Battle Creek Salmon and Steelhead Restoration Project

Initial Response to the Technical Review Panel Report

This document provides an initial response to the California Bay-Delta Authority (CDBA) (formerly CALFED) Ecosystem Restoration Program (ERP) Technical Review Panel Report, dated September 2003. The purpose of this initial response is to provide the Technical Review Panel and the ERP Technical Panel with information on how the Project Management Team (PMT) and Adaptive Management Team (AMT) plan to address the Panel's comments. Each Technical Panel Report comment is noted in *italics*, and is followed by a PMT/AMT response. The PMT/AMT looks forward to the Panel's input on this initial response while the final response to the Technical Review Panel Report is being prepared.

2.2 Goals and Objectives

2.2.1 ***Abbreviated Comment:*** *Restore Viable Salmon and Steelhead Populations. The Restoration Project and the Adaptive Management Plan (AMP) plan both call for restoring self-sustaining viable populations of species targeted for restoration, but do not set expectations for numbers of adult returning salmon and steelhead.*

AMT Response: The Preliminary Draft Revised AMP sets the following two tiered numeric goal for the target species:

- Tier I: First it is expected that the numeric goals for attaining genetically viable self sustaining populations will be finalized in the future with the forthcoming NMFS (NOAA Fisheries) Endangered Species Technical Recovery Team reports on each species by 2006. However, in the mean time the revised plan recommends an interim numeric goal that is considered to be moderately conservative (see attached literature review on viable populations). The AMT proposes an interim self-sustaining population goal of 1,000 adults as an estimate genetic viability based upon the attached literature review (Attachment A). The population would be judged to be self-sustaining at the genetically viable level if the mean annual spawning abundance over any consecutive 10 year period is 1,000 adults. A span of ten consecutive years considers variation associated with environmental fluctuations, including severe storms, drought, and ocean conditions. An ancillary goal for salmon is to have a number of juvenile out migrants that is the expected production from 1,000 adults. The juvenile equivalent goal will allow out migrant monitoring efforts to annually assess goal attainment and help sort out confounding factors relating to occurrence of lower than expected survival factors as the fish migrate to and live in the ocean. An interim estimate of the juvenile equivalent to 1,000 adults is not yet available but is being calculated based upon the life history model for upper Sacramento River salmon in Hallock (1987). The interim juvenile equivalent goal will be revised when newer relevant life history model information is prepared. An out migrant goal for steelhead is not being developed at this time. There is no well accepted life history model with survival rates available for natural upper Sacramento River steelhead. In addition, out migrant steelhead cannot be differentiated from resident trout movements.

- Tier II: First it is recognized that in order to achieve the interim viability goal the creek must have a carrying capacity substantially greater than 1000 adults. Secondly, once the viable population goal is achieved the AMP will need to continue working toward the next goal of restoring the creek to its estimated carrying capacity. The estimated carrying capacity of a restored Battle Creek was developed for the Anadromous Fisheries Doubling Plan (USFWS 1995) and exceeds the proposed interim viable population goal by at least a factor of two. The specific production estimates resulting from the Restoration Project include spring-run and winter-run Chinook salmon at 2,500 each and steelhead at 5,700. Although the absolute values of the carrying capacity estimates are highly uncertain, especially for winter-run chinook, there is reasonable certainty that they exceed the viable population level. It will be important to revise carrying capacity estimates during the post project period; especially for winter-run chinook, using surveys of available spawning habitat and cold water refugia associated with spring water inputs.

2.2.2 ***Abbreviated Comment:*** *Measures to minimize stranding or isolation of fish. The Restoration Project documents are vague and do not adequately define ramping rates developed to limit stranding and isolation of juveniles during hydro power operations that cause rapid high volume fluctuations.* (Note that the word 'straying' was originally indicated in this comment, but after an inquiry was made about the use of this word, the Technical Review Panel indicated that 'stranding' was the appropriate word to be used.)

AMT Response: The Restoration Project 1999 Memorandum of Understanding (MOU) establishes the operational constraints on hydro project operations to avoid stranding and isolation of juvenile fish when creek flows must be ramped down after an outage is over and powerhouse diversions resume. The excerpt from the MOU on this part of the project follows (Figure 1).

FIGURE 1
(Excerpt from 1999 MOU)

Flow Ramping Criteria

When returning the water conveyance facilities listed below to service, following forced or scheduled outages where the available diversion flow has been released to the natural stream channel, the following criteria will govern the maximum rate at which water is diverted from the stream channel back into the conveyance system:

Season	Ramping Rate*
Year Round	0.10 ft./hour

* Modification of method described in "Hydropower Flow Fluctuations and Salmonids: A Review of the Biological Effects, Mechanical Causes, and Options for Mitigation by Mark A. Hunter, State of Washington Department of Fisheries, September 1992."

It may be feasible to establish a threshold criteria of flow and stage above which ramping will not be required. An analysis of existing instream flow methodology data, stream cross-section information, and field observations will be conducted and recommendations made for initial threshold criteria within 90 days of the effective date of this MOU.

Monitoring of stream stage for ramping purposes will be at a confined, (i.e., narrow) stream transect immediately below the diversion point for the conveyance facility being returned to service, or at another appropriate location at the facility if a suitable transect is not available immediately below the diversion point.

Water conveyance facilities covered by these provisions are:

North Battle Creek Feeder
Cross-Country Canal
Eagle Canyon Canal
Inskip Canal
Coleman Canal

Planned maintenance requiring dewatering of these conveyance facilities will be scheduled during the period of February 1 through April 30 in order to minimize potential effects on anticipated anadromous fishery life stages that may be present in the affected stream reaches. Duration of the actual outages will be that necessary to complete the work associated with the conveyance facility itself.

The modification of the ramping rate method (Hunter 1992; commonly referred to as the Washington State Method) consisted of substituting 0.1 foot per hour for the recommended rate of 1 inch per hour (equal to 0.083 foot per hour). The purpose of the substitution was to make the measurements compatible with PG&E instrumentation (tenths of a foot vs. inches). The MOU also specifies that it may be feasible to establish a threshold above which a ramping rate will not be required. The CDFG and PG&E collaborated on such a study to establish a threshold (CDFG File Correspondence dated March 7, 2001). This study at a site judged to be the most sensitive to stranding and isolation of fish in either of the forks identified a threshold flow of 460 cfs.

2.2.3 Provide reliable passage for adult and juvenile salmonids

Abbreviated Comment: *The AMP objective number 3., "Provide reliable upstream passage of adult salmon and steelhead to the appropriate habitat over natural obstacles within the restoration project area while maintaining an appropriate level of spatial separation among the runs." was found to be vague and all documents that were examined lacked specific descriptions and measures regarding this objective.*

a. *The Panel believes designs should include specifications agreed to in earlier discussions, sometimes years prior to the drawings.*
b. *The Panel strongly encourages staff involved in the conceptual designs and interested parties to thoroughly review the final plans prior to contract award and construction.*
c. *The plans do not indicate intended hydraulic conditions within the system such as maximum and minimum water levels.*

PMT/AMT Response:

Please refer to Section 2.6 responses to address screen and ladder design-related comments.

The specific descriptions of how passage over natural obstacles was determined are included in the references section of the EIS/EIR for the Restoration Project in a document prepared by Thomas R Payne and Associates entitled "Battle Creek Fisheries Studies Task 4: Surveys of Barriers to the Upstream Migration of Anadromous Salmonids". This study used the methods described in Powers and Orsborn 1986, "Analysis of Barriers to Upstream Migration: An Investigation of the Physical and Biological Conditions Affecting Fish Passage Success at Culverts and Waterfalls. Project No.82-14." Bonneville Power Administration, Division of Fish and Wildlife, Portland, Oregon. 120 pp.

The measures to assess attainment of the objective of passage over natural obstacles includes use of snorkel surveys and spawner/redd surveys to identify congregations of migrants or spawners below natural obstacles that would indicate a tendency for impaired passage and spatial separation of the different races of salmon.

2.3 Strategies to Achieve Objectives – The PMT concurs with the Review Panel Statement.

2.3.1 Strategies for Restoration of Instream Flow

Abbreviated Comment – a: *The Panel believes the key to meeting instream flow is the transfer and enforcement of water rights as described in the plan.*

AMT Response: The transfer of water rights as described in the plan (dedication of flow to the environment under Water Code Section 1707) is an action that will be decided by the State Water Resources Control Board in response to a petition supported by all the parties to the MOU. At all remaining dams the instream flow releases cannot be dedicated to the environment under Water Code 1707 because they are regulated under the Federal Power Act. In addition, the minimum instream flows are subject to change under the AMP and water right setting processes are not set up for allocating variable unspecified amounts of water. The key to meeting the instream flow below the dams licensed by the Federal Energy Regulatory Commission (FERC) is amendment of the license to require the flows specified in the MOU as adjusted by the Adaptive Management Program and approved by FERC.

Abbreviated Comment – b: *Decision makers should note that the endangered status of winter-run Chinook salmon gives this stock higher priority than other salmonid species and runs in the Sacramento River basin for actions by management agencies.*

AMT Response: The Biological Technical Team for the Battle Creek Work Group developed the minimum instream flows specified in the MOU. During the development of the minimum instream flows winter-run Chinook were given priority when their habitat needs conflicted with those of steelhead. Battle Creek is not considered critical habitat for winter-run Chinook under the NMFS (NOAA Fisheries) 1997 Draft Winter-run Chinook Recovery Plan (neither are several other areas winter-run are known to occur, such as the interior river delta). The Recovery Plan does, however, identify a need to prepare a feasibility study for the reestablishment of a winter-run Chinook population in Battle Creek.

2.3.2 Strategies for Restoration of Stream Function

Abbreviated Comment: *Elimination of cross-basin transfer of North Fork water into the South Fork would be a major benefit for adult and juvenile salmon. It appears, however, that this strategy is not adhered to for all conditions. Maintenance of facilities downstream of the South Fork powerhouse can cause North Fork water to be directed into the South Fork. Although costly, the isolation of North Fork water from South Fork instream flow is biologically reasonable to restore stream function for salmonids.*

AMT Response: The MOU for the Restoration Project includes terms that guard against false attraction to the extent controllable by limiting planned maintenance activities to a wet season period having elevated South Fork flow volume to dilute North Fork water. In addition, the specified period for planned maintenance is outside the winter-run and spring-run Chinook spawning time giving migratory adults some time to test for natal waters and redistribute appropriately (See Figure 1: Excerpt from MOU- last paragraph). The MOU defines the action as “guarding against false attraction” which acknowledges that there will be some factors in hydropower operation that will not be practical or feasible to control for complete isolation.

2.3.3 Strategies for Fish Passage at Dams - PMT Response is located in Section 2.6.

2.4 Preferred Alternative

Abbreviated Comment: *The Panel agreed that it was worth noting that the project as defined for this review does not incorporate a barrier to fish passage into the Coleman Powerhouse tailrace. Attraction of adult salmonids into the tailrace channel is currently a problem and fish are captured and transported to the mainstem. According to the Project Technical Team, the barrier on the Coleman Powerhouse tailrace is being investigated. The Panel feels this barrier should be scheduled and implemented as an integral part of the project.*

PMT Response: The Coleman Powerhouse tailrace fish barrier is not a project feature of the proposed project (action) described in the 1999 MOU. In 2001, a temporary fish barrier at the Coleman Powerhouse tailrace was installed by CDFG. This picket weir barrier was removed this year due to its poor condition and because it was anticipated that a permanent barrier would be installed. The remedy to prevent false attraction of salmon and steelhead out of Battle Creek and into the Coleman Powerhouse Tailrace is being actively pursued under the Central Valley Project Improvement Act’s Anadromous Fisheries Restoration Program. PG&E, FWS, CDFG, and NMFS (NOAA Fisheries) have been coordinating, and PG&E has hired a consultant to prepare the conceptual and detailed design of the permanent fish barrier. The parties anticipate the permanent fish barrier will be installed as soon as practicable after technical, financial and permitting issues are resolved.

2.5 Project Features – The PMT concurs with the Review Panel Statement.

2.5.1 Fish Passage Improvements – The PMT concurs with the Review Panel Statement.

2.5.1.1 Dam Removal

Abbreviated Comment: *Each dam removal proposed under the preferred alternative scenario will result in the release of a wedge of sediment stored upstream of the dam. The exact volume and grain-size distribution is presently unknown.*

The relatively small amounts of fine sediments stored below each dam, and the existing supply limitations to fine sediment transport suggest that turbidity and downstream siltation will not create problems during and following dam removal, particularly if dam removals are conducted at high to moderate flows, and are separated by at least two days as suggested by Hepler et al. (2001). If dam removal occurs during low flow conditions, downstream siltation will reduce primary production from periphyton; macroinvertebrate habitat and community diversity; and an abundance of interstitial habitat in gravels. The duration of this impact will be an important control on the impact’s severity.

PMT Response: Studies regarding the release of impounded sediments are discussed in the report, "Sediment Impact Analysis of the Removal of Coleman, South, and Wildcat Diversion Dams on South and North Fork Battle Creek," prepared by Blair Greimann (April 2001) and referenced by the Technical Review Panel. Negligible amounts of sediment exist behind Soap Creek Feeder and Lower Ripley Creek Diversion Dams and no analysis was necessary for these two sites. Battle Creek carries a large range of sediment sizes from fine sand to larger boulders, but with very little silt or clay, such that turbidity is not expected to be a significant problem during dam removal at any site. The amount of material stored behind Wildcat Diversion Dam is relatively small (5,000 yd^3) and would not cause significant impacts to the steep downstream channel when released. Much larger volumes of sediment are stored behind both Coleman and South Diversion Dams (28,000 and 30,000 yd^3, respectively) on the South Fork, where small pilot channels are proposed to help ensure fish passage immediately following dam removal. The excavated sediment would be left on the stream banks for erosion during higher flood flows. These sediment volumes are much less than the annual sediment transport capacity of the South Fork (~100,000 yd^3) and most of the impounded material should be eroded within the first year after dam removal. The eroded sediments are not expected to have significant impacts on the bed gradations over long reaches of the river, and any local impacts should be temporary and minor. Since Coleman and South Diversion Dams are separated by over 11 river miles, and Inskip Diversion Dam will remain between the two dams, the sediment released at South Diversion Dam should not cause an incremental impact at Coleman Diversion Dam.

2.5.1.2 Upstream Ladders and Screens on Water Diverted From the Streams – The PMT concurs with the Review Panel Statement.

2.5.1.3 Elimination of In-Stream Mixing

PMT Response: The Panel states its understanding of how designs prevent the mixing of North Fork and South Fork waters. Because there appears to be some misunderstanding about the specific design elements, the following clarification is offered:

Mixing of North Fork and South Fork waters can occur at 2 PG&E facilities: South Powerhouse and Inskip Powerhouse. To prevent this mixing, the waters from both the powerhouse discharges and from the bypass or wasteway facilities must be captured and conveyed directly to the canals to avoid any mixing.

At South Powerhouse, mixed waters from the powerhouse discharges and from the natural drainage channel wasteway would be directed through a new 1,200-foot-long tunnel excavated through the hillside on the north side of the creek. The flows would discharge directly into Inskip Canal at a point about 1,300 feet downstream of Inskip Dam. To accomplish the hydraulic connection between the tailrace channel flows and Inskip Canal, the peninsula would be raised and armored.

At Inskip Powerhouse, mixed waters from the powerhouse discharges would be conveyed through a new 660-foot-long buried pipeline to directly discharge into Coleman Canal. Mixed waters from the existing overland wasteway for the powerhouse (these waters presently discharge into the South Fork approximately 500 feet upstream of the Inskip Powerhouse) would be conveyed through a new 5,662-foot-long penstock bypass system. This system is a combination of buried pipe and open chutes crossing the plateau area above the powerhouse facility. The bypass would discharge directly into Inskip Canal.

2.6 Project facilities

2.6.1 Design Considerations

2.6.1.1 Inskip Dam and Diversion

Comment - a: *For a few days each spring, and for periodic maintenance of the turbines, the steel high-pressure penstock that supplies water to the powerhouse will be shut down for maintenance. Currently no facility exists to divert water from the Inskip Canal. For reasons not fully disclosed in the Conceptual Design Report, the project includes a bypass structure to bypass water when the penstock is shut down. At least 11 alternatives were reviewed including a "do nothing" alternative. The "do nothing" alternative was considered too severe because of economic and environmental concerns. However, considering the overall cost of the bypass facility, the economics may not be completely justified. The cost of the structure appears to be approximately $1.5 million (actual construction costs were impossible to determine because costs were not delineated by element of the project), or about 6% of the total construction budget. Less cost might be incurred by simply paying for the lost power production due to the infrequent outages associated with maintaining the facility.*

PMT Response: An overflow wasteway currently exists on the Inskip Canal to release bypass flows directly to the South Fork in the event of an emergency shutdown of Inskip Powerhouse. This structure is to be modified by the addition of stop planks, as shown on drawing OA-60-96, to prevent future operation. The proposed replacement bypass facility, or penstock bypass, is currently estimated to cost approximately $4.3 million, rather than the $1.5 million indicated in the Technical Panel Review Report.

The proposed Inskip Powerhouse Bypass is a necessary component of the Restoration Project to fulfill the need of maintaining reliable production of fish and energy, as developed in the MOU. The frequency and magnitude of the need for the bypass structure is illustrated in the hydrograph shown in Figure 2. The hydrograph illustrates the planned and unplanned outages as powerhouse discharge going to zero. These discharges may occur at unpredictable times. During planned outages and especially during unplanned outages, water flowing in the canal towards the powerhouse once a shutdown has occurred will have to be released around the powerhouse. Environmental damage from an uncontrolled release of water would be the certain result without some form of bypass structure intact.

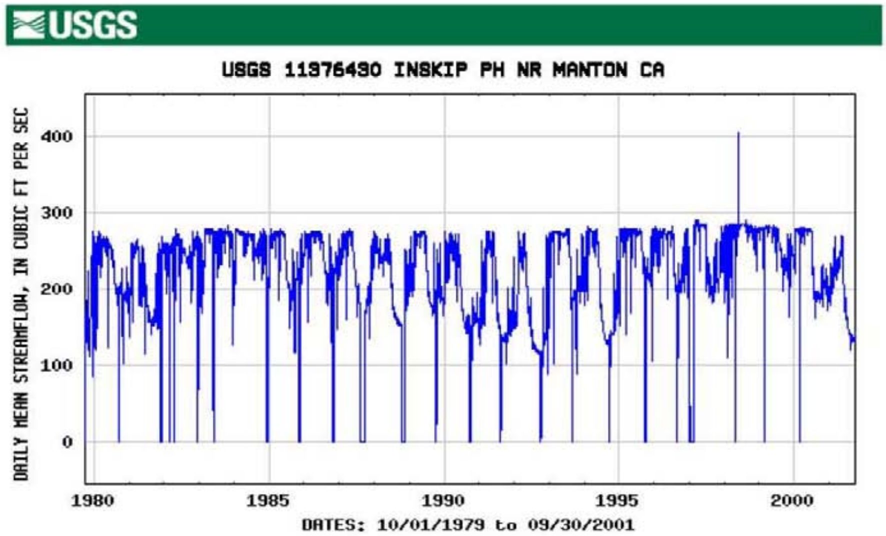


FIGURE 2

Comment - b: *The Preliminary Technical Report indicates the orifice size in the fish ladder has been changed from 15 inches to 24 inches. It did not indicate why the change was made. It should be confirmed that this would not adversely affect the performance of the ladder. The report indicates this ladder design was selected for its previous performance, but does not indicate what effect this change might make.*

PMT Response: A larger orifice was proposed for this fish ladder because the design team wanted the fish ladder to have a total capacity of approximately 39 cfs. 40 cfs is PG&E's minimum instream flow requirement for the months May through November. The design team wanted at least the minimum flow requirement of 40 cfs to pass entirely in the fish ladder. A standard half ice harbor with 15 inch orifices has an approximate total capacity of 29 cfs with one foot of head. To make the capacity of the ladder able to handle the 40 cfs minimum flow at one foot of head, the orifice size was increased to 24 inches. With this configuration, there is approximately 22.5 cfs flowing through the orifice and 16.5 cfs flowing over the weir section for a total ladder capacity of 39 cfs.

A larger orifice passes more water, thus requiring that more energy be dissipated in the downstream pool for proper fish ladder operation. The energy dissipation required to prevent carryover from one pool to the next was calculated and found to exceed the standard energy dissipation value. The width of the non overflow section of the fish ladder was increased from three to four feet to increase the energy dissipation between pools. The calculated energy dissipation between pools (4.7 ft-lb/sec/ft^3) is still slightly greater than the acceptable energy dissipation of standard half ice harbors (4.5 ft-lb/sec/ft^3). The design team agreed that the slight exceedance of the accepted energy requirement due to the larger orifice size should not adversely affect the operation of the fish ladder. Additionally, even though pool and chute fish ladders operate on different principles than Ice Harbor fish ladders, the newly constructed pool and chute fish ladder at A.C.I.D. Dam on the Sacramento River has 24-inch orifices and all accounts indicate that that fish ladder is working well.

2.6.1.1.1 Inskip Ladder-Type Selection:

Abbreviated Comment - a: *For the Inskip fish ladder, each weir should have close to one foot of head to provide the desired plunging flow conditions.*

PMT Response: The PMT agrees that ice harbor fishways should have one foot of head to provide ideal plunging flow conditions and notes that the fishway has been designed so that through the range of design flows there would be one foot of head between each step in the fish ladder, and no more than one foot of head across any of the control structures.

Abbreviated Comment - b: *The project drawings reviewed did not have information concerning water surface profiles.*

PMT Response: Water surface profiles will be added to the appropriate drawing profiles, elevations, and sections in the final design drawings.

Abbreviated Comment – c: *To throttle this excessive head, the design does provide a gate at the end of the screen section.*

PMT Response: This gate is used to dissipate one foot of head or less under all design conditions. This gate will not be required to dissipate more than one foot of head during normal design conditions. The gate at the downstream end of the fish screen is only one of several features used to dissipate head.

Abbreviated Comment – d: *Throttling several feet of head with entrance gates may not provide appropriate fish passage conditions.*

PMT Response: This is a very technically complex part of the fishway design. The fish team spent several meetings discussing the expected dissipation of head throughout this section of the fishway. The fishway is designed to always meet the accepted criteria of having one-foot head drop or less through a control structure. It was never the plan to dissipate more than one foot of head with any individual structure.

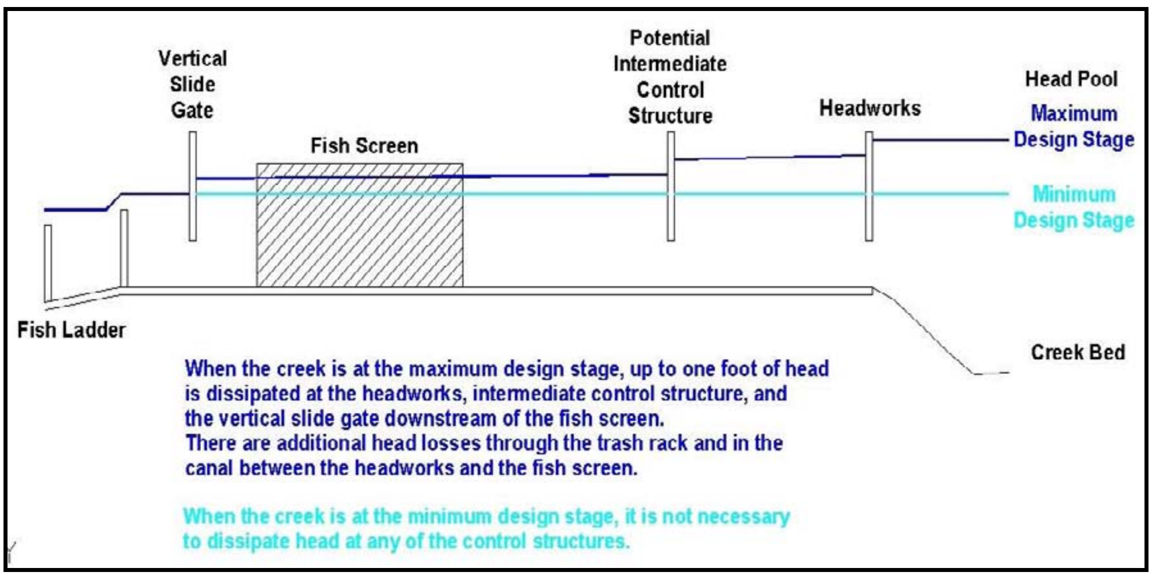
In the preliminary engineering report the maximum design condition was a 4.5 foot change in water surface elevations between the top pool of the fish ladder and the creek upstream of the headwork's. Calculation were performed for each structure and are summarized:

- 0.2 feet of head would be dissipated by the trash rack (this was neglected.
- One foot of head would be dissipated by the headgates.
- One foot of head would be dissipated by the roughness of the tunnel
- 0.5 foot of head would be dissipated by the sediment trap
- One foot of head would be dissipated by the intermediate control structure (if required).

- One foot of head would be dissipated by the gate at the downstream end of the fish screen.

These calculations show that at the maximum design conditions, no more than one foot of head is dissipated at any one structure.

During the final design process a new hydraulic analysis was performed. This new analysis showed that with a concrete lined canal where the tunnel used to be, there would be about one foot less head dissipated than there would be for the unlined canal proposed in the preliminary design. For this reason the final designers added one step to the fish ladder so that now only 3.5 feet of head needs to be dissipated. It should be noted that as a cost saving measure, the plan has been to not initially install the hardware necessary to dissipate a full foot of head at the intermediate control structure. Based on the available hydrology and hydraulics, it was determined that a condition where there was a 3.5 foot head differential would rarely, if ever, occur during the operational range of the fish ladder. If it is determined that this condition occurs while fish are migrating upstream, then gates will be added to the intermediate control structure most likely as part of the adaptive management program.



