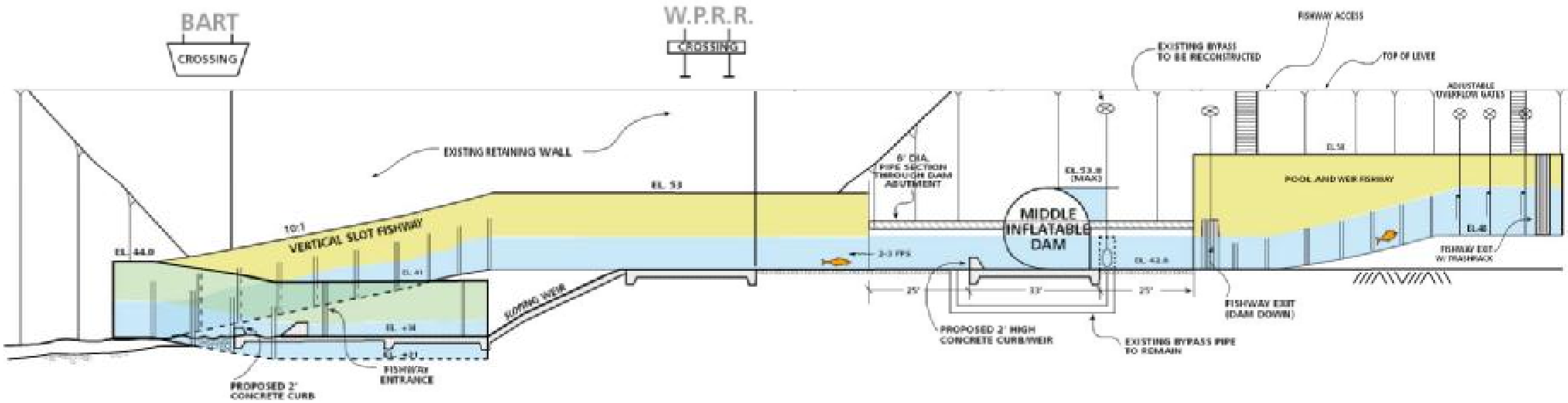

Figure 5-Elevation

Proposed Fishway at BART WEIR and Middle Inflatable Dam

Alameda Creek Fish Passage

CH2MHILL

SAC-W-160108.ZZ.03 Figure 9. 11-22-00 tiffany

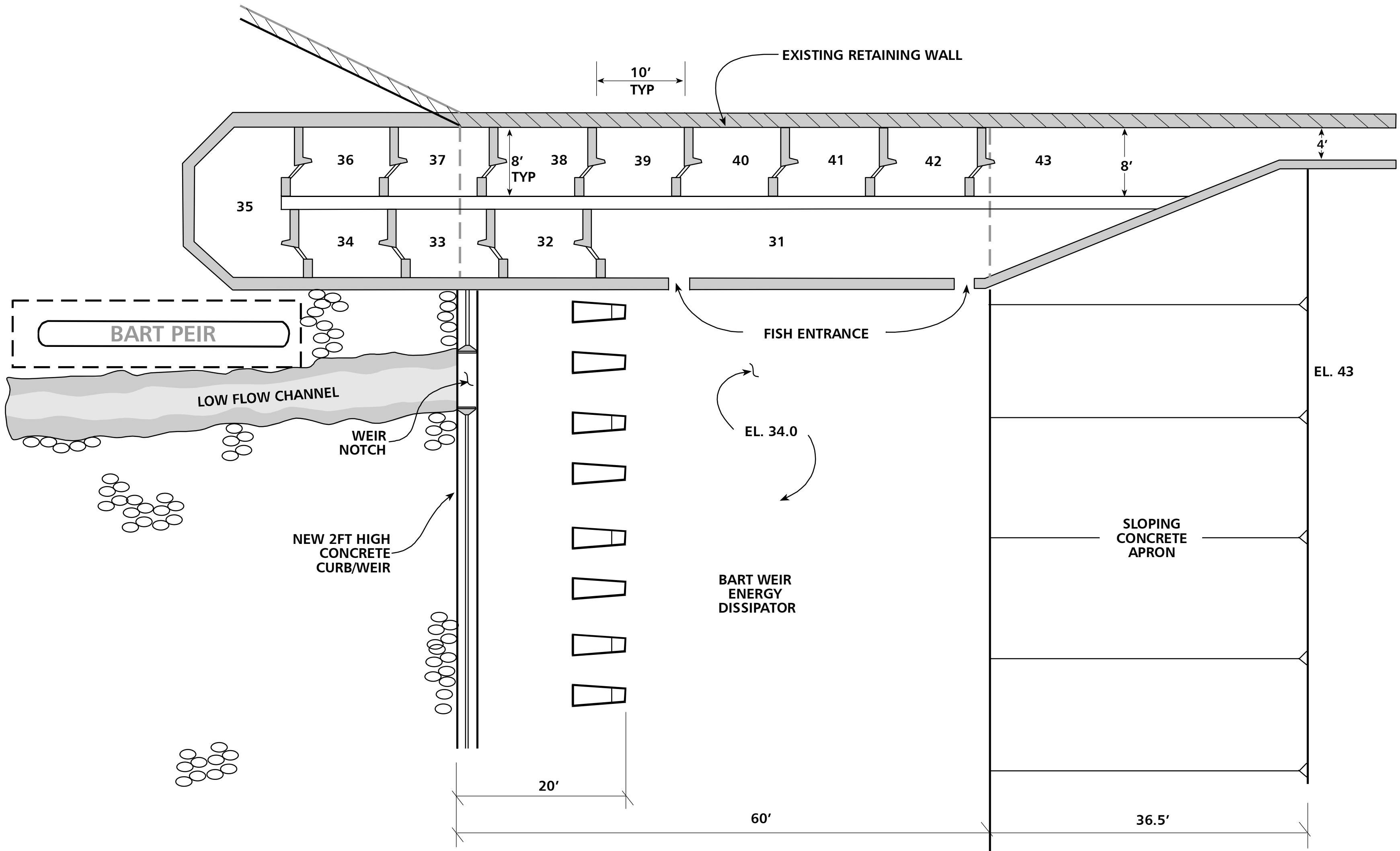

Figure 6-Detail Plan
Proposed Fishway at B.A.R.T. WEIR and MIDDLE Inflatable DAM
Alameda Creek Fish Passage

CH2MHILL

APPENDIX B

Committee Review Comments

LOWER ALAMEDA CREEK/BART WEIR FISH PASSAGE ASSESSEMENT

APPENDIX B - COMMITTEE REVIEW COMMENTS AND RESPONSES

Comment Number	By	Reference of comment	Document section	Comment	Response
1	Pete Alexander, EBRPD		Other species, scoring	Give greater weight to other species. The following native species have been observed in Alameda Creek near the project and would benefit from improved passage: Chinook salmon, Lamprey, Sacramento Sucker, Sacramento Pikeminnow, Hardhead, Prickly Sculpin, and Hitch.	Weight for other species has been increased and species are listed.
2	Several		Implementation Costs	Cost estimates seem low – comment from several people – looks like good relative numbers but recent experience is very low estimates	See discussion in "Implementation Cost" section. Contingency increased to 30% and 10% city location factor, 4% annual inflation rate, and 15% annual material escalation factor added
3	Jeff Miller, ACA		Description of Alternatives	Add a table comparing fishway design flows at what stream flows. "The report needs to analyze at what range of stream flows would 30-60 cfs be contained in the vertical slot fishways, and would a few to 100 cfs be contained in the pool-and-drop fishway."	Hydraulic Capability Table added to "Description of Alternatives" section.
4	Eric Cartwright, ACWD		Introduction	Add some of the history from sub-groups that led to these options.	Paragraphs added to the "Introduction" section for both alternative fishway studies.
5	Eric Cartwright, ACWD		Comparison matrix	The parameters of compatibility with middle dam passage and water supply seem out of place.	Parameters of compatibility with middle dam and water supply are removed from the comparison matrix.
6	Laura Kidd, ACFCWCD		Maintenance	Maintenance is a big deal. Even weekly inspections are too much to expect	Level of maintenance activity is estimated for each alternative.
7	Roger Leventhal , Far West	1	General	Open scoring to other experts	Scoring influenced per collective input from Committee via written comments and discussions and from Committee presentation. Revisions were made accordingly. Additional peer review is not within the scope of work.
8	Roger Leventhal , Far West	2	General	Perform complete hydraulic analysis of all options before ranking	Vertical slot and pool-and-chute fishways have been studied via scaled models in the laboratory and numerous applications in the field. The hydraulics, velocity fields, energy dissipation, performance under varying structure and hydraulic profiles and fish passage effectiveness are well understood. Complete hydraulic analysis is appropriate for final design. No
9	Roger Leventhal , Far West	3	General	Natural complexity of roughened channel undervalued	Natural complexity is recognized as a positive attribute of the roughened channel. It can also be a detriment because of uncertainties at low flow.
10	Roger Leventhal , Far West	4a	Fish Passage Hydrology	Flow at 530 cfs may be too high for consideration. Incorporate fish sightings into fish passage hydrology analysis	Paragraph added to the "Fish Passage Hydrology" section. Alameda Creek Alliance, Far West fish sighting data, and CEMAR/Far West/WRECO Natural Fishway report indicate fish observed at BART Weir at flows from 700 cfs to 1,360 cfs. Statistical hydrologic analysis and correlation of allowable period of delay most common methods of selecting fish passage flow. Fish sighting data from Far West added as an appendix.
11	Roger Leventhal , Far West	4b	Fish Passage Hydrology	Low flows of 35 cfs to 45 cfs irrelevant toward fish passage in Alameda Creek.	This comment is unsubstantiated. Fish sighting data indicates otherwise. Per ACWD, NOAA has recommended a low flow requirement for the Lower Rubber Dam fishway at 20 cfs and has expressed a similar preference for said rate of flow at the BART Weir fishway as well. NOAA comments that the downstream channel is highly modified and modifications could include improvements to low flow passaage.
12	Roger Leventhal , Far West	5	Page 8	Recommend change "complexion" to "complexity".	Changed.
13	Roger Leventhal , Far West	6	Fish passage evaluation	Rank access to roughened channel higher than other options	Partially agree. Ranking has been changed to reflect full channel flow. Exit conditions aren't as good as full vertical slot though. With extended vertical slot separated, comparison to it is eliminated for this parameter.
14	Roger Leventhal , Far West	7	Passage of steelhead	Rank passage through roughened channel higher	No change. Passage is good but not as certain as through vertical slot at all flows.
15	Roger Leventhal , Far West	8	Other species	Increase weight of passage of other species	Weight for other species has been increased and species are listed.
16	Roger Leventhal , Far West	9	Safety of fish	Fish are more safe in roughened channel than vertical slot	Disagree. Fish in roughened channel are exposed. Parameter was split into safety of adult fish and juvenile fish.
17	Roger Leventhal , Far West	10	Potential for fish passage evaluation	Remove fish passage evaluation from the ranking or at least move out of fish passage section.	Disagree. NOAA expressed a desire for the capability of future biological monitoring.
18	Roger Leventhal , Far West	11	Required operating flow	Do not rank required operating flow until fish passage flows are further defined. Assess ability of engineered fishways to operate at higher flows.	No change. Discussion of flow requirements and capability of fishway at low flows should be discussed concurrently.
19	Roger Leventhal , Far West	12a	Sediment and bedload mgmt	Acknowledge that Alameda Cr has high sediment and bedload	Changed.
20	Roger Leventhal , Far West	12b	Sediment and bedload mgmt	Engineered fishways do not handle sediment (and debris) as well as roughened channel.	The engineered fishways handle sediment well. They are self-flushing for the size of bedload in Alameda Creek. The only issue is sediment accumulation at the exit of the roughened channel and reduced vertical slot.
21	Roger Leventhal , Far West	13	Debris	Roughened channel will pass debris better than vertical slot	Disagree. Vert slot has trash rack so most debris does not enter fishway. Debris in roughened channel may block passage. It may also help. Maintenance access to the roughened channel is poor.
22	Roger Leventhal , Far West	14	Durability	Roughened channel is more durable because it's easier to repair	Disagree. Roughened channel extends beyond existing concrete that would support engineered fishways. Large footprint is more vulnerable to failure and leaking. Individual boulders can be repaired but comparable failure is not likely in engineered fishway.
23	Roger Leventhal , Far West	15	Accommodate extension to above middle weir	Do not use a ranking among alternatives	Parameters of compatibility with middle dam and water supply are removed from the comparison matrix.
24	Roger Leventhal , Far West	16	Water supply	Same argument as Comment #5	Parameters of compatibility with middle dam and water supply are removed from the comparison matrix.
25	Roger Leventhal , Far West	17	Public safety	Fishway is not a public safety issue. (assume this comment is about roughened channel). All options would score the same.	Disagree. Roughened channel is attractive nuisance. Vertical slots are closed and inaccessible by people. Pool and chute is dangerous. ACFCWCD has expressed concern about any facility being an attractive nuisance.
26	Roger Leventhal , Far West	18	Permitting	Roughened channel will be easier to permit	Agree it would be easier if it ranks higher than other alternatives for fish passage. NOAA and CDFG were asked if they had a preference but stated
27	Gordon Becker, CEMAR	1	p5 pp4	Use correct citation here and forward	Citation revised.
28	Gordon Becker, CEMAR	2	p13 pp5	"Ranks highest of all four" not reflected in table	Changed.
29	Gordon Becker, CEMAR	3	p15 pp2	"Best of all options" not reflected in table	Changed.
30	Gordon Becker, CEMAR	4	Safety of fish p17 pp6	Re-write entire paragraph. Passage flow (200-400 cfs) not confined to "narrow" fishway as described.	Text changed to clarify that the fish are more confined in the artificial channel than in the downstream channel.
31	Gordon Becker, CEMAR	4a	p17 pp6	Sill cited already part of the project. Delete mention.	Agree. Clarified.
32	Gordon Becker, CEMAR	5	p19 pp6	No basis provided for situation of fish are moving on low flows. Contrary to existing data. Note caveat, re-rank, and lower weighting factor. Explain basis.	Not true. See response to Comment No. 11 and No. 35.
33	Gordon Becker, CEMAR	6	p29 pp2	low sill is Already specified in CEMAR report (p. 30). Delete suggested change	Agree. Clarified.
34	Gordon Becker, CEMAR	7	Potential for fish passage evaluation	Move to "other" category. Not fish passage.	No change. Biological monitoring is not a direct fish passage objective but it certainly is a part of population recovery, which is an overall goal of the project.
35	ACWD	1	Low flow passage	NOAA is asking for 20 cfs low flow passage at lower dam.	Discussion of low flow considerations added to "Fish Passage Hydrology" section. See response to Comment No. 11 above.
36	ACWD	2	Fish Passage Hydrology	Assessment for the BART weir passage alternatives should also include consideration of the planned Upper Rubber Dam ladder. This consideration should include fish passage as well as water supply/operational impacts.	Paragraph added to the end of the "Fish Passage Hydrology" section acknowledge the need for system-wide compatibility.

