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CASPAR CREEK FISH PASSAGE
IMPROVEMENT PROJECT
FINAL DESIGN REPORT

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1.0 BACKGROUND

The Caspar Creek watershed has been a long-established experimental forest operated jointly by the US Forest Service and California Department of Forestry. The two forks of Caspar Creek are the focus of much of the research and are utilized as paired-watersheds. This project's objective is to improve upstream and downstream fish passage conditions for adult and juvenile salmonids at the two existing flow measurement weirs on the North Fork and South Fork of Caspar Creek.

The flow measurement weirs were both constructed in 1962, providing a long term and relatively accurate record of flows. The weirs are nearly identical and consist of a compound v-notch and horizontal sharp crest weir. The v-notch has a 120-degree angle and is 2 feet deep. Based on weir calculations, it is filled at a flow of 24.5 cfs, at which point the water begins to flow over the horizontal portions of the weir (Figure 1.1).

Figure 1.1 - North Fork Caspar Creek weir at a flow that fills the v-notch and begins to overtop the horizontal portions of the weir, estimated to be roughly 30 cfs. The nappe appears to be streaming across the concrete below the v-notch weir, resulting in less than ideal conditions for leaping fish.

1.1 Existing Fish Passage Facilities

By 1964 wooden fish ladders were constructed at both the North and South Forks (Figure 1.2). They consist of an approximately 5 ft wide by 33 ft long ladder containing horizontal wooden weirs, with 1 foot drops between weirs. A horizontal spillway extends across the channel adjacent to the fish ladder (Figure 1.3). The spillway is about 30 feet wide on the South Fork and 40 feet wide on the North Fork.

As part of their recent Biological Opinion, NOAA Fisheries identified the structures as an impediment to upstream migrating adult and juvenile salmonids. Stranding of juvenile salmonids within the tailwater pool upstream of the existing fish ladder during low flows was also identified as a problem. The stranding is a result of leakage through the wooden boards of the fish ladder spillway weirs at low flows, preventing water from flowing in the ladder. This leads to entrapment of the juveniles within the pool between the fish ladder and flow measurement weir, which becomes increasingly shallow and experiences elevated water temperatures during summer months.

Figure 1.2 - Photo taken in 1964 of fish ladder and spillway below the South Fork weir, shortly after construction.

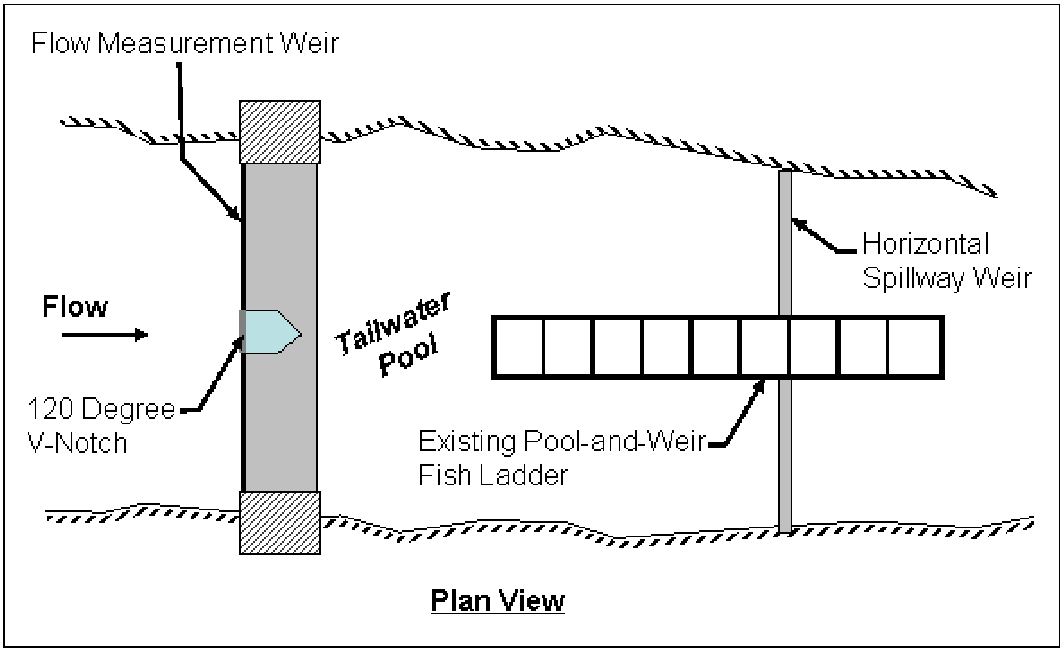


Figure 1.3 – Diagram of existing fish ladder configuration below flow measurement weirs on the North and South Forks of Caspar Creek.

1.2 Design Process

Design and engineering services were provided by Winzler & Kelly and Michael Love & Associates (MLA) through a contract with Trinity County and the Five Counties Salmonid Conservation Program (Five Counties). As part of the project, a Technical Advisory Team (TAT) was formed consisting of the design team members and staff from the Five Counties, California Department of Forestry (CDF), US Forest Service Redwood Sciences Laboratory (RSL), National Marine Fisheries Service (NOAA Fisheries), and the California Department of Fish and Game (CDFG). The TAT was responsible for providing and clarifying project objectives and constraints, reviewing design alternatives, preliminary designs, and the final engineering design and specifications package.

The TAT met at the site in August, 2005, and again in Santa Rosa in January, 2006 to discuss the project. Additionally, TAT members participated in multiple conference calls. Meeting notes are provided in Appendix A.

2.0 PROJECT OBJECTIVES AND CONSTRAINTS

2.1 Objectives

The objective of the project is to improve fish passage and habitat conditions at the flow measurement weirs on the North Fork and South Fork Caspar Creek by replacing the existing redwood fish ladder facilities at both sites with new facilities. These new passage facilities should:

1. Improve upstream passage conditions for adult coho salmon and steelhead trout during winter migration flows.

2. Provide suitable upstream passage conditions during summer for juvenile salmonids.

3. Eliminate potential for stranding or impingement of juvenile salmonids associated with the fish passage facility.

The new fish passage facilities should attempt to satisfy the criteria and actions described in the National Marine Fisheries Service's Biological Opinion.

2.2 Constraints

The central hydraulic constraint of the project is constructing a fish passage facility that does not compromise the accuracy of the North Fork and South Fork flow measurement weirs. For the flow measurement weir to operate as intended, the Technical Advisory Team (TAT) has stated that the tailwater (water surface immediately below the flow measurement weir) must remain a minimum of 0.2 feet below the flow measurement weir crest. When the tailwater elevation exceeds this criteria, we refer to the flow measurement weir as being "partially submerged". The TAT agreed to the following design criteria for ensuring accuracy of the flow measurement weirs would not decrease with new fish passage facilities:

1. The tailwater elevation must remain 0.2 feet below the flow measurement weir crest elevation at all streamflows up to the flow in which partial submergence occurs under existing conditions. These flows have been estimated by MLA to be roughly 280 cfs for at the South Fork weir and 295 cfs for North Fork weir.

2. Submergence of the flow measurement weir, when it occurs, should be no greater in magnitude than what now occurs under existing conditions.

Due to limited personnel and the remote location of the project sites, the structure is desired to be low maintenance, requiring minimal adjustment and be limited to seasonal operation of the fish ladder and spillway. Also, the fish passage structure should not be prone to frequent plugging with debris or sedimentation.

3.0 HYDROLOGY

As part of the Caspar Creek experimental watershed, streamflow gaging stations at the project sites have been in operation since water year 1963, providing data on daily minimum, maximum, and average flow. As part of this project, the flow data was used to estimate recurrence intervals of peak flows and to aid in selecting fish passage design flows.

3.1 Peak Flows and Recurrence Intervals

To assist in the design of the fish passage facility, estimates of peak flows associated with specific recurrence intervals were needed. USFS Redwood Sciences Lab provided the design team a flood frequency analysis based on the Gumbel distribution using peak flow data from Water Years 1963 through 2001 (Table 3.1).

Table 3.1 - Peak flows and associated return intervals for the North and South Forks Caspar Creek.

Return Interval	North Fork	South Fork
1.5 years	100 cfs	112 cfs
2 years	126 cfs	139 cfs
5 years	188 cfs	205 cfs
10 years	229 cfs	249 cfs
25 years	280 cfs	304 cfs
50 years	319 cfs	346 cfs
100 years	357 cfs	386 cfs
150 years	379 cfs	410 cfs

3.2 Fish Passage Flows

Both NOAA Fisheries and the CDFG have design guidelines for fish passage at road-stream crossings (CDFG, 2002; NOAA Fisheries, 2001). The two sets of guidelines were developed together and are functionally equivalent. Although the guidelines are targeted at road-stream crossings, some of the criteria can be applied to this project. The guidelines contain recommended fish passage design flows for adult anadromous and juvenile salmonids.

Fish passage design flows are generally targeted to a specific species and lifestage of the fish. There is typically a lower and upper design flow which encompasses the range of flows that upstream passage should be provided. Beyond this flow range it is not necessary to provide suitable passage conditions.

Fish passage design flows are commonly defined in terms of exceedance flows based on flow duration curves constructed using daily average flow. Annual exceedance defines the average duration that the flow is equaled or exceeded in a year. For example, flows within a stream are greater than the 50% exceedance flow for half of the year, on average.

3.2.1 Passage Flows for Adult Anadromous Salmonids

For adult anadromous steelhead trout and coho salmon NOAA Fisheries and CDFG recommend providing suitable upstream passage conditions between the 50% and 1% exceedance flows. If the 50% exceedance flow is less than 3 cfs, than 3 cfs is used as the lower fish passage design flow.

To assist in determining suitable design flows for adult steelhead and coho, flow duration curves were constructed for each of the sites (Figure 3.1). From the flow duration curve passage design flows for adult steelhead and coho were obtained (Table 3.2).