Abbreviated Comment – e: *The use of this gate at the exit as a bypass presents additional concern. The National Marine Fisheries Service((NMFS (NOAA Fisheries)) criterion requires that the bypass entrance extend from the floor to the water surface. The intent of this is to avoid a vertical surface in the flow that would provide an area of low velocity for juveniles to hold in. When the gate is in place, it provides the vertical surface, which is not allowed.*

PMT Response: This comment is currently being addressed.

Abbreviated Comment – f: *Apparently, the conceptual design anticipated a vertical swing gate, which would have provided better bypass flow conditions than the vertical slide gate used in the final design. Discussion indicated that the gate was changed based on cost considerations.*

Even the vertical gate still presents flow concerns with these high head drops since a vortex can occur behind the gate.

PMT Response: A vertical swing gate was proposed during the preliminary design process, but was later changed due to cost and complexity issues. The Ladder & Screen Technical Team determined that a swing gate would need to be a customized and fabricated item. This complexity, as well as the cost associated with a swing gate were weighed against a standard vertical slide gate, and it was determined that a standard slide gate would be sufficient and would be utilized.

Abbreviated Comment – g: *For this installation, a fixed vertical slot fishway should be reconsidered since no controls would be necessary, if properly designed.*

PMT Response: There are several reasons why a vertical slot fish ladder was not proposed for this site. The main reason for not pursuing a vertical slot fish ladder was major concerns voiced by representatives of both NMFS (NOAA Fisheries) and CDFG early on in the conceptual design process. They believed that the reliability of vertical slot ladders was questionable, and that if another fish ladder type would work well, then a vertical slot ladder should not be constructed. Based on these comments, DWR did not pursue the construction of a vertical slot fish ladder at this site.

If a vertical slot fish ladder similar to the one proposed for Eagle Canyon were constructed at this site, it would theoretically eliminate the need for the gate to control head at the downstream end of the fish screen, but NMFS (NOAA Fisheries) still requires a gate at this location because they require that fish screen bypass entrances be provided with independent flow control. None of the other presently proposed control structures could be eliminated unless a taller fish screen was also constructed. Based on these considerations, and the fact that the water surface level must be maintained within specified limits on the fish screen, there would be no real advantage to replacing the proposed half Ice Harbor fish ladder with a vertical slot fish ladder.

Abbreviated Comment – h: *The possibility of negative effects on juvenile fish passing through the ladder such as predation by resident fish should be considered.*

PMT Response: Environmental specialists and biologists from CDFG, USFWS, and PG&E concurred with the proposed designs for routing the juvenile fish throughout the fish ladder during the design team meetings. It is thought that predation by resident fish is no more likely in the fish ladder than other areas in the creek. The PMT concurs with the comments made by the CBDA Technical Review Panel in Section 2.6.1.1.1 that this is likely the best configuration for juvenile routing. Given the relatively large elevation difference between the fish screen and the tailwater below Inskip Dam (27 Feet), the safe dissipation of energy in a separate juvenile bypass would require constructing a very long channel which could itself harbor predators.

2.6.1.1.2 Access to the Inskip Diversion Dam

Abbreviated Comment: *Access to the dam site would be improved. Considering the frequency of use of this facility it is difficult to understand the justification for the design standards.*

PMT Response: During the December 10, 2003 PMT Meeting, it was agreed that the road would be narrowed from 16 feet to 12 feet (except at turn-outs), pavement thickness would be reduced from 4 inches to 3 inches, and consideration would be given to a grade steeper than 12 percent. Adjustments are being made to draft designs and specifications, and potential cost reductions associated with these changes are being evaluated.

2.6.1.1.3 Fish Screens

Abbreviated Comment – a: *The fish screen design is typical of current practice and should provide adequate performance. The large amount of incline may make flow balancing more difficult. The lower portion of the screen is somewhat shadowed by the floor behind it. Placing the screens on a sill or lowering the floor in the area between the screens and the control louvers could lower this effect.*

PMT Response: The screens are inclined to provide the necessary surface area in the available water depth, and the louvers behind the screen are aligned with the screen face to balance the flow along the fish screen. If the floor downstream of the screen were lowered, resulting in the screen sitting on a curb, it is not clear if this would improve flow at the bottom. Although the velocities involved are small, lowering the floor downstream theoretically results in an expansion, with attendant head losses, which tend to reduce flow and velocities. If the benefit of the lowered floor is to reduce friction losses between the water passing through the bottom of the screen and the floor, the low velocities would likewise indicate this positive effect would be minor. If the floor downstream of the screen is lowered, resulting in the screen sitting on a curb, and if the louvers are kept in the same position, the change would require multiple alterations to the final design plans, but may not pose other significant complications.

Abbreviated Comment – b: *Flow conditions with the current design do not appear to meet NMFS (NOAA Fisheries) screen criteria. One problem is the short transition from the inclined screens to the vertical bypass section.*

PMT Response: This transition could be lengthened, but that would require shifting a large section of the fish ladder to the west, and the realignment of roads and cut slopes. The designated representatives from the fisheries agencies were involved in this aspect of the design process and were in concurrence with the original design.

Abbreviated Comment – c: *Several screen facilities have flashboards just upstream of the bypass entrance to control flow; this would not meet NMFS (NOAA Fisheries) design criteria.*

PMT Response: This does not apply to the Inskip fish facilities.

Abbreviated Comment – d: *At the entrance to the bypass, the floor is often sloped upward to provide acceleration to the bypass flow, which captures juveniles.*

PMT Response: The bypass entrances were designed so that the velocity into the entrance was at least equal to the maximum velocity vector along the fish screen. The transition area at the downstream end of the fish screen confines the water bypassing the screen into a narrower channel and should serve to accelerate the water into the upper portion of the fish ladder. The designated representatives from the fisheries agencies were involved in this aspect of the design process and were in concurrence with the original design.

Abbreviated Comment – e: *There are provisions for video counting of adults in the ladder. Discussions indicated that the fish would be crowded to the surface to facilitate counting, but the plans did not show this feature. This should be reviewed.*

PMT Response: To make sure that the water velocity into the fish screen bypass was at least equal to the maximum velocity vector along the fish screen, the upstream end of the pool at the top of the fish ladder was designed to be two feet wide, and this is where the fish counting station is located. A white background on one wall and multiple cameras on the opposite wall will enable the entire water column to be filmed. During final design, other configurations for crowding the fish were investigated but were abandoned because of their potential for accumulating debris. Since electronic technology advances rapidly, and since there are often several years between the concept phase and when construction occurs, the Ladder & Screen Technical Team decided during final design to not specify the exact camera type or configuration in the contract, but to install the cameras via notice of change during construction, or to install them separately after construction. During the December 10, 2003 PMT Meeting, the team reconsidered this issue and now plans to include cameras (*Flagship Video Model CVC620WP* suggested) for all three ladders in the constructions specifications. If underwater video technology advances between now and installation, the camera specifications will be revised accordingly.

2.6.1.2 South Dam and Powerhouse

Comment – a: *While it appears that several alternatives for transporting water from the tailrace to Inskip Canal were investigated, it is not apparent that the decision to conduct a tunnel was made on the basis of costs. Surface piping is in general much less expensive than tunneling. A pipe in the river or for direct connection to the tunnel was investigated and rejected. A pipe from the powerhouse directly to the Inskip Canal was not discussed in documents available to the Panel. For instance, a pipeline mechanically secured to the hillside could conceivably be substantially less expensive than a tunnel. Tunnel construction is nearly 8 % of the overall project construction costs.*

PMT Response: The proposed culvert through the tailrace dike provides for continued power generation at South Powerhouse during construction of the new bypass tunnel, and is justified for this purpose alone. Future diversions through the culvert for tunnel inspection and maintenance (which would result in water mixing) may be acceptable for short durations and at certain times of the year, which could be identified and planned for in advance. A similar capability is also proposed at Inskip Powerhouse, which would have a slide gate added at the downstream end of the tailrace structure to permit continued power generation during inspection and maintenance of the tailrace connector pipeline.

A buried pipeline was considered as an alternative to the open channel between South Powerhouse and the bypass tunnel inlet, but was rejected based on costs and the difficulty of accommodating the overflow wasteway bypass flows from the Cross-Country Canal to the tailrace channel. A pipeline alternative to the proposed bypass tunnel was considered during the Value Engineering study, utilizing precast concrete box culvert sections founded on bedrock along the right stream bank. Concerns for potential flotation and construction difficulty resulted in no apparent cost savings over the proposed designs. A pipeline within the stream channel would also restrict the natural channel width at this location and be visible from the private resort located beyond the left stream bank. In addition, a direct pipeline from South Powerhouse to the Inskip Canal would have to bypass the fish screen and intake structures at Inskip Dam, requiring extensive rock excavation at this location.

Abbreviated Comment – b: *RCC is used for the construction of a dike to contain effluent from the South Powerhouse and direct the flow into the tunnel. Considering the remote location, RCC appears to be an unusual choice for dike construction.*

PMT Response: During the December 10, 2003 PMT Meeting, it was agreed that RCC would not be used. Instead a "Mechanically-Stabilized Earth" (MSE) wall alternative with overtopping blocks is now recommended, and designs, specifications and costs for this alternative are now being developed.

2.6.1.3 Soap Creek Feeder Dam – The PMT concurs with the Review Panel Statements.

2.6.1.4 Lower Ripley Creek Diversion Dam – The PMT concurs with the Review Panel Statements.

2.6.1.5 Coleman Diversion Dam

Abbreviated Comment – a: *A buried woodpile cofferdam is to be removed down to the excavated pilot channel elevation. However, streambed erosion subsequent to pilot excavation may result in woodpiles protruding above the streambed if not removed.*

PMT Response: The specifications include drawings detailing the existing structures at Coleman Diversion Dam and the pilot channel excavation limits. A specific plan for removal of the dam is required to be submitted by the Contractor for approval, in accordance with the specifications. The existing timber piles were specified to be saw cut at the pilot channel grade, rather than requiring an additional piece of equipment to completely withdraw the piles from the subsurface. The tops of the existing piles have been exposed in the past with no apparent problems. However, if a potential public safety hazard could result following dam removal and sediment erosion, we will reevaluate this requirement.

Abbreviated Comment – b: *Specifications (02221) discuss placing rubble from dam demolition immediately downstream of the dam in the stream. Without further information on how sediment will erode and a timeline showing how the streambed would aggrade to cover this material, it is not possible to determine what considerations were made regarding possible impediments to fish passage.*

PMT Response: During the December 10, 2003 PMT Meeting, it was agreed that all rubble, including masonry-covered boulders, from dam demolition would be removed from all project sites. The specifications are being adjusted to reflect this change.

Abbreviated Comment – c: *Consideration of effects of mobilizing relatively large amounts of sediment that could affect rearing and spawning habitat should be reviewed. As an alternative to allowing sediment to erode immediately upon dam removal and possibly cause downstream fisheries impacts, sediment could be excavated and temporarily placed on embankments at an elevation that would allow it to be mobilized only in runoff events that would generally mobilize spawning material.*

PMT Response: Sediments impounded by Coleman Diversion Dam consist of naturally-occurring bedload materials that have been sluiced downstream in the past. Provisions for anti-spawning mats are included in the specifications to prevent spawning in existing beds within the downstream construction area during the construction period. No long-term impacts to existing spawning and rearing habitat are anticipated by the release of less than one-fourth of the total annual sediment transport volume of the stream, having gradations similar to the downstream bed materials. Mechanical excavation and removal of the impounded sediments at Coleman Diversion Dam is not believed to be necessary. The proposed excavation of the pilot channel and placement of sediments along the stream banks will have the effect of delaying the erosion of a significant portion of the impounded sediments to a later flood event.

Abbreviated Comment – d: *Retaining abandoned fish ladders on the abutments may also involve some risk.*

PMT Response: The existing fish ladders at Coleman Diversion Dam are to be completely removed in accordance with the current specifications, with the possible exception of minor concrete footings on the right abutment. Retention of the left abutment fish ladder was considered during the conceptual design phase to preserve an historic artifact at the site and to reduce costs; however, full removal is now required to address public safety concerns.

2.6.1.6 Wildcat Diversion Dam

Abbreviated Comment – a: *As an alternative to allowing sediment erode immediately and possibly cause downstream fisheries impacts, sediment could be excavated and temporarily placed on embankments at an elevation that would allow it to be mobilized only in flood events that would mobilize spawning material. Placing angular pieces of the masonry dam also presents possible short-term conflicts for fish passage and spawning in this critical reach for winter-run Chinook salmon.*

PMT Response: During the December 10, 2003 PMT Meeting, it was agreed that all rubble, including masonry-covered boulders, from dam demolition would be removed from all project sites. The specifications are being adjusted to reflect this change. Based on visual inspection, the impounded sediment volume behind Wildcat Dam is so minimal that a pilot channel would not be required at this location. Any mechanical excavation of these materials would be costly due to the equipment required and would seem to be of little benefit. In addition, there have been no specific impacts to winter-run Chinook salmon identified due to proposed removal operations.

Abbreviated Comment – b: *The major cost item for the Wildcat Dam removal is retrieving the pipe containing the diverted flow.*

PMT Response: Removal of the 24-inch-diameter steel pipeline is costly, but is believed to be prudent and necessary to avoid a potential public safety hazard. The pipeline crosses land owned both by PG&E and by private landowners, and is to be removed from its concrete supports for the entire length. Timber supports and cable ties are also to be removed. Similar removal requirements are proposed for the South Canal, which includes numerous metal flumes on concrete supports, and for the Soap Creek Feeder Canal, which consists of a 24-inch pipe on concrete saddles. The PMT only plans to leave concrete saddle supports and footings intact that are considered stable, difficult to access, not readily visible, and not a significant public hazard.

2.6.1.7 North Fork Creek Feeder Diversion Dam

2.6.1.7.1 Fish Screen Structure

Abbreviated Comment – a: *The floor of the screen structure downstream of the screen panel should be lowered so as not to impede flow through the lower portion of the screen and to allow the louvers to be effective throughout the full depth of the screen.*

PMT Response: The differential in the screen floor is to allow sediment to settle out without impacting the bottom portion of the screen. By having the screen on a lifted area, the entire length of the screen remains free from sediment. If the floor downstream of the screen were also lowered, resulting in the screen sitting on a curb, it is not clear if this would improve flow at the bottom. Although the velocities involved are small, lowering the floor downstream theoretically results in an expansion, with attendant head losses which tend to reduce flow and velocities. If the benefit of the lowered floor is to reduce friction losses between the water passing through the bottom of the screen and the floor, the low velocities would likewise indicate this positive effect would be minor. If the floor downstream of the screen is lowered, resulting in the screen sitting on a curb, and if the louvers are kept in the same position, the change would require a fair amount of changes to the drawings but may not pose other significant complications.

Abbreviated Comment – b: *The dual-brush cleaning assembly, provides no opportunity for debris that is trapped between the brushes to get removed and the debris will tend to accumulate and will adversely affect the performance of the brushes.*

PMT/AMT Response: The proposed facilities are based on criteria driven designs that can be seen on existing fish screening facilities of similar scale, however, other facilities (e.g. GCID) sometimes have rails beyond the end of the fish screen and at a slight angle into the flow so the brush assembly can be separated from the surface and the debris removed by the flowing water. Such an arrangement at Battle Creek is very difficult due to the tight space limitations and concrete abutments. An inverted brush at each end of the screen was not used because it projects above the surface of the screen, something the Ladder and Screen Technical Team wanted to avoid, and CDFG and NMFS (NOAA Fisheries) criteria discourage obstructions or protrusions that may cause eddies or harm fish.

If the proposed cleaning system does not perform adequately, the Adaptive Management Team would investigate alternative methods or modifications to remove debris trapped between the cleaning brushes. Modifications could include use of a single brush cleaning system; the single brush system would require exemption from the CDFG screen criteria, which could be granted if it is warranted.

Abbreviated Comment – c: *The brush assembly should be equipped with provisions to remove material from the brush at the end of brush travel.*

PMT Response: See comment for item "b" above.

Abbreviated Comment – d: *The juvenile bypass outfall may have predators entering the structure, debris clogging the pipe, and inspection problems.*

PMT Response: The ladder and screen technical team also had concerns with the above items, but with much thought and discussion, came to agreement on the design of the outfall as currently shown in the drawings. Debris should be limited to seasonal leaves and small sticks. The trash rack at the front of the screen should keep out larger debris. The bypass outfall pipe could be raised or shortened so predators can't enter the structure. This would also address the exit invert being submerged at the design flow. Raising the pipe would decrease the amount of bypass flow though, so shortening may be the better solution. The bypass outfall pipe was extended to its current location because of the natural pool that exists during lower flows. The pipe could be shortened if a plunge pool was excavated at the new outlet. If this were done, NMFS (NOAA Fisheries) bypass outfall criteria, such as insuring the presence of adequate ambient river velocities, would need to be considered (see item e. below).

Abbreviated Comment – e: *The plunge pool shown on the plans is not adequately detailed.*

PMT Response: It is intended that the excavation for the plunge pool be directed by the construction inspectors with input from the fisheries biologists to ensure that the final product will provide the appropriate depths and characteristics to prevent predators from being an issue, but to still provide a safe means of escape for the bypassed fish.

The location of the proposed bypass outfall took into consideration the NMFS (NOAA Fisheries) bypass outfall criteria listed below:

- Ambient river velocities at bypass outfalls should be greater than 4.0 fps, or as close as obtainable.
- Bypass outfalls shall be located and designed to minimize avian and aquatic predation in areas free of eddies, reverse flow, or know predator habitat.
- Bypass outfalls shall be located where there is sufficient depth (depending on the impact velocity and quantity of bypass flow) to avoid fish injuries at all river and bypass flows.
- Impact velocity (including vertical and horizontal components) shall not exceed 25.0 fps.
- Bypass outfall discharges shall be designed to avoid adult attraction or jumping injuries.

The bypass outfall pipe was extended to its current location because of the natural pool that exists during lower flows. The site was selected considering sufficient pool depth, at the same time having adequate ambient velocities. The natural plunge pool that the bypass outfall pipe flows into requires only minor excavation for low flows. Shortening or raising the bypass outfall pipe (item d.) will also affect the plunge pool.

Abbreviated Comment – f: *The plans show the juvenile bypass outfall pipe with very little cantilever. It appears that the flow will end up on the footing for the outboard pipe support. The section shows very small footings, but the details show a much larger footing, which will extend farther into the flow. The potential for damage to the pipe should be considered in the design. The plans show another pipe connection to the well, which has a blind flange.*

PMT Response: The design of the bypass pipe was discussed in detail during the final design process. The intent is for the pipe to break away with minimal damage to the supports and the screen structure under extreme flow conditions. That is the reason for the blind flange, and for using relatively inexpensive HDPE pipe. The slope of the pipe and length of the pipe were determined by the technical fisheries advisory team prior to final design.

Regarding the bypass pipe and footing beneath, the footings on drawing 0A-60-306 are not at the right scale and will be corrected. The end of the pipe is close to the end of the support, but the footing of the support will be excavated and will have compacted backfill six inches over the top of the concrete. It would not be difficult to lengthen the pipe such that it culminates further out, but the outfall invert was of concern. If the pipe were lengthened, the outfall invert would be lower. Shortening or raising the bypass outfall pipe (item d.) will affect the cantilever length.

2.6.1.7.2 Fish Ladder Structure – The PMT concurs with the Review Panel Statement.

2.6.1.7.3 Access – The PMT concurs with the Review Panel Statement.

2.6.1.7.4 Operations and Maintenance – The PMT concurs with the Review Panel Statement.

2.6.1.8 Eagle Canyon Dam

2.6.1.8.1 Fish Screen Structure

Abbreviated Comment – a: *The Eagle Canyon fish screen selection and application of the established criteria should be reexamined for this facility.*

PMT Response: This comment applies to the selection of a fish screen approach velocity of 0.40 fps instead of the 0.33 fps approach velocity that was used at Inskip and North Battle Creek Feeder. The fish screens at Inskip, North Battle Creek Feeder, and Eagle Canyon are all in-canal, and under CDFG and NMFS (NOAA Fisheries) fish screening criteria, the allowable approach velocity for fish screens in canals is 0.40 fps. The more conservative value of 0.33 fps was used at Inskip and North Battle Creek Feeder because it was possible to do so without dramatically increasing the cost of the projects. A 0.33 fps approach velocity fish screen was considered for Eagle Canyon, but initial engineering calculations showed that it was not economically feasible to construct a fish screen that large at this site. The diversion site is in a steep canyon with near vertical walls which restricts the width of a fish screen structure. Additionally, the distance in canal between the diversion dam and a canal tunnel limits the length of the canal where a fish screen could be located. The designated representatives from the fisheries agencies were involved in this aspect of the design process and were in concurrence with the original design.

Abbreviated Comment – b: *The floor of the fish screen structure downstream of the screen panel should be lowered so flow is not impeded through the lower portion of the screen and allows the louvers to be effective throughout the full depth of the screen.*

PMT Response: The floor at Eagle Canyon is at the same elevation upstream and downstream of the screen, unlike Inskip and NBCF, where the screen floor is 6 inches higher than the floor upstream. If the floor downstream of the screen were lowered, resulting in the screen sitting on a curb, it is not clear if this would improve flow at the bottom. Although the velocities involved are small, lowering the floor downstream theoretically results in an expansion, with attendant head losses which tend to reduce flow and velocities. If the benefit of the lowered floor is to reduce friction losses between the water passing through the bottom of the screen and the floor, the low velocities would likewise indicate this positive effect would be minor. If the floor downstream of the screen is lowered, resulting in the screen sitting on a curb, and if the louvers are kept in the same position, the change would require multiple alterations to the final design plans, but may not pose other significant complications.

Abbreviated Comment – c: *The dual-brush cleaning assembly, provides no opportunity for debris that is trapped between the brushes to get removed and the debris will tend to accumulate and will adversely affect the performance of the brushes. The brush assembly should be equipped with provisions to remove material from the brush at the end of the brush travel.*

PMT Response: The proposed facilities are based on designs that can be seen on existing fish screening facilities of similar scale, however, other facilities (e.g. GCID) sometimes have rails beyond the end of the fish screen and at a slight angle into the flow so the brush assembly can be separated from the surface and the debris removed by the flowing water. Such an arrangement at Battle Creek is very difficult due to the tight space limitations and concrete abutments. An inverted brush at each end of the screen was not used because it projects above the surface of the screen. This was something the Ladder and Screen Technical Team wanted to avoid, and CDFG and NMFS (NOAA Fisheries) criteria discourage obstructions or protrusions that may cause eddies or harm fish. If the present cleaning system is thought to be inadequate, the design team could reconvene to investigate alternative methods for removing debris trapped between the cleaning brushes.

Another option would be to redesign the system so that only one cleaning brush is used. Based on CDFG criteria that every part of the fish screen must be cleaned at least once every 5 minutes, and the NMFS (NOAA Fisheries) brush speed recommendation of 1 to 6 inches per second, a cleaning cycle on a 60 foot fish screen with one brush would be 4 minutes at the maximum brush speed. This would meet the accepted criteria and standards.

Abbreviated Comment – d: *The bypass uses a design where flow from the screens is reintroduced into the fishway flow about two thirds of the way down the ladder. The combination of debris, turbulent energy dissipation, potential predators, and juveniles needs to be carefully considered.*

PMT Response: The combination of debris, turbulent energy dissipation, potential predators, and juveniles were carefully considered and discussed in detail during the final design process. Other alternatives were considered for the design of the fish screen and bypass, but no other options were deemed feasible.

There are three trash racks upstream of the fish screen - a headworks trash rack, a primary trash rack, and an automated secondary trash rack - which should eliminate most debris from the fish screen bay and fish bypass areas. For small debris, gravel, and sediment entering the fish bypass, there is a sluiceway to flush the system. Also, PG&E is aware that it will have an obligation to keep the fish bypass clean.

The option of routing the fish bypass under the fish ladder and out to the creek was considered and dismissed. The gradient of the creek is quite steep at this location, making the construction of a bypass system that would return fish directly to the creek and meet the NMFS (NOAA Fisheries) criteria costly and impractical at all potential bypass exit locations. NMFS (NOAA Fisheries) criteria are listed on pages D-16 and D-17 of the engineering concepts technical report. The low flow channel is more than 50 feet away from the proposed fish facilities, and a fish bypass exit into the channel may not significantly reduce predation because channel velocities are frequently low at that location (and other locations), depending on the total flow in the creek. It is thought that predation by resident fish is no more likely in the fish ladder than other areas in the creek. We concur with the comments made by the CBDA Technical Review Panel in Section 2.6.1.1.1 that this is likely the best configuration for juvenile routing

The present design is based on suggestions from CDFG personnel as described in the meeting notes in the 10th bulleted item on page B-28 of the engineering concepts technical report. A representative from NMFS (NOAA Fisheries)was also at the meeting where this concept design was proposed, discussed, and agreed upon. The fish bypass drop-well design includes a removable steel plate that will reduce turbulence in the drop-well. This energy dissipation plate, along with average velocities of about 0.6 ft/sec through the horizontal bypass slot into the fish ladder, should provide juveniles with a smooth transition from the drop-well into the fish ladder, and also prevent adult fish attraction to the drop-well.