LOWER ALAMEDA CREEK/BART WEIR FISH PASSAGE ASSESSEMENT

APPENDIX B - COMMITTEE REVIEW COMMENTS AND RESPONSES

Comment Number	By	Reference of comment	Document section	Comment	Response
37	ACWD	3	Water supply	The potential water supply impacts of the roughened channel should be evaluated further, as well as potential sources of supply that could be secured to operate this facility.	Paragraph added to the "Introduction" section regarding ACWD reconsideration of consolidation points of diversion at Upper Rubber Dam.
38	ACWD	4a and b	Water supply	Redundancy / reliability / flexibility of water supply deemed best by maintaining the two existing points of diversion at the Upper and Middle Dams. These factors have led ACWD tentatively preferring the extended vertical slot fishway alternative. Proximity of Hayward Fault and other potential failure or operational needs also support need for two separate diversions.	Mentioned in paragraph added to "Introduction" section.
39	ACWD	4c	Water supply	Capital cost of consolidated diversion at Upper Dam outweighs cost of maintaining Middle Dam diversion and constructing extended vertical slot fishway alternative.	Mentioned in paragraph added to "Introduction" section.
40	ACWD	5	Implementation Costs	Reconcile costs with new CH2M estimate	CH2M-Hill ammended cost estimate incorporated into "Implementation Costs" section and Appendix.
41	ACWD	6	Fish Passage Hydrology	Coordinate with flow studies	Mentioned in paragraph added to end of "Fish Passage Hydrology" section.
42	ACWD	7	Public safety	Agree with safety / liability issue	No change.
43	Jeff Miller, ACA	p1 pp6	Fish passage	"Evaluate which alternative most efficiently passes steelhead at flows of 250-400 cfs, and should quantify what overall stream flows would allow fish passage through the various alternative fishways."	Sentence added to "Fish Passage Hydrology" section denoting that fish predominantly observed at BART Weir when flows range from 250 cfs to 400 cfs. Hydraulic capabilities paragraph and summary Table added to end of "Description of Alternatives" section.
44	Jeff Miller, ACA	p1 pp6	Fish passage	The report needs an analysis of the whether fish are likely to move efficiently at higher flows, up to 800 cfs. Evaluation needs to assess fishways' efficiency over range of flows when steelhead are expected to be migrating.	See discussion in "Fish Passage Hydrology" section (10% fishway flow to stream flow relationship). Hydraulic capabilities paragraph and summary Table added to end of "Description of Alternatives" section.
45	Jeff Miller, ACA	p2 pp2	Flood control	The analysis for the vertical slot fishway concludes the fishway would block roughly 1.5% of the USACOE design flood. The calculation for the roughened channel is expressed in feet of water level rise, and should instead also be expressed in % of the USACOE design flood, for comparison.	Since a HEC-2 hydraulic model was not developed to determine water surface impacts attributed to the vertical slot fishway, percent of flow way obstruction is the only qualification we can provide at this time. The CEMAR/Far West/WRECO was more detailed and therefore hydraulic impacts were determined from the hydraulic model. An approximation of flow way obstruction has been added to the respective paragraph for the roughened channel fishway.
46	Jeff Miller, ACA	p1 pp6	Fish Passage Hydrology	Fishway design at the BART weir must also be compatible with planned passage facilities at the ACWD's middle and upper rubber dams.	Discussion of low flow considerations added to "Fish Passage Hydrology" section. See response to Comments No. 11 and 35 above.
47	Jeff Miller, ACA	p1 pp6	Passage thoughout system	Operation of the ACWD's middle and upper rubber dams and the resultant flows that pass the BART weir should be considered in choosing a fishway.	Discussion added to the "Introduction" section and the end of the "Fish Passage Hydrology" section acknowledging the need for system-wide compatibility.
48	Jeff Miller, ACA	p2 pp2	Passage thoughout system	Consider fish passage in the lower Alameda Creek channel as a whole, consider the complex of barriers fish will have to pass for successful upstream migration, and choose a fishway design that will most efficiently pass fish at flows that allow them to continue to move upstream.	Analysis of fish passage downstream of the BART complex is outside scope of this study. Discussion of low flow considerations and compatibiliy with downstream passage facilities added to "Fish Passage Hydrology" and "Introduction" sections respectively.
49	Laura Kidd, ACFCWCD	pp20-21	Operation and maintenance	Debris management in terms of relative annual man-hours required to maintain each alternative is important to my agency. Weighting factor of 9?	Effort needed for debris management in terms of relative annual man-hours required to maintain each alternative has been estimated.
50	Laura Kidd, ACFCWCD	p17 pp8	Safety of Fish	Specify how fish may be "trapped" in pool and chute option. By poachers?	Text modified to say fish are vulnerable to poaching.
51	Laura Kidd, ACFCWCD		Comparison ranking	Scores should be reflected in the text as well as table (e.g. "Public Safety: Reduced Vertical Slot (8) Access to the...."	Scores are added to the text for each parameter and alternative.
52	Laura Kidd, ACFCWCD	p14 pp3	Fish Access Into and Out of Fishway	If we eliminate the weir, is there added danger to downstream-moving fish/smolts that get washed over the BART Weir?	The low weir downstream of the fishway exit is uniform across the channel so there is no concentration of flow over it and there is no effect on distribution of flow over the dam. It will cause some downstream migrants to use the fishway rather than pass over the shallow depth over the weir.
53	Gary Stern, Steve Thomas, NMFS		Extended vertical slot issues	There are a number of fish Issues associated with operation of the Middle Dam that are beyond the scope fish passage. Remove those parameters from the matrix. Discuss in alternatives descriptions and comparisons sections.	Agree. The presence of other issues is mentioned though not listed.
54	Gary Stern, Steve Thomas, NMFS		Safety of fish	Safety of fish is important. Separate into two parameters; adults (poaching, exposure, stranding) and juveniles (predation, stranding). Weight adults 4 and juv 3 so the emphasis of safety overall stays the same. Scoring looks good.	Safety of fish split into safety of adult fish and safety of juvenile fish.
55	Gary Stern, Steve Thomas, NMFS		Biological monitoring	Site could be a valuable population monitoring opportunity. It would be good to have the possibility for some entity to install a camera to count fish or a trap to look for ad-clips. Change the parameter to include "biological monitoring." Recognize that the task could be done here or at the upper weir fishway assuming it is a barrier at least at the same range of flows and access and footprint would accomodate the facility. Increase weight to 4.	Biological monitoring kept as a parameter.
56	Gary Stern, Steve Thomas, NMFS		Passage of non-target species	Weight is appropriate but not clear what other species would be there. Provide a list of other species that have been observed or expected in the	Weight was increased slightly due to other comments.
57	Gary Stern, Steve Thomas, NMFS		Comparison matrix	Clearly separate the extended vertical slot in the text and table as an option that is only associated with continued operation of the Middle Dam.	Matrix is split so the extended vertical slot is clearly separate from the other alternatives.
58	Gary Stern, Steve Thomas, NMFS	Debris	Maintenance	We can not assume an appropriate level of maintenance will be performed since the District may not maintain the facility more than once a week or ten days. A vertical slot fishway can become clogged on high flows when fish will want to pass so if maintenance personnel will not be available to clear the ladder passage can be hindered for a good portion of a high flow passage window. Change the scores on Debris (under O&M) to reflect to importance of prompt and regular maintenance to ensure a vertical slot ladder is passable when	Effort needed for debris management in terms of relative annual man-hours required to maintain each alternative has been estimated.
59	Gary Stern, Steve Thomas, NMFS	Low flow passage	Low flow passage	Low flow passage is important considering flashiness and low winter flows of Alameda Cr. Major channel modifications are made to Alameda Cr each decade and improvements for low flow passage might be made in the future. The scores are appropriate; increase the weight to 7.	Changed. See Comment No. 35.
60	Gary Stern, Steve Thomas, NMFS	Debris	Debris	There may be two components to debris: (1) fish passage performance of the structure with moderate to heavy debris; and (2) the amount of maintenance effort required to keep the structure operating effectively.	Text added to clarify that debris is the risk of debris. It includes both probability and consequence of debris. Effort needed for debris management in terms of relative annual man-hours required to maintain each alternative has also been estimated.