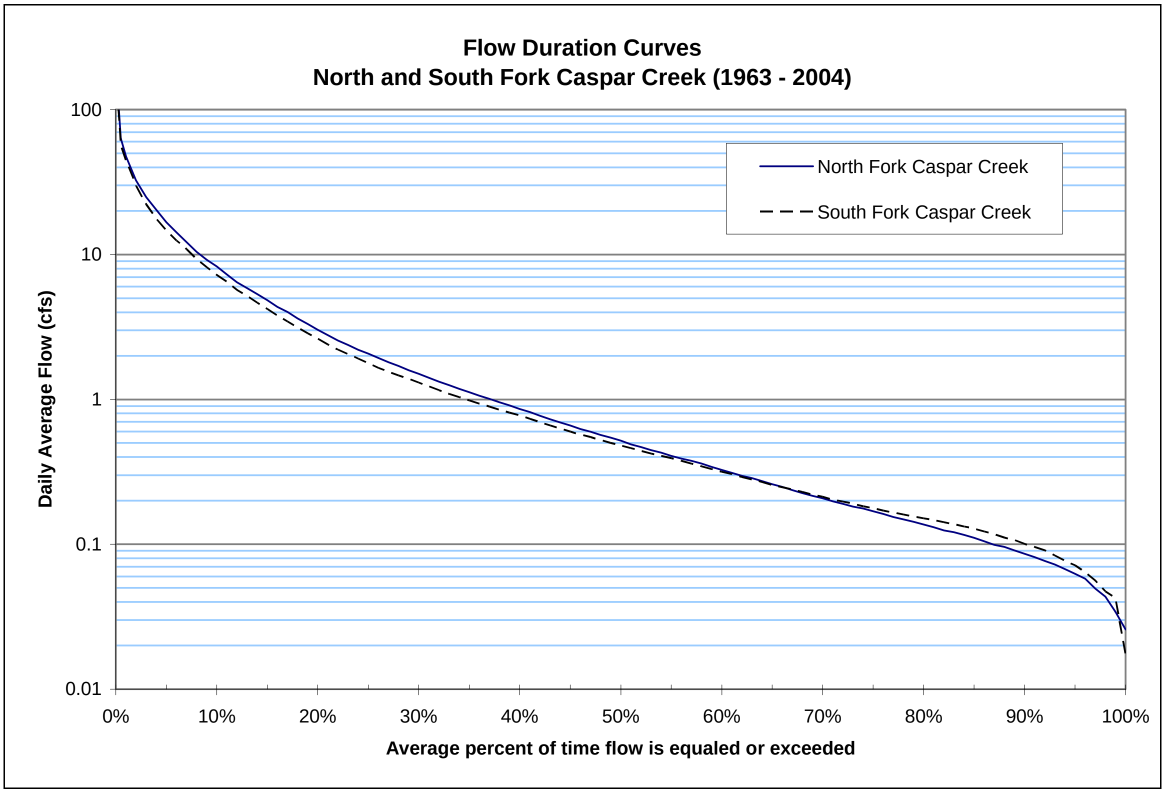


Figure 3.1 – Annual flow duration curves for the North and South Forks of Caspar Creek.

Table 3.2 – Lower and upper fish passage design flows for adult anadromous steelhead trout and coho salmon at the flow measurement weirs, based on NOAA Fisheries (2002) and CDFG (2001) guidelines.

Adult Steelhead and Coho	North Fork	South Fork
Lower Passage Design Flow	3 cfs	3 cfs
Upper Passage Design Flow	47.6 cfs	44.3 cfs

3.2.2 Passage Flows for Juvenile Salmonids

NOAA Fisheries' Biological Opinion for the project focuses on upstream juvenile passage during summer. The Biological Opinion does not require juvenile passage during the remainder of the year. Table 3.3 summarizes flow characteristics for both forks during the typically dry months of June through October. During this period flows are extremely low. For all of these months the 10% exceedance flow is less than 1 cfs. Note the consistency between the two forks. From 1963 through 2004 the minimum flows ever recorded at the North Fork and South Fork measurement weirs were 0.026 cfs and 0.014 cfs, respectively.

Based on this information, the juvenile summer upper fish passage flow was set at 1 cfs. The lower juvenile salmonid passage flow was effectively set at no flow (0 cfs).

Table 3.3 - Monthly median and 10% exceedance flows, based on daily average flows from 1963 – 2004.

	North Fork Caspar Creek		South Fork Caspar Creek	
Month	**Median Flow**	**10% Exceedance**	**Median Flow**	**10% Exceedance**
June	0.39 cfs	0.86 cfs	0.38 cfs	0.73 cfs
July	0.21 cfs	0.46 cfs	0.24 cfs	0.41 cfs
August	0.12 cfs	0.26 cfs	0.15 cfs	0.26 cfs
September	0.09 cfs	0.19 cfs	0.11 cfs	0.20 cfs
October	0.10 cfs	0.29 cfs	0.13 cfs	0.39 cfs

4.0 SELECTION OF FISH PASSAGE STRUCTURE

Based on the project objectives and preliminary analysis of the streams' hydrologic characteristics, various fish passage structures for the North and South Forks of Caspar Creek were considered.

- Vertical slot fish ladder,
- Pool and chute fishway, and
- Traditional pool and weir ladder.

The most challenging constraint was to minimize the water surface drop over the flow measurement weir while still meeting the no-submergence criteria. This requires a design that minimizes the degree to which water levels below the flow measurement weir rise in response to increasing flows.

4.1 Vertical Slot Fish Ladder

The vertical slot fish ladder was considered undesirable due to its susceptibility to plugging by debris. Additionally, the wide range of fish passage flows would cause substantial change in depth within the vertical slot fish ladder, compromising its ability to provide suitable fish passage conditions over the flow measurement weir.

4.2 Pool and Chute Fishway

A channel spanning pool and chute fish ladder has the advantage of being able to accommodate very high flows while still maintaining fish passage. This eliminates the need to provide attraction flow. However, water depth over the upper weir would increase relatively quickly as flow increases. To avoid submerging the flow measurement weir would require locating the upper pool and chute weir lower than in the existing fish ladder. This would increase the drop height over the flow measurement weir at fish migration flows, worsening fish passage conditions.

4.3 Pool and Weir Fish Ladder

To minimize the drop height over the flow measurement weir at fish passage flows while meeting the non-submergence criteria, a traditional pool and weir fish ladder with a horizontal spillway was considered the preferred structure type. This type of design provides the greatest discharge for a given change in water level over the upper weir. A pool and weir fish ladder would maintain a portion of the flow within the ladder and the remaining flow going over the spillway.

4.3.1 Labyrinth Weir Spillway

The relatively confined channel at each of the project sites restricted the length of the spillway weirs. To increase the spillway capacity a labyrinth shaped weir was examined. The preferred one-cycle labyrinth weir would increase the effective length of the spillway, increasing its hydraulic capacity allowing for a smaller drop height over the flow measurement weir to be maintained.

The pool-and-weir fish ladder could also be constructed for seasonal adjustments to reduce the drop height over the flow measurement weir for accommodating juvenile passage during summer. This would consist of raising the tailwater to approximately 0.3 feet below the v-notch weir by installing seasonal weirs to the upstream end of the fish ladder and raising the spillway elevation.

5.0 POOL AND WEIR FISH LADDER DESIGN

5.1 Hydraulic Criteria for Fish Passage

5.1.1 Maximum Drop Height

The NOAA Fisheries and CDFG guidelines for fish passage at stream crossings recommends avoiding discrete water surface drops over structures exceeding 6 inches for juvenile salmonids and 12 inches for adult salmonids.

5.1.2 Pool Depth

The recommended minimum water depth within each pool is 2 feet for adult salmon and steelhead (Flosi et. al, 1996)

5.1.3 Attraction Flow for Fish Ladders

Fish ladders often convey only a portion of the total streamflow. As with the existing fish passage facility, the remaining flow goes over a spillway. To ensure fish find the entrance (downstream end) of the fish ladder, there must be sufficient flow exiting the ladder. This is referred to as “attraction flow”, and is measured as the percentage of the total flow contained within the ladder. Members of the TAT recommended that the attraction flow be at least 20% between the lower and upper fish passage design flows.

5.1.4 Turbulence

Within a pool and weir fish ladder energy associated with the plunging water over each weir is dissipated through turbulence within the receiving pool. Excessive turbulence within a fish ladder can block upstream passage. A standard measure of turbulence is the Energy Dissipation Factor (EDF), which is the rate energy is dissipated per volume of water. Bates (2001) recommends that the EDF not exceed 4 ft-lbs/s/ft^3 for adult anadromous salmon and steelhead. No guidance has been developed for juvenile salmonids.

5.1.5 Sidewall Height

The sidewall runs along the sides of a fish ladder. Based on input from members of the TAT, the top of the walls should be sufficiently tall to provide at least 2 feet of freeboard at the upper passage flow to reduce the risk of adult salmon and steelhead inadvertently leaping out of the ladder.

5.2 Description of Proposed Design

The accompanying design drawings and technical specifications provide the details of the final engineering design. Additionally, Figure 5.1 is included in this report to provide an illustration of the primary components of the final design. These components include:

- Pool-and-weir fish ladder with summer low-flow removable weirs
- Viewport structure with observation windows for monitoring fish behavior
- Spillway structure with vertically adjustable weir gates
- Roughened riffle downstream of fish ladder
- Cat-walk for access to the fish ladder and spillway structure
- Sluicegates for draining fish ladder and tailwater pool
- Modifications to the concrete dam face below v-notch on flow measurement weir

The North and South Fork sites share the same design components with identical dimensions. The only major difference between the two site designs is the side of the channel in which the fish ladder is placed. Minor differences between the two site designs allow for the structures to fit into the surrounding site conditions.

Consideration into the accessibility, maintenance, and construction costs of the fish ladder at each site resulted in the placement of the ladder on the same side of the channel for which the access road terminates. Unless otherwise stated, the design component explanations below are applicable to both sites.