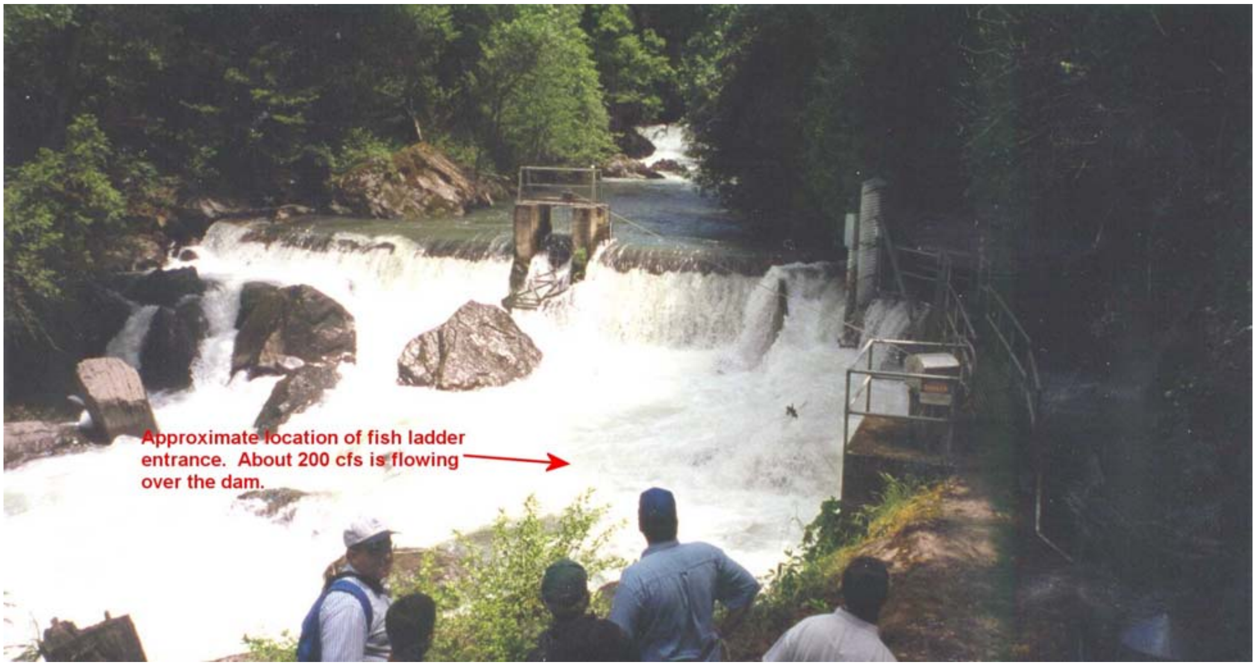
Abbreviated Comment – e: *There are provisions for video counting adults in the ladder. Discussions indicated that the fish would be crowded to the surface to facilitate counting, but the plans did not show this feature. This should be reviewed.*

PMT Response: The counting station will be located at the upstream baffle in the fish ladder. The counting apparatus will likely be a series of cameras attached to brackets on the upstream side of this baffle and they will record fish passing upstream through it. During final design, other configurations, including the crowding of fish, were investigated but were abandoned because of their potential for accumulating debris and because many areas contain turbulent water that may make it difficult to see fish. Since electronic technology advances rapidly, and since there are often several years between the concept phase and when construction occurs, the Ladder & Screen Technical Team decided during final design to not specify the exact camera type or configuration in the contract. The decision was to install the cameras via notice of change during construction or to install them separately after construction. The video monitoring details at Eagle Canyon are shown on drawings OA-60-369 and 370. To clarify the drawings, the locations of the video monitoring will be added to appropriate fish ladder plan views.

2.6.1.8.2 Fish Ladder Structure

Abbreviated Comment: *The vertical slot type ladder entrance would appear to be problematic during the higher flow regimes. Further attention should be given to the hydraulic conditions associated with the ladder entrance.*

PMT Response: The fish ladder entrance condition was given serious consideration and was discussed in detail during the preliminary design process. In addition, numerous site visits to observe many different flow conditions were made with representatives from both CDFG and NMFS (NOAA Fisheries). The desire was to have the entrance as close to the dam as possible, but not so close that the turbulence created by water spilling over the dam would obscure the entrance slots. Two fish ladder entrance locations are proposed to allow for flexibility of operation during varying tailwater conditions. The upstream entrance is designed to be open during low flows when the pool near the base of the dam is stable. When the pool conditions in front of that slot become so turbulent that finding it might be difficult, that slot should be closed and the high-flow slot should be opened. The high-flow slot is positioned so that fish, swimming along the velocity shadow created by the 30-degree angle in the wall, will be attracted to the entrance pool rather than continue upstream into the shear velocity zone created by the swifter, highly turbulent water near the base of the dam. The flow conditions and fish behavior should be monitored to ensure the entrances are performing as designed. It may be found that one of the entrance slots performs better under all conditions and would thus remain open continuously.



2.6.1.8.3 Access– The PMT concurs with the Review Panel Statement.

2.6.1.8.4 Operations and Maintenance– The PMT concurs with the Review Panel Statement.

2.6.1.8.5. Adult Ladder Design– The PMT concurs with the Review Panel Statement.

2.7 Cost Issues

2.7.1 Cost Estimate

Concerns related to specific costs items include:

- *Bid items 25 and 26 have the same quantities and unit costs – It is possible, but unlikely.*

  PMT Response: The work for these two bid items are both located at Coleman Diversion Dam. The first is the removal of the Dam and the second is the removal of a Pilot Channel behind the Dam. The quantities of material are from takeoffs of the existing Dam and the design of the pilot channel. The unit costs for excavation would likely equal each other because of use of same equipment in the same area doing similar work.

- *Bid item 41 is large enough to make review difficult. This may be a reasonable bid item, but it is not much information to review.*

  PMT Response: This bid item is for "Class 1 Tunnel Excavation and initial support" for over 1,000 feet of ten foot diameter rock tunneling. The price includes the set-up and removal of significant amounts of equipment. RS Means estimates the total cost at $945 to $2,525 per linear foot. The Government estimate is on the low end of this range and considered reasonable.

- *Bid item 52 – Same Issue – It seems that this quantity of pipe would be costed with excavation, back fill, installation and pipe as separate items. This is a big bid item, and if there are changed conditions in the field this lineal foot unit cost would make the negotiation more difficult.*

  PMT Response: This bid item is for the quantity of pipe install excluding excavation and backfill. These two items (excavation and backfill) are contained in separate bid items. Any item that has an overrun or underrun within 15% of the original quantity is paid at the bid price. Only if the quantity exceeds this 15% will a change to the contract occur and negotiations become necessary.

- *Bid item 120 – Having a lump sum line item for fish screens is difficult to evaluate. Is this for all the projects? Does it include the support structure?*

  PMT Response: This bid item is for the fish screens at Inskip Diversion Dam only. The bid item includes the cost, "…of 56 wedge wire or profile bar screen panels and associated equipment" installed. The support structure is called out under bid item 107, "…steel framing for fish screen structure."

- *Bid item 107 is for metal fabrication at Inskip. It includes the support structure and metal work not already covered in other sections.*

  PMT Response: Specification Section 05500 – Metal Fabrications, Paragraph 1.01 A. Metal Fabrications for Inskip Diversion Dam: 1. "Includes railings, gratings, ladders, stairs, hatches, equipment canopy, video monitoring supports, and steel framing for fish screen structure." Again each bid item has the specification section in the description of the item.

- *Lump sum costs for water and water removal for various uses are very high but the Panel had no way to evaluate these costs. In general, the cost information did not provide enough detail to allow a detailed review. This item accounts for approximately 6% of the total project construction costs.*

  PMT Response: Lump sum cost estimates for water removal and for diversion and care of stream flows and dam releases were developed based on Government assumptions for the methods and materials required for such activities, including temporary sumps, wells, and cofferdams.

- *Lump sum price compilations limited the Panel's ability to comment on the overall reasonableness of the costs for the project.*

PMT Response: The specifications indicate what is included in each bid item, including lump sum items.

2.7.2 General Cost

Comment: *Cost estimates for the most expensive elements of the project were combined into one estimate. For many of the items the Panel had no means of determining to which part of the project the cost item applied. The total cost for these combined items accounted for 60% ($14.4 out $24 million) of the total construction costs. The items also accounted for the majority of the cost increase on the project. This also made it difficult and in some cases impossible to comment on the reasonableness of an element of the design.*

PMT Response: The five cost estimates provided to the Technical Review Panel were prepared using the specification bid schedules. The Hydro specification cost estimate ($14.4 million) the Panel mentions consists of 141 separate bid items. Each of these bid items states the description of the work and the specification section where information concerning the scope of the bid item can be found. This one estimate (Hydro) includes many elements that were combined so as to reduce overhead costs and because of expected work similarities. Some of these separate bids items are sizable, and may not include estimates for each major project element or feature. Separate estimates have been prepared for comparison purposes (budget sheets) on each project feature, but do not represent official estimates for construction contracts. As a result of unknowns at the time of the original estimates, some of these Hydro specification features have increased in cost.

3.0 MONITORING

Abbreviated Comment: *One of the most fundamental deficiencies in the Battle Creek Restoration Project is the limited resources available for monitoring the implementation and success of the actions funded by the California Bay-Delta Authority. Monitoring for habitat conditions, habitat use by juvenile salmonids, habitat use by migrating juveniles and smolts, habitat use by adult salmon, and passage effectiveness at fish ladders and fish screens are minimal.*

AMT Response: Funding for monitoring required in the Restoration Project MOU was not fully included in the original cost estimates for the Restoration Project provided to CALFED. The USFWS is currently performing monitoring similar to the five elements outlined in the MOU (Section 7.3) including: 1) fish counts at the CNFH barrier weir, 2) snorkel surveys to determine relative abundance, distribution and immigration timing of adults; 3) rotary screw trapping to determine relative abundance, distribution and outmigration timing of juveniles; 4) temperature monitoring and 5) examination of fish passage conditions at natural obstacles.

These monitoring activities are currently being funded by CALFED through a three year contract ending in 2004. Funding for these activities will be included as part of the Restoration Project in the amended request. Bridge funding is currently being sought from CALFED to continue this monitoring until funding is available either from a PSP for long term monitoring or through funds for the Restoration Project. The current monitoring is important for measuring the success of the Restoration Project by providing baseline information, refining scientific methods and the adaptive management process, and detecting, diagnosing and solving fisheries problems associated with operation of the hydropower system.

The current monitoring is important for adaptive management and evaluation of the CALFED funded Battle Creek Interim Flow Project, which is providing flows to sustain threatened fish population in Battle Creek pending construction of the Restoration Project. The monitoring has resulted in many beneficial actions including:

a) increasing flows in the South Fork of Battle Creek in 2002 and 2003;
b) reducing the potential impact of barrier weir trap operations on threatened and endangered species by i) running the trap for more hours of the day, which allows more fish to pass, ii) shifting trap operations to peak passage periods, iii) shifting trap operations to hours of cooler water temperatures;
c) detecting fish in areas that could be detrimental to their survival, thereby improving future PG&E operations;
d) identifying temporary passage barrier in North Fork and suggesting experiments to improve fish passage;
e) identifying increased spring Chinook mortality from predation, poaching, thermal stress, false attraction, and entrapment;
f) collecting tissue samples for genetic baseline analysis essential for future analyses;
g) fish passage timing information that may be used to better manage spring and fall Chinook;
h) estimates of winter and spring Chinook populations and production; and
i) documenting the success of the CALFED Interim Flow Project.

3.1 Fish

3.1.1 Monitoring of juvenile salmon

Comment: *The Battle Creek Restoration Project is designed to increase habitat available for rearing juvenile salmon, yet limited funds are provided for measuring the abundance of juvenile salmonids and their use of the habitat restored by increasing flows in Battle Creek. The project assumes that upstream passage of adult salmon will seed the available habitat with young salmon, the additional volume of habitat will be occupied, and the increased availability of cool water habitats will increase the abundance of juvenile salmonids. Monitoring provides limited funds for operating two smolt traps and conducting snorkeling surveys for adult salmon and jacks. No monitoring is provided for juvenile salmonids, distributions, and abundances of juveniles within the Battle Creek drainage, or patterns of habitat use.*

Downstream migrant traps will play a key role in the monitoring of juvenile salmonids. The monitoring agencies, USFWS and CDFG could consider Passive Integrated Transponder (PIT) tags to provide additional data on the rate of naturally produced adult returns. These monitoring approaches need to be weighed against the mortality rate associated with handling and tagging at different sizes and degree of smoltification. If juvenile out-migrant numbers increase as expected, tagging a carefully determined portion of the run can provide cost-effective information with a minimal impact on the population.

<u>AMT Response</u>: The Adaptive Management Teams agree with this assessment. An evaluation of juvenile salmonid habitat use was included in the AMP as a focused study in the response section of habitat objective 1 (Maximize usable habitat quality). The study was to be triggered if "observed habitat use is not consistent with expected habitat use at a time when there are enough salmon and steelhead to get a reliable data set".

The AMP will be revised to include monitoring elements related to juvenile abundance, distribution and habitat use. The Restoration Project budget will be revised to include funding for juvenile habitat use studies relying on direct observation / snorkeling. One year of funding will be sought for the first year after the Restoration Project is completed and adult fish have been allowed access to the project area. Juvenile salmonid densities may be too low to achieve study objectives and may remain so for many years. Conducting the juvenile studies in the first year will aid in determining the feasibility and logistics of the study, as well as provide baseline data to track the projects' progress over time. During the pilot year, statistical analysis may be able to predict the juvenile population size and number of observations required to detect significant differences. Determining the statistical power of the study may aid in determining when there will be sufficient numbers of fish to begin the rest of the juvenile study. This trigger will be used to determine when to pursue funding for the rest of the study.

The study will have three objectives: 1) to verify the juvenile salmonid microhabitat suitability indices upon which the restoration project flows are based; 2) to determine the distribution of juvenile salmonids in the restoration project area to verify successful passage and production; and 3) to determine the relative abundance of juvenile salmonids in reaches of the restoration project to determine if they are using the reaches as predicted in conceptual and flow models. Project area will be habitat typed, and divided into reaches. Sites approximately 100 m in length, with all major meso-habitat types, will be selected within each reach. Juvenile abundance will be determined at the sites by direct counts, by species and by size class.

The Adaptive Management Teams will continue to consider using PIT tags to monitor the rate of natural returns, especially, as the Panel noted, when and "if juvenile out-migrant numbers increase as expected." Currently, the number of smolt size fish is too small to provide statistically reliable estimates, and the "mortality rate associated with handling and tagging" noted by the Panel, is unacceptable with small populations of threatened species. As these populations grow, there will be opportunities to incorporate of PIT tagging into monitoring.

3.1.2 Monitoring of adult returns

Comment: *Monitoring to obtain population estimates for adults and jacks will rely heavily on adult counts at fish ladders, carcass counts, snorkel surveys, and/or redd surveys. These monitoring approaches could usually be done at reasonable costs. In the Draft AMP monitoring is increased once the anadromous salmonid populations reach "Viable Population Levels" (EIS/EIR 2003; Appendix D; Objective 4). At that time, monitoring will expand to estimate carrying capacity for each species and life stage of salmon and steelhead. Another major task is to estimate Cohort Recruitment Rate for a minimum of 16 years and this will likely extend for the "term of the AMP. Once the populations reach viable population levels, monitoring for salmonids not listed under the Endangered Species Act do not require this intensive monitoring* *plan. In light of the fact that the Panel considers the post-construction evaluations for fish minimal and the funding for the monitoring inadequate, the proposed monitoring for this objective is excessive. In its recommendations on monitoring, Kier and Associates (1999) included comments on cost and level of monitoring, the authors of the proposed monitoring above would find useful.*

The Licensee will conduct and/or fund adult counts at the fish ladders up to the Licensee's commitment in the initial three-year period of project operation. This level of monitoring is minimal considering the life history of salmonids. Post-construction evaluation should be prepared to address the movement and possible delay of adult salmon through fish ladders in the system. In the first three years of the project, returns may be so low that this may not be identified as an issue. However, to ensure that adult fish have the opportunity to maximize use of the habitat, the Panel suggests the monitoring agencies consider a small number of radio-tagged adult to test the assumption that delay and fallback are not issues.

The monitoring agencies should reconsider the cost of video monitoring if the analysis cannot be automated. Intermittent use of a fish trapping facility to sample fish was mentioned in the Biological and Environmental Monitoring (EIS/EIR 2003). The Panel suggests considering the possible use of PIT tag technology in the future as a monitoring tool. Considerable savings in funds could result if designs of ladders incorporate slots for inserts for adult traps or PIT tag detection coils.

AMT Response: The AMT agrees in general with the Panel's comments but believes that there may have been some confusion interpreting the plan. Incorrect wording in the AMP led to confusion concerning the level of monitoring immediately after the Restoration Project and later when populations reach Viable Population Levels. The intent was to have approximately the same level of monitoring during both periods. Likewise, the cohort replacement rate would be tracked from the beginning of the project using monitoring required by the MOU, and would not be added in after the populations are viable.

The potential for radiotelemetry studies to evaluate fish passage at dams and natural barriers was included in the AMP as focused studies. A radiotelemetry study will be added to the AMP and to the amended budget request to CALFED. The study will primarily utilize hatchery steelhead and a smaller number of spring Chinook. Key uncertainties addressed will include delay at dams and natural barriers, and fallback. Important information may also be gained relative to the location of holding and spawning areas, rates of mortality, and use of thermal refugia.

Although, methods for adult fish counts through ladders were discussed by the AMP and the fish screens and ladders design team, final designs and specifications for monitoring equipment were not developed in part because of the rapid advancements being made in these technologies. It was felt that by the time equipment was needed 3 or 4 years after the design phase, the technologies would have advanced so far as to make the specifications obsolete. Video monitoring may be improved by 1) use of digital recording to replace video recording; 2) incorporation of computers for reviewing videotapes or digital recordings, thereby reducing labor costs; 3) incorporation of infrared camera technology perhaps with digital still cameras; and 4) incorporation of electronic fish counters using conductivity. [Note that the PMT, and the

Adaptive Management Teams would need to agree to add the last two elements.] Placeholder costs and design considerations will be added to the proposal and plans, based on current technology.

The designs for the fish ladders will be checked and revised if necessary to incorporate slots for inserts for adult traps or PIT tag detection coils. The Adaptive Management Teams will continue to consider using PIT tags to monitor adult passage, especially if it can be incorporated into juvenile to adult survival studies as well.

3.2 Habitat – Each individual habitat response is addressed below.

3.2.1 Physical Habitat

Abbreviated Comment: *The Project is designed to increase stream flow to 30-50 cfs to provide habitat. Whether the planned actions will be successful or to what degree they will be successful will not be measured under the monitoring plan.*

AMT Response: The monitoring program is being revised consistent with a revised AMP focused on effectiveness of the flow prescriptions. The physical characteristics of the channel associated with the flow were modeled using standard methods in PHABSIM that included calibrating to test flows in the range of 30 to 50 cfs. The Habitat Suitability Curves used to establish use of the physical habitat by fish have more uncertainty; however, these can be updated as needed in accordance the AMP.

3.2.2 Water Temperature

Abbreviated Comment: *There is no temperature-monitoring plan, and any information on stream temperature that will come from existing measurement stations operated by the Licensee or cooperating agencies.*

AMT Response: There is an existing water temperature monitoring network operating over 10 to 20 stations continually since 1995 (a more robust network was established in 1998). The network will continue to be operated using available funding sources, including CALFED. During the post project period grant applications will be submitted for continued monitoring. CALFED can only issue contracts for monitoring activities for a period of three years. In addition, the reconceived AMP recommends coldwater refugia studies documenting the extant, distribution and use of cold water refugia that develop with the release of Eagle Canyon Springs and Bluff Spring waters to adjacent stream sections on each of the forks. In regards to water temperature monitoring efforts the EIS/EIR for the project now contains the more robust SNTEMP model developed to support habitat analysis (Attachment B).

3.3 Flow (Hydrology)

Abbreviated Comment: *Recommend flow conditions be monitored in association with monitoring of sediment dynamics and fish populations.*

AMT Response: Under the Facility Monitoring Plan included in the Draft Amendment to the FERC license PG&E is required to continuously monitor the minimum instream flows at each dam (spill flows are only monitored occasionally). Presently, the full range of flows near the terminus of the forks are being continuously monitored by gauges installed and operated the Department of Water Resources. It is recommended that the high flow calibration of the gauges be improved based on past comparisons with the USGS gauge downstream of the forks. During the post project period grant applications will be submitted for continued monitoring. CALFED can only issue contracts for monitoring activities for a period of three years.

3.4 Sediment Dynamics

Abbreviated Comment: *The removal of five dams, and the consequent release of wedges of sediment, presents an excellent opportunity to collect a detailed dataset of sediment dynamics and channel response.*

AMT Response: The AMP is being reconceived and will take advantage of the opportunity to document sediment dynamics. An annotated outline of the reconceived AMP is attached (Attachment C).

PMT Response: The Project Management Team agrees with these recommendations for monitoring after removal of Coleman and South Diversion Dams on the South Fork only. Monitoring at the Wildcat Diversion Dam site on the North Fork is not as critical due to the steep channel slope and relatively small amount of impounded sediment. Monitoring the small tributary channels following the removal of Lower Ripley Creek and Soap Creek Feeder Diversion Dams is also unnecessary due to the negligible amounts of sediment and streamflow at both sites. A formal sediment monitoring plan will be developed for the South Fork removal sites and responsibilities for performing the monitoring will be determined as part of the plan.

4.0 MITIGATION

Comment: *The Panel recognizes the importance of mitigation in a project that requires extensive construction and site modification. Several aspects of the proposed mitigation measures and costs raise serious questions. The original proposal included $1,000,000 for mitigation and that funding request was increased to $4,300,000 in the new proposal. Several of the mitigation efforts seem excessively costly, and call for almost as much new funding for monitoring mitigation as is provided in the entire project for monitoring of all project elements.*

PMT Response: Streamlining environmental compliance and avoiding and minimizing environmental impacts have been priorities throughout the development of the project. Environmental cost estimates were based on environmental costs from previous construction projects in California.

The one million dollars in the original (1999) CALFED proposal was not for mitigation; rather it was specifically for Biological and Environmental Monitoring of “anadromous fish populations and related ecosystem health” (per section 7.3 of the Restoration Project MOU, and listed as ‘Monitoring’ in Table 5 of the original proposal). Mitigation costs in the original proposal, which includes environmental compliance, mitigation of construction impacts, and mitigation monitoring were factored into capital costs for construction. At this early stage of project planning, $2,020,000 was budgeted for environmental compliance, as shown in Table 3 of the original proposal, and $570,000 was budgeted for mitigation of construction impacts and mitigation monitoring. The $570,000 cost estimate for construction mitigation and mitigation monitoring was derived as an estimated 2.0% of the estimated project cost of $28 million in 1999.

Subsequent to the original proposal, extensive biological surveys were performed at construction sites. In addition, updated project design and construction details were developed for each site. Both the biological surveys and updated design information allowed for a better estimation of needs for environmental compliance, construction mitigation, mitigation monitoring, and their associated costs. In April 2003, estimated costs for construction mitigation and mitigation monitoring increased from $570,000 to $4 million (not $4.3 million). At the same time, total agency costs for the project increased to $62 million. Therefore, revised estimated costs for construction mitigation and mitigation monitoring equated to 6.5 % of the estimated total project cost of $62 million in April 2003.

At this time the Restoration Project's Environmental Team is examining alternative mitigation procedures that are consistent with the CALFED process established in the Programmatic Record of Decision. One of these alternatives could reduce Restoration Project costs by recognizing CALFED-funded conservation easements occurring in the Battle Creek watershed as CALFED program actions related to the Restoration Project. If the conservation biologists conclude that the habitat types on these easement lands are similar to those adversely affected by Restoration Project construction, and would not exist in the long-term absent the conservation easement, then these lands may be suitable mitigation credit for the Project impacts to those habitat types.

4.1 Wetland Mitigation

Comment: *The Battle Creek Project will increase stream flows from 3cfs to 30-50 cfs and restore extensive riparian wetlands along its margins. However, the project will impact only 10.5 acres of existing wetlands. The mitigation plan calls for construction of new wetlands to mitigate for those impacts of the project and do not balance the impacts on wetlands with the riparian wetlands created by the project. In addition, the estimated costs of wetland construction are extremely high based on experience of the Panel. The Panel recommends the California Bay-Delta Authority check with consulting agencies to see if the wetlands created by the project can be considered in the mitigation plan and if wetland construction is required.*

PMT Response: All jurisdictional waters, including wetlands, are regulated by the U.S. Army Corps of Engineers (Corps). In addition to the estimate of temporary and permanent wetlands impacts due to construction, an estimate of riparian wetlands that could potentially be created, due to the increase in stream flows, could be developed and provided to the Corps as part the Clean Water Act section 404 permit application for the Restoration Project. Because it is unknown at this time if the Corps would consider the potential creation of riparian wetlands, due to increased flows, as mitigation for wetlands impacted by construction activities, a cost estimate for wetland impact site restoration (associated with temporary impacts) and off-site wetland creation and/or restoration (associated with permanent impacts) has been prepared. Actual needs for wetland mitigation will be determined through the section 404 permitting process. The estimate was developed utilizing wetland mitigation costs from previous construction projects in California.