Alameda Creek Alliance

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October 17, 2006

Laura Kidd
Alameda County Flood Control & Water Conservation District
951 Turner Court, Room 300
Hayward, CA 94545

Re: Alameda Creek Alliance Comments on Draft BART Weir Fish Passage Study

Thank you for the opportunity to comment on the Lower Alameda Creek/BART Weir Fish Passage Assessment. We do not have an opinion at this point on which fishway design alternative is preferable.

Our primary concern is that the fish passage alternative chosen for the BART weir most efficiently passes steelhead trout and salmon. Based on 9 years of observations and fish rescue operations at the BART weir, adult steelhead trout in lower Alameda Creek have typically moved upstream through the flood control channel to the BART weir after major storms, and have been observed attempting to ascend the BART weir at flows ranging from about 250-400 cfs, on the downward side of the hydrograph after a storm.

The Wood Rogers assessment describes the fishway attraction flows for 4 fish passage alternatives, but does not explain what percentage of total stream flows these amounts represent. The roughened channel fishway would pass fish from 50 to 800 cfs, and would contain all stream flows up to 800 cfs, which would include the range of flows at which steelhead have been seen attempting to migrate past this barrier. The vertical slot fishways would operate within 30-60 cfs flow range and the pool-and-chute within a few to 100 cfs flow range. The report needs to analyze at what range of stream flows would 30-60 cfs be contained in the vertical slot fishways, and would a few to 100 cfs be contained in the pool-and-drop fishway.

The total stream flow at which the fish ladders operate (not just the flow in the ladders) needs to be sufficient for steelhead to migrate through the lower 10 miles of flood control channel to the fish ladder. The flow also needs to be sufficient to allow steelhead to continue upstream, pass a fish ladder at the upper rubber dam, and migrate up to 10 miles upstream to suitable spawning habitat. Given the flashy nature of the Alameda Creek watershed, and the narrow window after storms for adult steelhead to migrate upstream, the fish passage design chosen needs to be the one that functions <u>most efficiently</u> at passing steelhead at flows at which they will actually be at the weir and which will also allow them to move upstream.

All of the 4 fish passage alternatives seem to provide downstream passage for smolts at low flows. The most important criterion for choosing a fishway design is how the fishway functions for upstream fish movement at flows when fish are expected to move past the complex of barriers in the lower channel. Delayed fish passage can mean missed spawning opportunities, given the nature of stream flows in Alameda Creek.

The final report should evaluate which alternative most efficiently passes steelhead at flows of 250-400 cfs, and should quantify what overall stream flows would allow fish passage through the various alternative fishways. We concur with the Alameda County Water District that the fishway design at the BART weir must also be compatible with planned passage facilities at the ACWD's middle and upper rubber dams. Operation of the ACWD's middle and upper rubber dams and the resultant flows that pass the BART weir should be considered in choosing a fishway. One option is a design such as the roughened channel that allows steelhead to move over the BART weir at higher flows when the ACWD would have the middle and upper rubber dam deflated and all flows will pass the rubber dams. All of the design options seem to allow steelhead to move upstream past the BART weir at low flows and would be compatible with fishways at the rubber dams designed for lower flows when water is pooled behind the rubber dam. The report needs an analysis of the whether fish are likely to move efficiently at higher flows, up to 800 cfs.

In the discussion of the effect on flood control on page 24, the analysis for the vertical slot fishway concludes the fishway would block roughly 1.5% of the USACOE design flood. The calculation for the roughened channel is expressed in feet of water level rise, and should instead also be expressed in % of the USACOE design flood, for comparison.

We encourage the ACFCWCD to look at fish passage in the lower Alameda Creek channel as a whole, consider the complex of barriers fish will have to pass for successful upstream migration, and choose a fishway design that will most efficiently pass fish at flows that allow them to continue to move upstream.

Sincerely,

Jeff Miller

Director, Alameda Creek Alliance

LOWER ALAMEDA CREEK/BART WEIR FISH PASSAGE ASSESSMENT
ACWD Comments on draft report
October 10, 2006

1. <u>Consideration of passage facility at modified foundation at Lower Rubber Dam:</u> As discussed at the September 21, 2006 Fisheries Workgroup meeting, ACWD is evaluating various designs for the modifications of the Lower Rubber Dam foundation (for fish passage under low flow conditions). At a recent meeting (August 2006), NOAA Fisheries staff indicated that the foundation should be modified to provide passage under flow conditions as low as 20 cfs. We suggest that Flood Control coordinate with NOAA Fisheries on the low flow design considerations, as it would not make sense to provide a low flow passage facility at the Lower Dam if passage could not also be provided at the BART weir under the same low flow conditions.

2. <u>Consideration of passage facility at ACWD's Upper Rubber Dam:</u> ACWD's Upper Rubber Dam is located approximately 1 mile upstream of the BART weir. As described in the 2001 fish passage feasibility study (CH2M Hill), ACWD plans on installing a fish ladder at this facility to provide fish passage when the dam is inflated. As with the BART weir and Middle Rubber Dam, the Upper Rubber Dam is also located within the flood control channel. Because of the proximity of the two planned fish passage facilities (BART weir and Upper Rubber Dam), the assessment for the BART weir passage alternatives should also include consideration of the planned Upper Rubber Dam ladder. This consideration should include fish passage as well as water supply/operational impacts.

3. <u>Water supply needs for "roughened channel" alternative needs to be further identified:</u> The draft report indicates that the roughened channel alternative may require a higher operating flow than the other alternatives. However, the draft BART Weir Passage report does not discuss the potential sources of these additional flows. ACWD is concerned about the potential water supply impacts to the upstream water agencies (including ACWD) should ACFC&WCD proceed with an alternative that requires higher flows. The potential water supply impacts of this alternative should be evaluated further, as well as potential sources of supply that could be secured to operate this facility.

4. <u>ACWD planning considerations for Middle Rubber Dam passage alternatives:</u> ACWD is currently evaluating various alternatives for fish passage at the Middle Rubber Dam, including: (1) an extended fish ladder that provides passage past both the BART Weir and Middle Rubber Dam (see Figure 1, evaluated as the "Extended Vertical Slot" alternative in the draft BART Weir Passage report,); and (2) re-operating the Middle Rubber Dam such that it is deflated during the winter/spring migration period (see Figure 2, evaluated as the "roughened channel" and "reduced vertical slot" alternatives). The "re-operation" alternative

will require the construction of significant new water supply facilities (to make up for lost diversion capacity in the winter/spring months with the Middle Rubber Dam deflated). These facilities include a new Alameda Creek pipeline and diversion structure to convey water from above the Upper Rubber Dam to the Quarry Lakes recharge pits. Under this alternative, all screened diversions would be consolidated upstream of the Upper Rubber Dam. Although ACWD is currently reviewing both alternatives, the preliminary conclusion reached by ACWD is that the extended fish ladder is preferred over the re-operation alternative. This preliminary conclusion is based on the following factors (which should also be considered in the draft BART Weir Passage report):

a. Redundancy/reliability: The extended fish ladder alternative will provide ACWD with two operating rubber dams (and associated screened diversions) throughout the year. Given the proximity of Hayward Fault to these facilities, this is an important consideration for ACWD. With the potential failure of one dam, the other dam could still be utilized for water diversions through screened intakes. In addition, routine maintenance of ACWD's facilities above the Upper Rubber Dam (as well as other in-channel projects, such as the recent Mission Bridge project) may require that ACWD keep the Upper Rubber Dam deflated for a long period. Without the use of the Middle Rubber Dam and associated diversions (as considered under the re-operation alternative), this may have a significant impact on ACWD's water supplies.

b. Operational flexibility: Maintaining two rubber dams operational throughout the winter and spring months (i.e. the extended fish ladder alternative) would also maintain existing operational flexibility for water supply operations. For instance, water could be supplied through screened diversions to the Quarry Lakes recharge pits via the Upper Dam, Middle Dam or both. In addition, maintaining the two rubber dams operational during the winter/spring would improve ACWD's capability to recharge water under high flow conditions. This operational flexibility may also provide benefits for fish passage. For instance, under certain conditions, a potential operating scenario after a high flow event may be to inflate the Middle Rubber Dam first, followed by inflating the Upper Rubber Dam at a later time. Under this operating scenario, a window of opportunity may provided such that in-migrating steelhead would only need to pass through one fish passage facility in the flood control channel (the extended fishway), in order to access the upper watershed.

c. Capital costs: Based on a recent study conducted by CH2M Hill (June 2006), the costs for ACWD passage facilities under the extended fish ladder alternative (fish ladders and screens) would be approximately $2 million less than the cost of the pipelines and screens required for the re-operation scenario (assuming that ACWD and Flood Control evenly split the costs of the extended fish ladder, estimated at $4.385 million - see comment #5 below). This does not include the operations and maintenance costs, which require further consideration.

5. <u>Cost estimates from CH2M Hill:</u> The draft BART Weir Passage report cites the 2006 CH2M Hill study for a cost estimate for an extended fish ladder over the BART weir and Middle Rubber Dam. However, the CH2M Hill cost estimate cited in the BART Weir Passage report was a preliminary estimate that was later revised for the final 2006 CH2M Hill report (attached). The final estimate for the cost of the extended ladder is $4.385 million, not $3.460 million as cited in the draft BART Weir Passage report. The key difference was that rather than using a single escalation factor to bring the total 2001 construction cost estimate to 2006 conditions, the unit costs for each line item were reviewed by CH2M Hill's cost estimator and brought up to 2006 cost conditions.

6. <u>Coordination with flow studies:</u> The draft BART Weir Passage report should recognize the flow studies that are planned by the Workgroup. These flow studies will include an assessment of historical hydrologic conditions throughout the watershed (including the flood control channel) as well as an assessment of passage constraints under low flow conditions. Ideally, this information should be utilized in the selection and final design of the fish passage facilities in the flood control channel.

7. <u>Safety/liability:</u> The draft BART Weir Passage report identifies public access and safety as an issue with the roughened channel concept. ACWD concurs with this assessment. Based on our operating experience in the flood control channel we believe that it would be difficult to prevent trespassers from accessing the roughened channel (e.g. kayakers during moderate and high flow events). ACWD is also concerned about potential liability issues, given that the District operations may directly impact flow conditions at the BART weir.