5.2.1 Pool-and-Weir Fish Ladder

The proposed fish ladder consists of reinforced concrete sidewalls, a concrete floor, concrete weirs, removable low-flow weirs, and one viewport structure. The fish ladder was hydraulically designed to provide adult salmonid passage during winter flows and juvenile salmonid passage during summer flows. Additionally, the fish passage facility was structurally designed to withstand infrequent high flows streaming over the top of the weirs within the ladder. The ladder has an inside width of 8.5 feet, and an overall length of 50-feet. Ten permanent concrete weirs spaced 4.5 feet apart on-center provide a 6 inch vertical drop between weirs. Pools below each weir are sufficient in size for energy dissipation. The design also includes four removable low-flow weirs that can be placed into the upper end of the fish ladder to improve juvenile passage conditions over the flow measurement weir during summer months. These removable weirs are spaced 2-feet on center, each consisting of an aluminum frame, neoprene *J-Bulb* seals to minimize leakage, fiberglass plating, and a adjustable fiberglass weir plate. Each adjustable fiberglass weir plate will provide up to 6 inches of vertical adjustment. This design feature provides flexibility for controlling the tailwater pool elevation during low flows and adjusting drop heights between the removable weirs. Each removable low-flow weir will weigh approximately 80 pounds, requiring a minimum of two people for placement in the ladder for summer operations and removal in the fall for winter operations. A cat-walk, described below, provides access across the fish ladder for installation and removal of the low-flow weirs. The dimensions for the removable low-flow weirs and the crest geometry are detailed in the design plans, and are identical for both the North and South Fork ladders. The hydraulic and fish passage performance of the fish ladder facility is summarized in Chapter 6.

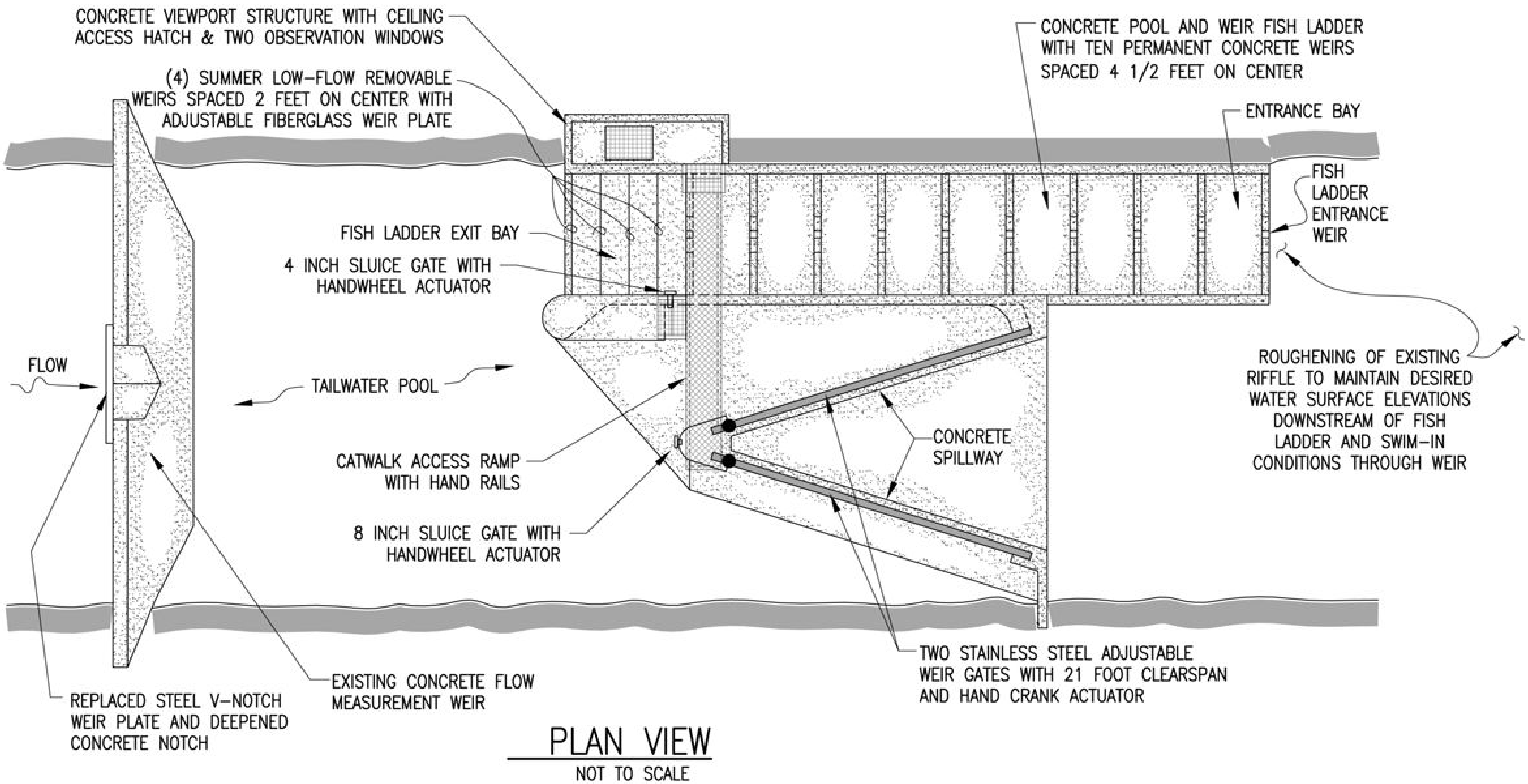


Figure 5.1 - Caspar Creek Fish Passage Facility Primary Components

5.2.2 *Viewport Structure*

Based on the request from the TAT, one view-port structure for each site has been incorporated into the final design, and is located at the exit of the fish ladder, spanning the upper two bays. The viewport chamber floor has dimensions of 3ft x 12.5ft which will provide adequate winter storage space for the removable weirs and additional video equipment during the summer months. The ceiling of the view-port structure has a recessed 3ft x 4ft diamond plated aluminum access hatch. The access hatch has been specified to be furnished with a lock as well as an extruded channel frame that will prevent rainwater from entering the viewport structure. The hatch has been sized to allow personnel access in addition to providing adequate clearance for transferring the removable weirs in and out of the viewport structure. A separate ladder will be required to allow access into the viewport structure. Each view-port structure will have two observation windows, providing a field-of-view into the upper two bays of the fish ladder. One window will provide viewing into the removable weir bay, while the other window will provide viewing into Bay 9. The observation window panel will consist of an Acrylic type polymer Plexiglas material. The dimensions of the observation windows are shown in the final design plans. Since these structures will be below the water level most of the year, there is a likelihood that some water will enter the structures. The design incorporates water stops in all construction joints of the concrete structure, but the design is not intended to provide a watertight structure. Any water that enters the structure will have to be pumped out.

5.2.3 *Concrete Spillway with Adjustable Weir Gates*

The final design includes a spillway with adjustable weir gates that provide flow control in and around the fish ladder, thus increasing the range of flows that fish passage conditions are suitable within the ladder. A standard spillway weir placed perpendicular to the flow path and adjacent to the fish ladder, similar to the existing fish passage facility, would not provide adequate capacity for passing design flows without submerging the flow measurement weir. As previously mentioned, the preferred design uses a single cycle labyrinth weir to increase the effective weir length of the spillway. The labyrinth weir configuration is a known and proven method for increasing the capacity of a spillway within a confining channel width. This configuration minimizes the rate in which the tailwater rises with respect to increasing flow, which minimizes the height leap over the flow measurement weir for adult fish while still meeting the project's "no submergence" criteria.

The single cycle weir configuration contains two vertically adjustable weir gates. The weir gates have identical dimensions, each providing a clear horizontal weir length of 21 feet, and a vertical adjustment range of 2 feet. The ability for personnel to vertically adjust the weir gates seasonally will allow tailwater surface elevation to be raised and lowered to satisfy adult and juvenile passage criteria without submerging the flow measurement weir. Operation of the fish passage facility for adult and juvenile salmon and steelhead passage during winter and summer months is further described in the following section. Each adjustable weir gate is operated by a single removal hand crank attached to a drive gear box for manual operation. As specified, under full operating loads, the maximum effort exerted on the hand crank shall not exceed 40-pounds. This requirement is included in the final design specifications, and is the industry standard for maximum required force for manual actuation.

Because of the relatively long span of each weir gate and the corrosive coastal climate, Type 304 stainless steel was the selected material for the weir gate slider. Additionally, the associated components including the guide frames and actuating stems are specified as Type 316 stainless steel. The other material option considered was aluminum, which resulted in a bulkier weir without any significant cost savings. The small cost savings in the cost of the aluminum weir gates would be at least partially offset by additional concrete required in the supporting structure to accommodate the bulkier weir gate.

Multiple weir gate manufactures were consulted during design development to ensure the proposed configuration was practical to construct. Some of the manufactures that provided technical feedback during this phase included Fontaine, Waterman, Golden Harvest, HydroGate, Rodney Hunt, and Armtec. The American Water Works Association (AWWA) requires all weir gate manufactures (including the ones listed above) to construct weir gates to meet performance specifications for leakage around the sealed periphery to not exceed 0.1 gallons per minute (gpm) per linear foot of periphery seal. The resulting combined maximum allowable leakage for the two weir gates would be approximately 0.01 cfs. This performance specification is particularly important during low summer flows when the desired performance of the fish ladder relies on the entire available streamflow passing through the ladder.

The guide frames of the weir gates are designed to be embedded into the reinforced concrete spillway and anchored to a reinforced concrete slab with dimensions shown on the design plans. The concrete slab will be anchored on the bedrock channel bottom, conforming to varying depths that shall be no less than 6-inches thick. The slab will prevent the approaching flow from potentially piping (leaking) under the spillway and fish ladder structures. Furthermore, the concrete slab will provide energy dissipation and scour protection from flow passing over the weir gates and plunging onto the downstream side of the spillway.