4.2 Elderberry Mitigation

Comment: *Mitigation is requested for the impacts of the project on three elderberry shrubs. The plant is the host for the endangered beetle in California. The Panel does not question the importance of maintaining habitat for the listed species, but the replacement costs are exorbitantly high (even considering the costs of irrigation and monitoring). The Panel recommends the California Bay-Delta Authority check with the consulting agencies to see if the shrubs can be replaced in a more cost-effective manner.*

PMT Response: In April 2003, three elderberry shrubs were estimated to need to be replaced or transplanted following guidelines developed under the Endangered Species Act (ESA). The unit cost of $25,000 is based on costs from previous projects impacting elderberry shrubs, and reflects conservation guidelines developed under the ESA and costs of real-world elderberry conservation activities, including land purchase, shrub transplanting, establishment of a complex of associated native species, and maintenance and monitoring of the site for five years. As an alternative to this approach to elderberry conservation, the Restoration Project is investigating opportunities for elderberry conservation using a mitigation bank. If it is determined that elderberry conservation using a mitigation bank would meet ESA requirements and be less expensive, this alternative will be pursued further.

4.3 Mitigation Monitoring

Comment: *The mitigation plan identifies funds for monitoring the mitigation efforts of the project that almost equal the total funds ($1,000,000) available for all future monitoring of project facilities and environmental and ecological responses to project restoration efforts. The Panel encourages the California Bay-Delta Authority to require monitoring of the mitigation efforts, however, these are secondary to monitoring the effectiveness of the project. This relative importance in monitoring information should be reflected in the budget.*

PMT Response: As discussed under Section 4.0, the $1,000,000 is specifically for fisheries-related biological and environmental monitoring and does not otherwise include facility monitoring, which is covered by other funding sources.

The PMT does not believe that monitoring of mitigation for construction impacts should be secondary to monitoring project effectiveness. We believe that avoiding, minimizing, and compensating for incidental adverse effects of the Restoration Project on fish and wildlife and their habitats to the extent practicable are all consistent with ecosystem restoration principles of the CALFED Bay-Delta Program. Successful mitigation of adverse effects is necessary to avoid re-direction of impacts and ensure balanced treatment of ecosystem components by the Restoration Project. Successful mitigation would be a criterion for defining Restoration Project success. Ensuring success of mitigation would be consistent with principles and/or requirements of the National Environmental Policy Act, California Environmental Quality Act, Endangered Species Act, Clean Water Act, and all other applicable environmental laws and regulations.

Because ensuring successful mitigation requires monitoring of mitigation efforts, it is necessary to allocate funds to mitigation monitoring. Spending funds on mitigation without ensuring its success could be wasteful of mitigation funds. The most important considerations are implementing only mitigation that is justified, while ensuring that the mitigation implemented is successful. It is the intent of the Restoration Project to develop a justifiable mitigation budget, including monitoring of mitigation success, by judiciously identifying mitigation needs consistent with ecosystem restoration principles of the Restoration Project and developing cost-efficient mitigation and monitoring activities.

5.0 ADAPTIVE MANAGEMENT

Abbreviated Comment: *Essentially all of the AMP actions will be directed at correcting design problems for the facilities or solving operating problems associated with the facility. The remainder of the adaptive management is directed at guaranteeing the minimum instream flows targeted by the project. Eleven specifics are listed in the comments.*

AMT Response: In response to this comment as well as recent guidance from the CALFED Science Panel, the AMT is in the process of developing a reconceived AMP. The AMT is receiving consulting services from CALFED Environmental Water Account Program. The specific comments of the Technical Review Panel on the AMP are being addressed in the reconceived AMP, the annotated outline of which is attached.

6.0 POTENTIAL COMPLICATIONS

6.1 Hatchery Effects

Abbreviated Comment: *Very few natural winter-run Chinook salmon are returning to Battle Creek as adults and the potential use of Livingston Stone NFH propagated juveniles or adults is not discussed. The plan does not provide an explanation or even a proposal as to how the endangered and highest ranked salmonid species, winter-run Chinook salmon will be reintroduced in a timely manner.*

PMT Response: Concerning the operation of Livingston Stone NFH, at present it is solely dedicated and permitted to supplement the existing natural spawning population of winter Chinook in the mainstem of the Sacramento River.

Concerning reintroduction of winter-run Chinook in a timely manner, this determination is guided by the NMFS (NOAA Fisheries) Draft Winter-Run Chinook Salmon Recovery Plan (1997). The Recovery Plan has two recommended actions specific to Battle Creek (Goal VII Objective 3) stating "1) Conduct a feasibility analysis of establishing viable, naturally self-sustaining populations in other rivers and creeks within the Sacramento River watershed" and " 2) Based on information developed from the feasibility analysis, develop and implement recommendations for establishing supplemental populations: For those steams identified for introduction, stream restoration actions should be developed to provide suitable habitat conditions for winter-run chinook, including water quality and flows for adult and juvenile chinook passage, adult holding, spawning, egg incubation, and juvenile rearing. Recommendations also need to consider 1) genetic implications to supplemental and overall population of winter-run chinook; and 2) magnitude of the main Sacramento River population that is needed before introductions begin." Upon completion of the decision making and permitting for the Battle Creek Restoration Project, the Project Management Team recommends that those agencies designated in the Recovery Plan begin preparation of the feasibility analysis ((NMFS (NOAA Fisheries), CDFG, USFWS)), agreeing to the recommendations and actualizing the plan (CDFG and USFWS). It is possible that the feasibility analysis will identify expansion of the existing Sacramento River winter Chinook supplementation program to include Battle Creek as one alternative method to reintroduce winter Chinook to Battle Creek; however the implementation may possibly require further institutional arrangements. Currently, policies and guidance for the use of hatchery propagated winter-run Chinook for conservation purposes (including reintroduction) that are in the winter-run recovery plan will be replaced by new guidelines being developed by NMFS (NOAA Fisheries). NMFS (NOAA Fisheries) is also leading a recovery planning process for all listed salmonids in the Central Valley

6.2 Harvest Management

Abbreviated Comment: *Measures taken in management of harvest to allow the project to be successful must be identified and reported regularly. This is especially important for the restoration of salmon and steelhead in Battle Creek, but generally for the overall fish restoration program. The Panel encourages reports from the regional technical recovery teams to track adaptive management and regional coordination of the project.*

PMT Response: The PMT agrees with the review Panel's observations that harvest could affect the success of the restoration program and needs to be considered in judging the success of the restoration project. Efforts to analyze data and manage ocean harvest for Central Valley spring and winter Chinook are currently taking place through a workgroup of the Pacific Fisheries Management Council (PFMC). The workgroup consists of biologists from the NMFS (NOAA Fisheries), CDFG, and USFWS, including a member of the Battle Creek Restoration Project Management Team and Adaptive Management Policy Team. The workgroup is analyzing tag recovery information from coded-wire tagged spring Chinook from Butte Creek and winter Chinook from Livingston Stone NFH to develop ocean harvest management objectives for listed Central Valley Chinook salmon. The workgroup will describe its findings and formulate harvest management recommendations to the PFMC in the spring of 2004 with the longer term goal of inclusion into a salmon amendment. The salmon plan amendment is expected to include recommended harvest rates that will allow for the recovery of listed spring and winter Chinook in the Central Valley. The recommendations will be shared with all agencies and interested parties including the California Bay-Delta Authority and the regional Technical Recovery Teams.

6.3 Sediment Impacts

Abbreviated Comment: *Monitoring sediment movement and channel response during and following dam removal should be able to detect the occurrence of this worst-case scenario, and adaptive management could be used to mitigate the effects of continued sediment movement and consequent habitat loss.*

PMT Response: The Technical Review Panel Report describes a worst-case scenario of sediment release during low flows resulting in the loss of downstream spawning habitat due to the deposition of fine sediments, the loss of pool volume and low-velocity habitats along channel margins, and/or the increased mobility of gravels during winter high flows when eggs are present. Such a scenario would only apply to the first 2.5 miles of the North Fork of Battle Creek, since no dams are to be removed upstream of Wildcat Diversion Dam. Similarly, the reach between Coleman and Inskip Diversion Dams on the South Fork of Battle Creek would be largely unaffected by the dam removals. A monitoring plan for sediment deposition areas on both the South and North Forks could be used to detect unfavorable (worst-case) conditions and AMP could be used to mitigate these impacts. If necessary, spawning fish may have to be discouraged from entering the South Fork for the first year following removal of Coleman and South Diversion Dams.

6.4 Downstream Effects– The PMT concurs with the Review Panel Statement.

6.5 Regional Climate Change– The PMT concurs with the Review Panel Statement.

7.0 OTHER CONSIDERATIONS

Abbreviated Comment: *An alternate strategy appears to be feasible that, for similar or reduced project cost, would increase benefits and reduce risk both for power production and fisheries. The strategy would involve producing electrical power from other sources, such as gas, wind, or solar energy and completely removing hydropower production facilities from the Battle Creek watershed.*

a. *Any number of other types of electrical energy production facilities could be constructed to produce the same power output as the proposed Battle Creek facilities for the cost anticipated for this upgrade.*
b. *Consideration could also be given to operating only the Volta facilities. Removing all facilities except Volta would significantly reduce impacts to fisheries. Dependable power production would still be 3.6 MW, about one-half of the proposed value resulting from changes based on the MOU.*
c. *Finally, offering PG&E a fixed price settlement to remove generation facilities from the watershed might also be a viable strategy.*

PMT Response:

a.& b. The economics for three additional Salmon Restoration alternatives were developed in response to this inquiry. Tables 1 and 2 summarize the economic findings.

c. The concept of offering PG&E a fixed price settlement to remove all facilities could, at minimum, include the costs to decommission all hydroelectric related facilities plus its net investment in the Project and severance damages. Severance damages could include forgone power costs over the terms of the current license plus transmission/distribution upgrades needed to ensure continued local-area reliability.

TABLE 1: BATTLE CREEK SALMON RESTORATION ECONOMIC SUMMARY USING FERC'S CURRENT COST METHOD

	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt A	Alt B	Alt C
	Resume existing FERC License conditions	MOU, with cost sharing	Install screens and ladders at diversions, …	MOU plus decommission Eagle Canyon	MOU plus decommission Eagle Canyon; w/o South Lower Ripley and Soap decommissioning	Decommission Entire Battle Creek Hydro Project	Decommission all diversion downstream of Natural Barriers	Decommission all facilities downstream of Natural Barriers
	No Action Alternative	**Five Dam Removal Alternative**	**No Dam Removal Alternative**	**Six Dam Removal Alternative**	**Three Dam Removal Alternative**	**Complete Removal Alternative**	**Remove downstream diversions**	**Remove downstream diversions**
Average Annual Energy, GWh	**230.89**	**162.17**	**190.56**	**137.05**	**159.57**	**0**	**124.3**	**59.3**
Total construction costs + ln15, $millions		**$70,235**	**$67,476**	**$63,977**	**$66,930**	**$98,509**	**$52,307**	**$59,044**
One-Time and Annually Recurring Cost Descriptions ($1,000's)								
Unrecovered Sunk Costs, or Net Book Value	**$34,600**	**$34,600**	**$34,600**	**$34,600**	**$34,600**	**$34,600**	**$34,600**	**$34,600**
Future Capital Additions (per year)	**$300**	**$300**	**$300**	**$300**	**$300**	**$0**	**$180**	**$150**
Operation and Maintenance (per year)	**$1,700**	**$1,783**	**$1,880**	**$1,750**	**$1,947**	**$0**	**$1,360**	**$1,020**
Storm repairs (every 10 years)	**$500**	**$950**	**$1,400**	**$800**	**$800**	**$0**	**$400**	**$300**
Construct Screens & Ladders, w/ connectors/bypass	**$0**	**$29,414**	**$47,938**	**$23,541**	**$30,566**	**$0**	**$0**	**$0**
One-time Screen/Ladder repairs	**$0**	**$600**	**$1,200**	**$400**	**$600**	**$0**	**$0**	**$0**
Decommissioning costs, w/ connectors/bypass	**$0**	**$19,145**	**$0**	**$22,897**	**$18,826**	**$70,800**	**$36,097**	**$33,335**
Envir Compliance, Montr & Mitgtn	**$0**	**$14,209**	**$14,209**	**$14,209**	**$14,209**	**$27,709**	**$16,209**	**$25,709**
MLFT Pathogen Problem Resolution	**$0**	**$2,329**	**$2,329**	**$329**	**$329**	**$0**	**$0**	**$0**
Future Water Acquisition	**$0**	**$3,000**	**$3,000**	**$3,000**	**$3,000**	**$0**	**$0**	**$0**
Construction outage costs	**$0**	**$1,259**	**$955**	**$841**	**$790**	**$0**	**$841**	**$0**
FERC License Amendment/EIS/EIR	**$0**	**$4,750**	**$4,750**	**$4,750**	**$4,750**	**$9,500**	**$5,700**	**$5,700**
Reimbursed Foregone Power (net present value)	**$0**	**$2,137**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
2003 Power Benefits (per year)	**$11,798**	**$8,287**	**$9,738**	**$7,003**	**$8,154**	**$0**	**$6,349**	**$3,030**

TABLE 1 (Continued): FERC Current Cost Method (Annual cost in 2003 dollars, $1,000's/yr)								
Unrecovered Sunk Costs, or Net Book Value	**$4,844**	**$4,844**	**$4,844**	**$4,844**	**$4,844**	**$4,844**	**$4,844**	**$4,844**
Future Capital Additions	**$427**	**$427**	**$427**	**$427**	**$427**	**$0**	**$256**	**$213**
Operation and Maintenance	**$1,700**	**$1,783**	**$1,880**	**$1,750**	**$1,947**	**$0**	**$1,360**	**$1,020**
Storm repairs	**$140**	**$266**	**$392**	**$224**	**$224**	**$0**	**$112**	**$84**
Construct Screens & Ladders	**$0**	**$4,118**	**$6,711**	**$3,296**	**$4,279**	**$0**	**$0**	**$0**
One-time Screen/Ladder repairs	**$0**	**$84**	**$168**	**$56**	**$84**	**$0**	**$0**	**$0**
Decommissioning costs	**$0**	**$2,680**	**$0**	**$3,206**	**$2,636**	**$9,912**	**$5,054**	**$4,667**
Envir Compliance, Montr & Mitgtn	**$0**	**$1,989**	**$1,989**	**$1,989**	**$1,989**	**$3,879**	**$2,269**	**$3,599**
MLFT Pathogen Problem Resolution	**$0**	**$326**	**$326**	**$46**	**$46**	**$0**	**$0**	**$0**
Future Water Acquisition	**$0**	**$420**	**$420**	**$420**	**$420**	**$0**	**$0**	**$0**
Construction outage costs	**$0**	**$122**	**$93**	**$82**	**$77**	**$0**	**$82**	**$0**
FERC License Amendment	**$0**	**$665**	**$665**	**$665**	**$665**	**$1,330**	**$798**	**$798**
Reimbursed Foregone Power	**$0**	**$207**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
2003 Power Benefits	**$11,798**	**$8,287**	**$9,738**	**$7,003**	**$8,154**	**$0**	**$6,349**	**$3,030**
Total Cost of Project Power	**$7,111**	**$17,517**	**$17,915**	**$17,005**	**$17,638**	**$19,965**	**$14,775**	**$15,226**
Going-forward Cost of Project Power	**$2,267**	**$12,673**	**$13,071**	**$12,161**	**$12,794**	**$15,121**	**$9,931**	**$10,382**
Total Net benefits (including NBV)	**$4,688**	**-$9,230**	**-$8,178**	**-$10,001**	**-$9,484**	**-$19,965**	**-$8,425**	**-$12,195**
Net benefits on a going-forward basis (excluding NBV)	**$9,532**	**-$4,386**	**-$3,334**	**-$5,157**	**-$4,640**	**-$15,121**	**-$3,581**	**-$7,351**

TABLE 2: SENSITIVITY ANALYSES	MOU, with cost sharing	Install screens and ladders at diversions, …	MOU plus decommission Eagle Canyon	MOU plus decommission Eagle Canyon; w/o South Lower Ripley and Soap decommissioning	Decommission Entire Battle Creek Hydro Project	Decommission all diversion downstream of Natural Barriers	Decommission all facilities downstream of Natural Barriers
Net Present Value cost in 2004 dollars, $millions							
I. EXPECTED CASE							
Screen, Ladder, Decommissioning Costs	**$70.2**	**$67.5**	**$64.0**	**$66.9**	**$98.5**	**$52.3**	**$59.0**
Replacement Power Costs	**$41**	**$24**	**$55**	**$42**	**$136**	**$63**	**$101**
Increased O&M	**$2**	**$5**	**$2**	**$4**	**($21)**	**($4)**	**($9)**
Total	**$113**	**$96**	**$121**	**$113**	**$214**	**$111**	**$152**
II. POWER VALUE UNCERTAINTY							
A. 4 cent power values							
Screen, Ladder, Decommissioning Costs	**$70.2**	**$67.5**	**$64.0**	**$66.9**	**$98.5**	**$52.3**	**$59.0**
Replacement Power Costs	**$32**	**$19**	**$43**	**$33**	**$107**	**$49**	**$79**
Increased O&M	**$2**	**$5**	**$2**	**$4**	**($21)**	**($4)**	**($9)**
Total	**$104**	**$91**	**$109**	**$104**	**$184**	**$97**	**$130**
B. 6 cent power values							
Screen, Ladder, Decommissioning Costs	**$70.2**	**$67.5**	**$64.0**	**$66.9**	**$98.5**	**$52.3**	**$59.0**
Replacement Power Costs	**$48**	**$28**	**$65**	**$49**	**$160**	**$74**	**$119**
Increased O&M	**$2**	**$5**	**$2**	**$4**	**($21)**	**($4)**	**($9)**
Total	**$120**	**$100**	**$131**	**$120**	**$237**	**$122**	**$169**
III. CONSTRUCTION COST UNCERTAINTY							
A. Construction costs 10% less than expected							
Screen, Ladder, Decommissioning Costs	**$63.2**	**$60.7**	**$57.6**	**$60.2**	**$88.7**	**$47.1**	**$53.1**
Replacement Power Costs	**$41**	**$24**	**$55**	**$42**	**$136**	**$63**	**$101**
Increased O&M	**$2**	**$5**	**$2**	**$4**	**($21)**	**($4)**	**($9)**
Total	**$106**	**$90**	**$115**	**$106**	**$204**	**$106**	**$146**

B. Construction costs 25% more than expected							
Screen, Ladder, Decommissioning Costs	**$87.8**	**$84.3**	**$80.0**	**$83.7**	**$123.1**	**$65.4**	**$73.8**
Replacement Power Costs	**$41**	**$24**	**$55**	**$42**	**$136**	**$63**	**$101**
Increased O&M	**$2**	**$5**	**$2**	**$4**	**($21)**	**($4)**	**($9)**
Total	**$131**	**$113**	**$137**	**$130**	**$238**	**$124**	**$167**

8.0 FINDINGS AND RECOMMENDATION

<u>**Findings** (designated as a 'bullet' followed by PMT Response)</u>

- *The overall goals of the Battle Creek Restoration Project are appropriate for regional conservation.*

  PMT Response: The PMT concurs with the Review Panel Statement.

- *Strategies used for salmonid recovery and environmental restoration in the Battle Creek Restoration Project are reasonable given the goals and constraints of the MOU.*

  PMT Response: The PMT concurs with the Review Panel Statement.

- *Application of screens and ladders is reasonable and prudent.*

  PMT Response: The PMT concurs with the Review Panel Statement.

- *Many of the elements of the project appear to be reasonable to meet the goals of the project. Most of the cost estimates for the elements designed appear to be appropriate; however, the Panel was unable to fully assess the costs because of lack of clarity or detail in the information provided to us. Some of the elements of the project should be re-examined based on the comments provided.*

  PMT Response: (See responses to sections 2.7.1, & 2.7.2)

- *Engineering designs of fish ladders do not explicitly consider fish trap installation and location requirements.*

  PMT Response: (See responses to sections 2.6.1.1, 2.6.1.1.1, & 2.6.1.8)

- *Fish-counting designs are not the most effective and in some cases are more expensive.*

  PMT Response: (See responses to sections 2.6.1.1.3 d., &2.6.1.8.1 e.)

- *Mitigation costs are extremely high and do not account for net increases in habitat and species of special concern.*

  PMT Response: (See response to section 4.0)

- *Non-attainment of some objectives may not indicate failure of the project. Commercial and sport harvest of salmon, regional weather patterns and changes in stream flow, downstream effects, and regional climate change may influence the responses of salmon to the Battle Creek Restoration Project and should be considered in the evaluation process of the AMP.*

PMT Response: The PMT concurs with the Review Panel Statement.

- *Monitoring efforts are severely under funded and seriously jeopardize the Adaptive Management Program. As a result, the AMP focuses primarily on design and implementation of structures.*

  PMT Response: (See response to section 3.0)

- *The restoration plan calls for sustaining viable populations, but does not set expectations for numbers of adult returning salmon. The Panel believes this failure to clearly identify the expected number of returning adult salmon in the objectives is a fundamental flaw of the Battle Creek Restoration Project.*

  PMT Response: (See response to section 2.2.1)

- *Funding for monitoring is inadequate to measure the success of the project or support adaptive management. The proposed monitoring in the Draft AMP Appendix D, Objective 4 calls for long-term (16+ years) high cost monitoring approaches inconsistent with other aspects of the monitoring plan and the funding level. The Plan recommends additional scrutiny and review before the California Bay-Delta Authority obligates funds to monitoring activities.*

  PMT Response: (See response to section 3.0)

Recommendations (designated as a 'bullet' followed by PMT Response)

- *Some portions of the design are deficient. The plans should be reviewed in detail for compliance with the best available design practice.*

  PMT Response: (Refer to responses in Sections 2.5 & 2.6). The plans (and specifications) will be reviewed for design compliance and sufficiency.

- *Funds for monitoring the intended responses of fish, channel geomorphology, water quality and temperature, and sediment dynamics need to be included in the Battle Creek Restoration Project. These funds are not adequate in the current request to the California Bay Delta Program and several critical outcomes of the project are not monitored. If these funds are not part of the proposal, alternate sources for these funds should be identified and the funding secured.*

  PMT Response: The AMP is in the process of being reconceived (see annotated outline and supporting documents – Attachments C, C-1 and C-2). This reconceived plan includes monitoring of the Panel's recommended physical and biological responses to the Project. The funding proposal will be revised to include the cost estimates for the Project monitoring identified in the Monitoring Appendix in the AMP. Funding proposals will be for a three-year period as this is the maximum allowed under the CALFED process.

- *The AMP should be strengthened and an explicit process for reviewing responses of salmon and sediment routing after dam removal need to identified and implemented.*

  PMT Response: The reconceived AMP includes monitoring of the Panel's recommended physical responses to the Project. There is a new section on sediment monitoring.

- *New ladders should include provisions for fish traps so that fish can be collected, examined, and marked. Trapping adult salmonids is proposed as a monitoring approach, but the plan underestimates the value of this option at all locations. The Panel recommends the design of fish ladders include an alternative for insertion of an adult fish trap where possible.*

  PMT Response: The screen and ladder team considered provisions for trapping adult fish. The discussion included biologists presently involved in trapping adult fish at similar sized ladders in Battle Creek. The ladder designs were judged to have sufficient flexibility to accommodate the types of portable traps used on Battle Creek and similar sized streams and ladders. The designs for the fish ladders will be checked by USFWS and any necessary revisions will be forwarded to the PMT. Possible revisions include adding slots for inserts for permanent adult traps or PIT tag detection coils.

- *The proposed adult fish passage-monitoring program does not use radio telemetry or PIT tag technology to monitor adult fish behavior or adult returns. The Panel recommends the monitoring program use radio telemetry to confirm that adults do not delay below ladders and considers PIT tag technology as a long-term monitoring tool.*

  PMT Response: The reconceived AMP includes a procedure for incorporating PIT tag technology as a long-term monitoring tool at an appropriate time in the population recovery (see response to section 3.1.2). In addition, the reconceived AMP provides for radio telemetry studies during the early stages of the Restoration Project implementation.

- *Newly constructed fish ladders need to account for remote sensing locations and construction requirements (e.g., PIT tag sensors).*

  PMT Response: Appropriate provisions for PIT tag sensors will be developed and incorporated.

- *The Coleman Powerhouse tailrace barrier should be planned and scheduled as an integral feature of the project.*

  PMT Response: The remedy to prevent false attraction of salmon and steelhead out of Battle Creek and into the Coleman Powerhouse Tailrace is being actively pursued under the Central Valley Project Improvement Act's Anadromous Fisheries Restoration Program as described in the Linkages Section of the AMP. This remedy is expected to be implemented on a timely schedule as described in the response to Section 2.4.

Viable Population Sizes and Interim Quantitative Goal

The AMP has adopted NOAA-Fisheries definitions of "viable populations" as the intermediate population goal and identifies the maximization of salmon and steelhead production and full utilization of carrying capacity as the final goal.[1] At this time, numerical targets for viable salmonid population levels of ESA-listed stocks in Battle Creek have not yet been determined by NOAA-Fisheries. However, the adaptive management process requires that quantitative goals be established against which progress in the implementation of adaptive management actions can be measured.

Quantitative estimates of adult salmon spawner abundance necessary to achieve genetically viable population levels (per definition by NOAA-Fisheries; McElhany et al. 2000) is difficult to determine and would best be left to the determination of the NOAA-Fisheries Technical Review Team who administers salmonid stocks listed under the Endangered Species Act. However, for the purposes of adaptive management, the AMTT has determined that 1,000 adult spawners per year of steelhead and each of four races of chinook salmon could serve as an interim quantitative goal until such a time that NOAA-Fisheries Technical Review Team establishes quantitative viable population levels.

To determine this interim quantitative goal, the AMTT considered several concepts of population genetic theory. One important concept is that of effective population size (N_e, Wright 1931 and Crow and Kimura 1970 as cited in McElhany et al. 2000). The effective size of a population is defined as the size of an idealized population that would produce the same level of inbreeding or genetic drift seen in an observed population in which one is interested (see Hartl and Clark 1989, Caballero 1994 for reviews as cited in McElhany et al. 2000). McElhany et al. (2000) reviews several estimates of the number of breeders per generation necessary to avoid deleterious genetic effects (Table 1).