Figure 1 – Extended Fish Ladder Alternative

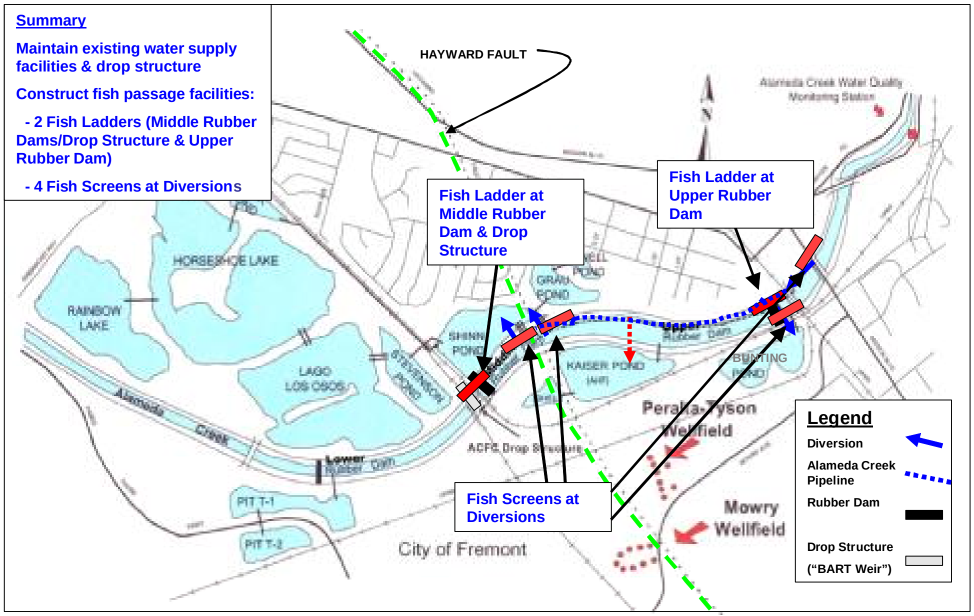
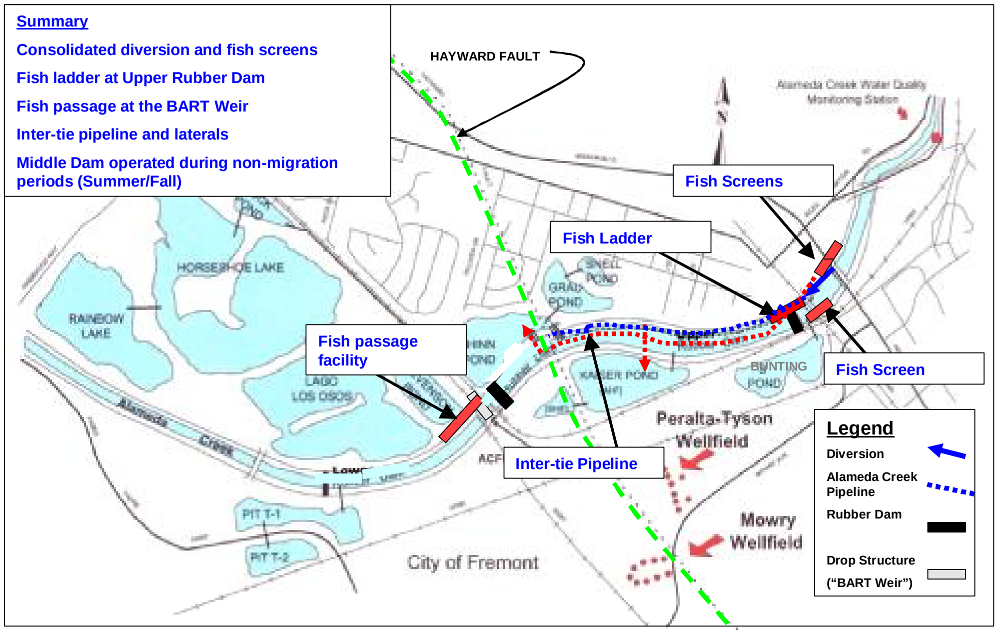


Figure 2 – Roughened Channel/Reduced Vertical Slot Alternative (Re-operation Alternative)



Ms. Laura Kidd
Alameda County Flood Control and Water Conservation District
By e-mail

September 26, 2006

Dear Laura,

Please accept the following comments on the Wood Rodgers/Ken Bates draft study, *Lower Alameda Cree/BART Weir Fish Passage Assessment* dated August 29, 2006. I have spoken by phone with the authors of the study and understand that changes have been made to the draft. This letter includes items which may already have been addressed through our conservations and several that have not.

Location	Citation	Comment
p. 5, ¶ 4	"…by FarWest/WRECO"	Incorrect citation. Use correct authorship here and forward.
p. 13, ¶ 5	"…ranks highest of all four…"	Reflect in Table B-1.
p. 15, ¶ 2	"…to be the best of all options…."	Reflect in Table B-1.
p. 17, ¶ 6	"Fish in the roughened…"	Re-write entire paragraph. Passage flow (200-400 cfs) not confined to "narrow" fishway as described. Sill cited already part of the project. Delete mention. Re-rank alternatives based on more-accurate information.
p. 19, ¶ 6	"Required Operating Flow"	**No** basis provided for situation of fish are moving on low flows. Contrary to existing data. Note caveat, re-rank, and lower weighting factor. Explain basis.
p. 29, ¶ 2	"Construct a low sill…"	Already specified in our report (p. 30). Delete suggested change.
Table B-1, row 6	"Potential for fish passage…"	Move item to "Other". Not a passage issue.

Thank you for the opportunity to comment on this draft. I can be reached at 510.559.420.4565 or at becker@cemar.org with questions.

Best,

Gordon Becker
Senior Scientist
Center for Ecosystem Management and Restoration

Ms. Laura Kidd
Alameda County Flood Control and Water Conservation District
By e-mail

October 11, 2006

Dear Laura,

Please accept my comments on the Wood Rodgers/Ken Bates draft study, *Lower Alameda Creek/BART Weir Fish Passage Assessment* dated August 29, 2006 ("the report"). I have only just recently been made aware of this report and am leaving for vacation on the 12th, so my comments represent a fairly quick review of the draft report. As the primary author of the Roughened Channel Natural Fishway Report (cited as the *FarWest/WRECO report*), I have focused my comments on the evaluation of this design alternative in the report.

First off, I appreciate the opportunity to provide comments to the draft report and I support the ACWD in their efforts to gain a third part review of the various design alternatives. I provide my comments in the spirit of improving fish passage through the BART weir structure.

General Comments

Alternatives Ranking System

1. It is not clear in the report exactly who (or whom) is doing the scoring of the various alternatives. My understanding is that Mr. Bates is the primary person ranking and scoring the various alternatives. I fully acknowledge Mr. Bates expertise as one of the leading practitioners in this field and this is not a criticism of his expertise, however, any scoring system reflects the views of the scorer and does not necessarily make any single ranking more objective (as indicated on page 3). Typically, this kind of ranking system would be scored by a variety of experts preceded by a full open discussion of the project against the scoring criteria and then the different scorecards would then be analyzed and ranked. It appears to me that the ranking and described in this report represent the views of a very small number of people and therefore do not reflect the different experience and expertise of other involved in fish passage. In particular, I would recommend that Professor Katapodis be engaged to provide a ranking of the various alternatives. As one of the leading designers and a builder of several roughened channels (as well as an expert on vertical slot fishways), Professor Katapodis would be a valuable expert to provide a review and ranking of the proposed designs. Recommend that the entire scoring system be opened up to other experts and then ranked.
2. The CEMAR/FarWest/WRECO report provided calculated numbers for depth, velocity and turbulence for all passage flows. My review of the January 2001 CH2MHill preliminary design report indicates that the report does not provide

these calculations that are essential for the evaluation of fish passage effectiveness. In addition, I have not seen calculations of these parameters for the extended vertical slot and pool and chute fishways described in the report. This report makes assertions about passage but does not provide the calculated numbers to prove the assertions. Therefore, it is not possible for me to review the rankings and assertions made in this report as to the effectiveness of various passage alternatives when the calculated design parameters are not made available for the engineered fishway alternatives. I recommend that design analysis be performed for all alternatives to be evaluated and then presented to a working group of experts for ranking. However, as stated below, the fish passage hydrology should be completed first.

3. I believe the report undervalues the value of complexity in the ranking of the natural roughened channel fishway alternative. This type of natural fishway attempts to mimic the natural conditions that fish have evolved to navigate through by evolution. The complexity of a natural fishway is difficult to model (especially with a one dimensional model) but it is exactly the complexity of flow paths that allow steelhead to find a mix of suitable passageways and resting areas behind boulders or logs under a wide range of passage flows. This design alternative is using the concept of engineering by learning from nature. The NOAS Fisheries Design Course on Natural Fishway Design (of which Mr. Bates was a listed instructor and has considerable expertise) stated that the proposed roughened channel design was suitable for the conditions in Alameda Creek for allowable slope and obstruction height. For obstructions in channels steeper then approximately five percent or with obstruction heights greater then 15 feet, a natural fishway may not be suitable and more engineered fishway designs may be the only alternatives. I believe the conditions at the Alameda Creek BART weir are suitable for construction of a natural fishway.

Fish Passage Hydrology

4. I fully agree that the most important next step in the project design is to further quantify fish passage flows under ACWD operating conditions through the BART weir. The roughened channel design report worked with the available flow data available at the time and the operations data made available by ACWD. In fact, we met with Mr. Jonathon Mann of NOAA fisheries and Mr. George Heise of DFG (by telephone) in October 2004 to discuss the passage flow numbers for the project, and that step led to the development of the flow numbers used in our report.
    a. The proposed revised flow number of 530 cfs for design passage flow may be too large in my opinion. Rather then just rely on a statistical analysis of flow data, we also plotted actual fish sighting data versus stream gauge flow rates for a variety of storms and fish were observed in the field at attempting to pass through the BART weir at lower flows, often in the range of 200 to 300 cfs (a sample of this data is attached and has been previously provided to the working group including ACWD). Although fish sightings are not conclusive, they are indicative and I do recommend

that actual fish sighting flows be incorporated into the fish passage hydrology studies.

b. Likewise, low flow fish passage flow numbers in the range of 35 to 45 cfs, as presented in the report, are also not significant for fish passage in Alameda Creek. Alameda Creek in the flood control channel is very wide and without a recognizable thalwag. An analysis should be made of the depth of flow in the entire channel with these kinds of flows. They will likely result in flow depths that are much too shallow for passage, however, this should be confirmed in the next stage of design.

Report Edits

5. Page 8, 3rd Paragraph – Recommend to change "complexion" to "complexity".

Review of Ranking Results

6. Page 13, Fish Access Evaluation – I do not understand the basis for raking the roughened channel below the engineered vertical slot fishway and equal to the other engineered fishways. The roughened channel handles the entire range of passage flows and should therefore provide for better fish access into the fishway. In fact, the most common problem with engineered fishways is the difficulty for fish to locate the entrance.