5.2.4 Roughened Riffle Downstream of Fish Ladder

Maintaining a tailwater control below the fish ladder is essential to ensure suitable ladder entrance conditions for fish. During large flow events velocities exiting the ladder and spillway can be substantially higher than those occurring within the natural channel. These higher velocities have a tendency for scour of the downstream channel bed and banks. To ensure that the ladder maintains swim-in conditions at all fish passage flows and the channel bed does not become scoured and incise, the design includes construction of a “roughened riffle”. The crest of the roughened riffle will be placed roughly 20 to 25 feet downstream of the fish ladder entrance bay and would be set at the same elevation as the crest of the ladder’s entrance weir. This results in a riffle crest elevation which is at or near the elevation of the existing streambed at that location; however, the roughened riffle will consists of coarser material than found in the natural channel bed. The riffle will be constructed of “engineered streambed material” consisting of well graded mixture of material ranging in size from the existing fine alluvium up to approximately 24 inch diameter angular rock. The D_{84} is specified to be 9 inches. The compacted material will average 2 feet in thickness and is designed to be relatively stable up to approximately 400 cfs.

5.2.5 Cat-walk

A key component to both the North and South Fork designs is an elevated access ramp, referred to as a cat-walk. The primary purpose of the cat-walk is to provide access to the spillway weir gate actuating gear boxes mounted on the concrete abutment in the center of the channel. The cat-walk also assists in accessing and installing the summer low-flow weirs. The cat-walk will span approximately 22 feet, starting from the channel bank, bridging the fish ladder and terminating at the concrete abutment where the gear boxes will be mounted. The framing and hand rail of the cat-walk consists of hot-dipped galvanized steel and fiberglass grate decking. To provide adequate clearance under the cat-walk, a design flow of 400 cfs and anticipated debris, 18 inches of freeboard is provided (from the high water surface elevation to the bottom of the cat-walk). In addition to facilitating access to the weir gate actuating gear boxes and fish adder, the cat-walk will also provide access for actuating two clean-out sluice gates.

5.2.6 Clean-Out Sluice Gates

Providing the ability to drain water impounded behind the spillway is essential. Research activities associated with the sediment basin upstream of the flow measurement weir will require draining the tailwater pool from time to time. Additionally, future maintenance of the stainless steel weir gates may require access to the upstream side of the spillway during low-flow conditions.

To accommodate these operational and maintenance activities, the design includes an 8 inch diameter sluice gate mounted to the upstream face of the concrete abutment and located between the two weir gates. This sluice will provide the means to drain and pass flow through the spillway, rather than over the top. The sluice gate was sized to provide sufficient flow capacity during low summer flow conditions, such that water will not remain impounded behind the spillway when fully open. The sluice gate will be manually actuated from the cat-walk by means of a removable wheel, similar to the actuating process of the weir gates. The primary reason for selecting the sluice gate over alternative flow control valves is because of the high resiliency of the gate seats from becoming fouled when operated under flow conditions carrying sediment and other incompressible solids.

The placement of a second sluice gate in the upper bay of the fish ladder is also included in the design. Having the ability to drain this bay may assist in removal of deposited sediment prior to placement of the low-flow weirs each summer. Thus, a 4-inch diameter sluice gate is included at this location and can be manually actuated from the cat-walk.

Similar to the AWWA leakage performance specifications for weir gates, all manufactured sluice gates must not exceed a leakage of 0.1 gallons per minute per linear foot of seal periphery. As previously explained for the hand crank actuating process of the adjustable weir gates, the maximum force exerted on the wheel to manually operate the sluice gates is specified to not exceed the industry standard of 40-pounds.

5.2.7 Modifications to the Existing Flow Measurement Weir

Modifications to the existing concrete flow measuring weirs are recommended to improve fish passage conditions. Under current conditions, flow passing over the steel v-notch weir plate and onto the sloping concrete face results in undesirable hydraulic conditions for fish attempting to leap over the weir. The proposed modifications shown in the final design plans will improve fish passage without adversely affecting the structural integrity of the concrete weir structure. The calibrated flow measuring capabilities will not be altered. The modifications include lowering the existing downstream concrete-notch portion of the structure approximately 2-feet, allowing flow passing over the v-notch weir plate to plunge freely into the tailwater pool. Because the existing v-notch weir plate would not effectively cover the proposed deepened concrete notch, it will be replaced. To ensure the calibrated flow measuring capabilities are not altered, the new stainless steel v-notch weir plate shall be identical to the existing weir plate. The design elevations are based on the elevation of the v-notch and redundant survey control is specified to ensure the new v-notch weir plate is placed at the same elevation.

5.3 Facility Operation

To convey a further understanding of the component functionalities, a brief description of the facility's seasonal operations has been included below. These descriptions are not intended to be substituted for an actual Facilities Operation and Maintenance (O&M) Manual.

5.3.1 Summer Operations

During the late spring or early summer, when flows are consistently at or below 1 cfs (the high juvenile salmonid passage flow), the four removable summer low-flow weirs should be placed in the upper bay of the fish ladder. If deposited sediment within the upper bay needs to be removed before installing the low-flow weirs, the sluice gates can be opened and the bay can be drained. Since the removable low-flow weirs are designed for loading associated with water on both sides of the weir, the gates should be closed and the bay filled with water before installing them.

Once these low-flow weirs have been seated in place, the adjustable spillway weir gates shall be raised to a predetermined height below the crest of the flow measurement weir. The preferred summer setting for the spillway weir gates based on design calculations is 0.30 feet below the flow measurement weir. This will divert the flow into the fish ladder. If flows rise substantially during summer operation due to a rare large precipitation event, the water will flow over the spillway weir-gate to avoid submergence of the flow measurement weir. The adjustable fiberglass plate attached to the uppermost removable low-flow weir should then be adjusted vertically to obtain the desired tailwater elevation. The difference in elevation between the surface of the tailwater and the v-notch on the existing flow measurement weir shall be set to no less than 0.2 feet. Once the preferred elevation of the tailwater pool is obtained, the plate on the remaining three removable low-flow weirs can be vertically adjusted to ensure the water surface drop over each weir is no greater than 6 inches. If desired, minor adjustments to the adjustable fiberglass plates on the removable low-flow weirs may be made throughout the summer to optimize juvenile fish passage conditions over the flow measurement weir as flows change.

5.3.2 Winter Operations

Prior to the onset of the fall rains and resulting increased flow rates, the four removable low-flow weirs shall be removed from the upper bay of the fish ladder and the spillway weir gates should be lowered to the established winter operational level. Based on design calculations, the preferred height of the spillway weir gates during winter operations is 0.7 feet above the crest of the upper permanent concrete fish ladder weir. However, there is some level of uncertainty associated with weir coefficients and calculated hydraulics. Therefore, during the first winter of operation the height of the weir gates should be monitored and may need to be adjusted to determine the optimum setting.

5.3.3 Need for Operations and Maintenance Manual

To maintain optimal functionality and performance of the spillway and fish ladder at each site, it is recommended that an Operations and Maintenance (O&M) Manual be developed prior to implementation. An O&M Manual would not only provide a written description of component functions, but would also provide operation guidance that would assist in achieving the ultimate goal of providing juvenile and adult salmonid passage under varying flow conditions. The appropriate balance between setting the spillway weir gate elevation to avoid backwatering of the flow measurement weir at peak flows while minimizing the drop height over the v-notch weir at adult fish migration flows is critical. It will also be important to find the optimal settings for the plate on the upper most removable low-flow weir to create suitable conditions for juvenile fish passage while avoiding affecting the accuracy of the flow measurements.

5.4 Opinion of Probable Construction Cost

An opinion of probable construction cost was prepared for both the South and North Fork sites, and is located in Appendix B. Because of the ongoing volatility of construction material costs, and based on feedback we have received from material suppliers, the opinion of probable construction cost should be re-evaluated after approximately 60-day intervals to remain current to market conditions.

6.0 HYDRAULIC DESIGN AND ANALYSIS

6.1 Methods and Approaches

6.1.1 Flow Measurement Weir

Determining the water surface drop over the flow measurement weir at various fish passage flows required constructing a discharge-stage rating table. The rating table was constructed using discharge equations provided by the USFS Redwood Science Lab. Two equations were utilized; one for stages from zero to two feet and the other for stages greater than two feet.

6.1.2 Fish Ladder Weir Hydraulics

A spreadsheet model was developed to perform weir calculations for analysis of the existing and proposed fish ladders and spillways. The standard equations for sharp crested weirs were applied (King, 1939):

Flow over horizontal sharp-crested weir: $$Q_H = C_H \frac{2}{3}\sqrt{2g}h_o^{1.5}$$

Flow over V-shaped sharp-crested weir: $$Q_v = C_v \frac{8}{15}\sqrt{2g}S_S h_o^{2.5}$$

Where, h_o is the depth over the weir, g is gravitational acceleration, and S_s is the side slope (horizontal : vertical) of a V-shaped weir. For the weir coefficients, C_v was set equal to a constant of 0.5 and $C_H = 0.602+0.075(h_o/L)$, with L = length of the weir crest. For composite weirs, total flow was calculated by adding and subtracting flows corresponding to the different weir shapes.

Submergence occurs when the water surface immediately below the weir rises above the crest elevation of the weir. Submergence decreases the flow rate over the weir. To account for this, the submergence equation given by Villemonte (1947) was applied:

Submerged discharge for sharp-crested weir: $$Q_s = Q\left[1-\left(\frac{h_o}{h_d}\right)^n\right]^{0.385}$$

Where, Q is the calculated discharge before accounting for submergence, h_d is the height of the downstream head over the weir crest, and n is a coefficient equal to 1.5 for rectangular weirs and 2.5 for V-shaped weirs.

6.1.3 Labyrinth Shaped Weirs

For design and analysis of the labyrinth shaped spillway weirs, design procedures outlined in *Hydraulic Design of Labyrinth Weirs* (Falvey, 2003) were followed and a spreadsheet model provided by the author was utilized.

6.1.4 Chute Flow

To estimate the tailwater elevation below the flow measurement weir during high flow events required calculating both the total flow over the spillway and through the fish ladder. Due to the extent that each weir would be submerged during these high flow events, we assumed the ladder would become a hydraulic chute containing streaming flow, rather than plunging flow. The Chezy equation was used to estimate chute (streaming) flow within the fish ladder during these high flows. The overall slope of the fish ladder is 12.5% and a Chezy roughness coefficient of 22 ft/s^2 was selected based on reported values for pool and chute fishways of similar slope (Bates, 2001).