Table 1. Recommended effective population sizes.

Recommended Effective Population Size (N_e)	Citation
50 to avoid inbreeding depression	Franklin 1980
500 for long-term population persistence	Franklin 1980, Soulé 1980
5,000 for long-term population persistence	Lande 1995
1,000 for long-term population persistence	Lynch 1990
100 per year for short-term genetic maintenance	Waples 1990

Based on genetic evidence, Allendorf et al. (1997) concluded that salmon populations with N_e below 500 (or N below 2,500) per generation would be at high risk and populations with N_e below 50 (or N below 250) per generation would be at very high risk. Wainwright and Waples (1998) noted that if demographic factors were included, thresholds for these categories would be higher, but they did not suggest specific values.

[1] this sentence is lifted from AMP

Reiman and Allendorf (2001) summarize effective population size recommendations with the so called "50/500" rule in a review relevant to conservation management. They report that the generally accepted rule is that N_e of less than about 50 is vulnerable to inbreeding depression. Although populations might occasionally decline to numbers on this order without adverse effects, maintenance of adaptive genetic variation over longer periods of time (e.g., centuries) probably will require an N_e averaging more than 500 (Allendorf and Ryman in press, as cited in Reiman and Allendorf 2001).

The most conservative way of gauging the success of the Battle Creek Restoration Project would be to set population goals in terms of effective population size (N_e). However, determining N_e and N can be complicated (e.g. Reiman and Allendorf 2001; Shrimpton and Heath 2003) and requires either detailed information on population demographics and breeding structure (e.g. sex ratio, Nelson and Soulé 1987; variation in age at maturity, and repeat spawning in steelhead, Reiman and Allendorf 2001) or extensive information on genetic population structure (Reiman and Allendorf 2001). An appropriate estimate of N would be the mean number of adults observed across years times generation length.

As a result, in Battle Creek, the AMTT will rely on an estimate of N_e, assumed to be some fraction of number of breeders per generation (N), as estimated by monitoring the number of spawners per year (N_b; Reiman and Allendorf 2001), and will specify interim population goals in terms of N_b.

In order to convert the recommendations of effective population size per generation in Table 1 to targets of yearly salmon spawning abundance, it is necessary to know the ratio of the effective number of breeders (N_b) to the observed number of breeders per generation (N) and the generation time for the population in question. Several studies suggest that a N_b/N ratio of 0.3 is approximately correct for salmon and steelhead in general (McElhany et al. 2000). With this ratio, the recommended minimum long-term genetically viable population sizes presented in Table 1 range from 1,670/generation (Franklin 1980 and Soulé 1980) to 16,700/generation (Lande 1995). The minimum spawning population size recommended by WDFW (1997) falls in this range (3,000/generation). For populations that spawn at multiple age classes, the spawners-per-generation value must be divided by the generation length (median age of reproduction) to obtain the corresponding numbers of spawners per year. For example, in Battle Creek, steelhead, spring-run, and winter-run chinook have an approximate generation time of 3 years. A range of about 557 to 5,567 breeders per year[2], therefore, may be reasonable minimum values for maintaining sufficient genetic diversity to ensure long-term persistence of chinook salmon populations.

The interim quantitative goal of 1,000 adult spawners per year falls within the range of 557 to 5,567 breeders per year described by McElhany et al. (2000). Reiman and Allendorf's (2001) most realistic estimates of N_e were between about 0.5 and 1.0 times the mean number of adults spawning annually. They concluded that cautious long-

[2] In fish with four year generation time, this range would be about 418 to 4,175 adult spawners per year.

term management goals for bull trout populations should include an average of at least 1,000 adults spawning each year. However, in a study of five populations of chinook, Shrimpton and Heath (2003) found little concordance between census population size and genetic-based population parameters (i.e. genetic diversity, N_e) despite considerable variation in both census population size and genetic parameters. For example, Bowron River chinook underwent a dramatic increase in population size (from less than 1,000 to about 9,000 adults per year but showed a decline in heterozygosity and allele number over the study period (N_e estimates ranged from 126 to 267.5). Shrimpton and Heath (2003) conclude that management decisions based on interpretations of population health should not rely exclusively on census estimates.

While much of this literature suggests that the interim quantitative goal in Battle Creek of 1,000 spawners per year is a valuable estimate, the findings by Shrimpton and Heath (2003) emphasize the need for a more accurate determination of Viable Population size by the NOAA-Fisheries Technical Review Team.

Implicit within these interim quantitative goals for the Battle Creek Salmon and Steelhead Restoration Project is an understanding that maintenance of the full expression of life history, dispersal, and the phenotypic diversity that can be distributed among diverse habitats may be as important as maintenance of genetic variation if populations are to remain resilient and productive in the face of natural disturbances (Healey 1994; Healey and Prince 1995; Rieman and Dunham 2000). Maintenance of genetic diversity is essential, but not necessarily sufficient, for effective conservation. Therefore, we refer the reader to the other non-quantitative aspects of Viable Populations that are managed for within the AMP.

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ATTACHMENT B

Table 4.5-4
Daily Average Water Temperature Under Various Environmental Conditions

Alter-native	Reach-Averaged Temperature (°F)											
	Normal-Normal				Dry-Warm				Wet-Cold			
	Jun	Jul	Aug	Sep	Jun	Jul	Aug	Sep	Jun	Jul	Aug	Sep
South Reach												
1	62.7	65.7	63.1	59.2	67.6	68.4	66.7	62.1	54.6	62.4	60.9	56.9
2	60.6	64.3	61.7	57.8	65.2	66.6	64.8	61.0	54.6	60.9	59.7	55.6
3	58.3	62.8	60.6	56.9	63.0	65.2	63.7	60.3	51.8	58.8	58.2	54.5
4	58.3	62.8	60.6	56.9	63.0	65.2	63.7	60.3	51.8	58.8	58.2	54.5
5	60.6	64.3	61.7	57.8	65.2	66.6	64.8	61.0	54.6	60.9	59.7	55.6
Inskip Reach												
1	64.8	73.3	70.2	65.0	75.7	76.0	74.4	67.7	58.4	64.7	67.9	62.4
2	63.1	66.2	63.9	59.9	66.8	68.7	67.3	62.6	58.4	63.9	62.5	58.4
3	63.8	68.5	65.6	61.0	69.5	71.6	69.8	64.6	56.4	63.8	62.8	58.1
4	63.8	68.5	65.6	61.0	69.5	71.6	69.8	64.6	56.4	63.8	62.8	58.1
5	67.0	70.7	67.4	62.5	72.7	73.6	71.7	65.8	60.7	66.9	64.9	59.7
Coleman Reach												
1	65.9	69.2	66.6	62.5	70.6	72.2	70.7	65.6	61.6	66.0	64.4	60.3
2	61.9	65.2	63.4	59.1	65.6	67.8	66.6	61.6	58.6	62.4	61.5	57.6
3	67.2	71.6	68.5	63.5	73.3	75.0	73.2	67.2	59.4	67.0	65.5	60.4
4	67.2	71.6	68.5	63.5	73.3	75.0	73.2	67.2	59.4	67.0	65.5	60.4
5	69.6	73.5	70.1	64.9	75.9	76.6	74.8	68.3	63.2	69.4	67.3	61.8
North Fork Battle Creek A18 Feeder Reach												
1	57.0	60.3	58.0	55.2	58.9	61.4	59.7	56.2	55.0	56.5	55.8	53.7
2	57.0	58.2	56.4	54.3	59.0	59.3	57.8	55.1	55.0	56.4	55.5	53.1
3	57.3	58.0	56.3	54.3	58.7	59.0	57.5	55.0	55.0	56.1	55.3	53.0
4	57.3	58.0	56.3	54.3	58.7	59.0	57.5	55.0	55.0	56.1	55.3	53.0
5	57.0	58.2	56.4	54.3	59.0	59.3	57.8	55.1	55.0	56.4	55.5	53.1
Eagle Canyon Reach												
1	60.6	67.4	65.9	59.8	73.1	69.8	69.5	62.2	56.5	60.4	63.7	58.0
2	59.6	60.4	59.0	56.7	62.0	61.6	61.0	57.9	56.3	58.7	58.2	55.8
3	59.7	60.2	58.9	56.6	61.7	61.4	60.7	57.7	56.3	58.4	58.0	55.7
4	59.6	60.0	58.7	56.3	61.4	61.0	60.3	57.4	56.2	58.3	57.8	55.4
5	59.5	60.3	58.9	56.5	61.8	61.3	60.7	57.6	56.1	58.5	58.1	55.5
Wildcat Reach												
1	63.6	71.0	68.3	62.3	76.0	74.5	73.3	65.8	58.2	64.7	65.6	59.7
2	62.3	64.7	62.5	59.1	66.4	66.7	65.5	61.1	57.8	61.8	61.2	57.6
3	62.1	64.1	62.1	58.7	65.5	66.0	64.8	60.6	58.0	60.9	60.6	57.3
4	61.1	62.5	60.9	57.8	63.6	63.8	62.6	59.4	57.4	59.8	59.3	56.5
5	61.0	62.9	61.1	58.0	64.3	64.5	63.3	59.7	57.3	60.2	59.7	56.6
Mainstem												
1	68.1	74.6	71.3	66.4	76.5	78.4	76.7	70.1	61.6	69.8	68.2	63.1
2	66.0	70.0	67.2	62.1	71.2	73.2	71.4	65.2	60.7	66.2	64.9	60.0
3	66.4	70.8	67.9	63.2	72.2	73.9	72.2	66.5	60.6	65.9	65.2	60.6
4	64.7	68.4	66.2	61.7	69.3	70.9	68.8	64.7	59.7	63.9	63.1	59.2
5	64.7	68.9	66.3	61.9	70.2	71.6	69.4	64.8	60.2	65.5	63.7	59.4

Source: SNTEMP MODEL : PG&E 2001.

Introduction to Draft Document:

The Adaptive Management Technical Team has endeavored to "reconceive" the Adaptive Management Plan based on Technical Panel review comments and input from Healey (2001 and 2003), and assistance from Environmental Water Program support staff. Changes include:

1) improving communication of previously existing good ideas, and

2) expansion of areas where plan fell short per adaptive management process, especially in the presentation of clear conceptual models and the description of uncertainties.

We have endeavored to maintain existing AMP language in original sections or subsections, in order to retain all concepts which were carefully designed into the original AMP, although these sections have been shuffled into a more Adaptive Management Process-based outline. The annotations here should help those familiar with the original AMP understand how this shuffling affects the document.

New figures/models (Figures 1-3) that capture the restoration planning and AMP processes will guide the narrative development of the Reconceived AMP. Additional models (one per objective) will be developed to more clearly show adaptive management process as laid out in original and revised objectives (a sediment model is included as an example and will be delivered under separate cover). The uncertainties table referred to in the outline is another large improvement bridging the gap between the original AMP and the more formal adaptive management approach based on learning. This uncertainties table is under review by AMTT/PT and will be forwarded under separate cover within a few working days.

Reconceived AMP Elements		Annotation/Comment
	Preface	as in AMP with revisions
	Acronyms	as in AMP with revisions
	Executive Summary	as in AMP with revisions; will be condensed to 1-2 pages
	Table of Contents	as in AMP with revisions
I)	Battle Creek Restoration Project Description	This may draw on Sect. I from AMP but will rely primarily on the concise wording in the MOU communicating a brief project description per Healey's 12/23 comments. Parts of Section I from AMP may need to be substantially revised
	A) Setting : This section will describe features in the watershed relevant to identification of habitat factors limiting the population of anadromous fish (Figure 1).	this is Sect. I 1.A from AMP, and includes some NEW text, being prepared by EWP consultants

Watershed features which suggest that many habitat problems typically affecting salmonids are unlikely to occur in Battle Creek, including:

- No surface water diversion occur in the forks or mainstem of Battle Creek within the project area (i.e. between Coleman Powerhouse and the upstream limits of anadromy) other than the hydro project; this limits the number of dams and diversions that need to be considered.
- The existing hydro system has negligible affect on high flow events and the wet season hydrograph due to the absence of reservoirs with significant storage capacity. This limits the projects affects on channel maintenance and stability, flushing flows and smolt out migration.
- High volume, cold (52°F) springs in both forks of the creek can be redirected to adjacent stream reaches to form cold water refugia. Battle Creek is the most spring dominated watershed within the remaining anadromous habitat of Central Valley.
- Existing hydro system dams do not significantly alter sediment routing through the system at high flows. The dams are low (10 to 28 ft. in height) narrow structures full of sediment leaving them with little or no trap efficiency. In addition, the dams all include large sluice gates 10 to 25 sq. ft. operated several times a year during high flow to pass any accumulated sediment in the vicinity of the gates.
- Land use dominated by large ranches (average parcel size is 400 acres in anadromous section) that isolate the creek from development and public access disturbances. Conservation easements are being established throughout the watershed to further buffer the stream.
- Topography in anadromous habitat, especially steep inner canyons, virtually isolate the stream from typical threats like cattle grazing, roads, and near stream logging.
- Geology/soil types of the anadromous zone and much of the rest

of the watershed is resistant to surface erosion and mass-wasting,

- Within the watershed there are key activities under the control of other entities that are closely linked to the restoration project; specifically the operation of the Coleman Hatchery which is being addressed by the CalFed Science Program workshop and re-consultation under Endangered Species Act when the restoration project is complete. The potential role of the Coleman Hatchery is also addressed in the current Winter-run Recovery Plan (1997). The Greater Battle Creek Conservancy is provides an open forum for coordinating adaptive management activities among various entities.

Watershed features that make certain types of habitat problems likely:

- Inadequate instream flow during the base flow period when approximately 97 percent of the unimpaired runoff is diverted out of the stream channel into adjacent canals. (See attached water budget from TRPA Battle Creek Hydrology Study)
- Passage problems due to low flow over natural obstacles in the stream channel and inadequate ladders on dams. Ladders fail current standards of conveying 10 percent of the stream flow by one order of magnitude. In addition, ladders are vulnerable to failure from debris (especially Alaska Steep pass units) and they are all situated on dams where they cannot be cleared of debris during wet season.
- Temperature problems for cold water fish species result from diversion of cold water springs on both forks directly into canals and away from adjacent stream channels. In addition, lower flows resulting from hydropower diversions increase the heat gain as the water travels down the canyon.
- Entrainment resulting from no fish screens and extremely high percentage of flow diverted (up to 97 percent of base flow).
- Powerhouse operations disrupt stream function and stability by: 1) causing rapid flow fluctuations of up to 200 cfs which can lead to redd-dewatering, and stranding and isolation of juvenile fish, 2) causing rapid changes in water temperature regime, and 2) diverting as much as 97 percent of the water from the North Fork into the South Fork leading to potential false attraction of returning adults to non-natal habitat that is at risk of rapid, detrimental fluctuations in water temperature.

B) Concise nuts and bolts description of all Project actions as listed in the MOU for the Project.

this will be NEW section, though will be modeled on existing text (from EIS and MOU)

C) Conceptual Models restoration project development model (Figure 2), and restoration project implementation model (Figure 3)

Conceptual models provide the explicit link between goals and objectives and restoration actions. Conceptual models are simple depictions of how different parts of the ecosystem are believed to work and how they might respond to restoration actions. These models are explicit representations of scientists' or resource managers' tacit understandings and beliefs. Conceptual models are then used to develop restoration actions that have a high likelihood of achieving an objective while providing information to increase

Some of the material included in this portion of the Introduction is discussed in more detail in the body of the report in the Adaptive Management Section understanding of ecosystem function and, in some instances, to resolve conflicts among alternative hypotheses about the ecosystem. The process of adaptive management can be enhanced when conceptual models are developed into simple computer simulations that can be used to explore the consequences of alternative options for restoration (Healey and Kimmer 1998).

The adaptive management process envisioned for Battle Creek is as endorsed in the CALFED Strategic Plan, Healey (2001), and Castleberry et all. (1996) regarding instream flow prescriptions. The AMP Team characterizes the restoration of Battle Creek as Passive Adaptive Management.

1) Describe watershed-based approach and assessment of limiting factors based on habitat, hydropower, hatchery and harvest influences (Figure 1)

2) Description of how linkages address those limiting factors that Restoration Project does not address

(e.g. CNFH, including findings of CalFed Science Workshop on Hatchery, re-consultation under ESA for hatchery once Restoration Project exists, Hatchery Reevaluation Program and Hatchery Management and Genetic Plan which will provide the science for the future Biological Assessment of CNFH that will be prepared upon implementation of the Restoration Project; this section will strongly introduce the concept of Linkages, but will also refer reader to more detailed (20 page) section on linkages later in document)

a NEW section will be added based on investigations and findings of studies in linkages section.

3) Restoration Project development process: Figure 2 and Figure 3 and a page or two explaining the general process without providing technical details.

Some reviewers have objected to the AMP's heavy reliance on references to Ward and Kier (1999) that summarizes the findings of the Biological Technical Team of the Battle Creek Work Group.

Several approaches were considered. The following was considered adequate in Mike Healey's 12/29/03 opinion.

To address this concern that not enough background technical information appears in the AMP, the reconceived AMP will generally describe the development process undertaken by the Biological Team of the Battle Creek Work Group (for which the new Figures help explain a lot) and refer to Ward and Kier (1999) for technical information, but will not attempt to include all relevant material from Ward and Kier (1999) and will not attempt to rewrite or condense material from this document due to time constraints and the likelihood of introducing errors.

D) Key Uncertainties and Learning Opportunities (this section enumerates uncertainties relative to conceptual models)

The Uncertainties Table is drafted and under review. It will be forwarded to CALFED under separate cover.

E) Goals and Objectives Summary

A broad goal is restoration of an assemblage of fish and fish dependant wildlife native to Battle Creek; however, the primary target species for restoration are winter-run chinook, spring-run chinook and steelhead.

II) Adaptive Management: A Tool To Address Uncertainty

This section will expand on similar material introduced above.

The adaptive management process envisioned for Battle Creek is as endorsed in the CALFED Strategic Plan, Healey (2001), and Castleberry et al. (1996) regarding instream flow prescriptions. The AMP Team characterizes the restoration of Battle Creek as Passive Adaptive Management.

A) Description of Adaptive Management

Adaptive management is an action-oriented approach to restoring and/or managing natural systems in a manner that improves the health and function of the ecosystem while simultaneously improving our understanding of system dynamics. Although adaptive management may lead to full-scale restoration of a particular ecosystem, the Restoration Project does not address every activity in the entire watershed that affects the ecosystem. Other major activities in the watershed are addressed in the linkages section of the AMP, including watershed-wide development activities and Coleman National Fish Hatchery operations. To the extent feasible, Restoration Project actions are designed to maximize the opportunity for learning and to carry forward the objective of ecosystem function or species restoration by linking to the other restoration actions in the watershed in a coordinated fashion. Thorough monitoring and evaluation of adaptive management actions is critical to successful learning and resolving scientific uncertainties. Results of monitoring and evaluation will be used to redefine the problem, reexamine goals and objectives, or refine conceptual models to ensure efficient learning and adaptation of management techniques and understanding. Using this process, the adaptive management plan is intended to respond to increased knowledge and understanding on an annual basis.

Adaptive management acknowledges uncertainty in the outcome of any management intervention in a system as complex as an ecosystem. The Battle Creek Salmon and Steelhead Restoration Project is especially complex because the water is being allocated for both hydroelectric development and ecosystem services. The primary action in the Restoration Project is increasing the flow of surface water and cold spring water in the stream channel. The Instream Flow Council (2002) recommends that adaptive management be used to answer critical uncertainties for the instream flow-setting process as described in Castleberry et al. (1996). This recommended adaptive management approach for addressing uncertainty associated with instream flow prescriptions suggested that the following steps:

* Set conservative, resource-protective interim flow standards based on available information; and

* Establish a credible monitoring program that allows the interim standards to serve as experiments; and

* Establish an effective procedure that allows revision of the

interim standards based on the new information.

The flow setting process used by the Biological Technical Committee of the Battle Creek Working Group and the AMP process will be compared to the above procedure.

Because adaptive management requires flexibility and openness, it can become difficult to set up in a regulatory setting such as Federal Energy Regulatory Commission hydropower licensing process as well as the other federal laws such as the ESA.

In passive adaptive management, the key task is to choose the best management policy (action) given the current understanding of the system and then to monitor implementation to ensure that performance is within expected limits. If possible, implementation should also be used as an opportunity to learn more about the system under management (i.e. address uncertainties in understanding). The following description is from Instream Flow Council 2002 and may be useful in this description of Adaptive Management: "Flow prescriptions are made using predictive models to make statements about flows and what changes can be expected to the hydraulic and water quality measures of habitat. The approach can assume a direct correlation between change in physical habitat and the number of fish and/or the general status of the ecosystem. Once the habitat objectives and the corresponding flow regime are agreed to, monitoring of the new flow regime can be carried out to verify the predictions. If monitoring does not substantiate the modeled predictions, changes would be made to the models followed by analyses and subsequent alternative recommended flow regimes."

B) Components of an Adaptive Management Plan

C) Describe why Adaptive Management is of Interest

The goal of this section will be to describe how an AM approach serves the interests of the parties involved in Battle Creek, including PG&E and the fisheries agencies. This section will discuss how adaptive management plan is consistent with the goals and objectives specified in the MOU and the purpose and need statement in the Environmental Document. It will also explain the value of AM learning process to CalFed Funding agency for Ecosystem Restoration.

III) Adaptive Management of Battle Creek Restoration Project

A) Adaptive Management Objectives	This includes the entire Section III (p 31 – 56) from AMP – These objectives have been reordered per life cycle (see Figure 1 and Figure 3) but maintain the original AMP name and numbering for ease of review at this stage.
1) Habitat Objective 3: Minimize false attraction and harmful fluctuations in thermal and flow regime . . .	as in AMP + new narrative + model
2) Passage Objective 3: Upstream passage of adults at natural obstacles	as in AMP + new narrative + model
3) Passage Objective 1: Upstream passage of adults at dams	as in AMP + new narrative + model + the radiotelemetry study originally included as a diagnostic study has been upgraded to a focused study – funds for this will be

	sought in request to CALFED
4) Habitat Objective 1: Maximize usable habitat quantity – volume	as in AMP + new narrative + model
5) Habitat Objective 2: Maximize usable habitat quantity – water temperature	as in AMP + new narrative + model
6) Population Objective 1: Increase spawning success and egg survival	as in AMP + new narrative + model, revising title to match here is under consideration
7) Habitat Objective 4: Minimize stranding or isolation . .	as in AMP + new narrative + model
8) Sediment Monitoring *(A focused sediment study is drafted and is in review. It will be delivered under separate cover)* Field data collection of sediment and channel morphological characteristics (channel platform and surface mapping, bed sediment volume and particle size surveys, channel elevation surveys, and sediment transport and model effectiveness evaluation) in order to: • validate existing sediment routing model and investigate model alternatives, • test current conceptual models of channel morphological change following dam removal and develop a greater understanding of post-removal sediment dynamics • relate channel morphological response to habitat values *See Monitoring Goals and Objectives section of the sediment monitoring plan.*	*The AMTT would like particular feed back on this sediment monitoring plan.* a NEW objective is being prepared and will be addressed with a focused study.
9) Riparian Habitat Research suggests that riparian vegetation is especially sensitive to minimum and maximum instream flows. The Restoration Project will significantly increase minimum instream flow. Monitoring riparian habitat for both adverse effects and benefits from the Project could include: a) Area of new riparian vegetation establishment on reaches and at different bank elevations; b) Survival and growth rates of seedlings at higher post project bank elevations; c) Area of Shaded Riverine Aquatic Habitat at higher post project bank elevations; and possible indirect effects from dam removal, such as excessive sedimentation, on nearby riparian habitat.	A study is described in the Focused Study Section
10) Nursery Habitat Use – Snorkel surveys will be conducted throughout the project area to see if nursery habitat is limiting. If determined to be necessary as a result of this study, a focused study of fish utilization of nursery habitat in lower Battle Creek will be recommended (see Table 1).	A study is described in the Focused Study Section.
11) Juvenile habitat use	A study is described in the Focused Study Section

The study will have three goals:

1) to verify the juvenile salmonid microhabitat suitability indices upon which the restoration project flows are based;
2) to determine the distribution of juvenile salmonids in the restoration project area to verify successful passage and production; and
3) to determine the relative abundance of juvenile salmonids in reaches of the restoration project to determine if they are using the reaches as predicted in conceptual and flow models.

12) Passage Objective 2: Downstream passage of juveniles at dams	as in AMP + new narrative + model
13) Population Objective 2: Increase fall/late-fall chinook populations to genetically-viable levels	as in AMP + new narrative + model
14) Population Objective 3: Increase steelhead and spring /winter chinook populations to genetically-viable levels	as in AMP + new narrative + model
15) Population Objective 4: Increase steelhead and chinook populations to fully utilize carrying capacity	as in AMP + new narrative + model
B) Annual Monitoring (Table 1)	This includes entire AMP App. Table 1
C) Focused Studies (Table 1)	This is essentially the original AMP Appendix Table 2 which has been expanded and merged into Table 1 to include additional studies with learning value.