7. Page 15: Passage of Adult Steelhead Through Fishway – I disagree with the lower scoring for the roughened channel due to the "randomness in the materials and design..". As previously discussed, I believe this randomness is the primary advantage of the nature-like fishway design alternatives. I also restate my recommendation that someone with experience in the construction of roughened channels such as Professor Chris Katapodis be retained to review and critique the proposed design since he has successfully constructed several of these types of fishways.

8. Page 16: Attraction and passage of non-target fish – The ability of the roughened channel to pass juvenile fish should be a more important element of the proposed ranking evaluations.

9. Page 17: Safety of Fish – This criteria ranking seems very arbitrary. How are fish less secure in an environment where there are rocks to hide behind versus in a concrete engineered fishway? I believe that the engineered fishways concentrate fish in a smaller area and are therefore more subject to predation.

10. Page 18: Potential for Fish Passage Evaluation – I don't agree with this criteria or its use in ranking alternatives. Fish passage can be assessed by fish surveys below and above the passageway and I don't see any difference between the roughened channel and any of the other fishways. At a minimum, it should be moved out of the "fish passage" section of the ranking.

11. Page 19: Required Operating Flow - The strength of the roughened channel fishway is its ability to operate over a wider range of flows. The 50 cfs minimum

flow given as the reason for the low ranking is too low for passage up the other 12 miles of the flood control channel. I do not agree with this ranking and suggest it not be used until fish passage flows are further quantified. Also, the reviewer did not assess the ability of the engineered fishways to operate at the higher design flows where the fish will actually be moving and not this likely impassible low flow.

12. Page 20, Sediment and Bedload Management - The report says that all the proposed engineered fishways (i.e. reduced vertical slot, extended vertical slot, pool and chute) are good at passing debris and sediment with the pool and chute fishway ranking the best. The report does not acknowledge that Alameda Creek has a high sediment yield , therefore, sediment and debris are significant concerns in the evaluation of the proposed fishways. I believe that engineered fishways do not perform as well with high sediment and debris loads as a roughened channel would.
13. Page 21: Debris - I disagree that an engineered fishway will pass debris better then a wide roughened channel. Even if some logs get entrained in the roughened channel (as stated in the report), this adds passage diversity and may actually assist with fish passage. Other opinions should be sought for ranking by this criterion.
14. Page 21: Durability of Structure – I disagree with the much higher raking given to concrete engineered structures and recommend additional review of this ranking. A rock structure may actually be easier to repair then a concrete structure.
15. Page 21: Accommodates Extension to above middle weir – This criteria is not suitable for an evaluation between alternatives for fish passage. I agree with the analysis, however, it is a new project if the middle weir is to remain and therefore, this criteria is appropriate for deciding if alternatives are feasible or not, but should not be used as a ranking between alternatives. For example, if the middle dam is to remain then the entire roughened channel alternative is no longer feasible and should be eliminated and this criterion is not valid. If the middle dam is not to be retained then this criteria is no longer valid for deciding between passage alternatives and should be eliminated. I recommend eliminating it as a criterion.
16. Page 22: Water Supply - See previous comment. If the middle dam is to remain then the roughened channel alternative is no longer valid. It should not be used as a criterion in deciding between fish passage between alternatives for the same barrier.
17. Page 25: Public Safety –I disagee that the proposed fishway is a public safety concern. One could make that argument about any of the proposed designs. I recommend a larger group review this ranking.
18. Page 25: Permitting - I believe that a natural fishway would be easier to permit if it is shown to meet all the passage criteria. I would rank it slightly better then the engineered alternatives.

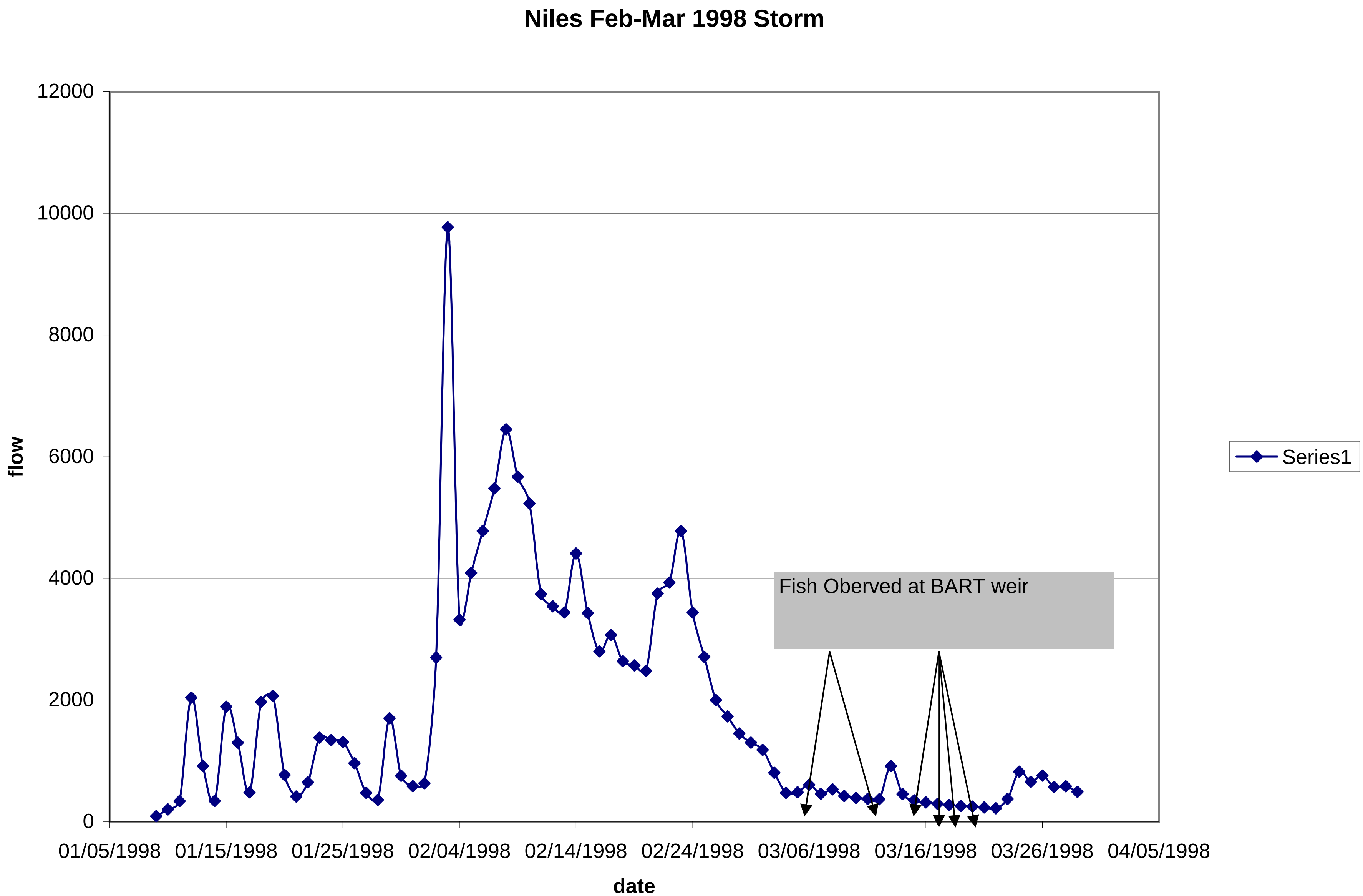
Unfortunately, I did not have time to review the cost estimates. I appreciate the opportunity to review the remainder of the draft report. It is a very good start on a ranking system between alternatives and I hope a passage alternative can be taken to the next stage and implemented in the creek. I am available to discuss this report or my team's design at any time.

Roger Leventhal, P.E.
Principal Engineer
FarWest Restoration Engineering
538 Santa Clara Ave, Alameda, CA 94501