6.1.5 Roughened Riffle

A roughened riffle was designed for controlling the tailwater elevation below the fish ladder. The composition of the engineered streambed material, which makes up the roughened riffle, was sized using methods outlined for roughened channels in "Design of Road Culverts for Fish Passage" manual (WDFW, 2003). This method relied on performing a bed stability analysis using the US Army Corps of Engineers riprap design method (ACOE, 1994). Equations by Limerinos (1970) and Mussetter (1989) were applied to estimate hydraulic roughness of the engineered streambed as a function of flow. The roughened riffle hydraulics were modeled assuming steady-state uniform flow. Bed material gradation and specifications were obtained using sediment distributions recommended by WDFW.

6.2 Selection of Fish Ladder Weir Shape

The preferred weir shape was developed in conjunction with design of the spillway and using the design criteria previously stated. Since the ladder would be used by both adult and juvenile fish, the drop over each weir was set at 0.5 feet.

The final selected weir shape has a low flow section in the center with adjoining gradually sloping weir crests (Figure 6.1). This weir shape balances the competing objectives of developing a fish ladder that creates hydraulic characteristics ideal for juvenile and adult passage *versus* minimizing the drop height over the flow measurement weir.

The low-flow section will concentrate low summer flows during upstream movement by juveniles and increase the capacity of the weir during adult migration flows. It is designed to contain up to 1.4 cfs within the low flow section, which is greater than the summer juvenile passage design flow of 1 cfs. Since juveniles tend to leap from the sides or edges of plunging water, the sides of the low flow notch are tapered at a 2H:1V slope to create a thinner nappe along the edges.

On each side of the low flow section are gradually tapered weir crests (6H:1V slope). These weir crests are designed to create a plunging nappe along the edges where the adult fish typically swim. This will provide quieter, less turbulent, waters along the edges of the ladder, which adult fish can use as they ascend. Additionally, the weir shape is configured so only the low-flow section is submerged by the downstream water surface at the adult high fish passage design flow. This ensures a plunging flow regime will be maintained along the edges of the weir during all fish migration flows, even if streaming flow begins to form down the center of the ladder.

To ensure that adult salmon and steelhead ascending the ladder do not leap over the sides, the side walls extend more than 2 feet above the water surface at the high adult passage flow.

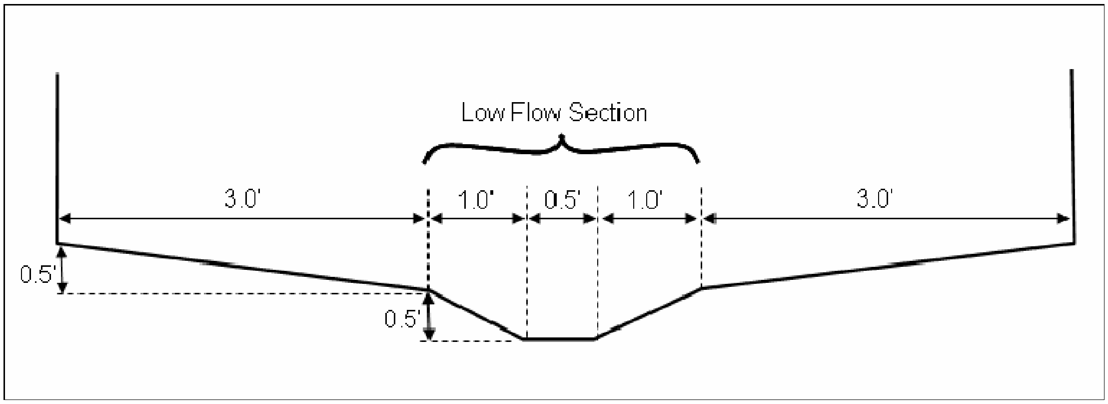


Figure 6.1 - Cross sectional view of preferred shape for the fish ladder weirs.

6.3 Fish Passage Performance

6.3.1 Optimal Settings for Adjustable Weirs

The proposed fish passage facility includes an adjustable spillway weir gate and four removable low-flow weirs with adjustable crest elevations. The spillway weir gates have a total vertical travel distance of 2.0 feet and the crests of each removable low-flow weir can be adjusted 0.3 feet. This provides the ability to optimize and fine-tune the hydraulic performance of the fish ladder for both winter and summer operations.

Part of the hydraulic analysis included determining optimal weir settings for both winter and summer operations using equations and methods described in previous sections. The optimal settings of the adjustable weirs were defined as conditions that minimized the water surface drop height over the flow measurement weir while not decreasing the accuracy of the flow measurement weir. Table 6.1 lists the identified optimal weir settings for winter and summer operations. The hydraulics associated with these settings is based partially on theoretical weir equations, estimated values for coefficients, and other assumptions inherent in this type of analysis. The actual optimal weir settings may differ somewhat, and will need to be identified through field testing once the fish passage facility is constructed. All hydraulic performance results presented in this section are based on the adjustable weir gates and summer weirs positioned at the optimal settings.

Table 6.1 – Optimal vertical settings for the adjustable spillway weir-gates and removable weirs for winter and summer operations. Height measured from the crest of each adjustable weir to the crest of the flow measurement weir's v-notch.

	Height to Flow Measurement Weir Crest	
Adjustable Weirs	**Winter Operations**	**Summer Operations**
Spillway Weir-Gates	1.40 feet	0.30 feet
Removable Summer Weirs	N/A	0.50 feet

6.3.2 Fish Ladder Hydraulics during Winter Operations

Attraction flow and EDF satisfy adult salmon and steelhead passage criteria up to the adult high passage flow (Table 6.2). The water surface drop over the flow measurement weir ranges between 2.24 feet and 3.30 feet at fish passage design flows. Although this is significantly more than the recommended 1.0 feet, the TAT members agreed that this was acceptable given the project constraints.

Water surface profiles associated with winter operations of the fish passage facility were constructed to check drop heights at various flows. Of particular interest were the entrance and exit of the fish ladder and at the flow measurement weir. These water surface profiles confirmed that water surface drops throughout the fish ladder do not exceed 0.50 feet at fish passage design flows. Figure 6.2 shows the water surface profiles associated with 15 cfs (roughly the 5% annual exceedance flow) and 24.5 cfs (when the v-notch of flow measurement weir is full).

Table 6.2 – Predicted fish passage conditions for proposed facility during winter operations. Spillway weir gates are set 1.40 feet below crest of Flow Measurement Weir.

Total Streamflow (cfs)	Attraction Flow[1]	Maximum EDF in Ladder[2] ($ft\text{-}lb/s/ft^3$)	Water Surface Drop at Measurement Weir (feet)
1.4	100%	0.4	2.24
2.0	100%	0.6	2.24
3.0[3]	100%	0.9	2.24
7.6	51%	1.2	2.55
8.3	48%	1.2	2.59
16.3	32%	1.6	2.90
16.7	32%	1.6	2.92
28.1	24%	2.1	3.17
44.3[4]	20%	2.7	3.28
47.6[4]	20%	2.9	3.30

[1] Proportion of total streamflow contained within the fish ladder. Remaining water flows over spillway weir gates. Design criteria requires at least 20% attraction flow.

[2] Energy dissipation factor (EDF) is a measure of the turbulence within the fish ladder pools. For adult salmon and steelhead the design criteria is to maintain EDF below 4.0 $ft\text{-}lb/s/ft^3$

[3] Lower adult passage design flow for both North and South Fork

[4] Upper adult passage design flow for both North Fork (47.6 cfs) and South Fork (44.3 cfs)