These may include:

Cold Water Refugia- Studies documenting the extent, distribution and use of cold water refugia that develops with the release of Eagle Canyon Springs and Bluff Spring waters to adjacent stream sections on each of the forks.
Ramping rate studies on the South Fork were applied to the North Fork. The standards are conservative for the North Fork because the risks of stranding are less and therefore could be refined.
Life History studies especially in reaches where the habitat requirements are marginal at certain times of the year.
Habitat use studies related to the model predictions of usable habitat for juveniles and adults.
Nursery habitat in lower Battle Creek -- An investigation of fish utilization of nursery habitat in lower Battle Creek and possible impacts from CNFH may be recommended to be performed by USFWS as part of the post-project Biological Assessment depending on the results of the Nursery Habitat Objective.

D) Adaptive Management Process	Reviewers have stated that operating procedures need adjustment. Healey (2003 page 2 paragraph 1) recommends a "new set of operating procedures." To address these suggestions, the reconceived AMP will describe 1) a clearer process of how data collected through monitoring and focused studies will be shared, evaluated and analyzed; and 2) a set of procedures that will be established to insure that these analyses are used to revise, when needed, the original AMP assumptions, uncertainties, and conceptual models; and 3) adaptive

management response pathways as described in original AMP. While these new procedures will be explicit and flexible, this flexibility will be bound by the constraints of the MOU.

1) Definitions	This includes entire Section I.F. from AMP
2) Organization	This includes entire Section II from AMP
3) Protocols	This includes entire Section V from AMP (p. 75 – 86)
E) Linkages (Table 2)	This includes entire Section IV from AMP (p. 56 – 75)

Although adaptive management may lead to full-scale restoration of a particular ecosystem, the Restoration Project does not address every activity in the entire watershed that affects the ecosystem. Other major activities in the watershed are addressed in the linkages section of the AMP. The most important restoration/management activities that require very close coordination with the Restoration Project are:

- Watershed management plan/strategy under the control of the Greater Battle Creek Watershed Conservancy
- Coleman National Fish Hatchery activities, primarily under control of the hatchery operator, the US Fish and Wildlife Service, with substantial involvement of the hatchery owner, the US Bureau of Reclamation. Activities include but are not limited to: 1)CalFed Science Program Workshop on Coleman Hatchery , 2) Coleman Hatchery Reevaluation (including Hatchery Genetic and Management Plan which will provide the science for the future Biological Assessment of CNFH that will be prepared upon implementation of the Restoration Project;), 3) Re-consultation with NOAA Fisheries under ESA when Restoration Project exists, 4) Hatchery Water Intake Project , and 5) Hatchery Barrier Weir.
- Sacramento River Winter-run Chinook Recovery Plan (Draft 1997) under control of NOAA Fisheries and the Technical Recovery Team. The Recovery Plan currently identifies the need for a feasibility plan for the reestablishment of winter-run chinook. The AMPT could recommend that NOAA Fisheries facilitate development of the feasibility plan by 2006 when the Restoration Project is expected to be fully operational. The plan could include contingencies.

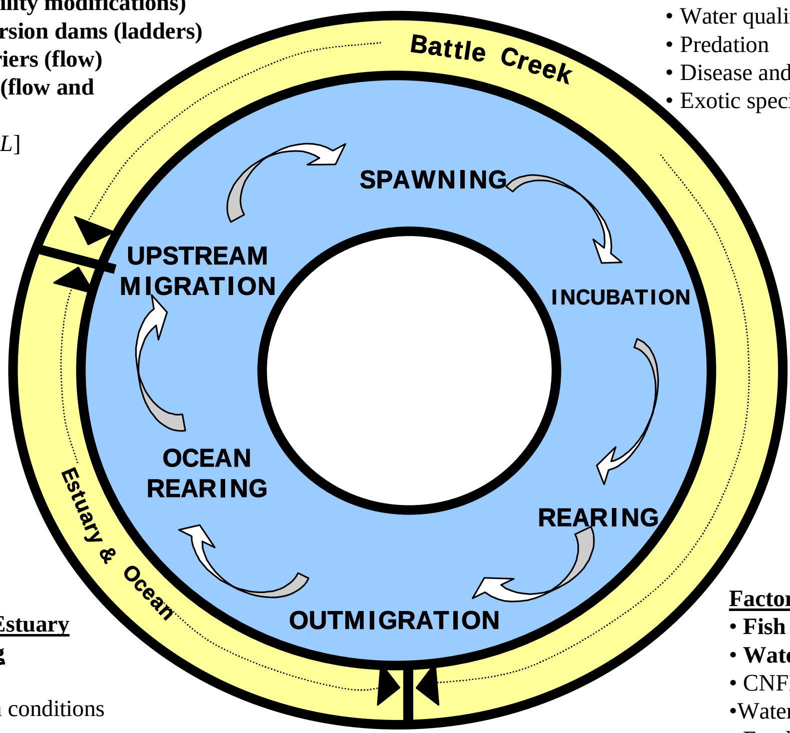
F) Contingencies: Identify funds for adjustments needed to address problems or failures in:

- water needs: CalFed Environmental Water per MOU;
- facility performance: Packard Adaptive Management MOU and PG&E upon exhaustion of Packard funds;
- monitoring: CalFed 3 year grants and agency funds

<u>Key</u>
- **Factors in Bold are addressed by Restoration Project**
- [*L*] Indicates factors addressed through linkages to other programs.

<u>Factors Affecting Upstream Migration</u>
- **False attraction (facility modifications)**
- **Fish passage at diversion dams (ladders)**
- **Fish passage at barriers (flow)**
- **Water temperature (flow and spring release)**
- CNFH Barrier Dam [*L*]
- Water quality
- Poaching
- Predation
- Competition
- Disease and other natural mortality factors

<u>Factors Affecting Spawning and Incubation</u>
- **Spawning habitat quantity (flow)**
- **Spawning habitat quality (sediment release)**
- **Redd dewatering (ramping rates)**
- **Water temperature (flow and spring release)**
- CNFH affects [*L*]
- Water quality
- Predation
- Disease and other natural mortality factors
- Exotic species invasions



<u>Factors Affecting Rearing</u>
- **Rearing habitat quantity (flow)**
- **Stranding (ramping rates)**
- **Water temperature (flow and spring releases)**
- CNFH affects [*L*]
- Water quality
- Habitat quality
- Food and nutrient avaiability
- Predation
- Competition for resources other than space
- Disease and other natural mortality factors
- Exotic species invations

<u>Factors Affecting Estuary and Ocean Rearing</u>
- Harvest [*L*]
- Estuary and Ocean conditions

<u>Factors Affecting Outmigration</u>
- **Fish passage at diversion dams (screens)**
- **Water temperature (flow and spring release)**
- CNFH affects [*L*]
- Water quality
- Food and nutrient availability
- Predation
- Competition
- Disease and other natural mortality factors

Figure 1. Battle Creek Limiting Factors Model with Key Uncertainties and Key Linkages.

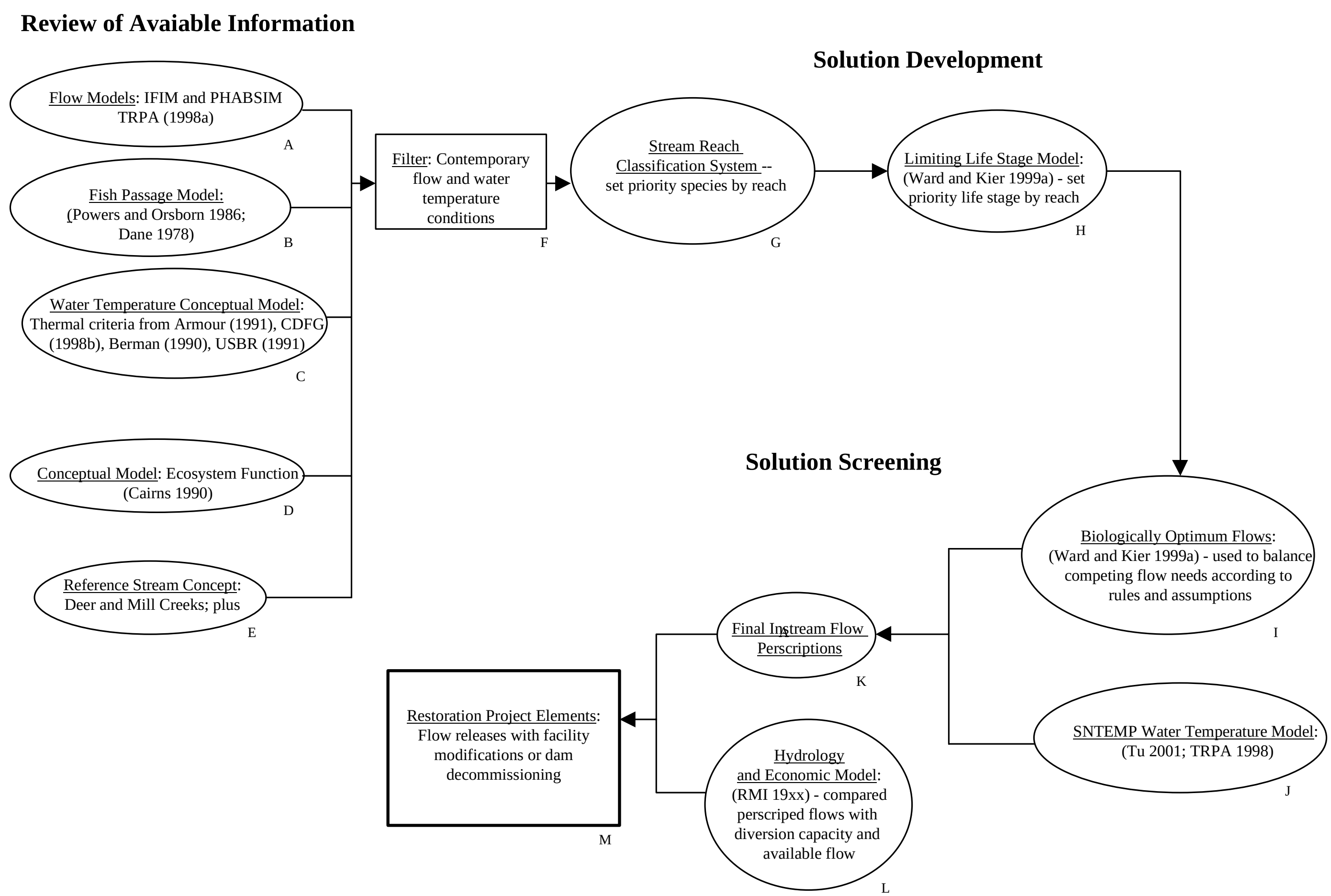


Figure 2 Model showing development of Battle Creek Restoration Project including key passive adaptive management steps (e.g. review of available information, development of plausible solutions, and solution screening).

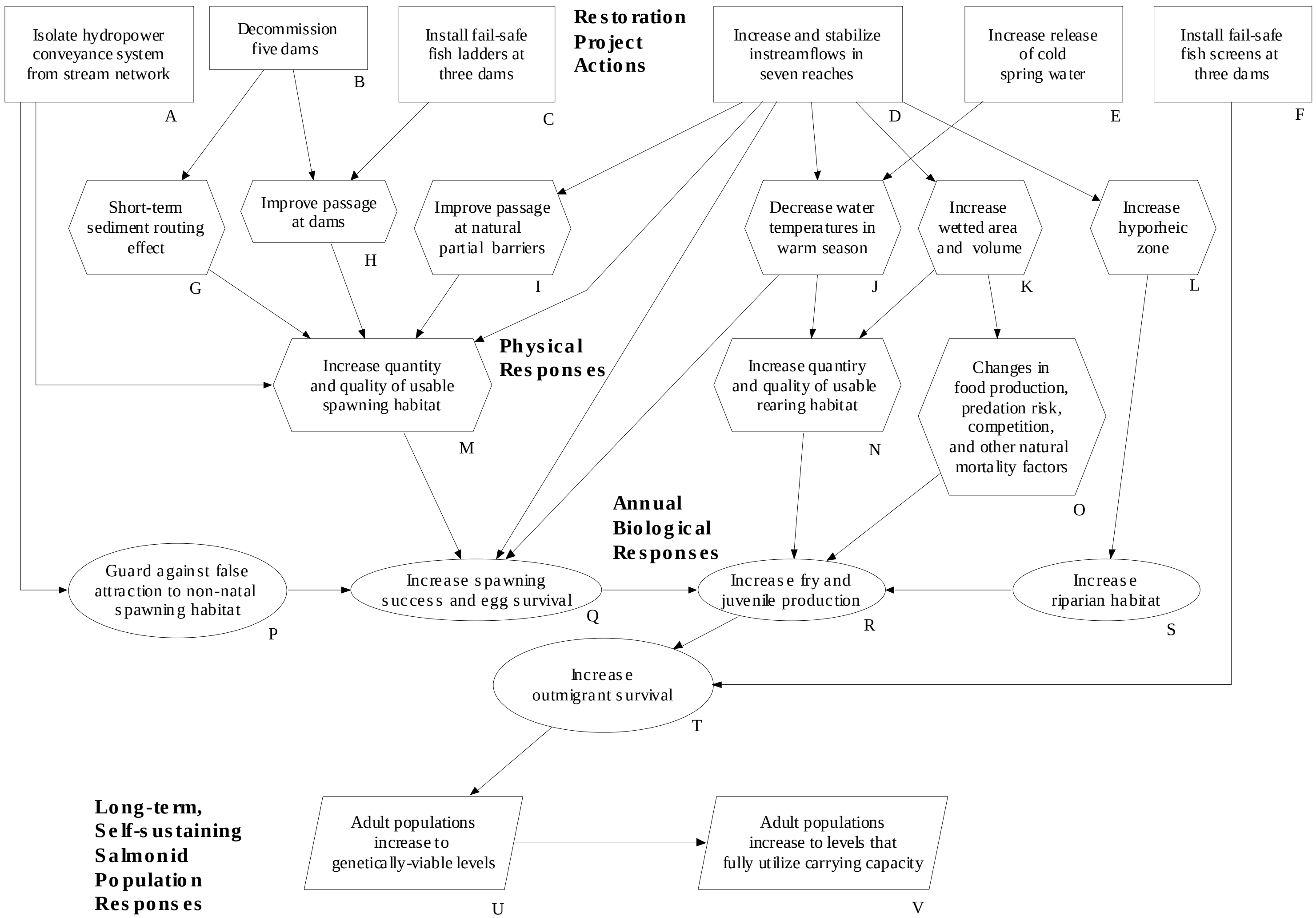


Figure 3. Restoration Project Implementation Model

Table 1. Annual Monitoring field studies, analysis, diagnostic studies and focused studies. **(This is a draft table and will under go significant revisions in the final AMP.)**

Adaptive Management Monitoring Tasks	Task Type	Objective	Responsibility	Timeline	Estimated Annual Cost
Estimate adult and jack population sizes using Coleman barrier weir.	field study	POP-1, POP-2, POP-3, POP-4	Resource Agencies	13 – 16 years minimum	**A** $50,000
– Compare 3 year-running average CRR with expected CRR when populations allow	analysis	POP-2, POP-3, POP-4	Resource Agencies	13 – 16 years minimum	included in A
– Evaluate CRR trends in light of limiting factors in the Sacramento River system	analysis	POP-2, POP-3	Resource Agencies	13 – 16 years minimum	included in A
– Compare CRR to Reference Watersheds	analysis	POP-2, POP-3	Resource Agencies	13 – 16 years minimum	included in A
– Compare CRR 10-year trend to CRR value of 1.0	analysis	POP-4	Resource Agencies	Term of AMP	included in A
Count adult and jack anadromous salmonids using electronic video or video and electronic methods at ladders	field study	PASS-1	Licensee[1]	3 years or longer per AMP protocols	proprietary information
Estimate adult and jack anadromous salmonid sub-population sizes and distribution by reach using counting facilities at new fish ladders, after PASS-1 is done.	field study	POP-1	Resource Agencies	After Licensee's responsibility ends until no longer needed	$30,000
Estimate juvenile production when adult populations are large enough to produce detectable numbers of outmigrants	field study	POP-1, POP-2, POP-3, POP-4	Resource Agencies	Term of AMP	**B** $250,000
– Compare juvenile production to expected production from previous spawners and ecological factors	analysis	POP-1	Resource Agencies	Term of AMP	included in B
– Compare juvenile production to production observed in Reference Watersheds	analysis	POP-1	Resource Agencies	Term of AMP	included in B
Estimate pre-project juvenile production	field study	POP-1	Resource Agencies	1998-2002	$250,000

[1] Pursuant to the MOU as explained in Passage Objective 1 and the Facilities Monitoring Plan, the Licensee is expected to operate electronic video or video and electronic counting equipment to count adult and jack anadromous salmonids for the first three years, or longer per AMP protocols, after the transfer of facilities from USBR to PG&E. The Resource Agencies will take over these fish counting responsibilities to satisfy Population Objective 1 at the end of the Licensee's obligation.

Adaptive Management Monitoring Tasks	Task Type	Objective	Responsibility	Timeline	Estimated Annual Cost
Estimate juvenile production at the terminus of each fork when adult populations are large enough to produce detectable numbers of outmigrants	field study	POP-1	Resource Agencies	5 years, 2002-2007	$100,000
Estimate adult and jack distribution using carcass counts, snorkel surveys, and /or redd surveys	field study	POP-1, POP-2, POP-3, POP-4, PASS-1, PASS-3	Resource Agencies	Term of AMP	**C** $155,000
– Evaluate physical and biological habitat conditions for each reach	field study	POP-1	Resource Agencies	Term of AMP	included in C
– Observe and record habitat use, and compare observed habitat use to expected habitat use	field study	HAB-1	Resource Agencies	Term of AMP	included in C
– Gauge salmon or steelhead response to tailrace leaks or discharge of water	field study	HAB-3	Resource Agencies and Licensee[2]	Term of AMP	included in C
– Monitor Ramping Rates and threshold flow levels for effects on stranding or isolating	field study	HAB-4	Resource Agencies and Licensee	During scheduled outages 2002-2007	included in C
– Monitor fish stranding	field study	HAB-4	Resource Agencies and Licensee	Term of AMP	included in C
–					
– Compare stranding and isolating effects of natural flow fluctuations and project induced ramping	analysis	HAB-4	Resource Agencies	Completed 2007	included in C
– Inspect potential barriers during annual surveys	field study	PASS-3	Resource Agencies	Term of AMP	included in C
– Compare spawner distribution relative to suspected barriers	analysis	PASS-3	Resource Agencies	Term of AMP	included in C
– Compare ladder counts with spawning distribution and predicted habitat use.	analysis	PASS-1, POP-1	Resource Agencies	Term of AMP	Included in C
– Compare observed spawner distribution relative to expected spawner distribution for a particular species	analysis	PASS-3	Resource Agencies	Term of AMP	included in C
– Document fish injury caused by fish ladders	field study	PASS-1	Resource Agencies	Term of AMP	included in C

[2] Licensee responsibility would be limited to reporting by staff of observations made during the course of normal project operations.

Adaptive Management Monitoring Tasks	Task Type	Objective	Responsibility	Timeline	Estimated Annual Cost
– Observe adult congregations below dam and compare to ladder counts	field study	PASS-1	Resource Agencies and Licensee	Term of AMP	included in C
Apply advancements in flow/habitat relationships	diagnostic analysis	HAB-1	Resource Agencies, Licensee	To be determined	unknown
Use Contemporary methodologies that consider flow regime to identify actual barriers	field study	PASS-3	Resource Agencies	contingent on need	contingent on need
Diagnose threshold flow on the North Fork at which Ramping Rates differ from 0.1 foot/hour	field study	HAB-4	Resource Agencies	During scheduled outages 2001-2003	$10,000
Conduct a diagnostic study of ramping thresholds in the North Fork to determine the flow level above which ramping rates may differ from 0.1 foot/hour.	diagnostic field study	HAB-4	Resource Agencies	Term of AMP	unknown
Monitor longitudinal water temperature regime	field study	HAB-2, POP-1	Resource Agencies	5 years minimum	$20,000
Monitor cold water from Bluff Springs	field study	HAB-2	Resource Agencies	Term of AMP	none
Monitor water temperature at target points within stream	field study	HAB-2, POP-1	Resource Agencies	Term of AMP	$5,000
Monitor climatic conditions	field study	HAB-2, POP-1	Resource Agencies and Licensee[3]	5 years minimum	$13,000 first year and $3,000 thereafter
Water temperature modeling	focused study	HAB-2	Resource Agencies	5 years	unknown
Monitor leaks and discharge for indications that it alters the South Fork thermal or chemical regime	field study	HAB-3	Licensee	Term of AMP	proprietary information
Compare leakage or discharge to stream flow rates	analysis	HAB-3	Licensee	Term of AMP	proprietary information
Monitor hydraulic parameters at fish ladders for Fail-Safe capabilities	field study	PASS-1	Licensee	Term of AMP	proprietary information
Study fish passage at ladders with tagged test fish	diagnostic field study	PASS-1	Resource Agencies	Term of AMP	unknown

[3] Licensee responsibility will be limited to granting permission for installation of climatic monitoring equipment at Licensee facilities.

Adaptive Management Monitoring Tasks	Task Type	Objective	Responsibility	Timeline	Estimated Annual Cost
Monitor fallback with tagged test fish	diagnostic field study	PASS-1	Resource Agencies	Term of AMP	unknown
Measure and compare hydraulic parameters at fish screens for calculated and measured diversion rates	field study	PASS-2	Licensee	Measure as relevant throughout the OMP	proprietary information
Monitor key hydraulic parameters at fish screens for Fail-Safe capabilities	field study	PASS-2	Licensee	Continuously throughout AMP	proprietary information
Observe canals for entrainment during other activities and when dewatered	field study	PASS-2	Licensee	Continuously throughout AMP	proprietary information
Fish community structure will be studied to determine changes in distribution of fish within Battle Creek from before and after implementation of the Restoration Project.	focused study	none	Resource Agencies	a single year of study before and at least one year of study after implementation of Restoration Project	unknown
Sediment Monitoring – a sediment monitoring study plan has been drafted and is in review. Final study design is pending CALFED Technical Panel comments on draft study design.	focused study	Sediment Monitoring	per MOU	dependent on need	final decision pending review
Riparian Studies – numerous potential surveys are being considered; determination on which specific surveys to be conducted is pending final review by AMTP	focused study	Riparian Habitat	per MOU	dependent on need	pending completion of objective
An investigation of fish utilization of nursery habitat in lower Battle Creek and possible impacts from CNFH may be recommended depending on the results of the Nursery Habitat Objective. This investigation may be performed by USFWS as part of Biological Assessment for the NOAA-Fisheries reconsultation with USFWS on CNFH after implementation of Restoration Project.	focused study, if needed	Nursery Habitat	USFWS	dependent on need	dependent on need
Juvenile Habitat Use – a new objective is currently being prepared; see goals of this study in annotated outline	pending completion of objective	Juvenile Habitat Use	per MOU	pilot in first year after implementation of Restoration Project; out years to be determined	pending completion of objective

Adaptive Management Monitoring Tasks	**Task Type**	**Objective**	**Responsibility**	**Timeline**	**Estimated Annual Cost**
Cold Water Refugia- Studies documenting the extant, distribution and use of cold water refugia that develops with the release of Eagle Canyon Springs and Bluff Spring waters to adjacent stream sections on each of the forks.	possible focused study	Water Temperature	per MOU	pending review by AMPT	pending review by AMPT
Life History Study -- studies especially in reaches where the habitat requirements are marginal at certain times of the year.	possible focused study	none	per MOU	pending review by AMPT	pending review by AMPT

Table 2. Linkages between the Adaptive Management of the Battle Creek Restoration Project and other planning or restoration programs and directives.

Restoration Project Planning
Memorandum of Understanding
Construction Monitoring
Facilities Transfer Agreement
Facilities Monitoring Plan
Operations and Maintenance Plan
Non-Project Restoration Programs In Battle Creek
Conservation easements and conservation water rights
Proposed fisheries management plan for the upper Sacramento River and tributaries
Sacramento Corridor Habitat Restoration Assessment
Proposed Coleman Powerhouse tailrace barrier construction
Coleman National Fish Hatchery, water-supply intake modifications
Coleman National Fish Hatchery, barrier dam modifications
Coleman National Fish Hatchery, Hatchery and Genetic Management Plan
Coleman National Fish Hatchery, Biological Assessment including focused studies that may be recommended by AMPT
Non-Project Restoration Programs Outside of Battle Creek
CALFED Ecosystem Restoration Program.
Comprehensive Monitoring, Assessment, and Research Program/CALFED Science Program
Central Valley Project Improvement Act
Anadromous Fish Restoration Program
Comprehensive Assessment and Monitoring Program
Recovery plans for threatened or endangered salmonids
Central Valley Salmon and Steelhead Restoration and Enhancement Plan
Upper Sacramento River Fisheries and Riparian Habitat Management Plan
Restoring Central Valley Streams- A Plan for Action
Steelhead Restoration and Management Plan for California.
Delta and Sacramento River operations and monitoring
Reference Watersheds
U.S. Bureau of Land Management
U.S. Forest Service
Battle Creek Watershed Conservancy
Local community participation
Sediment quality monitoring
Watershed assessment
Water temperature and climate monitoring
Data management and dissemination
Non-Project Restoration Emergencies
For example, hazardous spills/toxic leaks

ATTACHMENT C-1

Introduction to Draft Uncertainties Table:

The following Uncertainties Table and introductory text attempts to capture all recognizable uncertainties in the adaptive management of the Battle Creek Restoration Project. This table closely follows the three conceptual models (Figures 1 to 3).

While the table is not complete (cells yet to be completed are indicated with "t.b.c."), the overall list of uncertainties is complete, as are several individual uncertainties where substantial information is included in each cell across a row. Determining "key" uncertainties, as defined below, involves a measure of professional opinion, and as such, can entail much constructive, though non-productive, debate.