510-522-7200 ph

APPENDIX C

Sample Fish Sighting Data



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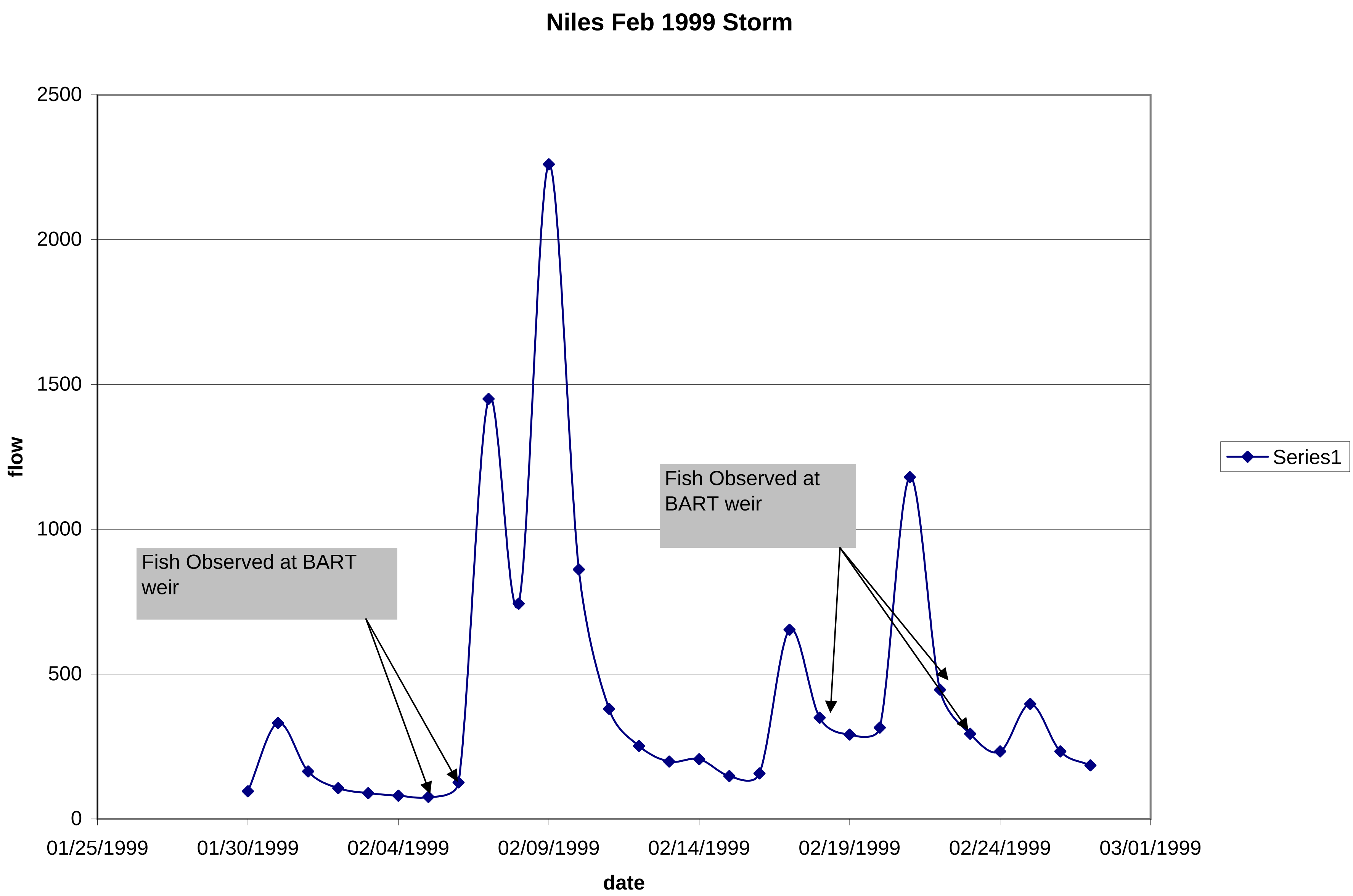
date
Fish Oberved at BART weir
Series1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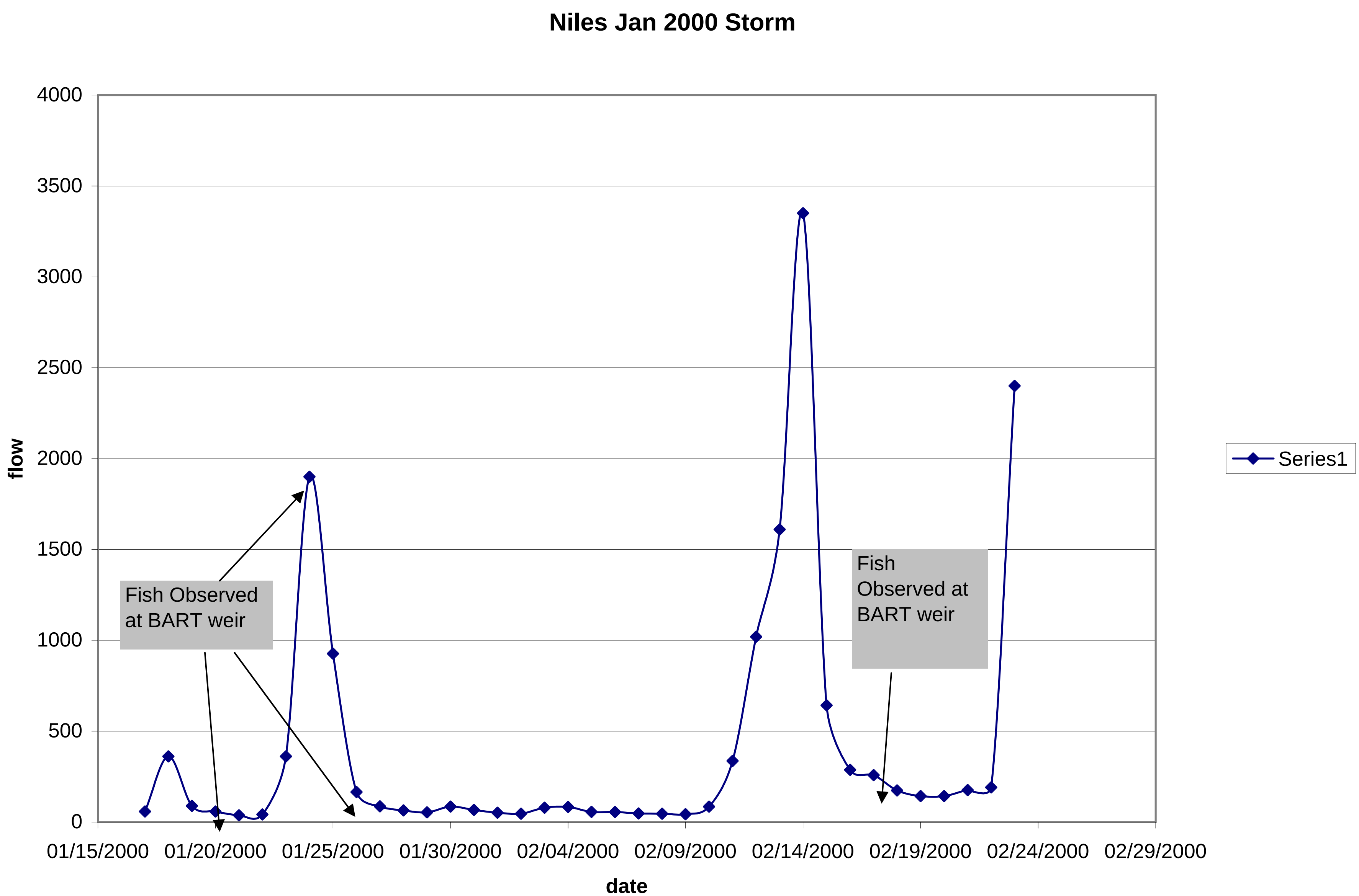
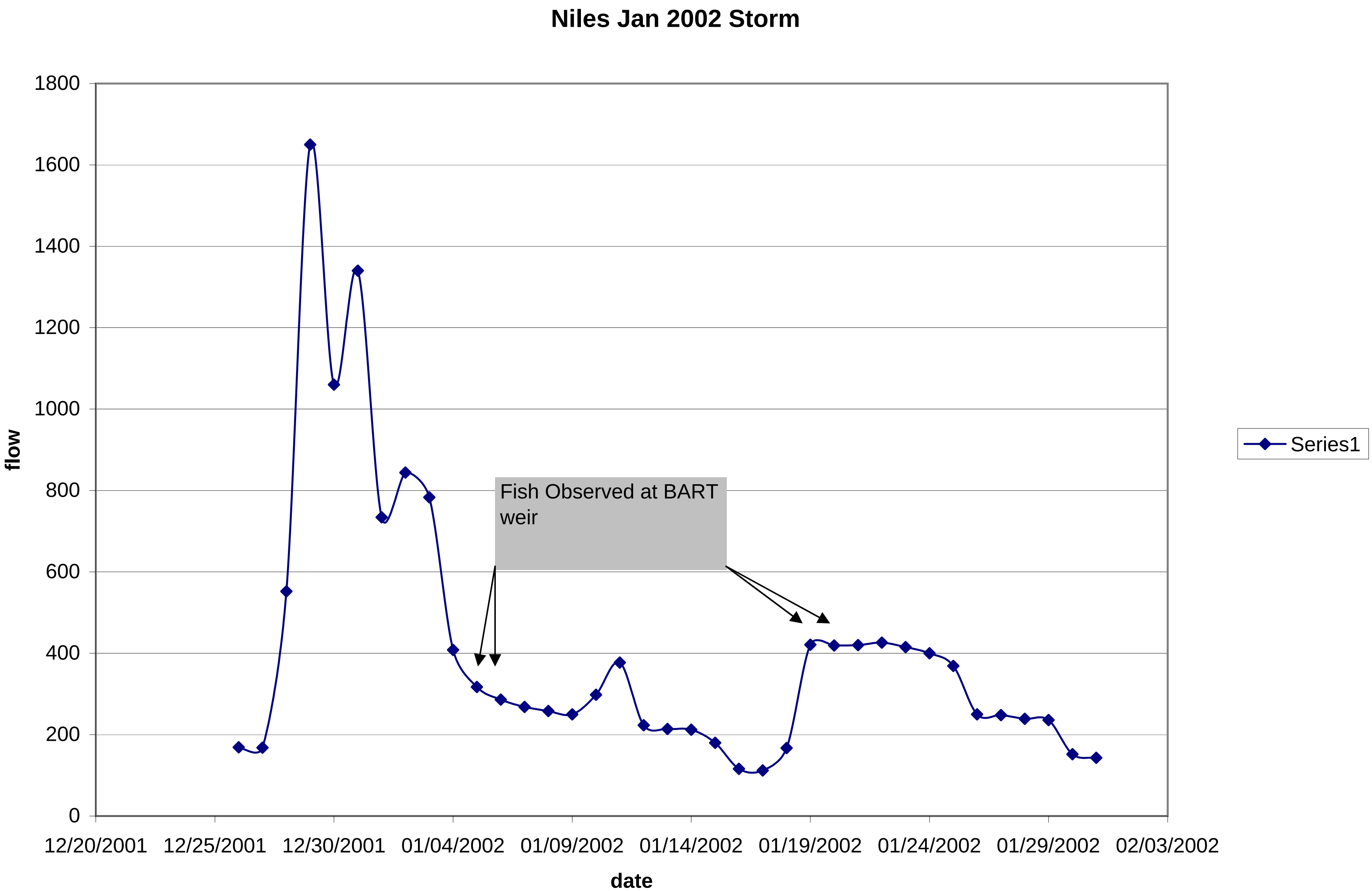
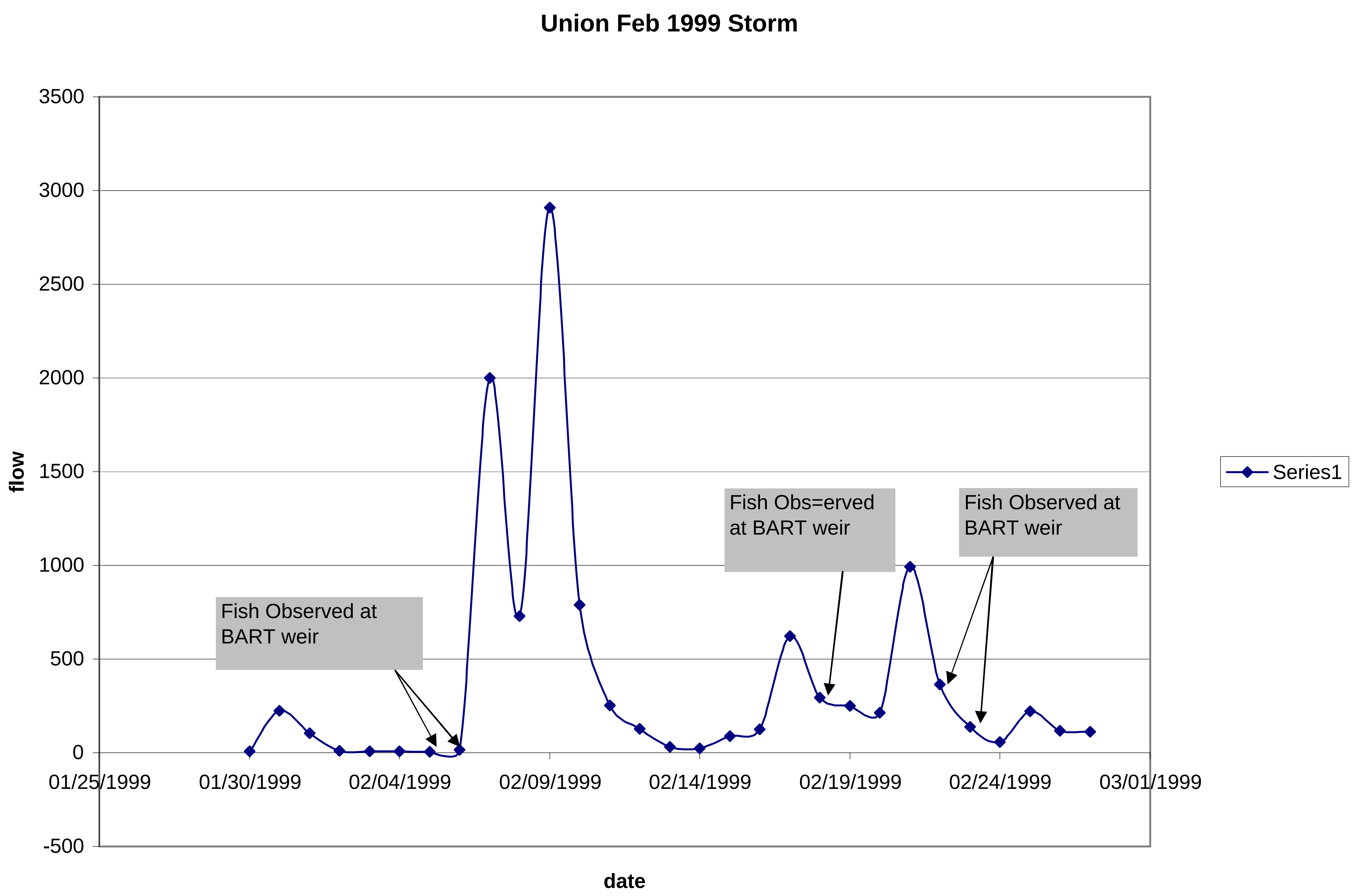
date
Fish Observed at BART weir
Fish Observed at BART weir
Series1