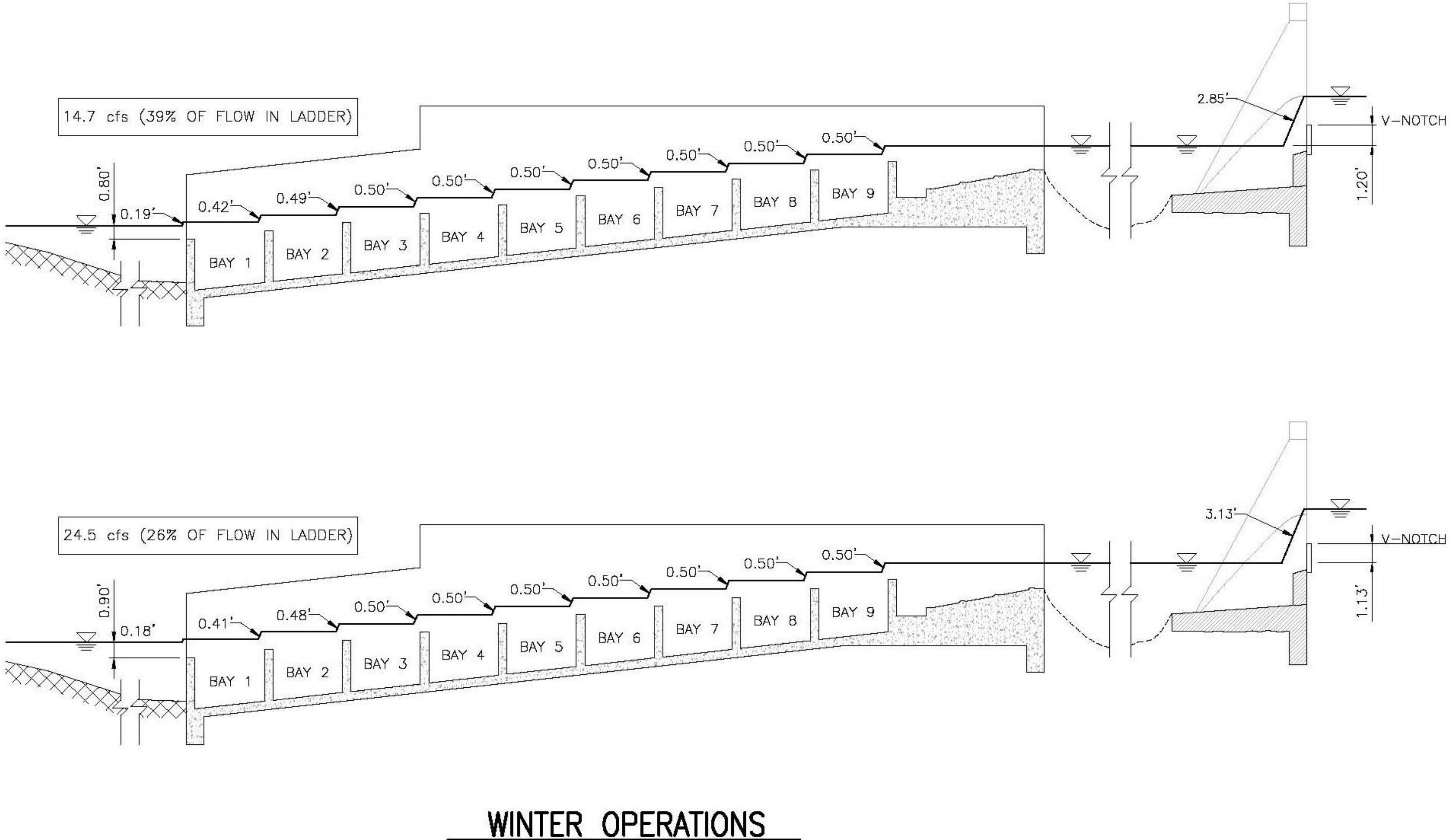


Figure 6.2 - Predicted water surface profiles and water surface drops associated with winter operations of the fish passage facility for (a) 15 cfs, which is the 5% exceedance flow, and (b) 24.5 cfs, which fills the v-notch of the flow measurement weir. The spillway adjustable weir-gates are set 1.40 feet below the crest of the flow measurement weir.

6.3.3 Fish Ladder Hydraulics during Summer Operations

During summer operations the optimal spillway weir-gates are set such that all of the streamflow flows through the ladder up to approximately 0.23 cfs (Table 6.3). At the upper juvenile passage design flow of 1 cfs, roughly 32% of the flow would be contained within the ladder. Also, at all juvenile passage flows the turbulence within small pools created by the removable weirs is minimal, with a maximum EDF of only 0.64 ft-lb/s/ft^3 at 1 cfs. Water surface drop over the measurement weir range between 0.64 feet at 0.01 cfs up to 0.83 feet at 1 cfs. Although this is more than the recommended 0.5 feet, the TAT members agreed that this was acceptable given the project constraints.

Water surface profiles associated with summer operations of the fish passage facility were constructed to check drop heights at various flows. These water surface profiles confirmed that water surface drops throughout the fish ladder do not exceed 0.50 feet. Figure 6.3 shows the water surface profiles associated with 0.25 cfs (roughly the 30% exceedance flow for period June 15 through September 30) and 1.0 cfs (upper fish passage design flow for juvenile salmonids).

Table 6.3 – Predicted fish passage conditions for proposed facility during summer operations. Adjustable low-flow exit weir set 0.50 feet below crest of Measurement Weir. Spillway adjustable weir gates are set 0.30 feet below crest of Measurement Weir.

Total Streamflow (cfs)	Attraction Flow[1]	Maximum EDF in Ladder[2] (ft-lb/s/ft^3)	Water Surface Drop at Measurement Weir (feet)
0.01	100%	0.01	0.64
0.04	100%	0.03	0.65
0.11	100%	0.08	0.68
0.23	100%	0.16	0.71
1.00[3]	32%	0.64	0.83
4.32	15%	0.82	1.20[4]

[1] Proportion of total streamflow contained within the fish ladder. Remaining water flows over spillway adjustable weir gates. Design criteria for juvenile passage requires at least 20% attraction flow.

[2] Energy dissipation factor (EDF) is a measure of the turbulence within the fish ladder pools. Maximum EDF occurs in pools formed by removable summer weirs.

[3] Upper juvenile salmonid passage design flow for both the North and South Forks.

[4] Tailwater 0.2 feet below crest of flow measurement weir.

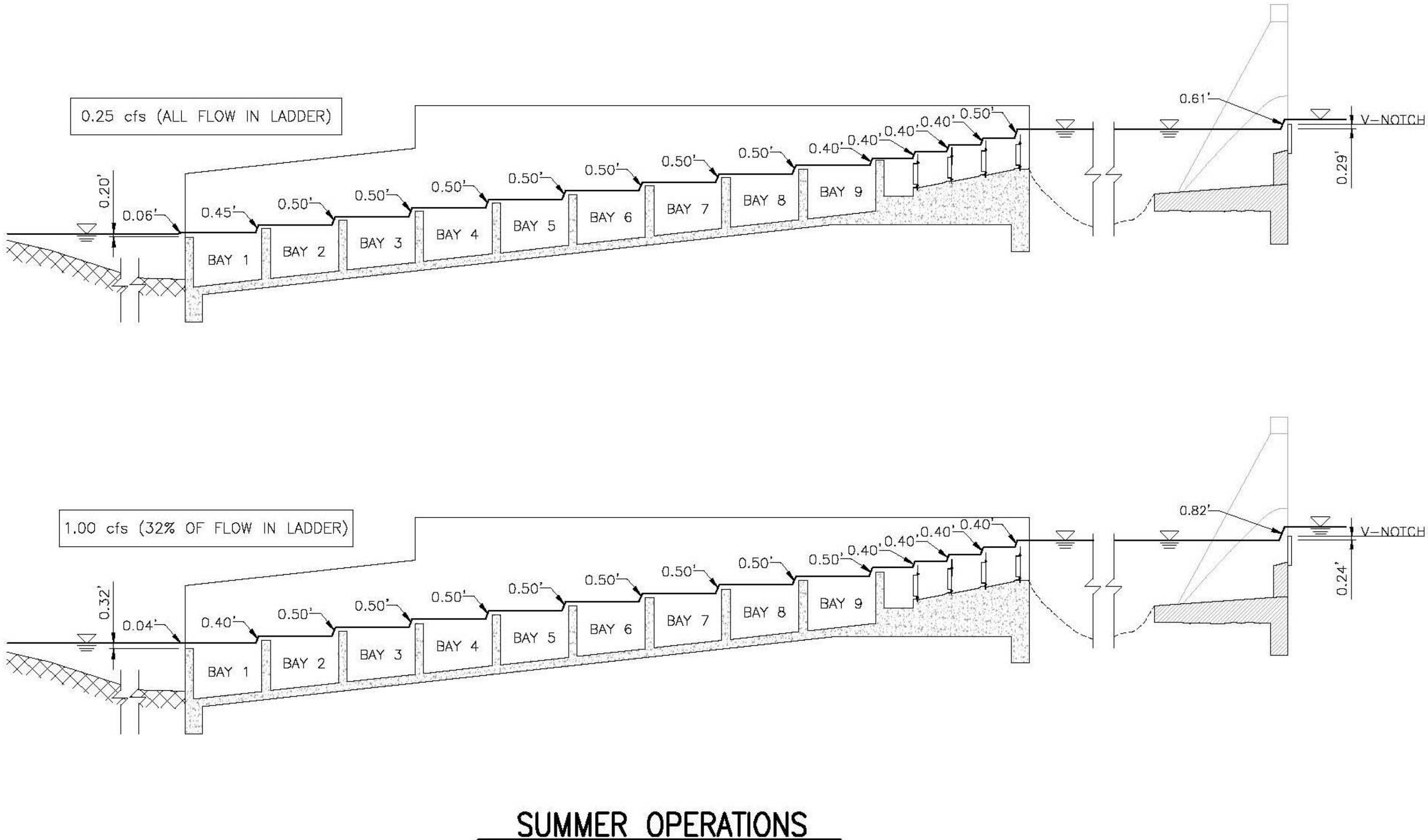


Figure 6.3 - Predicted water surface profiles and water surface drops associated with summer operations of the fish passage facility for (a) 0.25 cfs, which is the 30% exceedance flow for period June 15 through September 30, and (b) 1 cfs, which is the upper fish passage flow for juvenile salmonids. The crest of the upper removable weir and spillway adjustable weir-gates are set 0.5 feet and 0.3 feet below the crest of the flow measurement weir, respectively.

6.4 Submergence of Flow Measurement Weir

6.4.1 Winter Operations

Tailwater rating curves showing water surface elevation below the flow measurement weir were constructed for both existing conditions and for the proposed fish passage facility. For each site the existing and proposed tailwater rating curves were compared to one another to ensure that the project will not increase the frequency or magnitude of submergence of the flow measurement weir (Figure 6.4). To create the rating curves required calculating and summing together the flows over the spillway and within the fish ladder at a given tailwater elevation. At these higher flows of interest the existing and proposed fish ladders were assumed to produce streaming flow, functioning as a roughened chute. For this analysis, the adjustable spillway weir crests (proposed conditions) were set at the preferred winter operational elevation 492.8 feet and 492.0 feet for the North and South forks, respectively.