The AMTT seeks comments from the CALFED Technical Panel in three areas:

- *Did we structure this attempt to describe the Project's key uncertainties in a way which adequately captures your earlier concerns?*

- *Do you feel this discussion of uncertainties adequately conveys the link between conceptual models and the adaptive management objectives / studies that we envision?*

- *Is the list of uncertainties sufficiently comprehensive? Should it include more or less detail?*

Key Uncertainties

The ecological dynamics of Battle Creek are not well understood despite the fact that many typical threats to salmonid populations are absent or are buffered within Battle Creek (as described in the Project Description). The following table lists many levels of uncertainties and is organized by uncertainties within 1) our understanding of factors limiting salmonid abundance in Battle Creek (Figure 1), 2) how the Battle Creek Restoration Project was developed (Figure 2), and 3) how implementation of the Battle Creek Restoration Project is expected to affect physical and biological processes (Figure 3).

These uncertainties range from basic scientific assumptions to questions about relationships within conceptual models to important unknowns in responses between biological processes and specific Restoration Project actions. We have used guidelines implicit in Healey's (2001) description of adaptive management to determine which of the many uncertainties are "Key Uncertainties."

We consider uncertainties to be "Key" if 1) the uncertainty has a high likelihood of affecting the success of the Restoration Project, and if 2) the uncertainty makes distinguishing between alternate adaptive responses difficult (Healey 2001). Furthermore, we use professional judgement to assess the quantity and quality of support within scientific literature for the assumptions that we use. That is, while all scientific understanding incorporates some level of uncertainty, the level of support for some scientific assumptions is sufficiently robust to suggest decreasing the emphasis on those uncertainties within this plan. Well supported assumptions which are not considered "key uncertainties" are included in this table to show readers that they were not overlooked.

For example, we are uncertain as to how thermal suitability criteria derived from the scientific literature for Sacramento River chinook salmon apply to Battle Creek fish (Table 1). We do not consider this a "Key Uncertainty", however, because this assumption is robustly supported by existing literature and because variation in thermal suitability would likely be sufficiently low that this uncertainty is unlikely to have a large affect on the success of the Restoration Project or on our ability to distinguish between alternate adaptive responses.

Conversely, a "key uncertainty" includes the effects of increasing flows on fish passage at natural obstacles. If the assumption is wrong that prescribed minimum instream flows will provide adequate passage of adult salmon to preferred spawning habitat, then this uncertainty has a high likelihood of affecting the success of the Restoration Project by lowering spawning success and population growth. In addition, the uncertainty of fish passage at natural obstacles makes distinguishing between alternate adaptive responses difficult. For example, a lack of adults reaching the preferred habitat because of fish passage problems at natural obstacles may be confounded with possible failures in the performance of fish ladders lower in the system, failures in North Fork production at earlier life stages, or factors from outside the watershed that limit the number of adults returning to Battle Creek.

Key Uncertainties are highlighted in **bold font** in Table 1. The comments explain: 1) why an uncertainty is not considered key and/or 2) tells how the Restoration Project addresses the uncertainty or why Restoration Project does not address the uncertainty. The column **"Model and Node"** allows the reader of Table 1 to visually place the uncertainty within the overall conceptual models by specifically referring to the appropriate conceptual model number and node letter.

ATTACHMENT C-1

Draft Uncertainties Table for Reconceived Version of Adaptive Management Plan

Table 1. Uncertainties inherent in the adaptive management of Battle Creek Salmon and Steelhead Restoration Project. Use The column "**Model and Node**" to refer to the appropriate conceptual model number and node letter (Figures 1 – 3)**.**

t.b.c. = indicates that contents of the cell are to be completed

Factor	Model and Node	Uncertainty (Key uncertainties in **bold**)	Rationale	Implication of Uncertainty	Activity to Address Uncertainty	Objective/ Study
Concept Models	1	**Factors identified as limiting, that will be addressed by the Restoration Project, may in fact not be limiting fish populations.**	t.b.c.	t.b.c.	t.b.c.	t.b.c.
Concept Models	1	**Factors identified as limiting may be insufficiently addressed by the Restoration Project or the other restoration/management activities described in the Linkages section of the AMP**	t.b.c.	t.b.c.	t.b.c.	t.b.c.
Concept Models	1	**Actual limiting factors in the Restoration Project Area may not have been identified and are not addressed by the Restoration Project.**	t.b.c.	t.b.c.	t.b.c.	t.b.c.
Concept Models	2E	**To what extend are habitat conditions, fish populations, and fish community structure in Deer and Mill Creeks comparable to Battle Creek (especially if impaired passage at Red Bluff Diversion Dam is not remedied during the May 15 to Sept. 15 period in which the dam is operated)?**	Could jeopardize our ability to distinguish between alternate responses when interpreting adult population data.	Variations in adult population levels may be difficult to interpret	t.b.c.	t.b.c.
Concept Models	2F	**To what extent do climate, flow, and temperature conditions in late 1990s, used in solution screening, compare with like conditions in 2006 to 2026?**	t.b.c.	t.b.c.	t.b.c.	t.b.c.
Concept Models	2G	**To what extent will steelhead and four races of chinook use the "A" and "B" grade habitats as predicted?**	t.b.c.	t.b.c.	t.b.c.	Passage Objectives 1 and 3
Concept Models	2D	A restoration approach based on the concept of ecosystem function (Cairns 1990) may not adequately overcome the lack of a theoretical basis for predicting rates and pathways of recovery.	Not key because literature is robust in its criticism of single-species approach and support for ecosystem approach.	t.b.c.	t.b.c.	t.b.c.
Concept Models	2G	Uncertainties are inherent in the use of professional judgement. To what extent did we get this right?	t.b.c.	t.b.c.	t.b.c.	t.b.c.
Concept Models	2H	Steelhead limiting life stages were not identified.	Not key because "conservative, resource-protective interim flow standards" were used to set flow levels per (Castleberry et al. 1996).	t.b.c.	t.b.c.	t.b.c.
Concept Models	2L	Effects of existing or future environmental regulation	Not key because Restoration Project removes the large amount of environmental liability associated with the existing project.	t.b.c.	t.b.c.	t.b.c.

ATTACHMENT C-1

Draft Uncertainties Table for Reconceived Version of Adaptive Management Plan

Factor	Model and Node	Uncertainty (Key uncertainties in **bold**)	Rationale	Implication of Uncertainty	Activity to Address Uncertainty	Objective/ Study
Concept Models		Will monitoring activities and focused studies create impacts on processes or limiting factors that could impede restoration of fish populations?	t.b.c.	t.b.c.	t.b.c.	t.b.c.
Concept Models	3	The relative importance of various components of the Restoration Project is unknown (Healey 2001).	Not key because, if other assumptions hold true, cumulative affects of all actions should generate success regardless of relative importance of individual components and because key uncertainties that could hinder our ability to distinguish among alternate responses are individually addressed (see the rest of this table).	t.b.c.	t.b.c.	t.b.c.
Passage/ Barriers	2B	**Uncertainties are inherent in fish passage/barrier models (Powers and Orsborn 1986; Dane 1978).**	Monitoring may suggest need to rely on updated models.	t.b.c.	t.b.c.	Passage Objective 3
Passage/ Barriers	2B	**Results of 1989 field studies may not apply to conditions occurring during the term of the Restoration Project (between 2006 and 2026).**	t.b.c.	t.b.c.	t.b.c.	Passage Objective 3
Passage/ Barriers	3D-3I	**Will new instream flows provide fish passage at natural obstacles that meets the level predicted using Powers and Orsborn methodology and will that level of passage meet or exceed that required for fish ladders?**	t.b.c.	t.b.c.	t.b.c.	Passage Objective 3
Passage/ Barriers	2B	The spatial and temporal dynamics of flow/barrier relationships are not well understood.	Uncertainty at this scale unlikely to affect project success or ability to distinguish between alternatives because larger-scale monitoring in Passage Objective 3	t.b.c.	t.b.c.	Focused Studies
Passage/ Dams	3C-3H	**Will fail-safe fish ladders insure adequate upstream passage at dams?**	All adults are exposed to fish ladders and their potential problems; passage problems at ladders could affect entire population.	t.b.c.	t.b.c.	Passage Objective 1
Passage/ Dams	3F-3T	Will fail-safe screens insure adequate downstream passage of juveniles at dams?	Only a portion of juvenile population may be exposed to fish screens. Not key because literature on this topic is generally accepted and robust. Fish screening has repeatedly been shown to improve outmigrant survival to adequate levels as defined in MOU.	Significant entrainment could reduce outmigrant survival.	Monitor performance of screens, check for possible entrainment.	Passage Objective 2
False Attraction	3A-3P	**Will facility modifications sufficiently isolate hydropower conveyance system from stream network to guard against false attraction?**	t.b.c.	t.b.c.	t.b.c.	t.b.c.
Spawning	3D-3M	**Will new instream flows increase the quantity and quality of usable spawning and rearing habitat?**	t.b.c.	t.b.c.	t.b.c.	t.b.c.

ATTACHMENT C-1

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Factor	Model and Node	Uncertainty (Key uncertainties in **bold**)	Rationale	Implication of Uncertainty	Activity to Address Uncertainty	Objective/ Study
Spawning	3H-3M	**How will spawning activity be distributed within the restored habitat that is made accessible by fail-safe fish ladders?**	t.b.c.	Chinook races could hybridize; production could be limited if adults can't reach best habitat.	Determine spawning distribution of various races.	Passage Objective 1
Spawning	3I-3M	**How will spawning activity be distributed within the restored habitat that is made accessible by reducing natural obstacles with higher instream flows?**	t.b.c.	Chinook races could hybridize; production could be limited if adults can't reach best habitat.	Determine spawning distribution of various races.	Passage Objective 3
Spawning	3P-3Q	**Will measures taken to guard against false attraction be sufficient for attaining the conservation goals for target species by assuring fidelity of returning spawners to suitable habitat?**	t.b.c.	t.b.c.	t.b.c.	t.b.c.
Spawning	3G-3M	**Will there be measurable affects on the quantity, quality, and use of spawning and rearing habitat caused by the amount of fine sediment discharged from dam removal, road building and instream construction activities?**	Sediment movement is difficult to predict and problems could arise (e.g. pool filling, fine sediment infiltration of gravels). Mitigation requirements (e.g. waste discharge permit will likely require excavation of stored sediment, erosion control, and construction timing) and small volume of sediment affected (5,000 cu. yd. on North Fork and 58,000 cu. yd. on South Fork) will likely minimize duration and magnitude of effects. Excavated sediments will be placed on high-flow terraces.	Affect estimates of carrying capacity and juvenile production during initial years post construction.	Assess sediment dynamics and associated channel morphological responses; validate existing fractional sediment routing models.	Focused Study
Spawning	3M-3Q	**How will post-project spawning success and egg survival be affected by increased quantity, quality, and use of spawning habitat?**	t.b.c.	t.b.c.	t.b.c.	t.b.c.
Spawning	2G	**Uncertainties are inherent in the estimate of the amount of available spawning habitat. These surveys were done at flows of 3 and 5 cfs by visual estimation of wetted perimeter at an unspecified higher flow (Kondolf 1989). Also, gravel mining at Inskip Reservoir was practiced at the time of the survey.**	Update estimate of spawning habitat under the initial flow regime after the course sediment delivered from dam removals reaches equilibrium in the system.	t.b.c.	t.b.c.	t.b.c.

ATTACHMENT C-1

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Factor	Model and Node	Uncertainty (Key uncertainties in **bold**)	Rationale	Implication of Uncertainty	Activity to Address Uncertainty	Objective/ Study
Spawning	2H	**Uncertainties inherent in estimates of redd area and utilization of available spawning habitat.**	Estimates of redd area, including defense area, were derived from studies of other Central Valley stocks.	Affect estimates of carrying capacity and juvenile production.	Carcass and redd distribution surveys; update estimates of redd area using Contemporary information; juvenile production estimates.	Population Objectives 1,2, and 3
Spawning	2H	**Uncertainties inherent in estimates of spawner to fry survival and in estimates of number of fry produced per WUA.**	Estimates were based upon upper Sacramento River studies in 1980's and prior (Hallock 1986).	t.b.c.	Update using Contemporary information available from reference populations.	Focused Study
Spawning	2H	**Uncertainties inherent in estimates of spawner to juvenile in estimates of number of juveniles produced per WUA.**	Estimates were based upon upper Sacramento River studies in 1980's and prior (Hallock 1986).	t.b.c.	Update using Contemporary information available from reference populations	Focused Study
Spawning	2H	Uncertainties inherent in estimates of female fecundity.	Deviation from literature predictions likely to be small and have small affect.	t.b.c.	t.b.c.	t.b.c.
Spawning	3D-3Q	**Will stabilized instream flows increase spawning success, egg survival, fry production and juvenile production by reducing stranding or redd dewatering**?	t.b.c.	t.b.c.	t.b.c.	t.b.c.
Rearing	3J-3N	**How will the quantity, quality, and use of rearing habitat be affected by decreased water temperatures in warm season?**	t.b.c.	t.b.c.	t.b.c.	t.b.c.
Rearing	3K-3N	**How will the quantity, quality, and use of rearing habitat be affected by increased wetted area and volume?**	t.b.c.	t.b.c.	t.b.c.	t.b.c.
Rearing	3K-3O	Food production, predation risk, growth, competition, disease, and other factors of natural mortality	t.b.c.	t.b.c.	t.b.c.	t.b.c.
Rearing	3K-3O	Do changes in natural mortality factors occur in response to increased wetted area and volume?	Not key because, if assumptions of ecosystem function hold true, these factors likely to improve with restoration of ecosystem process and therefore are unlikely to affect the success of Restoration Project. Measures of these factors generally are insufficiently powerful to help distinguish between alternative responses.	t.b.c.	t.b.c.	t.b.c.

ATTACHMENT C-1

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Factor	Model and Node	Uncertainty (Key uncertainties in **bold**)	Rationale	Implication of Uncertainty	Activity to Address Uncertainty	Objective/ Study
Stranding	3D-3Q	Will ramping rates initiated at designated threshold flows be sufficient to prevent significant stranding and isolation of juvenile salmon and steelhead in each of the forks?	Threshold flow was determined at the site most susceptible to stranding in the entire Project Area; conservative methodology was used for determining ramping rates; ramping will only occur infrequent as this hydroelectric project is not a peaking project	Biologically significant salmon or steelhead stranding or isolation could occur.	Collect evidence of fish stranding during the course of other monitoring studies.	Habitat Objective 4
Physical Habitat	3B-3G	What will be the long-term effects of dam decommissioning on channel stability?	Not key because dams are built on stable bedrock; any channel responses are unlikely to be large enough to have a measurable effect.	t.b.c.	Assess sediment dynamics and associated channel morphological responses; validate existing fractional sediment routing models.	Focused Study
Physical Habitat	3B-3H	Will upstream/downstream fish passage at former dam sites meet the level of unimpaired passage expected under the Restoration Project for fail-safe fish ladders?		t.b.c.	t.b.c.	Passage Objective 3
Physical Habitat	3D-3L	Will new instream flows increase the extent of the hyporheic zone thereby increasing riparian habitat?	Expected changes unlikely to affect success of Restoration Project and not a powerful metric for distinguishing between alternative responses. Monitoring needed for assessing mitigation for construction impacts to riparian.	t.b.c.	t.b.c.	t.b.c.
Physical Habitat	2A	**Uncertainties are inherent in the IFIM and PHABSIM models (Instream Flow Council (2002 and Castleberry 1996) including: 1) sampling and measurement problems associated with representing 42 miles of stream; 2) sampling and measurement problems associated with developing habitat suitability curves; and 3) problems with assigning biological meaning to weighted usable area; especially without presenting confidence intervals.**	This uncertainty is addressed in the annotated outline section on adaptive management per Castleberry (1996) consistent with the terms in the MOU and resources in the CalFed Environmental Program. The AMP expires in 2026 when the flow schedules may be subjected to revision at the time of relicensing. Analysis of alternative flow regimes and negotiations in preparation of the re-licensing activity may begin as soon as 15 years after the Restoration Project's currently scheduled completion date.	t.b.c.	t.b.c.	t.b.c.
Physical Habitat	2A	**Habitat suitability criteria curves developed in 1989 in TRPA 1998a, which were based on studies outside of the Restoration Project Area and were applied to the three species targeted by the Restoration Project, may not be completely appropriate to each of the target species.**	t.b.c.	t.b.c.	Collect habitat suitability data from reference populations	Focused study

ATTACHMENT C-1

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Factor	Model and Node	Uncertainty (Key uncertainties in **bold**)	Rationale	Implication of Uncertainty	Activity to Address Uncertainty	Objective/ Study
Physical Habitat	2A	Predicted affects of instream flow on the physical characteristics of wetted area, depth, velocity, and cover may not adequately characterize the actual conditions in the 42 miles of habitat	Not key because the physical relationships between increase flow and changes in depth and velocity (if not cover) are generally accepted and robust (e.g. Leopold, Wolman, and Miller 1992).	t.b.c.	Compare methodology used in 1989 with current methodology to gauge uncertainty	t.b.c.
Physical Habitat	2I	Did Restoration Project instream flows achieve a proper balance between the competing needs of various life-stage/species combinations?	Not key because "conservative, resource-protective interim flow standards" were used to set flow levels per (Castleberry et al. 1996) if other assumptions hold true.	t.b.c.	t.b.c.	t.b.c.
Physical Habitat	2I	Was the target of achieving 95 percent of maximum WUA appropriate for the adaptive management approach?	Not key because "conservative, resource-protective interim flow standards" were used to set flow levels per (Castleberry et al. 1996) if other assumptions hold true; Restoration Project flows can be viewed as "experimental" in that they may only be in place between 2006 (expected completion date of Restoration Project) and 2026 (when the FERC license is renewed and new flow regime may be implemented).	t.b.c.	t.b.c.	t.b.c.
Physical Habitat	2I	Daily flows and unusually high flows are believed to be the major flow-related factors limiting production..	Not key, if assumptions of ecosystem function hold true. Unlikely to affect success of Restoration Project because fish populations have evolved to accommodate the natural flow regime. Only daily flows can be controlled below dams. Unusually high flows events are natural, uncontrollable events which may impact fish production by scouring redds or limiting rearing habitat.	Unusually high flows events are natural, uncontrollable events which may impact fish production by scouring redds or limiting rearing habitat.	If anticipated production levels are not observed, then examine hydrograph for unusually high runoff events with possible deleterious effects.	Population Objective 1
Physical Habitat	2I	Catastrophic effects of floods on available fish habitat and fish populations cannot be anticipated or controlled.	Project success is measured over multi-year scale to account for annual variation in production.	Year classes could be lost or long-term habitat impacts could occur.	Compare with reference streams to estimate the magnitude of effect.	Population Objective 1
Physical Habitat	2I	What hydrologic affect does the hydroelectric project have on channel forming processes?	The affect is probably not measurable because the project does not include enough storage to effect seasonal changes in the hydrograph and because channel forming flows are much greater than the diversion capacity of the project.	t.b.c.	t.b.c.	t.b.c.
Physical Habitat	2A	Estimated instream flow requirements Baldwin Creek below Asbury Dam were based upon simple visual observations of wetted perimeter and release of spring water for coldwater refugia without development in a formal study.	Not key because the amount of habitat is extremely small (0.75 miles) relative to the overall project.	Minor affect on steelhead production.	Possible experimentation.	none

ATTACHMENT C-1

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Factor	Model and Node	Uncertainty (Key uncertainties in **bold**)	Rationale	Implication of Uncertainty	Activity to Address Uncertainty	Objective/ Study
Physical Habitat	2I	Are Keswick Reach inflows and accretion adequate to provide predicted WUA in lower Keswick reach?	Limited habitat in this reach unlikely to affect success of Restoration Project on steelhead or chinook restoration.	Minor affect on steelhead production	none	none
Physical Habitat	2L	**Does this model adequately predict available flow and diversion capacity for both instream and hydro uses under different water year types?**	Viable hydroelectric project success criteria may not be met due to this uncertainty.	t.b.c.	post project flow monitoring will be used to validate models	t.b.c.
Physical Habitat	2L	**Effects of possible climate change on hydrology**	Currently not predictable.	t.b.c.	Hydrology will be monitored throughout the region.	t.b.c.
Water Temp.	2J	**Uncertainties are inherent in SNTEMP model which averages temperatures by reach and over monthly time periods (e.g. *list the typical limitations and assumptions*).**	t.b.c.	Estimates of carrying capacity may be confounded.	Temperature monitoring on key reaches.	Habitat Objective 2
Water Temp.	2J	**Uncertainties are inherent Tu's (2001) application of the SNTEMP model in Battle Creek (e.g. is Redding climate data applicable to Battle Creek? What are the effects of canals on thermal gain?)**	t.b.c.	Estimates of carrying capacity may be confounded.	Temperature monitoring on key reaches.	Habitat Objective 2
Water Temp.	3D-3J	**Will post project instream flow releases result in predicted water temperatures targets in warm season?**	t.b.c.	t.b.c.	t.b.c.	Habitat Objective 2
Water Temp.	3E-3J	**Will post project release of cold spring water result in predicted water temperatures targets in warm season?**	t.b.c.	t.b.c.	t.b.c.	Habitat Objective 2
Water Temp.	3E-3J	**How are cooling affects of spring releases spatially distributed within stream network?**	t.b.c.	t.b.c.	t.b.c.	Focused Study
Water Temp.	3E-3J, 2C	**Are there microhabitat benefits (thermal refugia) that could result from spring releases that were overlooked by reach-scale SNTEMP model?**	t.b.c.	t.b.c.	t.b.c.	Focused Study
Water Temp.	3Q, 3N	**How will spawning success and egg survival be affected by water temperature regime in warm season?**	Compare observed to predicted temperature regime. Calculate predicted embryo survival based on the temperature regime.	Estimates of carrying capacity may be confounded.	Temperature monitoring on key reaches.	Habitat Objective 2
Water Temp.	3J-3Q, 2C	**How will juvenile production (growth, survival, distribution) be affected by water temperature regime in warm season?**	t.b.c.	t.b.c.	t.b.c.	t.b.c.

ATTACHMENT C-1

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Water Temp.	2C	Are literature-derived thermal suitability criteria applicable to Battle Creek fish?	Not key because literature is robust and was developed for the same stocks of fish likely to colonize this stream from nearby habitats.	Estimates of carrying capacity may be confounded.	Consider focused studies based on Contemporary information from reference populations	Habitat Objective 2
Population Dynamics	2H	**IFIM results (WUA curves) cannot be confidently converted to estimates of fish production without validating the 1989 IFIM model for Battle Creek salmon and steelhead (e.g. establishing confidence limits and examining transects for significant changes in channel morphology and applying more appropriate habitat suitability curves, etc).**	Efforts may include, 1) post project reconnaissance level survey of PHABSIM transects to examine changes in channel morphology over the last 20 years, 2) compare the habitat suitability curves used in the IFIM study to those currently available for target species for current applicability	t.b.c.	Establish validity of the model	t.b.c.
Population Dynamics	3Q-3R	**Will fry and juvenile production be improved by increased spawning success and egg survival?**	t.b.c.	t.b.c.	t.b.c.	t.b.c.
Population Dynamics	3N-3R	**Will fry and juvenile production be improved by increased usable rearing habitat?**	t.b.c.	t.b.c.	t.b.c.	t.b.c.
Population Dynamics	3O-3R	Will fry and juvenile production be improved by improvements in natural mortality factors?	Not key because, if assumptions of ecosystem function hold true, these factors are likely to improve with restoration of ecosystem process and therefore are unlikely to affect the success of Restoration Project. Measures of these factors generally are insufficiently powerful to help distinguish between alternative responses.	t.b.c.	t.b.c.	t.b.c.
Population Dynamics	3S-3R	Will fry and juvenile production be improved by improvements in riparian habitat?	Not key because unlikely to affect success of Restoration Project and not a powerful metric for distinguishing between alternative responses	t.b.c.	t.b.c.	t.b.c.
Population Dynamics	3R-3T	**Will the number of surviving outmigrant steelhead and chinook salmon increase by improvements in fry and juvenile production?**	t.b.c.	t.b.c.	t.b.c.	t.b.c.
Population Dynamics	3M	**Will there be density-dependent competition relating to spatial and temporal overlap of different races of chinook salmon?**	t.b.c.	t.b.c.	t.b.c.	t.b.c.
Population Dynamics	3T	**Will the estimated number of outmigrant salmon be within the range of what is predicted from the estimated number of spawners based upon the commonly accepted survival rates from spawning to outmigration?**	t.b.c.	t.b.c.	t.b.c.	t.b.c.