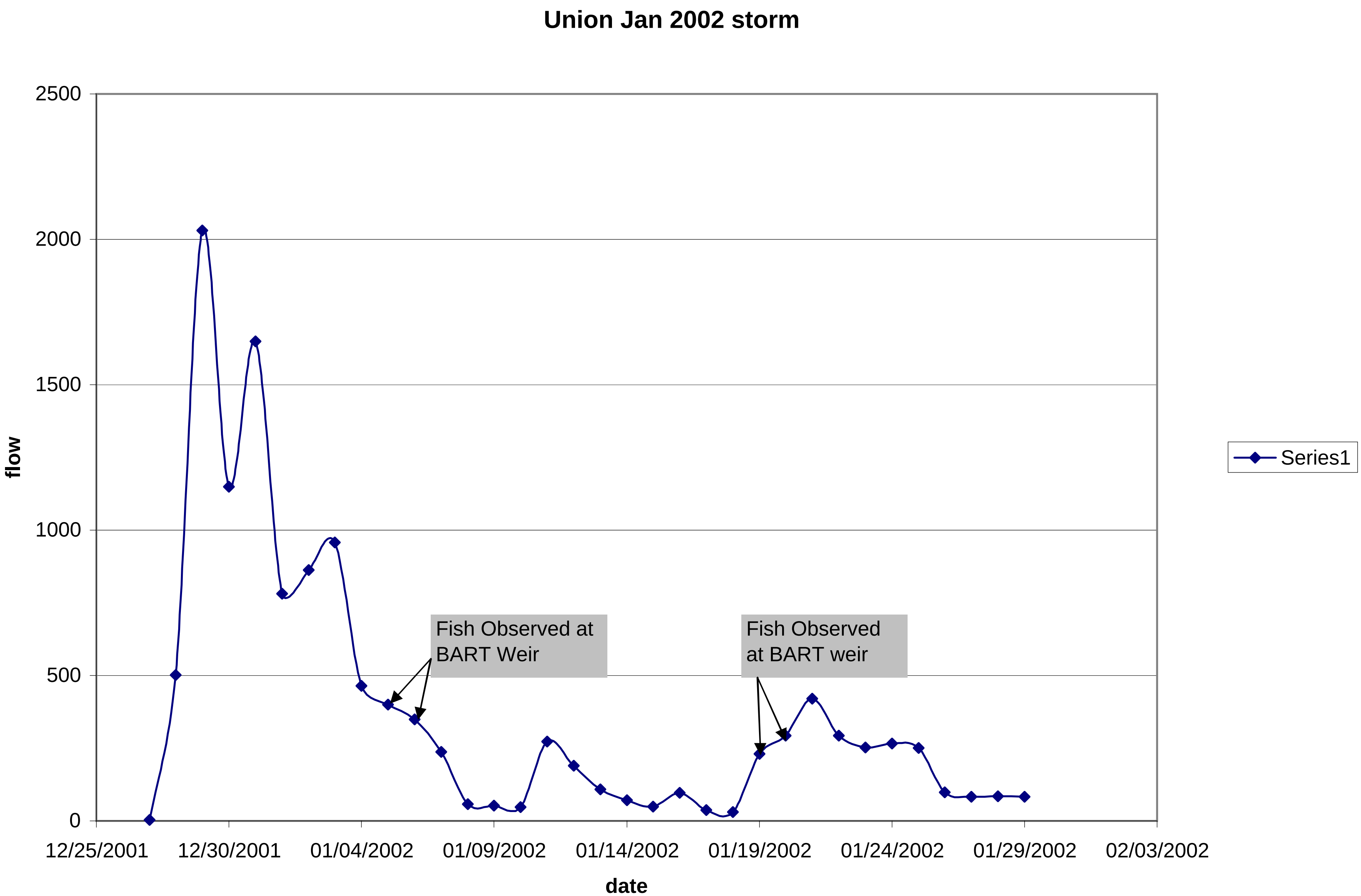
Niles Jan 2000 Storm
flow
4000
3500
3000
2500
2000
1500
1000
500
0
01/15/2000
01/20/2000
01/25/2000
01/30/2000
02/04/2000
02/09/2000
02/14/2000
02/19/2000
02/24/2000
02/29/2000
date
Series1
Fish Observed at BART weir
Fish Observed at BART weir



Niles Jan 2002 Storm
1800
1600
1400
1200
1000
800
600
400
200
0
flow
Fish Observed at BART weir
Series1
12/20/2001
12/25/2001
12/30/2001
01/04/2002
01/09/2002
01/14/2002
01/19/2002
01/24/2002
01/29/2002
02/03/2002
date



Union Feb 1999 Storm
flow
3500
3000
2500
2000
1500
1000
500
0
-500
01/25/1999
01/30/1999
02/04/1999
02/09/1999
02/14/1999
02/19/1999
02/24/1999
03/01/1999
date
Series1
Fish Observed at BART weir
Fish Obs=erved at BART weir
Fish Observed at BART weir



Union Jan 2002 storm
2500
2000
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flow
12/25/2001
12/30/2001
01/04/2002
01/09/2002
01/14/2002
01/19/2002
01/24/2002
01/29/2002
02/03/2002
date
Fish Observed at BART Weir
Fish Observed at BART weir
Series1

APPENDIX D

Scoring Matrix

Table D-1 Comparison matrix of alternatives

BART Weir Fish Passage

Characteristic	Weight 0-10	Option 1 Reduced Vertical Slot		Option 2 Roughened Channel		Option 4 Pool and Chute		Option 3 Extended Vertical Slot	
		Score 0-10	Product	Score 0-10	Product	Score 0-10	Product	Score 0-10	Product
Fish passage									
Attraction of adult steelhead to fishway	10	7	70	10	100	9	90	7	70
Fish access into and out of fishway	10	6	60	8	80	6	60	8	80
Passage of Adult Steelhead Through Fishway	10	10	100	8	80	7	70	10	100
Attraction and Passage of Non-Target Species	3	3	9	8	24	3	9	3	9
Safety of adult fish	5	8	40	5	25	7	35	9	45
Safety of juvenile fish	2	4	8	6	12	7	14	5	10
Potential for Biological Monitoring	4	8	32	2	8	4	16	9	36
Operation and maintenance									
Fishway Flow Control	9	10	90	10	90	10	90	10	90
Required Operating Flow	7	7	49	5	35	9	63	7	49
Sediment and Bedload Management	6	8	48	9	54	9	54	9	54
Debris	8	7	56	5	40	5	40	8	64
Durability of Structure	8	10	80	6	48	8	64	10	80
Design and Construction									
Construction Complexities	4	5	20	4	16	8	32	4	16
Certainty of Structural Design	6	9	54	6	36	9	54	9	54
Flood Control									
Affect on flood control	10	7	70	7	70	8	80	7	70
Other									
Public safety	8	8	64	4	32	3	24	8	64
Aesthetics, Education	2	5	10	7	14	5	10	6	12
Permitting	6	5	30	5	30	5	30	5	30
Total - overall score			890		794		835		933
Total - overall, normalized			100		89		94		100
Total - fish passage only, normalized			97		100		89		100

APPENDIX E

Implementation Cost Estimates

WOOD RODGERS

Alameda County Flood Control & Water Conservation District **Updated: 4-Dec-06**
Bart Weir Fish Passage - Reduced Vertical Slot Fishway Alternative
Opinion of Probable Implementation Costs
Project No. 8133.001

ITEM NO	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
	A. General				
1	Mobilization & Demobilization (5%)	1	LS	n/a	$50,000.00
2	Contract Admin/Submittals/RFI's/Schedules/Coordination (3%)	1	LS	n/a	$30,000.00
3	Liability Insurance (1%)	1	LS	n/a	$10,000.00
4	Performance and Payment Bonds (2%)	1	LS	n/a	$20,000.00
5	Temporary Facilities and Utilities	1	LS	n/a	$20,000.00
6	Surveying and Construction Staking	1	LS	n/a	$5,000.00
7	Cal Labor Code Section 6707 Sheeting, Shoring, and Bracing	1	LS	n/a	$10,000.00
8	Overhead and Profit (10%)	1	LS	n/a	$100,000.00
	General Subtotal				**$245,000.00**
	B. Civil Site Work				
9	Establish Creek Access	1	LS	$20,000.00	$20,000.00
10	Bypass and Dewatering System	1	LS	$40,000.00	$40,000.00
11	Demo Existing Weir/Apron and Dispose	110	CY	$1,000.00	$110,000.00
12	Miscellaneous Site Work/Finish Grading/Hydroseeding	1	LS	$10,000.00	$10,000.00
13	Roadway Resurfacing	1	LS	$10,000.00	$10,000.00
	Sitework Subtotal				**$190,000.00**
	C. Downstream Weir and Guide Channel				
14	Weir Excavation and Spoil	190	CY	$20.00	$3,800.00
15	Reinforced Concrete Weir/Curb	150	CY	$600.00	$90,000.00
16	Channel Excavation and Spoil	100	CY	$20.00	$2,000.00
17	Grouted Rock Berms and Channel Invert	200	CY	$200.00	$40,000.00
	Weir and Channel Subtotal				**$135,800.00**
	D. Vertical Slot Fishway				
18	Ladder Excavation and Spoil	500	CY	$20.00	$10,000.00
19	Foundation Prep and Subbase	1,200	SF	$2.00	$2,400.00
20	Entrance Transition (Doweling/Reinf/Concrete/Placement/Finish/Cure)	30	CY	$600.00	$18,000.00
20	Fishway Slab on Grade (Forming/Reinf/Concrete/Placement/Finish/Cure)	50	CY	$600.00	$30,000.00
21	Fishway Walls (Formwork/Reinf/Concrete/Placement/Finish/Cure)	150	CY	$1,000.00	$150,000.00
22	Fishway Baffles (Formwork/Reinf/Concrete/Placement/Finish/Cure)	20	CY	$1,200.00	$24,000.00
23	Fishway Mechanical - 4' x 4' Exit Sluice Gate with Manual Operator	2	EA	$10,000.00	$20,000.00
24	Fishway Mechanical - 2' x 4' Entrance Stop Gate with Operator	2	EA	$8,000.00	$16,000.00
25	Fishway Mechanical - Removable Handrail (Installed)	120	LF	$50.00	$6,000.00
26	Fishway Mechanical - Exit Trash Racks (Installed)	2	SF	$5,000.00	$10,000.00
27	Fishway Mechanical - 3/16" x 2" Galv Steel Grating (Installed)	960	SF	$35.00	$33,600.00
28	Fishway Mechanical - Ladders and Stairways	1	LS	$20,000.00	$20,000.00
	Fishway Subtotal				**$340,000.00**