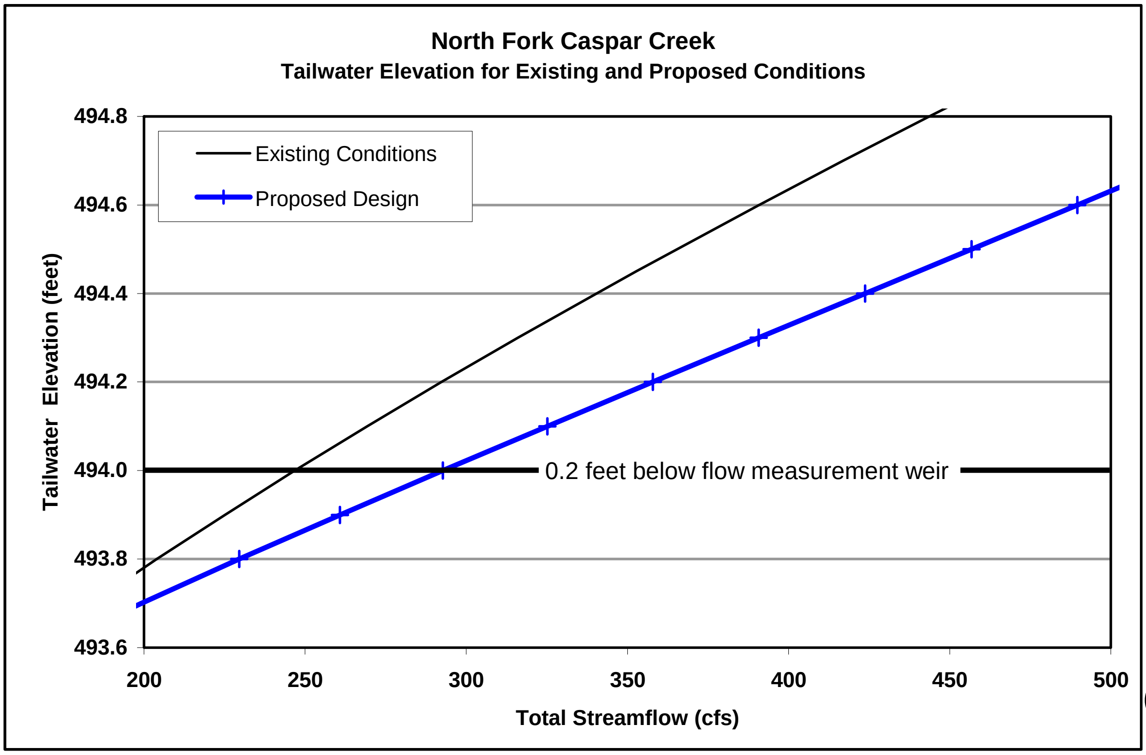
The rating curves show that the predicted water levels under the proposed design will be lower than under existing conditions, thus satisfying the submergence design criteria. Calculations of the proposed design predict that the tailwater will reach 0.2 feet below the flow measurement weir crest at about 290 cfs, which is roughly the 25 year peak flow (Table 6.4).

Table 6.4 – Tailwater stage below flow measurement weir for existing conditions and the proposed design.

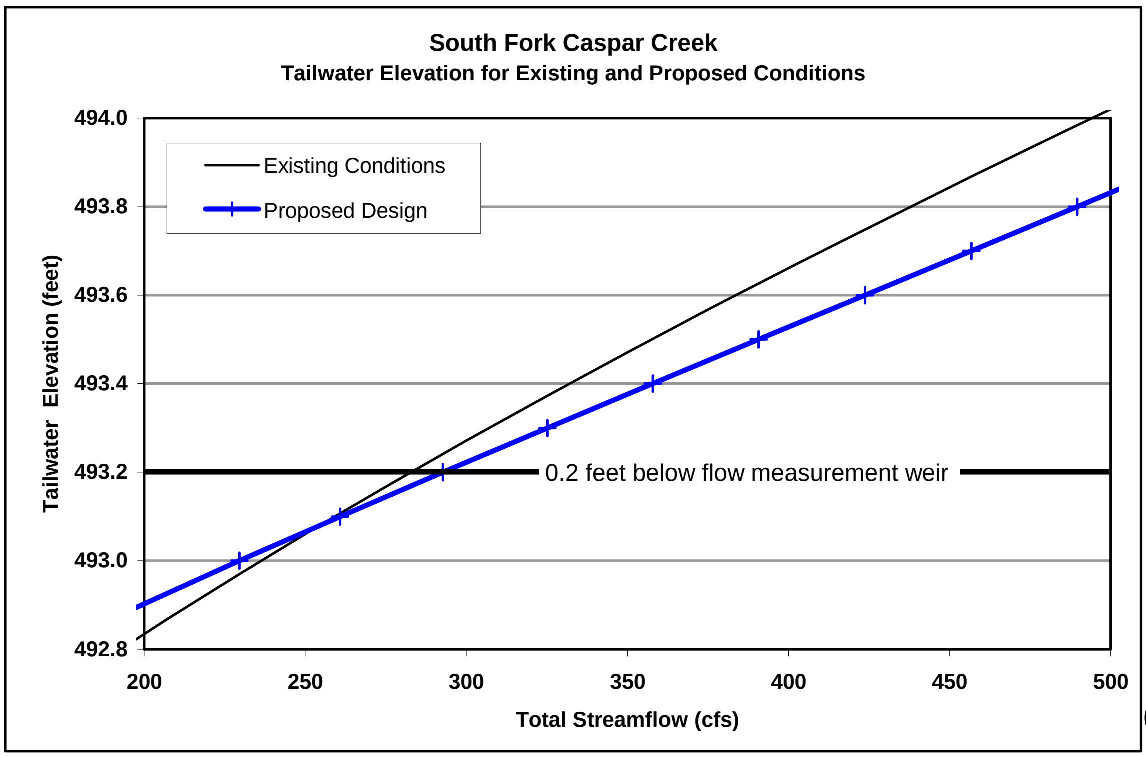
	North Fork		**South Fork**	
Criteria	Existing	Proposed	Existing	Proposed
Tailwater 0.2 ft below Flow Measurement Weir	250 cfs	290 cfs	275 cfs	290 cfs
Submergence Depth above Flow Measurement Weir at 400 cfs	0.4 ft	0.1 ft	0.3 ft	0.1 ft

6.4.2 Summer Operations

Using the optimum adjustable weir settings for summer operations (Table 6.1), the water surface would reach the submergence threshold of 0.2 feet from the crest of the flow measurement weir at roughly 4.3 cfs (Table 6.3). When defining a summer operations period of June 15th through September 30th, this is an extremely rare flow event. Based on flow records spanning 1963 to 2003, a flow greater than 4.3 cfs between June 15th and September 30th has occurred no more than three times on South Fork Caspar Creek and has never occurred on North Fork Caspar Creek. All of the occurrences on the South Fork occurred in June or September, close to the beginning or end of the summer operations period. It is assumed that staff at the site will lower the spillway weir-gates if a large rainfall event is anticipated during this summer operations period, thus avoiding any submergence of the weir.



(a)



(b)

Figure 6.4 – High-flow tailwater rating curves on the North Fork (a) and South Fork (b) of Caspar Creek, showing the predicted water surface elevation directly below the flow measurement weirs for both the existing and proposed fish passage facilities.

7.0 CONSTRUCTION PROCESS

7.1 Bidding and Contracting Considerations

How the project is bid and the selection of a contractor can affect the overall outcome of a project, even with the same design documents. Seemingly simple items like the number of working days specified or the amount of time allowed to prepare a bid can influence the outcome of bid results. This project contains a variety of construction items that may be rare for a single contractor to be well versed in. For instance the construction methodology for installing a roughened channel is not yet a common construction technique on the North Coast. This project will require a crew experienced in forming and pouring structural concrete. We recommend that a mandatory pre-bid conference be held to communicate the project and design constraints, as well as answer any questions. Answers to questions should be sent to all contractors in the form of bid addendums. We recommend that the design engineer be involved in this process. We also suggest requiring contractors to supply a list of similar projects with references. The goal of these suggestions is to end up with a competent contractor and reduce the probability of having change orders.

7.2 Construction Management Considerations

This project is a complex design that will require the involvement of the design team during construction to help ensure it will function as desired. Some project components and construction methodologies are similar to public works construction projects where the design team is normally part of the construction process, especially with modifications of existing facilities and uncommon construction techniques or design parameters. Commonly the geotechnical engineer will evaluate the excavation prior to foundations being constructed, the structural engineer would inspect the connections to the existing structures and form work, and the main design engineers would check submittals, respond to requests for information (RFIs), review and draft necessary change orders, and make regular site visits to monitor progress, answer questions, and make sure critical design details are not inadvertently changed or overlooked in the field just because they do not reflect typical construction methods. In this way, the design team typically assists the owner's representative or full time inspector with their duties. While this type of construction support is common on public works projects, it is not as common on restoration projects.

8.0 REFERENCES

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Appendix A
TAT Member Conference Call Notes
(May 31, 2006)

TRINITY COUNTY
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Natural Resources Division
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(530) 623-1351 ext. 9 FAX (530) 623-1353
cjordan@trinitycounty.org

June 13, 2006

To: Caspar Creek Fish Passage Improvement Project Technical Advisory Team

From: Christine Jordan

Re: Caspar Creek Fish Passage Improvement Project – May 31, 2006 Conference Call Minutes

Conference Call participants included:

Fay Yee	–	CDF
Tom Lisle	–	USFS Redwood Sciences Lab
Jack Lewis	–	USFS Redwood Sciences Lab
Elizabeth Keppeler	–	USFS Redwood Sciences Lab
Marcin Whitman	–	CDFG
Jeffrey Jahn	–	NOAA'S NMFS
Rick Wantuck	–	NOAA NMFS
Steve Allen	–	Design Team Project Manager
Mike Love	–	Design Team Hydrologist
Mark Lancaster	–	5C Program
Christine Jordan	–	5C Program

The following pertains to the May 31, 2006 conference call questions and issues raised in relation to Winzler & Kelly's and Michael Love & Associates Preliminary Design Submittal (PDS) for the Caspar Creek Fish Passage Improvement Project.

1) Pit Tag Antennae

- The actual pit tag antennae will not be incorporated into the final design.
- The ladder will be a concrete structure, allowing USFS Redwood Sciences Lab to retrofit the ladder with the necessary equipment for conducting the required effectiveness monitoring of the new ladder structure.
- Winzler & Kelly will discuss mounting requirements for antennae with Rod Nakamoto (RSL Fisheries Biologist) to see if any mounting hardware or considerations should be included in the design.

2) View-ports

- One modified viewport chamber per ladder structure will be incorporated into the final design.

- The modified viewport chamber will be located near the exit of the ladder(s), spanning the last full size bay and the first section of the removable summer weirs so that both types of bays can be viewed from one chamber; the size shall be the same as the two existing viewports put together without a center divider.

- The ladder will be equipped with mounting brackets so a whiteboard can be mounted on the opposite wall from the viewport window to allow for improved video-recording quality. The whiteboard will be removable for cleaning.