ATTACHMENT C-1

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Factor	Model and Node	Uncertainty (Key uncertainties in **bold**)	Rationale	Implication of Uncertainty	Activity to Address Uncertainty	Objective/ Study
Population Dynamics	3U	The scientific definition of genetically viable populations levels is tentative or vague.	Not key because the best available science suggests that sufficient habitat exists to support even the most conservative genetically viable population levels. Viable population levels are likely to be low enough to not influence the success of project. The science used to generate actual estimates of genetically viable populations levels is sufficiently vague to not be helpful in distinguishing between alternative responses.	Achievement of numerical targets may not mean that genetic considerations have been met.	Encourage Technical Review Team to complete research into viable population levels for Battle Creek.	none
Population Dynamics	3U	**Will variability in adult population levels correlate with outmigrant abundance?**	t.b.c.	Limiting factors not addressed by Restoration Project could impede population growth.	Compare population growth with Reference Streams	Population Objectives 2 and 3
Population Dynamics	3V	**What is the carrying capacity of Battle Creek for each salmonid stock?**	Unknown carrying capacity confounds measure of success.	t.b.c.	t.b.c.	Population Objectives 3
Population Dynamics	3V	**How will carrying capacity estimates vary over time?**	Unknown carrying capacity confounds measure of success.	t.b.c.	t.b.c.	Population Objectives 3
Population Dynamics	3V	**How can we tell when fish populations are fully utilizing carrying capacity?**	Unknown carrying capacity confounds measure of success.	t.b.c.	t.b.c.	Population Objectives 3
Population Dynamics	n.a.	What will be the response of the fish community structure (including non-salmonids) within Battle Creek as a result of project implementation?	The AMPT proposes this study in light of the recognition that other ecosystem values may be affected, beyond salmonids and beyond other fish populations. This proposed study of changes in fish community structure is an attempt to balance between a narrow focus on salmonids and the broader suite of ecosystem implications not already covered in Linkages.	Other ecosystem values may be affected	Study changes in distribution of fish before and after Restoration Project implementation	Focused Study

ATTACHMENT C-1

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Project success is measured in economic as well as biological terms. This table attempts to capture economic uncertainties that exist within the Restoration Project. However, the reader should recognize that the this table was prepared by biologists who may be unqualified to perform detailed economic analyses.						
Economics	2L	**Are diversions that are not decommissioned going to be economically viable?**	Viable hydroelectric project success criteria may not be met due to this uncertainty	Future decision-making may need to consider cost-effectiveness.	Licensee to monitor economic viability.	none
Economics	2L	**Are upgrades to dams that are not decommissioned cost effective?**	Not related to a measure of Restoration Project success though may be useful in distinguishing between alternative responses.	Future decision-making may need to consider cost-effectiveness.	AMP/MOU/FERC protocols shape decision making process related to possible future dam modifications	none
Economics	2L	**Prediction of future climate as it affects hydrology and hydro production with Restoration Project**	Viable hydroelectric project success criteria may not be met due to this uncertainty	Future decision-making may need to consider cost-effectiveness.	Hydrology will be monitored throughout the region	none
Economics	2L	**Prediction of future price structures for electric energy with Restoration Project**	Viable hydroelectric project success criteria may not be met due to this uncertainty	Future decision-making may need to consider cost-effectiveness.	Licensee to monitor economic viability.	none
Economics	3D-3Q	Will ramping rates achieve the best compromise between stranding and economics?	Not key because ramping is so infrequent that it is not a significant economic driver of the Battle Creek Hydroelectric Project.	Overly conservative ramping rates could reduce hydroelectric project generation.	none planned	Habitat Objective 4

Stillwater Sciences

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MEMORANDUM

DATE: January 9, 2003

FROM: Peter Downs and Jay Stallman

SUBJECT: Battle Creek Adaptive Management Sediment Monitoring Plan: draft

Background

The U.S. Department of the Interior Bureau of Reclamation and the California State Water Resources Control Board have submitted the Battle Creek Salmon and Steelhead Restoration Project (Restoration Project). The Restoration Project has the goal of restoring and enhancing about 42 miles of anadromous fish habitat in Battle Creek and an additional 6 miles of habitat on its tributaries, while minimizing the loss of renewable energy produced by the Battle Creek Hydroelectric Project (Federal Energy Regulatory Commission Project No. 1121). The Restoration Project preferred alternative as described in the EIR/EIS involves removal of five dams and appurtenant facilities, installation of fish screens and ladders, installation of stream gages, and changes to instream flows (Jones and Stokes 2003).

The Restoration Project includes an important adaptive management component to monitor the effectiveness of restoration actions and make additional adjustments to the Hydroelectric Project facilities and/or operations as needed (Kier Associates 2001). A Technical Review Panel (Panel), formed by the Calfed Bay-Delta Program, provided a comprehensive evaluation of the Restoration Project preferred alternative as described in the EIR/EIS. The Panel recommended increased emphasis on monitoring in the Battle Creek Restoration Project in order to: "1) identify deficiencies or critical actions for adaptive management; 2) document the degree of success of the project; or 3) identify key responses or relationships for planning and implementing similar projects throughout the region" (Borcalli et al. 2003, p. 21). The Panel specifically noted that no funds or measurements were provided for the monitoring of sediment movement at dam removal sites.

The Project Management Team for the Restoration Project agreed with the Panel's recommendations to monitor sediment dynamics following removal of the Coleman and South Fork Diversion Dams on the South Fork. Monitoring of sediment dynamics following removal of the Wildcat Diversion Dam, Lower Riply Creek and Soap Creek Feeder Diversion Dams however, was not considered critical due to the small amount of stored sediment and steep channel gradients. The Project Management Team's recommendations were largely in response to a sediment impact analysis and numerical model study conducted by the Bureau of Reclamation that focused on the downstream effects of removing the three largest dams (South, Coleman, and Wilcat diversion dams) on bed material size, sediment load, and stream hydraulics (Greimann 2001). The Bureau's study concluded that the majority of sediment will be removed from storage during the first year, if dam removal is followed by normal or wet years but may take longer if dam removal is followed by dry years.

Key Uncertainties and Learning Opportunities from dam removal

While removal options are currently being evaluated for many dams, far fewer have actually been removed and fewer still with potentially significant stores of coarse sediment. As such, there has been little opportunity to study how channels responds to dam removal and the associated uncertainty in our knowledge is high. Contemporary understanding has, in fact, often been based on investigations of the after effects of other disturbances that result in large amounts of sediment being injected rapidly into the channel, such as landslides, debris flows etc. As such, there is a potential to learn significantly from these dam removals.

The removal of these diversion dams will release sediment stored in the existing impoundments to downstream reaches, potentially causing changes in upstream and downstream channel morphology, hydraulics, and bed surface texture. The sediment transport characteristics - including the size distribution, spatial distribution, and residence time of sediment released to downstream reaches - will partially determine success or failure of salmonid habitat restoration efforts over the short term and may require remedial management actions as part of an adaptive management program over the long term.

The current demand for cost-efficient dam removal strategies that minimize environmental impacts requires resolution of several key uncertainties related to the evolution of a reservoir deposit and downstream channel reaches following sediment release. These uncertainties have direct implications for the short- and long-term success of the Battle Creek Restoration Project. Accurate prediction of sediment dynamics in rough, steep-gradient streams such as North Fork and South Fork Battle Creek, for example, is difficult using existing fractional sediment routing models due to extreme variability in hydraulic conditions and bedload transport rates. Resolution of these key uncertainties therefore, requires an approach structured in empirical testing of predictive conceptual and numerical models. This approach has the greatest potential to produce transferable information about fundamental fluvial geomorphic processes, if these dam removal projects are monitored appropriately. Monitoring of coarse and fine sediment downstream of proposed dam removal sites in the Battle Creek basin is therefore proposed to:

- assess sediment dynamics and associated channel morphological responses in a rough, steep-gradient channel;
- develop new or calibrate existing fractional sediment routing models;
- provide information to evaluate the performance of dam removals relative to habitat improvements in the Battle Creek basin,
- assess the need for adaptive management responses to changing physical conditions and;
- add to our general understanding of sediment dynamics following dam removal.

The sediment monitoring component of the adaptive management plan addresses two main areas of uncertainty:

1) *Process-form linkages.* Better conceptual models of sediment transport dynamics and channel morphological response following dam removal are needed. Removal of Wildcat Diversion dam, South Diversion dam, and Coleman Diversion dam on Battle Creek provide an opportunity to develop and test conceptual models of heterogeneous sediment release in a rough, steep-gradient channel setting. Empirical results will:
    a. test current conceptual models of channel morphological change following dam removal;

  b. contribute to the formulation and calibration of sediment transport models applicable to removal of individual dams in Battle Creek; information that can be used conjunctively with flume experiments to reduce the uncertainty in our predictive capabilities following dam removal;
  c. examine the cumulative impact of multiple dam removals, for which there is currently very little information.

2) *Form-habitat linkages.* Little is known about the spatial and temporal habitat response to sediment dynamics following dam removal. Aquatic habitat may respond through:

  a. short-term changes in the quantity of habitat in response to deposition and erosion during large bed-mobilizing flows that redistribute formerly impounded coarse sediment;
  b. short-term changes in the textural quality (i.e., grain size distribution) of spawning habitats in response to selective fine sediment transport during lower flows;
  c. Long-term evolution of the quantity and quality of spawning, rearing, and holding habitats as the formerly impounded sediments redistribute downstream during different water year types.

Uncertainties related to *habitat-biology* (e.g., population response to altered habitat conditions) and *intra-biology* linkages (e.g., biotic interactions such as predation or competition) are dealt with elsewhere in the Adaptive Management Plan.

Conceptual model

Hypotheses for process-form and form-habitat changes following dam removal are based on geomorphic system understanding developed from existing conceptual models. Conceptual models have only recently been developed for dam removal and, in a recent review of the effects of dam removal on river form and process, Pizzuto (2002) states that "our greatest need is to improve the ability to develop and test conceptual models that will indicate relevant processes controlling the evolution of the river following dam removal" (p.689). Currently, conceptual understanding is based on models developed to illustrate channel form and process changes caused by channel incision following straightening (Doyle et al. 2002, 2003; Wooster 2002). However, these models are probably most appropriate in fine-grained or sand-gravel based environments. Dam removals in Battle Creek offer the prospect of refining the existing models for coarse (Coleman) and very coarse heterogeneous sediments (South Diversion) where transport of stored sediment is more event-driven by flows exceeding a particular magnitude than process-driven immediately following dam removal (Pizzuto 2002; Stillwater Sciences 2002). Sediment transport scenarios modeled for Battle Creek under different flow-year types (Greimann 2001) corroborate the prospect of event-driven basis channel evolution.

Previous studies on sediment waves or pulses indicate that a pile of coarse grained sediment in a river evolves by dispersion rather than translation (e.g., Lisle et al. 1997, 2001; Cui et al. 2003a,b; Cui and Parker, in press). Numerical studies on dam removal in steep gradient rivers indicate that, in addition to the general dispersive behavior, sediment deposition downstream of the dam occurs only at reaches of low sediment transport capacity (e.g., Stillwater Sciences, 2000; Cui and Wilcox, in press; Cui et al. in press [a,b]). We believe the depositional characteristics following the removal of the dams on the Battle Creek will be similar. Due to the small amount of sediment in the reservoirs, however, the deposition will be in a much small scale and amplitude, and the deposition will most likely be in the existing pools.

The conceptual model for sediment response following dam removal on Battle Creek (Figure 1) is, therefore, driven by the increase in slope at the face of the stored sediment wedge following dam removal. Sediment is eroded from the face of the stored sediment (either on a ‘process’ or ‘event’ driven basis) causing incision by knickpoint propagation and channel formation through and potentially upstream of the stored sediment. The eroded sediment will aggrade downstream of the former dam site with finer sediments initially transported further downstream. These effects may result in reduced pool volume, fining of gravel substrates, and increased aerial extent of gravel bars. The dynamics of aggradation will depend on whether the released sediment acts as a stationary store of material that disperses over greater and greater distance through time or a translating pulse of material with limited attenuation downstream (more likely in fine-grained sediments). It is possible that habitat-related impact will depend on which of these modes of transport dominates: translation will create significant short-term habitat changes as the sediment pulse passes, whereas dispersal may cause a less substantial but longer lasting impact due to longer sediment residence time. In steep-gradient channels, downstream sediment deposition will not be evenly distributed and may be confined to pools, the lee of boulder and bedrock flow obstructions, bars forced by planform curvature, lower-gradient channel segments, and floodplain surfaces. Some component of the finer fraction of coarse-grained sediments will deposit in pools following flow events. The length of time require to reach an equilibrium channel condition (if applicable) is a function of the sediment grain size distribution, stored sediment volume available for transport, channel gradient, and frequency of bed-mobilizing flow events. Both the form of the equilibrium channel condition and the time required to reach equilibrium following sediment release are unknown. The downstream extend and duration of the ‘short-term’ impact of sediment release on aquatic habitat is similarly unknown.

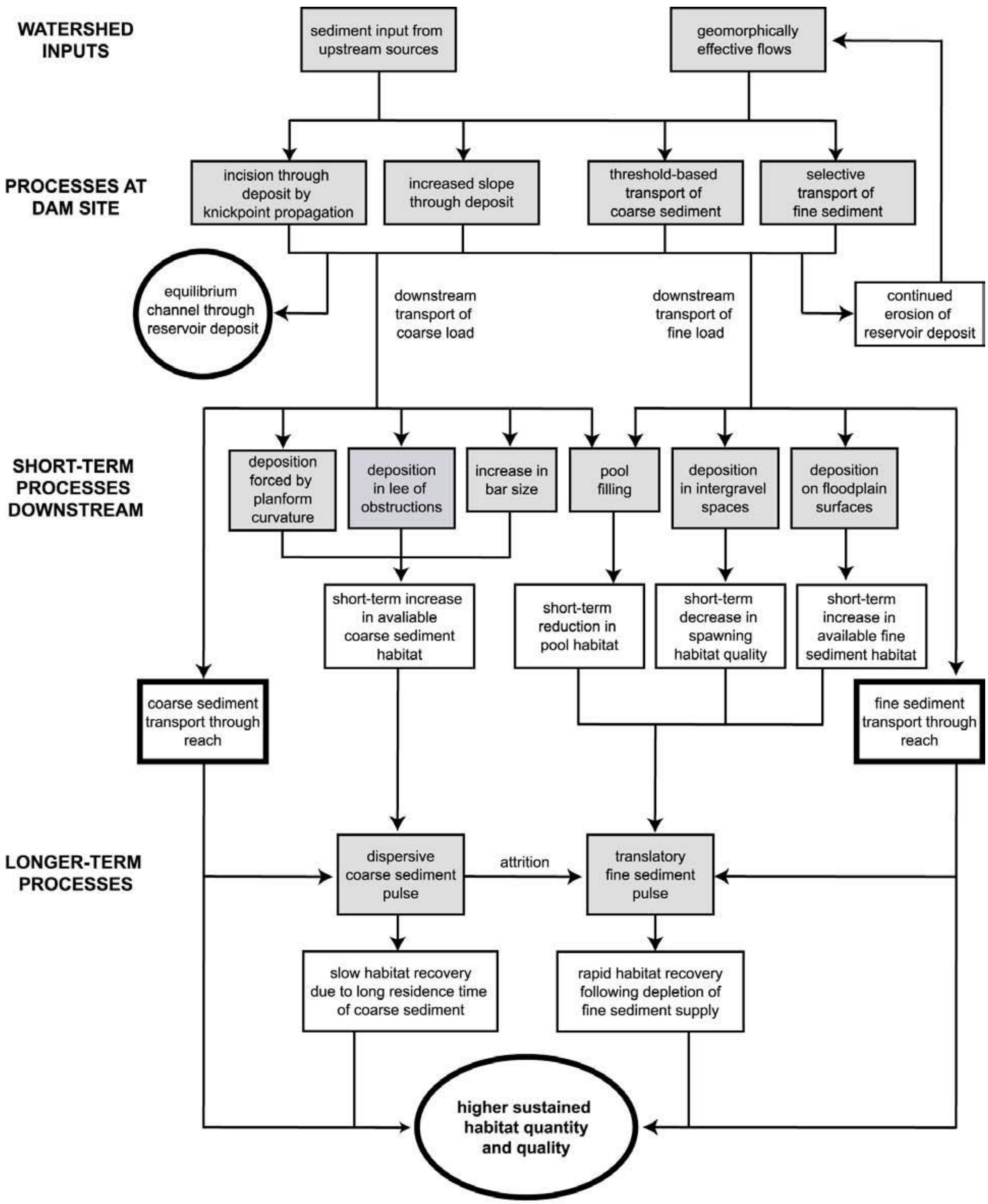

Figure 1. Conceptual model of channel response following dam removal in Battle Creek.

Hypotheses

Sediment transport dynamics: process – form linkages

1) Following dam removal, the downstream release of coarse sediments occurs primarily by dispersal (e.g. as predicted by Lisle et al. 2001) rather than by translation and progressive downstream attenuation. As such, a significant volume of sediment will be deposited as it disperses across the existing scour pool, and the effect will become undetectable a relatively short distance downstream due to attenuation and attrition of coarse sediment particles (e.g. Cui and Parker, in press).

2) Because of the relatively small amount of sediment, the evolution of the channel thalweg following dam removal may not match the predictions made by previous sediment transport modeling. This is especially true given that the estimated deposition will be mostly in existing pools, and numerical models do not have the mechanisms to reproduce the detailed features such as pool-riffle sequences, alternate bars (e.g., Cui and Wilcox, in press). However, the general trend, time needed to flush the sediment downstream and general magnitude of deposition, however, should be similar to model predictions.

3) The significant distance between the South Diversion and Coleman dams, the small amount of fine material stored in South Diversion and Wildcat dams, and the continuing existence of the Inskip Diversion will not result in cumulative sediment impacts from removal of multiple dams.

4) Following significant flows after dam removal, the downstream deposition of sediment released from the reservoir deposit will act primarily to (i) fill pools, (ii) enlarge and fine existing point bars in alluvial channel reaches (e.g., Coleman reach) , and (iii) deposit in backwaters and locations with hydraulic flow separation in reaches controlled by large boulder and bedrock obstruction (e.g. at channel margins and around large roughness elements in the South Diversion reach);

Channel habitat evolution: form – habitat linkages

5) Following dam removal, there will be negligible short-term effect on pool habitat downstream of the South Diversion because of the small amount of fine sediment present, and because the majority of sediment will be deposited in channel margins;

6) Availability pool habitat downstream of the Coleman diversion will decrease in the short-term due to pool filling by sand until the upstream ‘excess’ supply of sand from the reservoir deposit is exhausted;

7) Removal will cause the volume of material stored in point bars and channel margins to increase and fine, facilitating encroachment by pioneer vegetation;

8) In the long-term following dam removal, there will be a notable increase in the availability of potential spawning habitat (assessed by habitat models) within South and North Fork Battle Creek to support the project’s overall goals of creating a viable, self sustaining population of spring- and winter-run Chinook salmon.

Monitoring goals and objectives

The following goals and objectives form the framework for a monitoring program designed to test the hypotheses presented above:

1) Conduct field measurements necessary to describe sediment transport dynamics, aggradation, and degradation in response to sediment release following dam removal. Field surveys will be stratified so that greatest resolution is reserved for areas with the greatest potential for change

   a. Characterize channel morphology and grain size distribution in project-affected reaches preceding and following dam removal.

   b. Characterize sediment volume and grain size distribution in reservoir storage preceding and following dam removal.

   c. Evaluate the form of sediment pulse, if any, as it propagates through downstream channel reaches over time.

2) Conduct field surveys that facilitate comparison of channel thalweg evolution to the predicted one-dimensional model simulations and to other, simpler, analytical methods developed ahead of dam removal to assess whether in situations such as Battle Creek, sophisticated model scenarios are truly warranted.

3) Relate channel morphological response to habitat values.

   a. Assess short-term changes in the quality and quantity of fish habitat, and the distribution of habitat types such as pools and riffles to the initial sediment release;

   b. Assess longer-term changes in the quality and quantity of fish habitat, and the distribution of habitat types such as pools and riffles during the morphological response following sediment release;

   c. Relate measured and simulated changes in channel morphology, particle size distribution and velocity distribution to salmonid habitat restoration objectives set forth in the Battle Creek Salmon and Steelhead Restoration Project.

Monitoring Components

The approach outlined in this sediment monitoring plan can be resolved into four important geomorphic parameters, namely: 1) channel planform and surface mapping, 2) bed sediment volume and particle size surveys, 3) channel elevation surveys, and 4) sediment transport and model effectiveness evaluation. The following methods were developed to document sediment transport dynamics and channel morphology in a typical reach of Battle Creek with confined morphology, channel slopes from 0.0150 to 0.0250, and intermittent bedrock and large boulder controls. The methods, however, must be customized to each affected reach of Battle Creek in order to effectively detect and quantify changes in channel morphology and particle size distribution resulting from reservoir sediment release.

Monitoring should begin at least one complete water year prior to dam removal and should be tailored to management actions taken ahead of dam removal. Monitoring should be intensive during the first year following dam removal, during which time, discharge and sediment sampling should occur during each mobilizing event and surveys of channel morphology should occur after each event. Monitoring in subsequent years should be based on periodic surveys following flow events of specified magnitude capable of mobilizing the remaining deposits. Monitoring should continue until a determination is made that the majority of the sediment once stored behind the dams has been transported away from the dam sites and is no longer causing significant channel changes either downstream or upstream of the site of the former dam (although naturally occurring high flow events will continue to drive channel changes).

Channel Planform and Surface Mapping

- Low elevation aerial photography of the reservoir deposit and potentially affected upstream and downstream channel reaches should be taken prior to dam removal to provide a record of baseline planform characteristics and the distribution of bed surface facies. The survey should occur following construction of pilot channels prior to dam removal. The low elevation photography, taken from a helicopter or using a balloon camera, should be corrected based on survey of ground control points and combined into a spatially accurate mosaic of the potentially affected channel reaches. Potentially responsive areas should then be identified by combining aerial photography and field reconnaissance mapping of channel morphology, existing alluvial features, wetted channel width, and high flow channel connectivity using the corrected photographic mosaic. Potentially responsive sites are those areas where aggradation and degradation is most likely to occur in response to reservoir sediment release and may include pools, channel segments with alluvial morphology, major gravel/cobble bars forced by planform curvature or large roughness elements, and floodplain depositional surfaces. These are the sites that warrant detailed investigation following dam removal. Low elevation aerial photography should be repeated immediately following dam removal and following the first storm season to document changes in channel planform and facies composition.

Bed sediment volume and particle size surveys

- Bed surface facies composition should be mapped in the field onto the spatially corrected photographic mosaic. The facies mapping can then be used to 1) determine where textural changes have occurred in response to the sediment pulse, 2) quantify the areal extent of facies changes, and 3) identify where pebble counts and bulk sediment samples should be collected.
- Pebble counts and bulk samples should be collected from the reservoir deposits and from responsive sites in downstream channel reaches to calibrate facies mapping and quantify changes in subsurface grain size distribution.
- Sediment grab samples should also be collected from the surface of pool margins to characterize the particle size distribution of sediment filling pools.
- Sampling of the extent of potentially suitable spawning habitat locations and gravel permeability in potential spawning areas is anticipated to be encompassed as part of the *habitat-biology* monitoring components of this project, and compared to pre-dam removal surveys. Likewise, analysis of rearing and holding habitat is not encompassed under this monitoring plan.

Channel elevation surveys

- A thalweg longitudinal profile should be surveyed from the upstream limit of potentially affected channel upstream of the reservoir deposit to the downstream limit of potentially affected channel downstream of the dam site.
- Within the limits of the thalweg survey, cross-sections should be surveyed at periodic intervals. Where appropriate, the 27 cross sections surveyed as part of the sediment impact analysis

conducted by the U.S. Department of Interior Bureau of Reclamation (Greimann 2001) should be reoccupied for sediment monitoring and be supplemented by other sections in strategic locations. Sediment depth should be measured across each cross section (if fine enough to probe).

- Scour and fill of gravel bars in the vicinity of cross sections should be measured using scour chains and/or scour cores, while sediment infilling of pools should also be quantified by measuring the thickness of fine sediment mantling the armored pool bed, similar to the methods described by Hilton and Lisle (1993) and the Sierra National Forest (USFS 1997).
- Detailed total station topographic surveys of the bed surface should be conducted at the potentially responsive sites identified using the low elevation aerial photography. Topographic surveys should commence prior to dam removal, be repeated immediately following dam removal and then again following bed-mobilizing floods during the first year after dam removal. If dam removal is followed by a dry year, topographic surveys need only be repeated at the end of the winter storm season. Topographic surfaces can then be used to calculate bed elevation and volume changes over time. After the first year, periodic topographic surveys should be conducted following bed-mobilizing flows until such time that the impact of the sediment pulse appears to be negligible.

Sediment transport and model effectiveness evaluation

- Data should be collected to establish sediment transport rating curves and to estimate average unit sediment discharge and sediment transport rate in the affected reaches in order to compare predicted and observed deposition rates, and judge the effectiveness of various modeling scenarios. However, direct measurement of sediment transport during flood events near the dam removal sites is compromised by challenging access and potential safety considerations. It is proposed that sediment data collection concentrates on establishing reliable stage-discharge and sediment rating curves for the existing gauge network, especially at the CDEC gauges, recently installed at bridge locations. As such:
  - Flow velocity and depth should be measured at regular, closely-spaced intervals across each gauge site section over range of high flows to extend the range of reliable stage-discharge records available at these gauges;
  - Bedload samples and depth integrated suspended sediment samples should be collected during each high flow sampling episode as the basis for constructing sediment rating curves for each gauge. Installing suspended sediment sensors may be an advisable means of extending the suspended sediment records beyond the high flows if warranted by hypotheses related to habitat.

Prospect of adaptive management actions

The nature of the sediment monitoring task and the relatively small volume of coarse material stored behind the dams means that the prospect of passively adaptive actions being required in this task is minimal. Instances in which remedial actions may be required include:

- Surveying evidence indicates significant threat to infrastructure as a function of the morphological evolution of the river following dam removal (e.g. threat to county road bridge downstream of South Diversion) Corrective actions may involve excavation of accumulated sediment;
- Surveying evidence indicates a significant volume of fine sediment accumulating in pools which, due to the volume of fine sediment still to be released from upstream, could be a long-term effect with negative habitat implications. Corrective actions may involve vacuum removal of accumulated fine sediment.

- Surveying evidence indicates significant fish passage impediments in the former reservoir site due to the routing of baseflow around large sediments. Corrective actions may involve rearrangement of the sediments, or reducing their effect using other sediment if the material is too large to maneuver.

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