ITEM NO	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
	E. Upstream Weir and Channel Transition				
29	Weir Excavation and Spoil	190	CY	$20.00	$3,800.00
30	Reinforced Concrete Weir/Curb	140	CY	$600.00	$84,000.00
31	Channel Excavation and Spoil	200	CY	$20.00	$4,000.00
32	Grouted Rock Invert	90	CY	$200.00	$18,000.00
	Weir and Channel Subtotal				**$109,800.00**
	Construction Subtotal :				**$1,020,600.00**
	City Location Multiplier (10%) :				**$102,100.00**
	Annual Inflation Rate (4%) :				**$40,900.00**
	Annual Material Escalation Factor (15%) :				**$47,000.00**
	Contingency (30%) :				**$306,200.00**
	Construction Total :				**$1,517,000.00**
	F. Professional Services				
33	Engineering/Design/Construction Administration (20%)	1	LS	$303,000.00	$303,000.00
34	Environmental Compliance and Permitting	1	LS	$50,000.00	$50,000.00
35	Surveying and Mapping	1	LS	$10,000.00	$10,000.00
36	Geotechnical	1	LS	$10,000.00	$10,000.00
	Professional Services Subtotal				**$373,000.00**
	Total Estimated Implementation Cost (Bid Early 2008):				**$1,890,000.00**

Note: The Opinion of Probable Cost above is based on Concept Level Drawings prepared by Wood Rodgers for ACFC&WCD. Neither Wood Rodgers nor the Client has any control over the cost of labor, materials, equipment, the Contractors' methods of determining bid prices, or other competitive bidding markets. Prices may vary from engineer's estimate due to bidding climate, competition, and materials escalation at time of receiving bids. The above cost estimate represents preliminary amounts that are subject to change pending confirmation of existing utilities, improvements, and existing structure conflicts with proposed project. Wood Rodgers, Inc. does not assume responsibility for the use of these costs in budget analysis and will not be held liable for capital improvement cost increases associated with the development of this project.

WOOD RODGERS

Alameda County Flood Control & Water Conservation District **Updated: 4-Dec-06**
Bart Weir Fish Passage - Roughened Channel Fishway Alternative
Opinion of Probable Implementation Costs
Project No. 8133.001

ITEM NO	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
	A. General				
1	Mobilization & Demobilization (5%)	1	LS	n/a	$75,000.00
2	Contract Admin/Submittals/RFI's/Schedules/Coordination (3%)	1	LS	n/a	$45,000.00
3	Liability Insurance (1%)	1	LS	n/a	$15,000.00
4	Performance and Payment Bonds (2%)	1	LS	n/a	$30,000.00
5	Temporary Facilities and Utilities	1	LS	n/a	$20,000.00
6	Surveying and Construction Staking	1	LS	n/a	$10,000.00
7	Cal Labor Code Section 6707 Sheeting, Shoring, and Bracing	1	LS	n/a	$10,000.00
8	Overhead and Profit (10%)	1	LS	n/a	$150,000.00
	General Subtotal				**$355,000.00**
	B. Civil Site Work				
9	Establish Creek Access	1	LS	$20,000.00	$20,000.00
10	Bypass and Dewatering System	1	LS	$50,000.00	$50,000.00
11	Demo Existing Weir/Apron and Dispose	280	CY	$1,000.00	$280,000.00
12	Miscellaneous Site Work/Finish Grading/Hydroseeding	1	LS	$10,000.00	$10,000.00
13	Roadway Resurfacing	1	LS	$10,000.00	$10,000.00
	Sitework Subtotal				**$370,000.00**
	C. Roughened Channel Fishway				
14	Excavation and Spoil/Backfill	500	CY	$30.00	$15,000.00
15	Foundation Prep and Subbase	15,000	SF	$2.00	$30,000.00
16	Grouted Rock Channel Lining	750	CY	$200.00	$150,000.00
17	Imported Boulders and Placement	60	CY	$150.00	$9,000.00
18	Grouted Rock Berms	500	CY	$200.00	$100,000.00
19	Reinforced Concrete Retaining Wall	200	CY	$1,000.00	$200,000.00
	Fishway Subtotal				**$504,000.00**
	D. Upstream Weir and Channel Transition				
20	Weir Excavation and Spoil	140	CY	$20.00	$2,800.00
21	Reinforced Concrete Weir/Curb	110	CY	$600.00	$66,000.00
22	Channel Excavation and Spoil/Backfill	800	CY	$30.00	$24,000.00
23	Foundation Prep and Subbase	6,500	SF	$2.00	$13,000.00
24	Grouted Rock Channel Lining	370	CY	$200.00	$74,000.00
25	Reinforced Concrete Retaining Wall	100	CY	$1,000.00	$100,000.00
	Weir and Channel Subtotal				**$279,800.00**

ITEM NO	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
	Construction Subtotal :				**$1,508,800.00**
	City Location Multiplier (10%) :				**$150,900.00**
	Annual Inflation Rate (4%) :				**$60,400.00**
	Annual Material Escalation Factor (15%) :				**$61,800.00**
	Contingency (30%) :				**$452,700.00**
	Construction Total :				**$1,962,000.00**
	F. Professional Services				
26	Engineering/Design/Construction Administration (20%)	1	LS	$392,000.00	$392,000.00
27	Environmental Compliance and Permitting	1	LS	$50,000.00	$50,000.00
28	Surveying and Mapping	1	LS	$10,000.00	$10,000.00
29	Geotechnical	1	LS	$10,000.00	$10,000.00
	Professional Services Subtotal				**$462,000.00**
	Total Estimated Implementation Cost (Bid Early 2008):				**$2,424,000.00**

Note: The Opinion of Probable Cost above is based on Concept Level Drawings prepared by Wood Rodgers for ACFC&WCD. Neither Wood Rodgers nor the Client has any control over the cost of labor, materials, equipment, the Contractors' methods of determining bid prices, or other competitive bidding markets. Prices may vary from engineer's estimate due to bidding climate, competition, and materials escalation at time of receiving bids. The above cost estimate represents preliminary amounts that are subject to change pending confirmation of existing utilities, improvements, and existing structure conflicts with proposed project. Wood Rodgers, Inc. does not assume responsibility for the use of these costs in budget analysis and will not be held liable for capital improvement cost increases associated with the development of this project.

CH2M HILL - Class 3 Cost Estimate

Lower Alameda Creek Fish Passage Project **Original Date** **June 12 2006**
Alameda County Water District, Fremont, California
Prepared By: R Lawson/RDD **Proposed Fishway**
Project No: 337049.AA.01 **at BART Weir & Middle Rubber Dam (Rubber Dam #1)**

Item No.	Description	Quantity	Unit	Unit Cost	Total Cost
A	General Items				
1	Mobilization/Demobilization	1	LS	$106,000.00	$106,000
2	Site Work, Access & Construction Staging	1	LS	$12,000.00	$12,000
3	Dewatering	1	LS	$88,000.00	$88,000
4	Remove & Reinstall Exist Rubber Dam Features	1	LS	$35,000.00	$35,000
5	Fish Monitoring Equipment & Items	1	LS	$88,000.00	$88,000
6	Electrical Service for Facility	1	LS	$29,000.00	$29,000
	Group Sub-Total			$358,000	
B	Lower Fish Ladder Structure				
7	Excavation Support, Cofferdam	1	LS	$200,790.00	$200,790
8	Excavation, General/Rock	1,800	CY	$33.00	$59,400
9	Concrete, Slabs & Footings	160	CY	$620.00	$99,200
10	Concrete, Walls (Normal)	400	CY	$1,450.00	$580,000
11	Concrete, Walls (Intricate)	30	CY	$1,730.00	$51,900
12	Patch Concrete Slabs @ Energy Dissipator	10	CY	$830.00	$8,300
13	Concrete Curb/Weir	20	CY	$1,560.00	$31,200
14	Fishway Entrance Openings	3	EA	$1,200.00	$3,600
15	72" CMP Fishway w/Light Openings	61	LF	$640.00	$38,720
16	Stairway/Ladder Access to Roadway w/Handrail	1	EA	$10,750.00	$10,750
17	Stairway/Ladder Access to Roadway w/Handrail	1	EA	$17,920.00	$17,920
18	Ladder Cover Grating	2,340	SF	$40.00	$93,600
19	Ladder Cover Handrailing	206	LF	$50.00	$10,300
	Group Sub-Total			$1,205,680	
C	Upper Fish Ladder Structure				
20	Excavation Support, Cofferdam	1	LS	$167,320.00	$167,320
21	Excavation, General/Rock	890	CY	$33.00	$29,370
22	Concrete, Slabs & Footings	90	CY	$630.00	$56,700
23	Concrete, Walls (Normal)	120	CY	$1,460.00	$175,200
24	Concrete, Walls (Intricate)	30	CY	$1,530.00	$45,900
25	Trash Rack, Fishway Exit w/Supports	60	SF	$120.00	$7,200
26	Stairway/Ladder Access to Roadway w/Handrail	2	EA	$7,170.00	$14,340
27	Ladder Cover Grating	1,350	SF	$40.00	$54,000
28	Ladder Cover Handrailing	168	LF	$50.00	$8,400
29	Adjustable Overflow Gate w/Operator	3	EA	$17,670.00	$53,010
30	Reinstall Dam Bypass Gate & Covers	1	LS	$29,460.00	$29,460
31	Install New Fishway Exit, Dam Out	1	LS	$17,670.00	$17,670
32	Regrade, Replace Rip-Rap and Slope Protection	1	LS	$11,780.00	$11,780
	Group Sub-Total			$670,350	
33	Construction Cost				$2,234,030
34	State Sales Tax on Materials	8.25%			$92,154
35	Contingency	30.00%			$697,855
36	Construction Cost Subtotal, June 2006				$3,024,039
	Use Rounded Total for Construction Cost			$3,020,000	

CH2M HILL - Class 3 Cost Estimate

Lower Alameda Creek Fish Passage Project **Original Date** **June 12 2006**
Alameda County Water District, Fremont, California
Prepared By: R Lawson/RDD
Project No: 337049.AA.01

Proposed Fishway at BART Weir & Middle Rubber Dam (Rubber Dam #1)

Item No.	Description	Quantity	Unit	Unit Cost	Total Cost
37	Engineering	20%			$604,808
38	Environmental Mitigation	5%			$151,202
39	Services During Construction & Inspection	15%			$453,606
40	Contract Administration	5%			$151,202
	Use Rounded Total for Project Cost			$4,385,000	

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