- The viewport chamber will be designed for year-round use, during high flows, and will be equipped with a neoprene or other waterproofing seal, and a lockable waterproof hatch system as equipment will be stored in the chamber. The lockable hatch should be large enough to allow personnel access and, if costs are feasible, large enough to place the removable summer weirs, or other equipment, into the bay for winter storage.
- Two separate view windows will be designed, each fitting appropriately within the outboard walls of the individual pool-weir bays (exit bay and the first section of the removable summer weir bays). The dimensions of any windows might be constrained by the typical lateral dimension between the pool weirs - which according to the drawings is 4 feet. In order to preserve structural integrity and continuity of the outboard walls, any or all windows would need to fit in between the pool-weir bays. Each window should be 3' x 3' dimension. This should provide an adequate field of vision for people and any video equipment. However, if a slightly narrower dimension (2.5 feet) is necessary to provide greater margin between the viewport opening and the concrete wall where the weirs intersect, this will be an engineering decision.

- The material should be 1-inch thick R-cast acrylic polymer (available through Reynolds Polymer: www.reynoldspolymer.com). There are other manufacturers of similar product lines and a thorough analysis of cost estimates for this particular material is warranted, if it has not already been explored.

3) O&M Manual

- A draft O&M manual for the operation and adjustment of the ladder sluice gates and installation of the low-flow summer weirs will be delivered as part of the final design (including the electronic Word document).

- USFS Redwood Sciences Lab will make repeated use of these ladder functions and adjustments and their personnel will modify the O&M over time.

- This draft document is not a part if the existing contract 05-339 and will be incorporated into proposed Amendment #1 to Trinity County Contract # 05-339.

4) Ladder Freeboard

- The freeboard on the ladder from the calculated water surface elevation to the top of wall will be increased to 2-feet.

- The existing planned condition is 1-foot of freeboard and this change will increase the probability of fish not leaping out of the ladder as they move up.

- This change will require additional concrete and adjustments to the design and Opinion of Probable Cost.

5) Footpath Railing & Catwalk Replacement

- A galvanized handrail anchored to the fish ladder wall will be incorporated into the final design.

- Replacement catwalk(s) that allow access over and to the V-notch weir dam(s) will not be incorporated into the final design. This specific expense for design and construction is not a part of the fish passage structure and will need to be designed, constructed and funded in cooperation by the USFS and/or CDF at a later date. The existing catwalk(s) and access structures are adequate for use during construction of the new fish ladder(s) and modification(s) of the V-notch.

The following items are included for clarification and follow up***:**

1) The sluice gate operation raising and lowering the water surface in the plunge pool, installation of the low-flow summer weirs, and cleaning of these structures after winter flows will be consulted with Scott Harris, CDFG biologist on the requirements for permitting. Scott was sent the material on the PDS and was not available to participate in the conference call.
***I have started discussing this with Scott, and I will advise USFS and CDF of any additional requirements.**

2) The bypass and dewatering during construction will be conducted under the existing provisions set forth in the Biological Opinion issued by NOAA in May 2003: (http://swr.nmfs.noaa.gov/FINAL-USFS-NFC-SFC.pdf) and existing CEQA permit. The potential sediment buildup in the plunge pool between the ladder and the weir dam was raised as a potential issue. Cleanout of this area will be concurrent with the cleanout of the upstream ponds as permitted in the existing NOAA Biological Opinion.

3) The replenishment of fine sediments to the proposed roughened riffle(s) was questioned by Marcin Whitman (CDFG). He suggested review of the recently published USFS *Stream Simulation Document* for the material sizing in the riffle. Marcin has also requested the rating curves for the ladder headwater and tailwater controls. Mike Love was involved in the review of the USFS guidelines and did incorporate them into this design.
***Mike Love will follow up on these tasks and deliver the rating curves to me for disbursement to the TAT.**

4) Liz Keppeler (USFS) will be on-site during construction when the required modifications to the V-notch weir plates and dam are made. The new weir plate(s) will be constructed of stainless steel and fabricated to fit the existing weir blades (v- notch and rectangular). The existing drain under the weir dam that allows for periodic excavation of the sediment accumulation upstream of the weir will also be maintained as part of the project.

5) *Fay Yee (CDF) will follow up on the requirement(s) of a Corps permit and on the necessary requirement for a Water Quality Certification permit.

6) I have followed up with Brad Valentine on the 1600 permit application requirements. It will be most effective if NOAA's NMFS and DFG review the final design simultaneously and work cooperatively to address any 'non-ladder specification' conservation measures (e.g. work windows, bypass flow criteria, etc.). Any measures will be integrated into the 1600 permit, and the amended Biological Opinion.

7) CDF final design specifications are required by Winzler & Kelly in order to assemble the final design package and construction drawings.
***Fay Yee will work with Steve Allen on getting the exact specification requirements for the construction drawings.**

8) ***Rod Nakamoto will coordinate with Winzler & Kelly on the mounting requirements for pit tag antennae to see if any mounting hardware or considerations should be included in the design.**

9) The Final Design submittal was proposed for the end of August. Another meeting will be required for the TAT to approve the final design prior to USFS issuing the design to NOAA for approval. These meetings and approvals will be expedited as CDF requires adequate time to apply for the required permits after NOAA approval and advertise the construction bid package. Any comments resulting from the final design submittal will be forwarded to Winzler & Kelly by the 5C Program so they can incorporate comments and provide a final stamped design package.

Should you have any concerns or questions on the information presented in this document, please contact me as soon as possible.

Sincerely,

Christine Jordan
Assistant Planner, Trinity County Planning Department
(530) 623-1351 Ext. 9
cjordan@trinitycounty.org

Cc: Steve Allen, Project Manager,
Winzler & Kelly Consulting Engineers

Michael Love, Project Hydrologist and Designer,
Michael Love & Associates

Mark Lancaster, Program Director,
Five Counties Salmonid Conservation Program

Appendix B
Opinion of Probable Construction Cost

Caspar Creek Fish Passage Improvement Plan

Engineers Opinion of Probable Construction Cost - Based on Final Design Submittal (Plans Dated 8/31/06) for South and North Fork Caspar Creek Sites
Prepared for: Trinity County Planning Department
Project # 1034105001

Item No	Item Description	Quantity	Unit	Unit Cost	Total
	Cost Shared Between North and South Fork Sites				
1	Mobilization and Demobilization	1	LS	$27,500	$27,500
				Shared Subtotal:	**$27,500**
	Cost Associated with North Fork Site Only				
2	Erosion, Sediment Control and Water Bypass	1	LS	$12,000	$12,000
3	Clearing, Grubbing and Demolition of Existing Redwood Fish Ladder and Concrete Channel Lining	1	LS	$10,000	$10,000
4	Structure Excavation of In-stream Sediment and Disposal	1	LS	$5,000	$5,000
5	Shoring and Trench Safety	1	LS	$5,000	$5,000
6	Structural Concrete (Spillway and Fish Ladder)	80	CY	$1,200	$96,000
7	Adjustable Weir Gate, Guide Frame, Stems, and Operators	2	EA	$37,000	$74,000
8	Fabricated Metal Catwalk Assembly with Cable Railing	1	LS	$10,000	$10,000
9	Fabricated Cable Railing for Fish Ladder	1	LS	$7,500	$7,500
10	Fabricated Aluminum Framed, Fiberglass Removable Low-Flow Weirs and Guides	4	EA	$750	$3,000
11	Rock Slope Protection (1-TON, Method A Placement)	175	Ton	$75	$13,125
12	Native Backfill (90% Relative Compaction)	45	CY	$25	$1,125
13	Structure Backfill (95% Relative Compaction)	20	CY	$50	$1,000
14	Engineered Streambed Material	50	CY	$300	$15,000
15	Rock Slope Protection (Facing Class)	45	Ton	$65	$2,925
16	Flow Measurement Weir Modifications	1	LS	$20,000	$20,000
17	Sluice Gates and hand wheel manual operator	2	EA	$3,500	$7,000
18	Observation Window	2	EA	$4,000	$8,000
19	Viewing Structure Access Hatch	1	EA	$1,500	$1,500
				North Fork Subtotal:	**$292,175**
	Cost Associated with South Fork Site Only				
21	Erosion, Sediment Control and Water Bypass	1	LS	$12,000	$12,000
22	Clearing, Grubbing and Demolition of Existing Redwood Fish Ladder and Concrete Channel Lining	1	LS	$10,000	$10,000
23	Structure Excavation of In-stream Sediment and Disposal	1	LS	$5,000	$5,000
24	Shoring and Trench Safety	1	LS	$5,000	$5,000
25	Structural Concrete (Spillway and Fish Ladder)	80	CY	$1,200	$96,000
26	Adjustable Weir Gate, Guide Frame, Stems, and Operators	2	EA	$37,000	$74,000
27	Fabricated Metal Catwalk Assembly with Cable Railing	1	LS	$10,000	$10,000
28	Fabricated Cable Railing for Fish Ladder	1	LS	$7,500	$7,500
29	Fabricated Aluminum Framed, Fiberglass Removable Low-Flow Weirs and Guides	4	EA	$750	$3,000
30	Rock Slope Protection (1-TON, Method A Placement)	265	Ton	$75	$19,875
31	Native Backfill (90% Relative Compaction)	50	CY	$25	$1,250
32	Structure Backfill (95% Relative Compaction)	20	CY	$50	$1,000
33	Engineered Streambed Material	75	CY	$300	$22,500
34	Rock Slope Protection (Facing Class)	65	Ton	$65	$4,225
35	Flow Measurement Weir Modifications	1	LS	$20,000	$20,000
36	Sluice Gates and hand wheel manual operator	2	EA	$3,500	$7,000
37	Observation Window	2	EA	$4,000	$8,000
38	Viewing Structure Access Hatch	1	EA	$1,500	$1,500
				South Fork Subtotal:	**$307,850**
				Combined Subtotal:	**$627,525**
				Estimating Contingency @ 15%:	**$94,135**
				Opinion of Probable Construction Cost Total:	**$721,660**

****Opinion of Probable Construction Cost should be updated after 60-days due to volatile material and construction costs****